OMRON

Fleet Operations Workspace Core

User's Manual

I635-E-04

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This manual was originally written in English. Created in the United States of America

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Revision History

Revision code	Date	Revised Content
01	June, 2019	Original release
02	October, 2019	Corrected errors
03	March, 2020	Added information for Fleet Simulator.
04	June, 2020	Added HD-1500, EULA, and PrecisionDrive support.

Chapter 1: Introduction

The Fleet Operations Workspace Core (FLOW Core) is OMRON's solution for setting up, integrating and managing an autonomous mobile robot (AMR) fleet within a factory environment. FLOW Core provides the software tools to connect the autonomous mobile robot (AMR) fleet, the factory's manufacturing control solution, establish maps, define operational rules, and ensure safe, consistent operation on the factory floor.

This user's guide covers the basic procedures for installing and using the FLOW Core software to set up and manage your AMR fleet. Some advanced operating procedures are discussed in later chapters of the guide.

The following topics provide an introduction to the Fleet Operations Workspace Core.

1.1 Fleet Operations Workspace Core Overview

The Fleet Operations Workspace (FLOW) Core is a suite of mobile-robotics software applications for programming and operating a fleet of AMRs within a factory environment.

The FLOW Core software fully integrates OMRON's autonomous AMRs and fleet management appliances (EM2100) to provide complete AMR fleet solutions. It incorporates specific tools to simplify integration with factory equipment and material-movement solutions (MES and ERP Solutions - refer to Related Manuals on page 16).

> **NOTE:** While this manual focuses primarily on fleet applications, the tools, capabilities, and techniques explained here can be used by customers deploying single AMRs as well.

FLOW Core software releases are coordinated to update both the AMR platforms and the fleet management systems for optimal performance with every new release.

FLOW Core software is installed at the OMRON factory on every AMR that OMRON produces. These AMRs can operate on their own, but are most effectively used in fleets. To support fleet operations, an additional Fleet Manager appliance is necessary.

OMRON provides two Fleet Manager configurations based on its standard EM2100 appliance, providing customers the option to purchase a Secondary unit as a backup, if desired. See Configure Paired Appliances on page 28 for setting up pairedFleet Managers.

> **NOTE:** The EM2100 is also the platform on which the Fleet Simulator runs. Refer to the *Fleet Simulator User's Manual* for information on the Fleet Simulator.

Table 1-1. OMRON Fleet Managers

Appearance	Product Type	Product Name	Model
	EM2100 Platform	Primary Fleet Manager	20271-900
	EM2100 Platform	Secondary Fleet Manager	20271-901
	EM2100 Platform	Fleet Simulator	20271-903

1.2 How the Fleet Operations Workspace Components Work Together

The figure below is a basic system architecture (for a fleet of AMRs) and illustrates the inter-relationship between Fleet Operations Workspace Core's various applications.

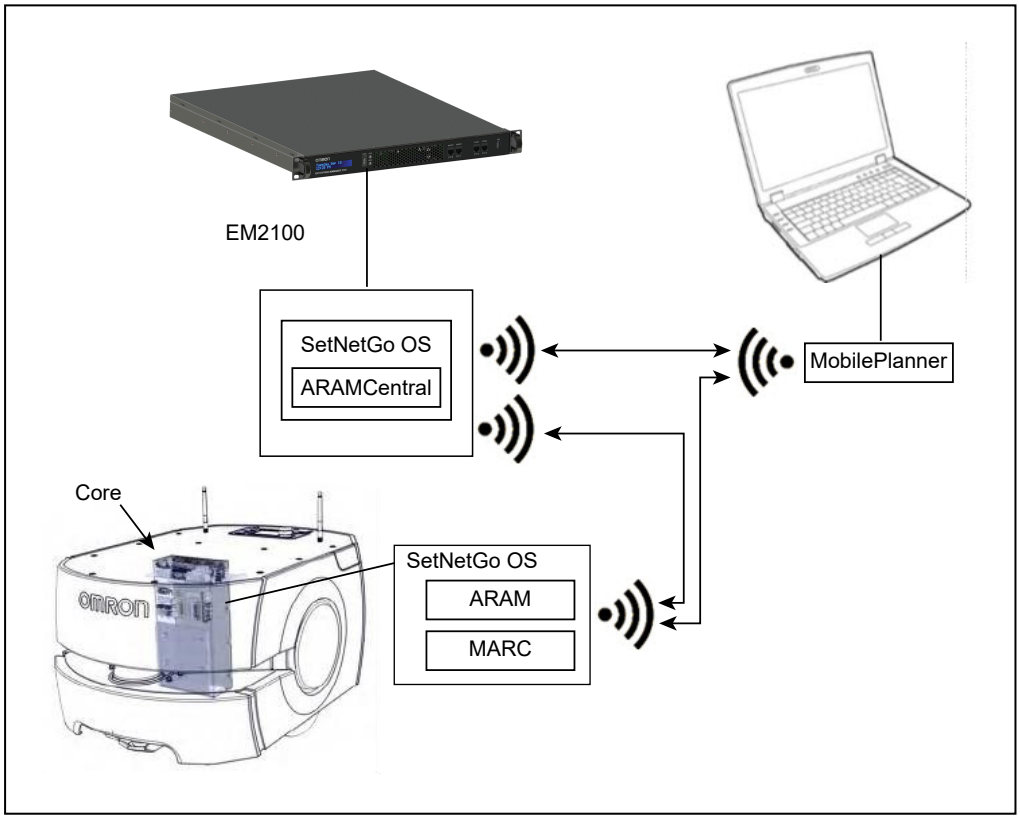


Figure 1-1. Components Working Together (LD-60 AMR Shown)

EM2100

The EM2100 is a network appliance, with built-in processor. It can be used to run the FLOW Core fleet management software or the Fleet Simulator software. As a Fleet Manager, the EM2100 coordinates the movement of up to 100 AMRs. It manages maps, AMR configurations, traffic control, and job queuing. FLOW Core licenses are activated on the Fleet Manager.

> **Version Information:** Fleet Simulator support was added in FLOW Core version 1.1.

MobilePlanner

MobilePlanner is the graphical user interface (GUI) for communicating with and configuring the AMR, and displaying and editing AMR map files. It is the "control center" of the Fleet Operations Workspace Core. Its user interface has the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, modifying AMR configurations, and more.

The AMRs use map files to determine where they are, plan navigable paths to goals, execute tasks at programmed goals, and to control other AMR tasks.

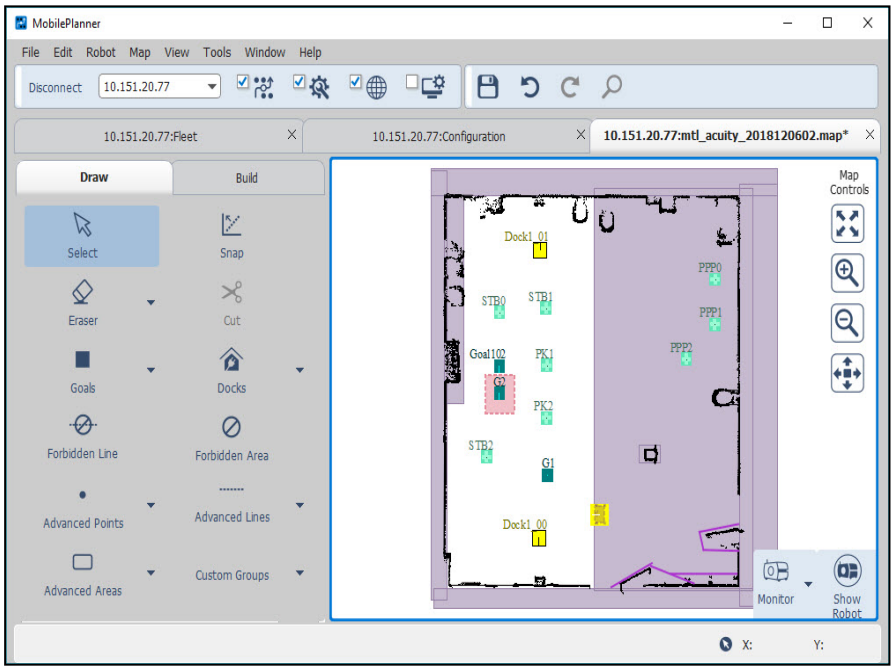


Figure 1-2. MobilePlanner Interface

From the MobilePlanner interface, you can:

- Connect to and drive the AMR.
- Create maps of the environment by importing and analyzing an AMR's scan data.
- Edit maps by adding goals (and adding tasks to those goals), docks, forbidden areas, and more. You can also erase stray or unwanted artifacts, combine pieces of maps, and

make other changes.

- Download and upload files, including maps and scan data, to and from an AMR.
- Set the system configuration parameters for the fleet.
- With the Fleet Manager, monitor the location and status of all AMRs in a fleet.
- View and interact with the job queuing manager.

For details, see MobilePlanner Interface on page 51.

MobilePlanner Accounts

User accounts with limited privileges provide the user with access to a limited set of tools for monitoring AMR and AMR job status, and allow for simple interventions in job execution sequences. For more information, see MobilePlanner Operator Account Overview on page 54.

SetNetGo

SetNetGo is the operating system that resides on AMRs and the EM2100 appliance. You can use the SetNetGo software to establish and configure your AMR's communication parameters, access diagnostic information (for example, download debug info file for service provider use, manage restore points, etc.), and perform software maintenance (upgrades). You most commonly access the SetNetGo interface through a tab in the MobilePlanner software, and then use that interface to enable the parameters needed.

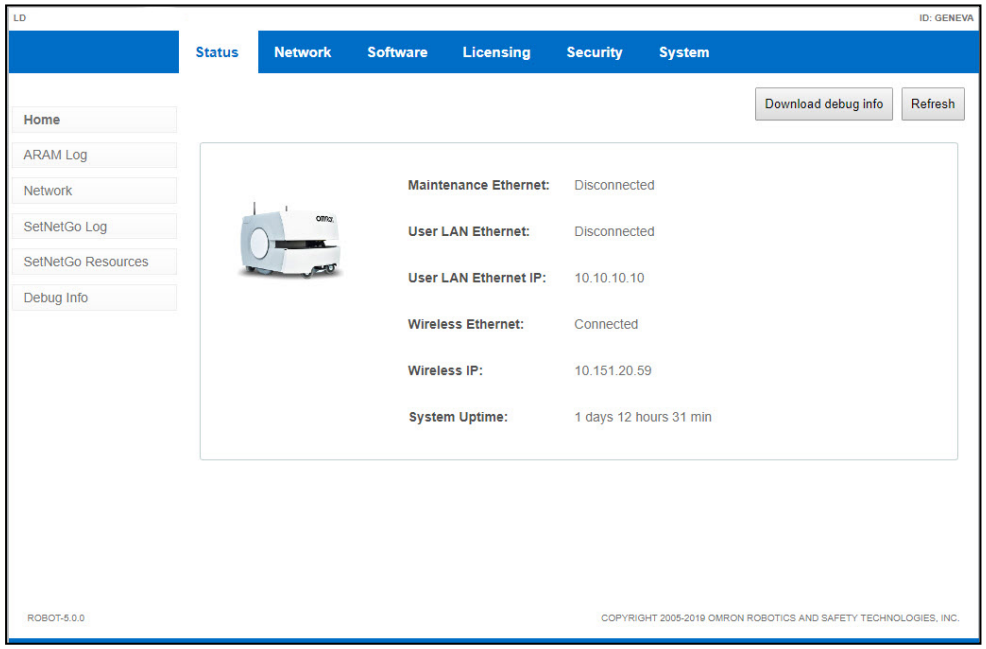


Figure 1-3. SetNetGo Interface

For details, see Overview of the SetNetGo OS on page 114.

NOTE: Optionally, you can connect to SetNetGo through a web browser. Refer to Connecting to SetNetGo via web browser on page 115.

ARAMCentral

As the fleet management software running on the EM2100 appliance, Advanced Robotics Automation Management (ARAMCentral) provides:

- Centralized configuration and map management.
- Job queuing and dispatch.
- Traffic management.
- Single-point of integration and communication for software clients and other automation equipment.

ARAM

The Advanced Robotics Automation Management (ARAM) software runs on the AMR's core, and does the following:

- Performs all the high-level, autonomous robotics functions, including obstacle avoidance, path planning, localization, and navigation, culminating in the AMR’s motion.
- Manages wired and wireless Ethernet communications with off-board software, for external monitoring, development, and systems coordination, including coordination of a fleet of AMRs through the Fleet Manager.
- Enables external monitoring and control with the MobilePlanner application.

MARC/Polo

Mobile Autonomous Robot Controller (MARC), which resides on the LD-series AMR core, manages the AMR’s speed and heading, sensor readings, emergency stop systems, bumpers, and pendant. It also computes and reports the AMR’s odometry readings (X, Y, and heading) and other low-level operations which it reports to ARAM.

Polo performs the same functions for the HD-1500 AMRs.

1.3 Fleet Operations Workspace Licensing

There are licensing options for both FLOW Core and advanced features. These licenses help customers manage the costs of their AMR fleets through lower, annual subscription payments for FLOW Core and activation of advanced features only if they provide benefits to your specific applications. The licenses currently available are listed in the following table. Contact your OMRON representative or Sales Office for pricing.

Table 1-2. Available Fleet Operations Workspace Licenses

Product	License Type	Product Description	Model
Primary Fleet Management	Subscription Operating License	License, 1 Yr Fleet Operations Workspace Core, Primary	20271-800
		License, 5 Yr Fleet Operations Workspace Core, Primary	20271-806
Secondary Fleet Management	Subscription Operating License	License, 1 Yr Fleet Operations Workspace Core, Secondary	20271-802
		License, 5 Yr Fleet Operations Workspace Core, Secondary	20271-807
Cell Alignment Positioning System (CAPS)	Perpetual Feature License	License, High Accuracy cell alignment feature for OMRON AMRs	20271-805
Fleet Simulator	Perpetual Feature License	License, Fleet Simulator	20271-804

All of these licenses are field-upgradable. Section 7.6 shows the steps required to acquire or update FLOW Core subscription, and Fleet Simulator and CAPS perpetual licenses.

1.4 How Can I Get Help?

For details on getting assistance with your OMRON software or hardware, you can access the corporate website:

http://www.ia.omron.com.

If you need help beyond what is covered in the manual, contact your OMRON representative.

Related Manuals

Manual	Description
Mobile Robot LD Safety Guide (Cat. No. I616)	Describes safety information for OMRON LD-series AMRs.
Mobile Robot HD Safety Guide (Cat. No. I647)	Describes safety information for OMRON HD-1500 AMRs.
LD Platform OEM User's Guide (Cat. No. I611)	Describes the installation, start-up, operation, and maintenance of the LD-60 and LD-90 AMRs.
LD-250 Platform User's Guide (Cat. No. I642)	Describes the installation, start-up, operation, and maintenance of the LD-250 AMR.
HD-1500 Platform User's Manual (Cat. No. I645)	Describes the installation, start-up, operation, and maintenance of the HD-1500 AMR
LD Platform Peripherals Guide (Cat. No. I613)	Covers peripherals for LD AMRs, such as the Touchscreen, Call/Door box, and Acuity Localization options.
Mobile Robots - HD Platform Peripherals Manual (Cat. No. I646)	Covers peripherals for HD AMRs, such as HAPS.
EM2100 Installation Guide (Cat. No. I634)	Describes the installation and initial configuration of an EM2100 appliance.
Fleet Operations Workspace Migration Guide (Cat. No. I636)	Describes the procedures for migrating your AMR from legacy to FLOW Core software, and from an EM1100 to an EM2100.
Fleet Operations Workspace Core Integration Toolkit User's Guide (Cat. No. I637)	Describes specific tools to simplify integration with factory equipment and material-movement solutions such as manufacturing execution systems (MES) and equipment resource planning (ERP) solutions.
Fleet Simulator User's Manual (Cat. No. I641)	Describes the operation of the Fleet Simulator.
Advanced Robotics Command Language Enterprise Manager Integration Guide (Cat. No. I618)	Describes the Advanced Robotics Command Language (ARCL) version for use with the EM2100 software. ARCL is a simple text-based command and response server used for integrating the Fleet Operations Workspace Core platform with an external automation system.

Chapter 2: Safety and Regulatory Information

2.1 Safety and Regulatory

OMRON LD AMRs adhere to the following domestic and international safety regulations:

- EN 1525 “Safety of Industrial Trucks. Driverless Trucks and their Systems”
- ANSI 56.5:2012 “Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles”
- JIS D 6802:1997 “Automated Guided Vehicle Systems - General Rules on the Safety”

OMRON's HD-1500 AMRs are evaluated to the following standards:

- EN ISO 10218-1
- UL 1740
- EN 60204-1
- EN ISO 13849-1

2.2 Warnings, Cautions, and Notes

Where needed, this user guide calls out critical, important, or emphasized text via special alert notifications. Below are explanations of the special alert notifications used in this manual:

WARNING: This indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or serious injury or death. Additionally, there may be significant property damage.

CAUTION: This indicates a situation which, if not avoided, could result in minor or moderate injury or in property damage.

IMPORTANT: Important indicates information that the user needs to know to use the system correctly.

NOTE: Notes provide supplementary information, emphasize a point or procedure, or give a tip for easier operation.

Version Information: This indicates information that only applies to certain versions of software or hardware.

2.3 General Safety Precautions

Read the installation and operation instructions, as well as the appropriate robot user's guide and robot safety guide before using the equipment.

- Do not ride on the AMR.
- Do not exceed the AMR's maximum weight limit.
- Limit operation to areas with no slope.
- Do not drop the AMR, run it off a ledge, or otherwise operate it in an irresponsible manner.
- Do not get the AMR wet, or expose the AMR to rain or moisture. The AMR has an IP rating of IP20.
- Do not use power extension cords with the docking station unless properly rated.
- Do not run the AMR if hair, yarn, string, or any other items are wound around the AMR's axles or wheels.
- Never access the AMR's interior with the charger attached. Immediately disconnect the battery after opening the battery compartment door.
- Never short the battery's terminals together.
- Do not use parts (including charging docks, etc.) not authorized by OMRON

2.4 Safety Commissioning

Safety standards require testing of the AMR's safety systems by a trained and qualified person, both before leaving the factory and again at the customer's site.

Safety commissioning is executed from the MobilePlanner main menu. Access and execute the safety commissioning procedure from MobilePlanner by selecting Robot > Safety Commissioning.

The safety commissioning procedure is guided by on-screen prompts. The instructions that you see will be based on the type of robot that you have connected. The procedures will test each E-Stop and Safety Laser on the AMR, as well as the E-Stop on the pendant. Details for running these procedures are given in each AMR user guide.

2.5 What to Do in an Emergency

Press the **E-Stop** button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use a type D extinguisher: foam, dry chemical, or CO_2.

2.6 Additional Safety Information

We provide more safety information in the following manual:

Mobile Robot LD Safety Guide (Cat. No. I616) and Mobile Robot HD Safety Guide (Cat. No. I647)

The *Mobile Robot LD Safety Guide (Cat. No. I616)* and *Mobile Robot HD Safety Guide (Cat. No. I647)* provide detailed information on safety for our AMRs. They also give resources for more

information on relevant standards. A safety guide ships with each AMR.

Chapter 3: Fleet Manager Configuration and Operation

The Fleet Manager capabilities within FLOW Core provide tools for programming and configuring individual AMRs and fleets, and for centralized job dispatch and real-time AMR monitoring within your facility.

3.1 EM2100 Configuration Overview

This section provides instructions for setting up and connecting the AMRs and Fleet Manager to a network.

OMRON's EM2100 appliance provides the operating environment for the FLOW Core software. It will be the primary interface device to the network and any PC(s) running MobilePlanner. The EM2100 appliance comes pre-loaded with a temporary, 120 day, FLOW Core license, which allows initial set-up, testing, and validation to begin immediately, without a full subscription license. A FLOW Core license must be purchased after the 120 day set-up period.

> **NOTE:** The EM2100 can also run in the Fleet Simulator operating mode, with a Fleet Simulator license. Refer to the Fleet Simulator User's Guide.

Configuration Tasks Overview

> **NOTE:** This section assumes that you have read and followed the instructions in the *EM2100 Installation Guide (Cat. No. I634).*

To configure the EM2100 appliance as a Fleet Manager, you must do the following tasks, which are described in detail later in this guide:

- Configure the network settings for the appliance Management Ethernet port.
- Configure the network settings for the FLEET ETH2 Ethernet port.
- Connect the Management and Fleet ports to the LAN.
- Define the login information.
- Configure each AMR to connect to the EM2100.
- Customize each AMR, if desired.

If you install a Secondary EM2100 appliance and configure Autosync, you must also:

- Install the same FLOW Core software version on the Secondary as is on the Primary appliance.
- Configure a unique IP address for the Management port.
- Connect the Management port to the LAN.
- Connect the FLEET ETH2 port to the LAN.

- Enter the Secondary Management IP address on the Primary appliance.
- Generate and download a key from the Primary appliance.
- Set the Secondary appliance Autosync role to Secondary.
- Upload the key to the Secondary appliance.
- Verify that the status of both appliances is active.
- Create a direct network connection between the Primary and Secondary appliances.

3.2 Power Interruptions

Use the front momentary power switch to turn the EM2100 on and off. The rear power switch should remain on unless you are uninstalling the appliance.

Power Interruptions on a Standalone EM2100

If there is an interruption to the power supply for any reason or duration, a standalone EM2100 automatically returns to its previous power state.

- A standalone appliance that was shut down and powered off when the interruption occurred remains shut down after you restore power.
- A standalone appliance that was powered on when the interruption occurred restarts automatically after you restore power.

After recovery from a power interruption, the EM2100 saves its job queue status and recovers the queue automatically after it restarts following a power failure. This does not apply to an operator-initiated emergency power off. Refer to: Power Interruptions on page 23.

Power Interruptions on an Autosync Appliance

This section assumes that you configured Autosync on two EM2100 appliances and connected each appliance to separate power circuits for redundancy. Providing that only one circuit was affected, one appliance should remain operating normally during the power interruption. The sequence of events and method of recovery depends on which appliance is affected:

A power interruption on the Primary appliance results in a loss of connectivity with AMRs and MobilePlanner. You should:

- Determine whether the problem is a power outage or a loss of network connectivity.
- Manually reconfigure the Secondary appliance to become the Primary Appliance. Fleet Management functions are restored but Autosync status is now disabled.

  Autosync will need to be re-configured once the power issue with the original EM2100 appliance is resolved.
- Verify that MobilePlanner and AMRs reconnect to the Fleet IP address.
- Review the job queue status in MobilePlanner and verify the status of AMRs to make sure that no jobs are incomplete.
- Restore power to the former Primary appliance.
- Change the former Primary appliance to a role of Secondary appliance.

A power interruption on the Secondary appliance results in no loss of connectivity with AMRs and MobilePlanner. You should:

- Verify that MobilePlanner and AMRs are connected to the Fleet IP address.
- Review the job queue status in MobilePlanner and verify the status of AMRs to make sure that no jobs are incomplete.
- Restore power to the Secondary appliance. Autosync will be restarted if it was running when the power was interrupted. Fleet operations should be unaffected.

If both Autosync appliances are affected by a power interruption, they both behave as described in: Power Interruptions on a Standalone EM2100 on page 23:

- All fleet operations are terminated during the power interruption.
- Normal Active Autosync operation resumes automatically after you restore power to both appliances.
- The Primary EM2100 saves its job queue status and recovers the queue automatically after it restarts. Autosync will reconnect automatically when power is restored.

3.3 Set the IP Address on a Client PC's Network Adapter

Use the Maintenance Ethernet port to connect a client PC to the SetNetGo operating system.

IMPORTANT: You must assign a static IP address. Do not use a DHCP server.

Configure the network adapter IPv4 address on the Client PC as follows:

1. Connect an Ethernet cable from the client PC's Ethernet port to the Maintenance Ethernet port on the EM2100 appliance.
2. In the command field on the Windows taskbar, enter the following command to open the Network Connections dialog: **ncpa.cpl**
3. Open the network properties of the PC ethernet network adapter used to connect to the Maintenance Ethernet port on the EM2100 appliance.
4. Double-click TCP/IPv4 to open the Internet Protocol properties dialog.
5. Enter as the IP address: 1. 2. 3. 5, or any IP address in the range 1. 2. 3. 0 to 1. 2. 3. 255, excluding 1. 2. 3. 4. (this is reserved for the Maintenance port).
6. Enter as the subnet mask: 255. 255. 255. 0.
7. Click **OK** to close the Internet Protocol dialog, and then click **OK** to close the Ethernet Adapter dialog.

In future, you can use the Maintenance Ethernet port for emergency access to the Appliance at IP address 1.2.3.4. (For example, if you lose the password or if there is a network IP address conflict.)

3.4 Connect Your PC to SetNetGo on the EM2100

SetNetGo enables you to configure and manage EM2100 and AMR settings. This section describes how to access SetNetGo through the Maintenance port to perform initial configuration.

The user interface for SetNetGo on an EM2100 provides a different set of parameters and options compared to SetNetGo on an AMR. The upper left of the screen shows EM2100, LD, LD-250, or HD depending on your SetNetGo context (the device on which it runs, such as the OMRON LD-series AMRs).

Configure Access and Security

After you connect to the Maintenance Port as described in: Set the IP Address on a Client PC's Network Adapter on page 24 you can open the SetNetGo web interface.

Connect your browser to SetNetGo and configure SetNetGo access as follows:

1. In the SetNetGo web interface, click the Security Tab and then click SetNetGo Access and check **Enabled** next to the following:

   Maintenance Interface is automatically enabled.

   - Wireless Ethernet/User LAN Ethernet
   - (Optional) Remote Reboot.

2. Change the account password (default is no password) as required and click **Apply**.

   NOTE: Passwords are limited to a maximum of 20 alphanumeric characters. For increased security, specify a long (10+ characters) password string with both uppercase and lowercase letters. Include several digits.

3.5 Configure Management Interface Network Settings

To configure the Management Network, you require:

- A dedicated static IP address. (Do not use 1.2.3.4. That address is permanently assigned to the Maintenance Ethernet port.)
- The subnet mask for the Management network.
- The IP address of the network Gateway.
- The IP address of a Domain Name Server (DNS) (this is only required if any hostnames will be used in the Fleet Manager configuration), so that the Fleet Manager can resolve all IP addresses.

Configure the Management Interface network connections as follows:

1. In the SetNetGo web interface, click the **Network** tab.
2. Click **Management Interface** and enter the:
   a. IP address.
   b. Subnet mask.
   c. Network Gateway IP address (typically a router).
3. Enter the IP address of your Domain Name Server (DNS), if required for devices other than the appliance and the fleet. Otherwise, leave it as 0.0.0.0.
4. Click **Apply**.

A message dialog informs you of the status of the change, and whether there is any affect on operations such as a restart or a time delay before the change takes effect.

3.6 Configure the Operating Mode

Configure the Operating Mode as follows:

1. In the SetNetGo web interface, click the **System** tab.
2. Click **Mode.**
3. Select the operating mode in which you will be using this EM2100.

   The choices will be:

   - Unconfigured (this is how the EM2100 ships)
   - Standalone Fleet Manager
   - Paired Fleet Manager
   - Fleet Simulator

   If a mode is greyed out, it means that you don't have the license to support that operating mode. Refer to Licensing Tab on page 126.
4. Click **Apply**.

   You will be shown several warning pop-ups. Respond **OK** to all.

   The EM2100 will reboot.

   At this time, **Status** > **Home** > **Mode of Operation** should show the operating mode that you selected.

A message dialog informs you of the status of the change, and whether there is any effect on operations such as a restart or a time delay before the change takes effect.

3.7 Configure the Fleet Interface Network Settings

To configure the Fleet Interface, you require:

- A dedicated static IP address to assign to the Fleet Interface port. This IP is allowed, but not required, to be on the same subnet as the Management IP. Do not use 1.2.3.4, because that address is permanently assigned to the Maintenance Ethernet port.
- The subnet mask for the network that your Fleet will use.
- The IP address of the network Gateway.

Configure the Fleet Interface network connections as follows:

1. In the SetNetGo web interface, click the **Network** tab.
2. Click **Fleet Interface** and enter the:
   a. IP address.
   b. Subnet mask.

c. Network Gateway IP address (typically a router).

3. Click **Apply**.

A message dialog informs you of the status of the change, and whether there is any affect on operations such as a restart or a time delay before the change takes effect.

3.8 Configure Paired Appliances

The default (shipped) configuration for an EM2100 is Unconfigured. The user will need to configure it as either Standalone or Paired Fleet Manager.

To create an Autosync pair, refer to Configure the Primary Appliance on page 29 and Configure the Secondary Appliance on page 30. The paired appliances then function as follows:

- The Primary unit is a fully-functional EM2100, running the Fleet Operations Workspace Core and actively controlling the fleet.
- The Secondary unit is powered on, with its web interface accessible to the Primary unit. However, the fleet management functions are inactive on the Secondary unit, and it is inaccessible from MobilePlanner or AMRs.

The Primary Fleet Manager has two active IP addresses, while the Secondary has only one active IP address.

EM2100 Autosync — Ethernet Cabling

The following figure shows the physical connection of Ethernet cables to the appliances.

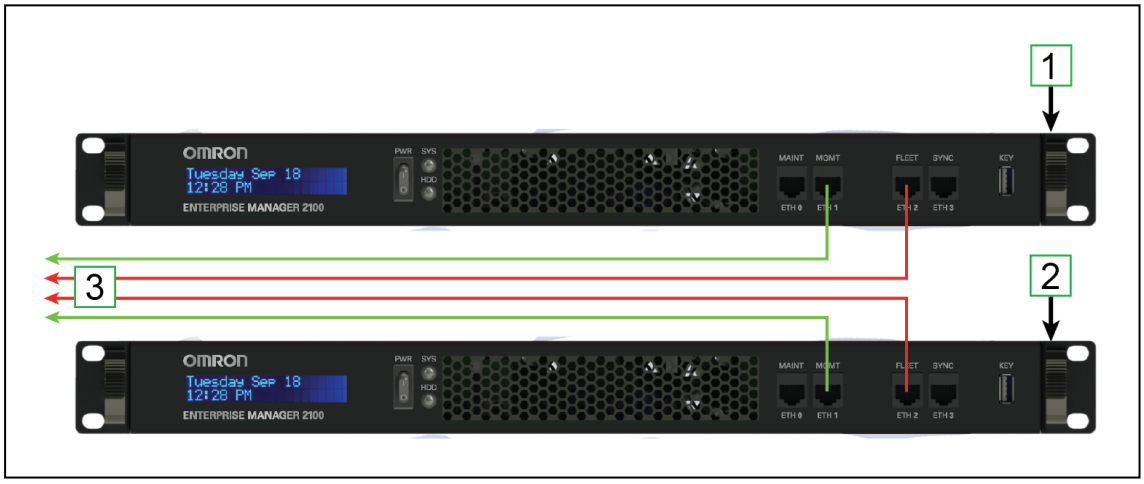


Figure 3-1. Cabling for an EM2100 Fleet Manager Pair

Callout	Description
1	EM2100 configured as a Primary appliance.
2	EM2100 configured as a Secondary appliance.
3	Ethernet cables to the LAN switch: • Primary and Secondary MGMT ETH1 • Primary and Secondary FLEET ETH2

Tasks in Autosync Setup

Before you set up Autosync, make sure that you have:

- Installed the Primary appliance and connected it to the network.
- Configured the Maintenance Ethernet interface on the Primary appliance.

- Physically installed the Secondary appliance hardware, as described in the *EM2100 Installation Guide*.

The tasks required to set up autosync between a Primary and Secondary appliance are:

- Configure the Primary appliance with a Fleet IP Address.
- Enter the Secondary appliance IP Address in the Primary appliance.
- Generate and Download the Primary key (to your PC).
- Set the Secondary appliance Autosync role to Secondary.
- Upload the Primary key to the Secondary appliance.

Configure the Primary Appliance

Do this only if you have two Fleet Manager appliances, and you want to configure one as a Primary Fleet Manager. You must first configure the Management and Fleet networks and cable the appliances.

1. In the SetNetGo web interface, click the **System** tab, then **Mode**.
2. Select **Paired Fleet Manager** from the drop-down menu. Click **Apply**.

   You will get a "Confirm Appliance Mode Change" pop-up message.

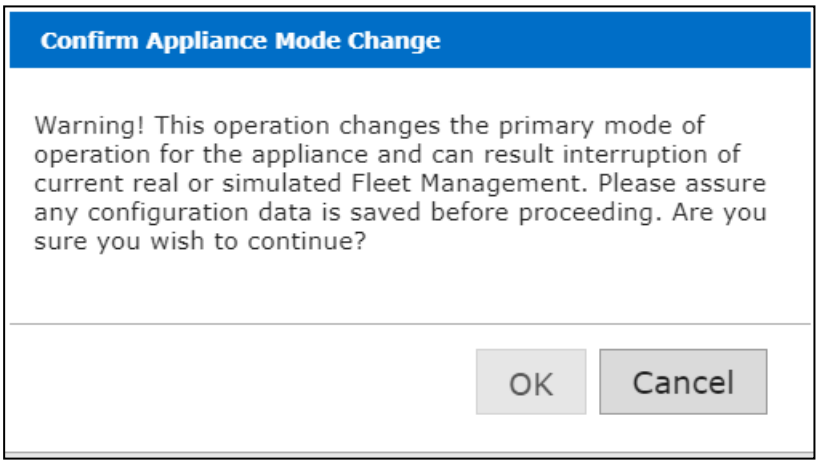


Figure 3-2. Confirm Appliance Mode Change Window

3. Click **OK**.

   You will get a second pop-up with a warning that this operation will interrupt the fleet management.
4. Click **OK**.
5. Click the Pairing button that appears in the left margin of the screen.
6. From the drop-down menu next to the Pairing Role, select **Primary**, and click **Apply**.
7. Enter the IP Address of the Secondary appliance. Click **Apply**.

8. You will get a message to confirm changes, saying that ARAMCentral will restart, disconnecting AMRs and clients. Click **OK**.
9. You will get a confirmation message that the changes were successfully applied. Click **OK**.
10. Click **Generate New Key** to create an SSL key, or **Download Existing Key**, if you previously created an SSL key.

    Uploading the SSL key to the Secondary appliance grants permission for the Primary to perform RPC calls required for synchronization.
11. You are prompted for a location to save the key file. Enter a location (path) where you want to save the file on your PC, so you can later upload it to the Secondary appliance.
12. A warning message indicates the pending disconnection of AMRs and clients. Click **OK**.

Your Primary Fleet Manager is now configured to run as part of a pair.

Configure the Secondary Appliance

Do this only if you have two Fleet Manager appliances, and you want to configure one as a Secondary Autosync appliance. You must first:

1. In the SetNetGo web interface, click **System** tab, then **Mode**.
2. From the drop-down menu choose **Paired Fleet Manager** and click **Apply**.
3. You will get a "Confirm Appliance Mode Change" pop-up message. Click **OK**.
4. You will get a second pop-up with a warning message that this operation will interrupt the fleet management. Click **OK**.
5. A Pairing selection will appear in the left margin of the screen. Click on **Pairing**.

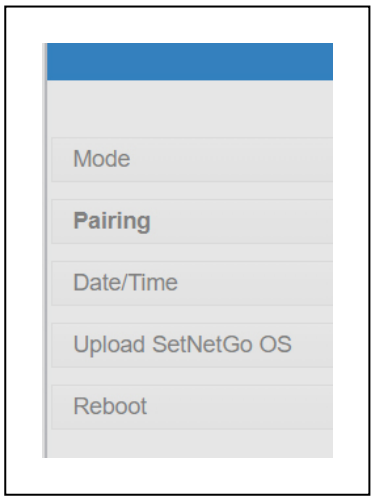


Figure 3-3. Pairing Selection, Left Bar

6. From the drop-down menu, next to the Pairing role, choose Secondary. Click **Apply**.

You will get a Confirm changes message that ARAMCentral will halt, disconnecting AMRs and clients. Click **OK**.

7. You will get a confirmation message that the changes successfully applied. Click **OK**.

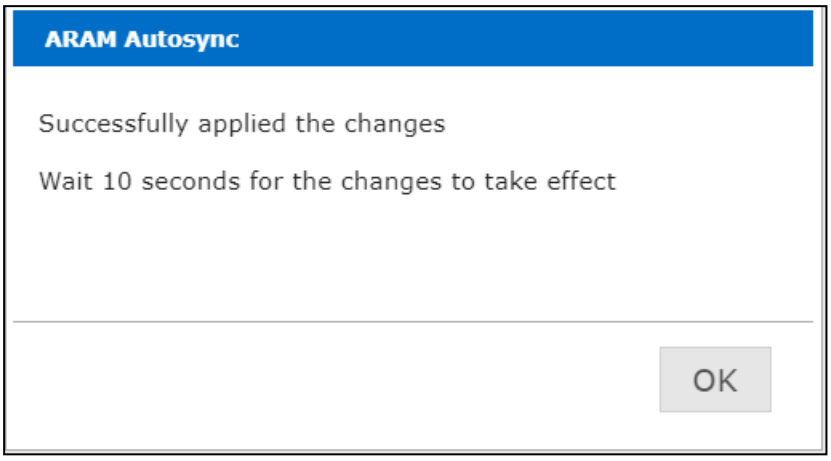


Figure 3-4. Changes Successfully Applied Window

8. Click **Choose File** to select the Primary SSL key from your PC to chose the proper file.

   Enter the name and path of the file to upload the key from the PC.

9. Click **Upload**.

   Your appliance is now configured as a Secondary appliance.

   NOTE: Although the Fleet Interface settings are saved for the Secondary appliance, the interface is inaccessible.

When the connection is complete, the Primary and Secondary appliances show a Current Status of *active*.

3.9 Configure Each AMR to Connect to the Fleet Manager

Before you can use the Fleet Manager appliance to manage AMRs, you must configure each AMR to connect to the appliance. To do so, you must connect to each AMR.

When an AMR connects to the appliance, the Fleet Operations Workspace Core overwrites the AMR's configuration parameters with Fleet parameters.

AMR Configuration Settings

To connect an AMR to the EM2100 appliance:

1. Launch MobilePlanner on your client PC and connect to the AMR's IP address.

   If this is a new AMR, its IP address will be the factory setting of 1.2.3.4 for LD-series AMRs, and 169.254.10.15 for the HD-1500 AMR. The connection must be hard-wired, because the AMR's wireless won't be configured yet.

2. Open the **Config** tab.

3. Check **Show Expert Parameters** to show the advanced configuration parameters.
4. From MobilePlanner, Config select **Fleet** and then **Fleet Manager Connection**.

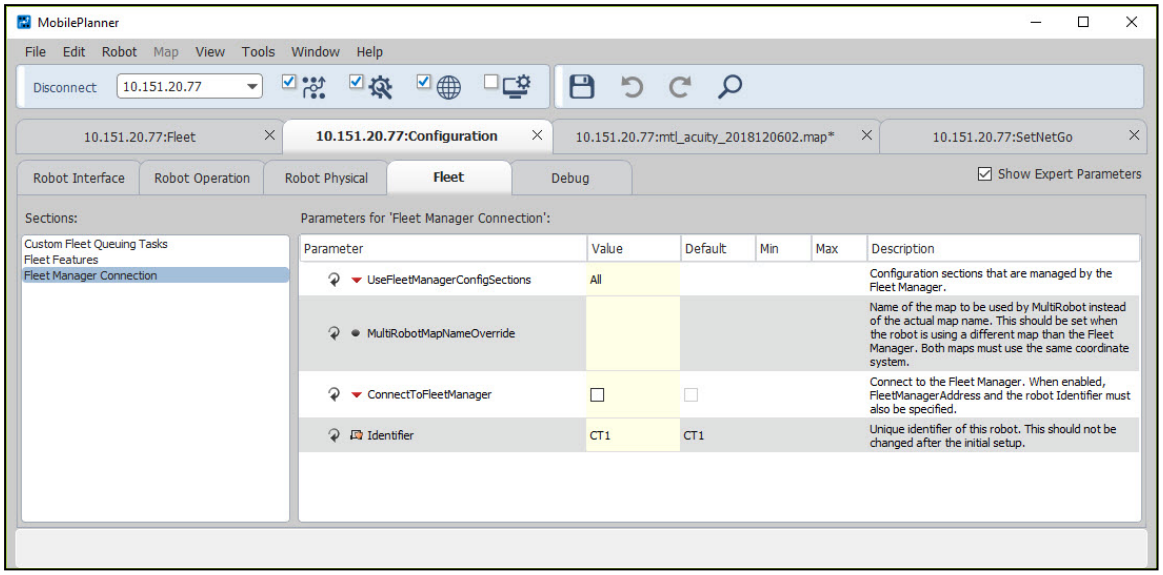


Figure 3-5. Fleet Manager Connection Screen

5. Check the **ConnectToFleetManager** checkbox.
6. Enter the IP address of the EM2100 appliance in the **FleetManagerAddress** field.

   NOTE: This is the Fleet IP address, not the Management IP address of the EM2100.

7. Enter an identifier in the **Identifier** field. You must use unique identifiers for each AMR. Do not change this identifier after initial setup.

Repeat these steps for each AMR that you want to add to the fleet controlled by this EM2100 Fleet Manager.

Fleet-Level Settings

From MobilePlanner, Config, on the Fleet Manager:

1. Select **Fleet** and then **Fleet Features**.
2. Check the **FleetManagerGatherScans** box.

   This enables Fleet Operations Workspace Core to gather any scan files created by the AMRs.

3. Back up (copy) any required maps to a storage location.
4. [OPTIONAL] Check **DeleteUnusedMaps** to permanently delete unnecessary map files from each AMR.

3.10 What to do if a Primary Fleet Manager Fails

This section applies only if you installed a second EM2100, autosynchronized with the Primary Fleet Manager.

In event of failure:

1. Using the SetNetGo interface, connect to the Management IP address for the Secondary Fleet Manager EM2100 appliance.
2. Click **Apply** (or click **Reset** to retain the previous values without your changes).

The AMRs automatically reconnect to the new Primary appliance.

The queue, configuration, and map data on the new Primary is identical to that of the old Primary, prior to failure. Depending on exact network configuration, it takes between 1-3 minutes for AMRs to reconnect and resume operation.

The original (failed) Primary appliance can now be safely removed from the rack without causing disruption to the fleet. The following considerations apply:

- The new Primary operates on the same Fleet IP as the old Primary appliance. Do not reconnect the old Primary to the network without first reconfiguring it. Doing so might cause a network IP conflict.
- The failed Primary has the queue file, which is no longer current. Before putting the failed Primary back into service, you should manually clear the queue. See Manually Clearing (Flushing) the Entire Queue on page 200.

3.11 Remove and Replace EM2100 Appliances from Autosync

This section describes how to remove an appliance from an Autosync configuration.

Remove a Primary Fleet Manager Appliance from Autosync

You might need to remove a Primary Fleet Manager appliance from an Autosync configuration while maintaining fleet operations. For example, if the Primary appliance is generating errors that indicate a potential failure or degraded performance. This procedure assumes that you do not make any changes to the software and data stored on the removed appliance.

To safely remove an EM2100 Primary Fleet Manager appliance from an Autosync configuration, you must promote the Secondary appliance to the Primary role as covered in the previous section. You can then safely remove the Primary as follows:

1. Verify that fleet operations are normal and job processing is on schedule.
2. Reconfigure the Primary appliance as a Secondary appliance. See: Configure the Secondary Appliance on page 30.
   MobilePlanner and fleet AMRs might lose their network connection to the appliance.
3. Reconfigure the Secondary appliance as the Primary appliance. See: EM2100 Configuration Overview on page 22.
4. Power off the Secondary appliance.
5. The Status tab in SetNetGo will now show that Autosync for the new Primary appliance

is disabled (it is now a standalone appliance).

6. Verify that MobilePlanner can connect to the Fleet IP, that fleet AMR operations resume, and jobs are processed as scheduled.

To restore a removed EM2100 appliance or to replace it with a new appliance, it should be put into the role of Secondary Fleet Manager, not Master. This will cause less disruption to the fleet.

Remove a Secondary Fleet Manager from Autosync

You might need to remove a Secondary Fleet Manager appliance from an Autosync configuration while maintaining fleet operations. For example, if the Secondary Fleet Manager appliance is generating errors that indicate a potential failure or degraded performance. This operation is less disruptive than removing a Primary Fleet Manager.

> **IMPORTANT:** This procedure assumes that you do not make any changes to the Fleet Manager configuration or to the software and data stored on the appliance.

To remove a Secondary Fleet Manager appliance from an Autosync configuration:

1. Verify that fleet operations are normal and job processing is on schedule.
2. Power off the Secondary Fleet Manager appliance.

   If a soft shutdown doesn't work, use a hard shutdown. Refer to the *EM2100 Installation Guide* for details on hard- vs. soft-shutdowns.
3. Verify that MobilePlanner can connect to the Fleet IP, that fleet AMR operations continue, and that jobs are processed as scheduled.

To restore a removed Secondary Fleet Manager appliance:

1. Verify that fleet operations are normal and job processing is on schedule.
2. If you have removed any network cables, reinstall them. Configure Paired Appliances
3. Power on the Secondary Fleet Manager appliance. (This should not affect fleet operations or Ethernet connections to MobilePlanner and AMRs.)
   Both appliances now indicate that Autosync is **Active.**

   If no changes have been made to the configuration, the Secondary appliance will come back up as a Secondary, but the Primary will be running as a Standalone.
4. Reconfigure the Primary appliance to be paired with the Secondary. See Configure the Primary Appliance on page 29.

Chapter 4: Fleet Operations Workspace Core Software

The Fleet Operations Workspace Core (FLOW Core) software has the tools and features to help you get your AMR up and running quickly. This chapter covers the initial steps needed to access your AMR with the PC and to begin using the Fleet Operations Workspace Core software.

4.1 How Do I Begin?

Before you can start using your AMR, there are a number of initial set-up and configuration steps you need to complete.

> **NOTE:** It is assumed that, prior to beginning fleet programming with FLOW Core, all AMRs and EM2100 appliances being used in the fleet have been unpacked, installed and set-up according to their respective user guides.

Procedure	Reference
Install the MobilePlanner software on your PC.	Install the MobilePlanner Software on page 39
Connect your PC to the AMR via Ethernet cable.	Step 1: Connect Your PC to the AMR via Ethernet on page 41
Configure the AMR for wireless communication.	Step 4: Configure Your AMR's Network and Security Settings on page 47
Establish a wireless connection to the AMR.	Step 5: Connect to the AMR Wirelessly on page 48
Scan the AMR's environment.	Scanning the Operating Area on page 88
Convert the scan to a map.	Convert the Scan into a Map on page 89
Use MobilePlanner software to edit (erase stray and other dynamic features from) the map.	Editing a Map File on page 93
Add docks, forbidden zones, goals, and route(s) between goals, etc. to the map.	Working with Map Files on page 90
Save the edited map on the AMR.	Saving the Map on the AMR on page 108
Localize the AMR.	Set the AMR's Initial Location on page 111
Create some tasks, and have the AMR begin performing them.	AMR Tasks on page 150

4.2 End-User License Agreement (EULA)

Users will be presented with and must agree to the End User License Agreement (EULA) in order to access and use any of the FLOW Core software content and functionality.

Definitions

- An **End User** is the person, company, or organization that actually uses the software and OMRON Mobile Robotics equipment.
- **System Integrators** are not End Users when they are installing OMRON Mobile Robotics solutions for another business.
- **System Integrators** are End Users when they own and install OMRON Mobile Robotics solutions for their own use (e.g. for test or demonstration fleets).

The Click-to-Accept (CTA) EULA will pop up:

- When the FLOW Core software is installed.
- Whenever the FLOW Core software is updated.
- Upon first launching SetNetGo software (Out Of the Box).
- Whenever the SetNetGo software is updated.
- Whenever a V2C (license) file is uploaded (first time, updates, and renewals).

  New entitlements are not required when existing dongles are transferred from a failed EM2100 or AMR to new EM2100 or AMR hardware. Therefore, no EULA is required in these cases.
- Whenever a new user-facing language is selected (in order to ensure delivery of the CTA EULA in the appropriate language).

Once the CTA EULA Prompt is Triggered

1. The CTA EULA pop-up will display in the language that matches the software installed.
2. The User must scroll through the entire End User License Agreement before the Accept button is enabled (this button is greyed-out until then).
3. The User must check either "End User" or "Manufacturer or System Integrator" before the Accept button is enabled.

   Accepting as "End User" will stop the CTA from re-triggering upon launching the software. All other triggers will still prompt user with the CTA pop-up.

   Accepting as "Manufacturer or System Integrator" will not stop the CTA from re-triggering upon launching the software. This is to ensure that the End User gets prompted when first launching the software "out of the box".
4. The User can either click Accept, or abort the process.

   Aborting the CTA EULA process will cancel and close out of the process that triggered the CTA EULA pop-up (V2C Upload, Language Change, Software Update, Software Install, First-Time/Out Of the Box Software Start Up).

   In this case, the User can re-trigger the CTA EULA prompt by initiating one of the trigger processess listed above.
5. If the software license is activated at the factory, in the Fleet Simulator bundle for example, the CTA EULA pop-up will be displayed and a selection must be made prior to the Simulator performing its intended functions.

   The intent here is that the Fleet Simulator should be able to connect to SetNetGo and MobilePlanner but no configuration or simulations can be run until the user clicks the Accept button.

Capturing CTA Interactions

1. Every time the CTA EULA process is initiated and completed, the following data shall be captured and logged:
    - What triggered the CTA EULA prompt (e.g "Software Update", "V2C Upload", etc.)
    - Date/Time CTA EULA process was triggered
    - Date/Time CTA EULA process was completed
    - Whether CTA EULA was Accepted, or the process was aborted (either of these will be considered as completed.
2. Users can access a reference log file, but will not have access to or the ability to make changes to the source data populating these logs.

    NOTE: The Click-to-Accept EULA functions only apply to the FLOW Core software. There is no impact on the Legacy MSS 4.X software.

4.3 Install the MobilePlanner Software

Before setting up a wireless connection to your AMR, you will need to install MobilePlanner on your PC. This software is the primary interface to the Fleet Manager and AMRs, and allows programming of the AMR fleet.

System Requirements

Verify that your PC meets the following requirements before installing MobilePlanner:

- **OS**: Windows 7 (32-bit/64-bit), Windows 8 (32-bit/64-bit),or Windows 10 (32-bit/64-bit).
- **CPU**: 1.5 GHz Dual-core (min).
- **RAM**: 1.5 GB (min) 4 GB RAM recommended).
- **GPU**: 256 MB (min).
- **HDD/SSD**: At least 250 MB available space.
- **Monitor**: XGA 1024 x 768.

Installing MobilePlanner

Ensure that your PC meets the system requirements, then install (or download and install) MobilePlanner.

NOTE: The MobilePlanner software installs into a MobilePlanner5 directory. This different install directory allows you to use the relevant MobilePlanner version with your fleet.

Version Information: Only MobilePlanner software version 5 or higher is compatible with FLOW Core. It is not compatible with OMRON fleets running on Mobile Software Suite version 4.X or earlier. Refer to https://automation.omron.com for release notes or contact your OMRON representative for more information.

1. Use one of the following methods to locate and/or install the MobilePlanner software:

   a. By **USB drive**: insert the software media (USB drive included with your AMR's documentation) into your PC, and browse to the USB drive to locate and install the software.

      From your EM2100: Open **SetNetGo** > **Software** > **Manage Installed Software** > **MobilePlanner** > **It can be downloaded here**. (Click on the "here" link in the EM2100 user interface, shown near the bottom of the following figure.)

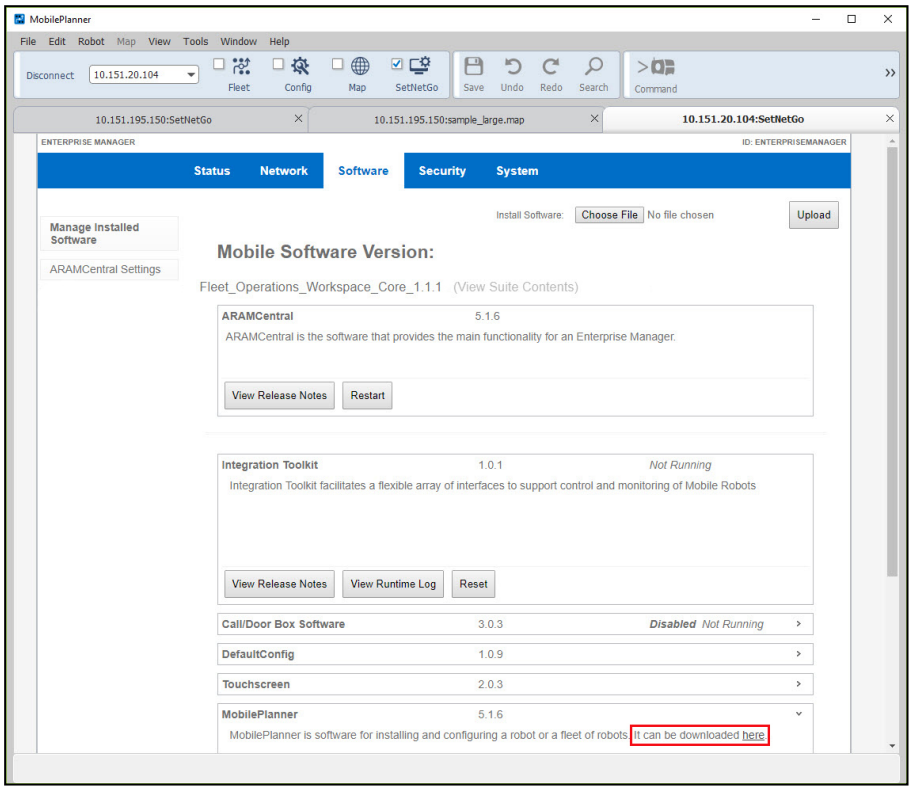


Figure 4-1. Manage Software Download

   b.

   c. By **download:** Contact your OMRON representative for assistance with downloading MobilePlanner software.

      To download MobilePlanner from the internet, access www.robotics.omron.com or contact your OMRON representative.

2. Launch the installer and, when the welcome screen appears, follow the prompts in each installation wizard window to complete the installation.

   If you used SetNetGo or downloaded the software, this will usually be in your Downloads folder. The actual location is determined by the settings in the browser that you use.

3. Click **Finish** when done.

4.4 Configure the AMR's Wireless Communications

Before you can start working with your AMR, you have to configure it for wireless communication (via WiFi) using your PC. To do this, you will first have to connect your PC to the AMR via Ethernet cable to gain access to the AMR's wireless settings. In general, the set-up process is as follows:

- Connect your PC to the AMR via Ethernet
- Set your PC's IP address
- Connect to SetNetGo
- Configure the AMR's network settings
- Establish a wireless connection to the AMR

NOTE: The setup steps above assume that the AMR is fully-charged, powered up, and ready. If this is not the case, please refer to your AMR's user guide for complete setup instructions.

Step 1: Connect Your PC to the AMR via Ethernet

To connect your PC to the AMR:

1. Open the AMR's maintenance access panel (left side, upper right corner), by pressing the access panel's upper left corner (see image below) into the side of the AMR.

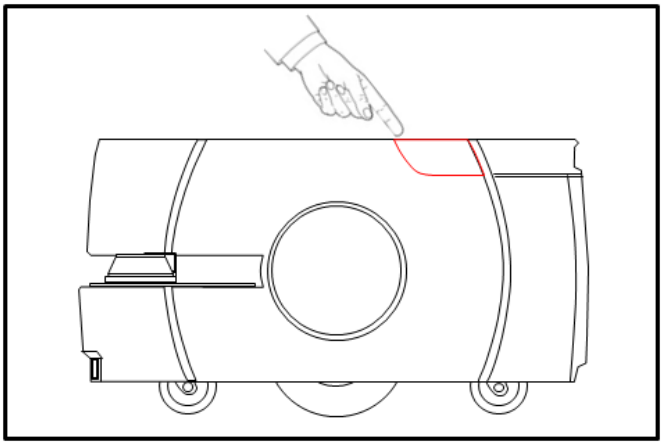


Figure 4-2. Maintenance Door Location

2. Using a standard (pass-through) or cross-over Ethernet cable, connect your PC directly to the AMR's maintenance Ethernet port. Refer to the following three figures. The AMR will auto-detect the cable type.

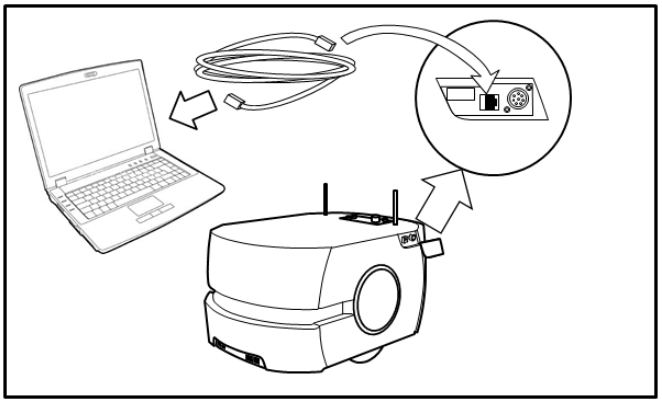


Figure 4-3. Maintenance Port Connection, LD-60 and LD-90

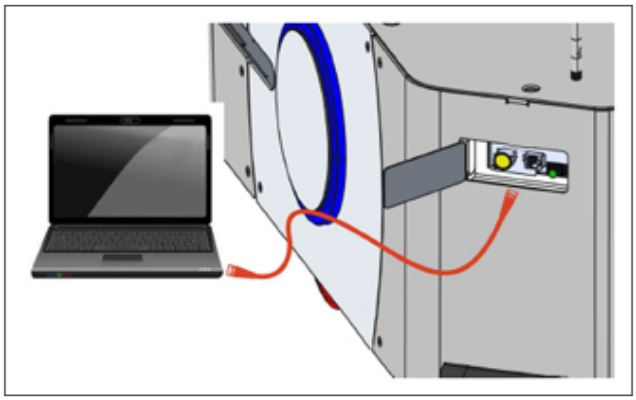


Figure 4-4. Maintenance Port Connection, LD-250

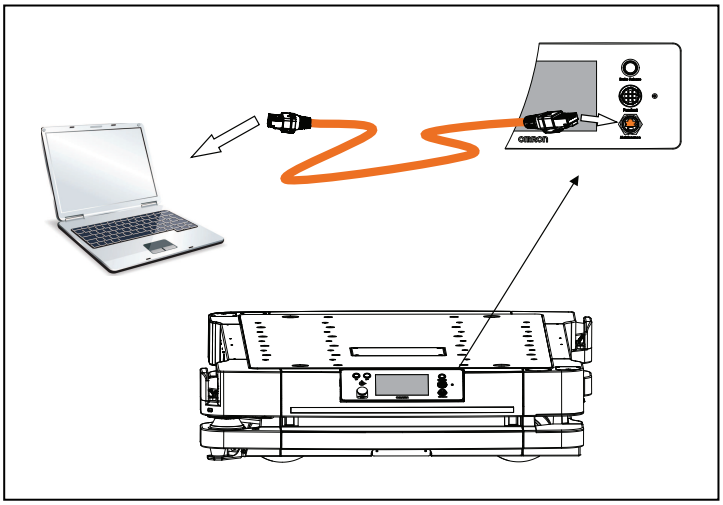


Figure 4-5. Maintenance Port Connection, HD-1500

Step 2: Set the IP Address on Your PC

In order to configure WiFi on your AMRs, the LD-series AMRs and the HD-1500 AMRs are accessed differently. If you have a combination of the two, we suggest that you set up all of the LD-series AMRs and all of the HD-1500 AMRs as two separate procedures.

LD-Series AMR IP Address Setup

Manually set your PC's Ethernet port IP address to 1.2.3.x, where x is any number 1 - 254, except 4 (which the AMR uses), and a Subnet mask of 255.255.255.0. No special DNS or gateway settings are needed.

> **NOTE:** The LD-series AMR's maintenance Ethernet port is always enabled and permanently set to IP address 1.2.3.4, with a Subnet mask of 255.255.255.0, for direct, wired access to the on-board systems.

1. Open your PC's Network Connections window.
2. Right-click on your PC's **Local Area Connection** Ethernet connection, and select **Properties**.

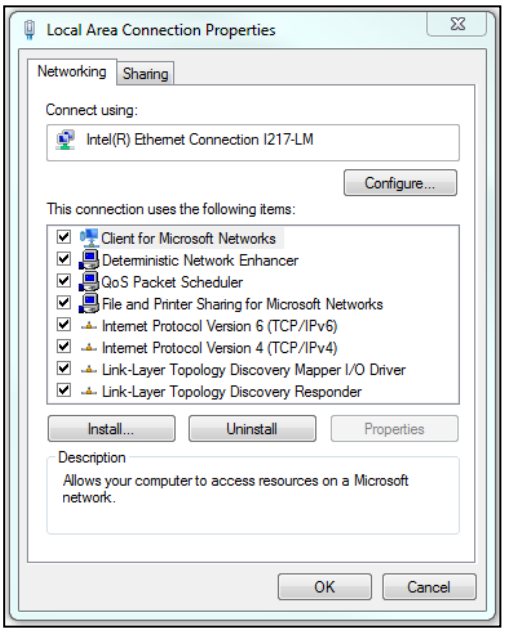


Figure 4-6. Windows Local Area Connection Properties Dialog

3. In the Local Area Connection Properties dialog box, click on the TCP/IP protocol your network uses (for example, Internet Protocol Version 4 (TCP/IPv4)), then click **Properties.**

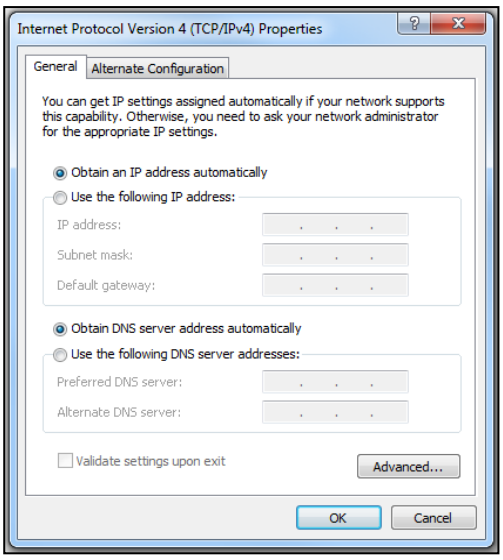


Figure 4-7. Windows Internet Protocol Properties Dialog

4. In the TCP/IP properties dialog box, click the **Use the following IP address:** radio button and enter an appropriate IP address (for example, 1.2.3.5) and Subnet mask 255.255.255.0.
5. Click **OK**.
6. Close the Network Connections window.

HD-1500 AMR IP Address Setup

To enable DHCP or change other TCP/IP settings (Windows 10)

1. Select **Start**, then select **Settings** > **Network & Internet**.
2. Do one of the following:
   - For a Wi-Fi network, select **Wi-Fi > Manage known networks**. Choose the network you want to change the settings for, then select Properties.
   - For an Ethernet network, select **Ethernet**, then select the Ethernet network you're connected to.
3. Under **IP assignment**, select **Edit**.
4. Under **Edit IP settings**, select **Automatic (DHCP)** or **Manual**.

   To specify IPv4 settings manually (IPv6 is not supported)

   a. Under **Edit IP settings**, choose **Manual**, then turn on either IPv4.

   b. To specify an IP address, in the **IP address**, **Subnet prefix length**, and **Gateway** boxes, type the IP address settings.

c. To specify a DNS server address, in the **Preferred DNS** and **Alternate DNS** boxes, type the addresses of the primary and secondary DNS servers.

- When you select **Automatic (DHCP)**, the IP address settings and DNS server address setting are set automatically by your router or other access point (recommended).
- When you select **Manual**, you can manually set your IP address settings and DNS server address.

5. When you're done, select **Save**.

Step 3: Access SetNetGo Software

The SetNetGo software lets you manage a variety of settings related to the AMR's connectivity. You can access SetNetGo from MobilePlanner (most common), or a secure web browser (for example, Chrome, Firefox, or Internet Explorer).

To Access SetNetGo from MobilePlanner

NOTE: Only start the following procedures if your computer is connected to the AMR via Ethernet cable.

1. Open the MobilePlanner software.
2. For an LD-series AMR, enter **1.2.3.4** into the AMR address field, then click **Connect**.

   For an HD-1500 AMR, enter 169.254.10.15 into the AMR address field, then click **Connect**.
3. Click the **SetNetGo** button (the large part of that icon, not the checkbox).
4. Click the **SetNetGo** tab.

To Access SetNetGo via Web Browser

1. Start a web browser on your computer.
2. Enter the URL **https://1.2.3.4** in the address bar of the web browser.

   This is the AMR's maintenance Ethernet address. When accessing the software from a wired maintenance Ethernet port, you do not need a username or password.

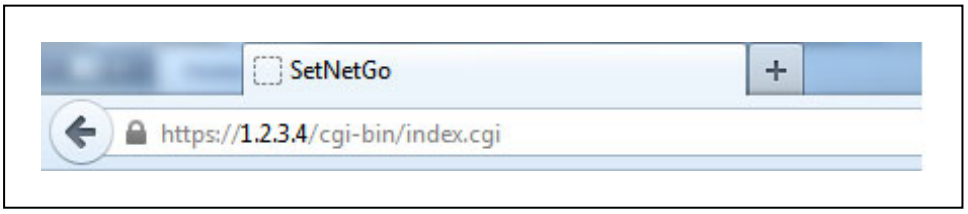


Figure 4-8. Browser Address Field

NOTE: You can ignore the certificate error that appears on the SetNetGo webpage; the error appears because the hardware is not attached to the Internet.

The SetNetGo startup screen is shown the following figure.

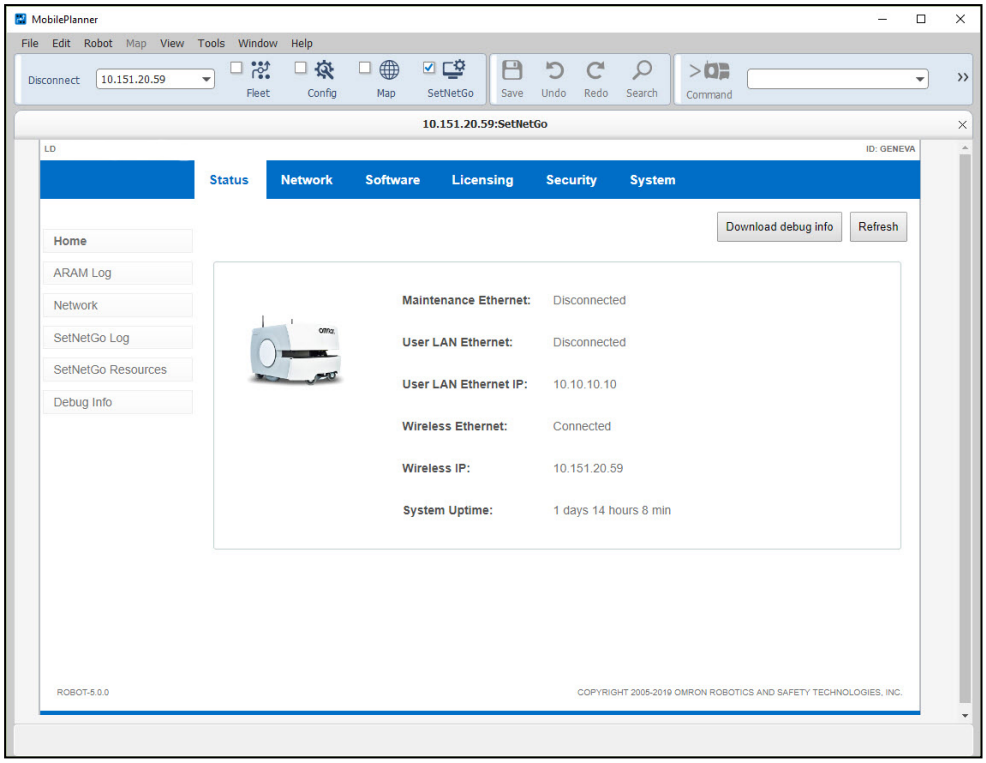


Figure 4-9. SetNetGo Interface

Step 4: Configure Your AMR's Network and Security Settings

To access your AMR remotely, you should set up a static IP address for each AMR. The SetNetGo interface allows you to configure your hardware's Ethernet settings, configure serial and TCP forwarding, and upgrade the on-board software. If you are not familiar with setting up a network or do not have an assigned IP address for the AMR, please see your system administrator.

> **IMPORTANT:** If you change any values in a SetNetGo screen, you must click **Apply** before switching to another sub-screen, or those values will not be saved. For example, when changing wireless Ethernet settings, be sure to click **Apply** before navigating back to the dashboard.

To configure network settings, click the **Network** tab at the top of the SetNetGo screen.

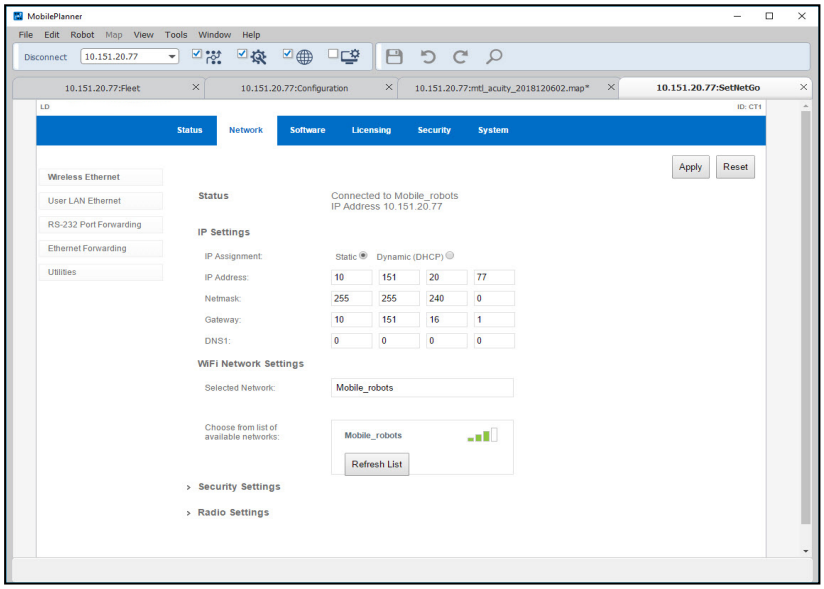


Figure 4-10. SetNetGo Interface

Network Menu	Description
Wireless Ethernet	Sets up your wireless Ethernet connection to your AMR, including IP settings, WiFi network settings, security settings, and radio settings.
User LAN Ethernet	This screen has user-configurable settings for interface mode, IP address, netmask, DHCP server for accessories, and DHCP IP range.
RS-232 Port Forwarding	Controls forwarding of serial data to a TCP port on the wireless and internal wired Ethernet networks, where the data is re-directed to a TCP port on an IP address accessible via the Wired Ethernet interface (which must be set to accessory mode). There is also port-forwarding for the two extra on-board serial ports to a TCP port on the wireless Ethernet interface.

Network Menu	Description
Ethernet Forwarding	Use the settings on this screen to control TCP port forwarding from your User LAN Ethernet interface to the wireless Ethernet interface.
Utilities	Use this screen to ping an IP address for testing and diagnostic purposes.

Set the Username and Password to secure access to the AMR

You must add one or more users, and assign usernames and passwords. Click the **Security** tab, then click the **Enabled** radio button and populate the username/password fields (see Setting Up User Accounts on page 132).

Step 5: Connect to the AMR Wirelessly

Now that you have installed the Fleet Operations Workspace Core and configured the AMR for wireless communications, connect to your AMR.

1. (If not already running) double-click the MobilePlanner icon on your PC desktop.

Figure 4-11. MobilePlanner Desktop Icon

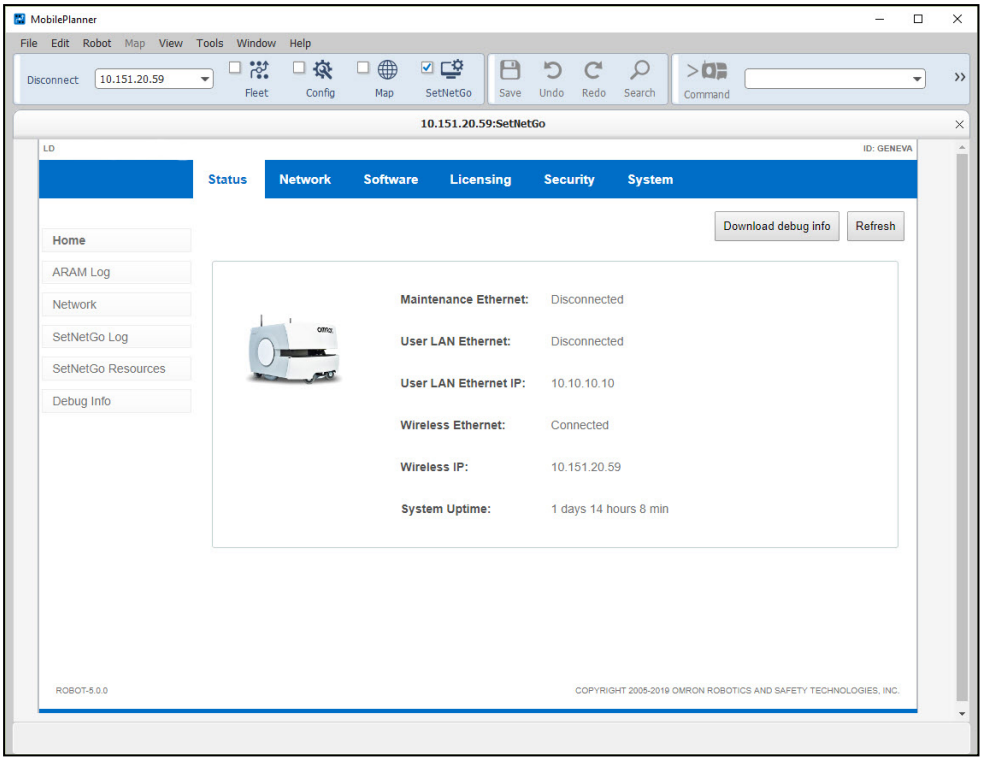


Figure 4-12. MobilePlanner Interface

> **NOTE:** If running MobilePlanner from an Operator account, the interface will look slightly different than above.

By default, the Fleet, Config, and Map buttons have checkmarks indicating those features will automatically load when you connect to the AMR.

2. In the **Connect** field, enter the IP address of the AMR, then click **Connect**.
3. Enter User Name and Password in the User Name and Password dialog box, then click **OK**.

> **NOTE:** If the SetNetGo button is checked, this User Name and Password dialog appears.

A login dialog appears in which you must enter a user name, password, and AMR server IP address.

> **NOTE:** After connecting to the AMR the first time, MobilePlanner remembers your user name. When connecting to the AMR again, you can select your user name from a combo box instead of having to re-enter, but you must still enter your password.

MobilePlanner completes its connection to the AMR. At this point, there is no map to load, so MobilePlanner opens with a blank map window.

Chapter 5: Using MobilePlanner Software

The MobilePlanner software is the "control center" of the Fleet Operations Workspace Core. Its user interface has the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, modifying AMR configurations, and more.

The following topics provide details on understanding and using the MobilePlanner features.

5.1 Overview of MobilePlanner

MobilePlanner has features you can use to scan the AMR environment, configure the AMR, create and edit maps, and more. The interface is designed to be user-friendly and efficient, which reduces the learning curve and the time needed for deployment.

The MobilePlanner interface supports the following languages:

- English
- French
- German
- Japanese
- Spanish
- Italian
- Korean
- Simplified Chinese
- Traditional Chinese

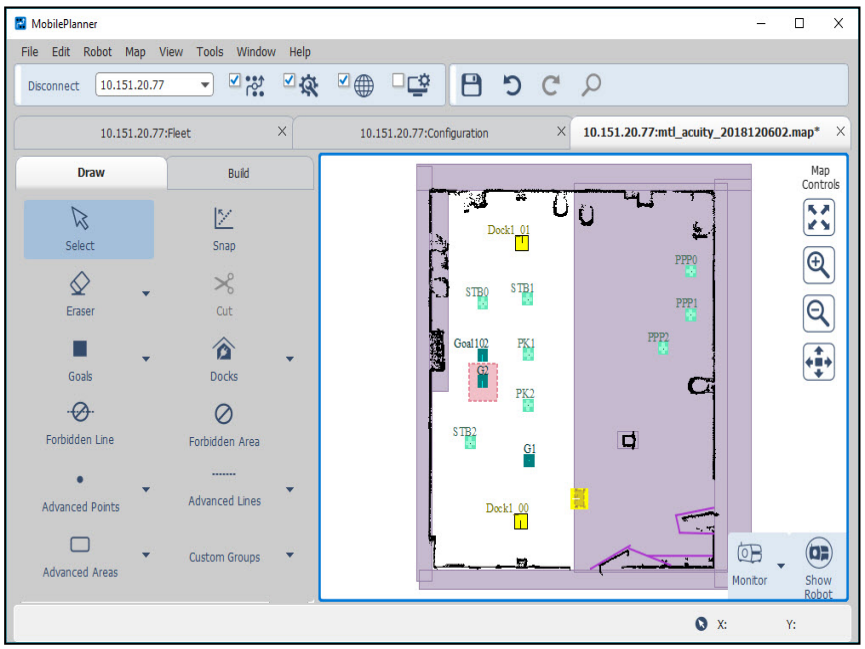


Table 5-1. MobilePlanner User Interface (with Map)

NOTE: While MobilePlanner is not necessary for each AMR, you must have at least one copy of MobilePlanner to create a map.

From the MobilePlanner interface, you can:

- Connect to and drive the AMR.
- Create maps of the environment by importing and analyzing an AMR's scan data.
- Edit maps by adding goals (and adding tasks to those goals), docks, forbidden areas, and more. You can also erase stray or unwanted artifacts, combine pieces of maps, and make other changes.
- Download and upload files, including maps and scan data, to and from an AMR.
- Set the system configuration parameters for the fleet.
- With the Fleet Manager, monitor the location and status of all AMRs in a fleet.
- View and interact with the job queuing manager.

These features allow you to create a map with goals, docks, and advanced lines and areas, and to start the AMR working in its environment.

5.2 MobilePlanner Interface

The MobilePlanner interface consists of the following main sections:

- Toolbar: Provides quick access to connection, mode buttons (Fleet, Config, Map, SetNetGo), file save, and undo/redo functions. Some of these items are also available from the File and Edit menus.
- Fleet button
- Config button
- Map button
- SetNetGo button

> **NOTE:** By default, the Fleet, Config, and Map buttons are checked, and will open each when you launch MobilePlanner and connect to an AMR.

The following figure is an example of the MobilePlanner interface showing a map of a single AMR, containing routes and goals. **Show Robot** is on, in the figure.

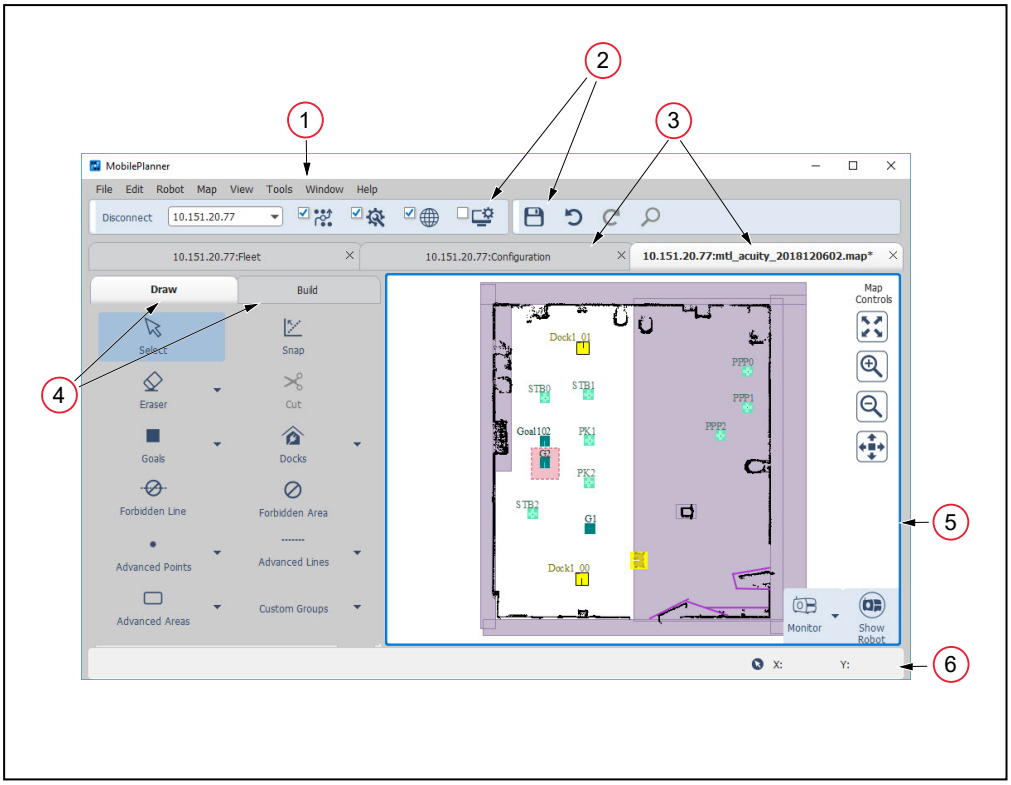


Figure 5-1. Sample MobilePlanner Interface

Table 5-2. MobilePlanner Interface Description

Item	Description
1	Main Menu
2	Toolbars
3	Mode Tabs
4	Function Tabs
5	Map Window
6	Tray

Configuration (Config) Tab

There are five tabs under the Config tab: Robot Interface, Robot Operation, Robot Physical, Fleet, and Debug. The many configuration parameters are covered in Configuring the AMR on page 140.

Map Tab

- When the map tab is selected, the main window displays a map of the AMR's operating space. The map consists of points and lines representing the walls, doors and other stationary features within the environment. For more details, see The MobilePlanner Map Window on page 70.

- The Draw and Build Tabs, to the left of the map, provide map editing tools, and tools for setting the AMR up to do tasks at goals (route building).
- Robot tools are visible below the map when **Show Robot** is toggled on. You can use these tools to drive, dock, adjust speed, etc. These items are also available from the Robot menu.
- To the right of the Robot tools is the Monitor icon. For details, see Using Monitor on page 68.
- The Status area, located below the map, (shown with **Show Robot** button toggled on) provides information on the AMR position, temperature, odometer, and battery charge. For details, see MobilePlanner Status and Tray Displays on page 75.

Map Features Legend

To view available map features in MobilePlanner, click **Map > Legend**. If **Show Robot** is on, the legend also shows map items associated with the AMR, like sensor readings, paths, etc.

SetNetGo Tab

The SetNetGo tab connects to the AMR's SetNetGo interface, and displays the various configurations associated with the AMR.

SetNetGo is the operating system residing on the AMR and EM2100. You use SetNetGo to configure and establish network communication with the AMR, download debug information, and perform software maintenance (upgrades).

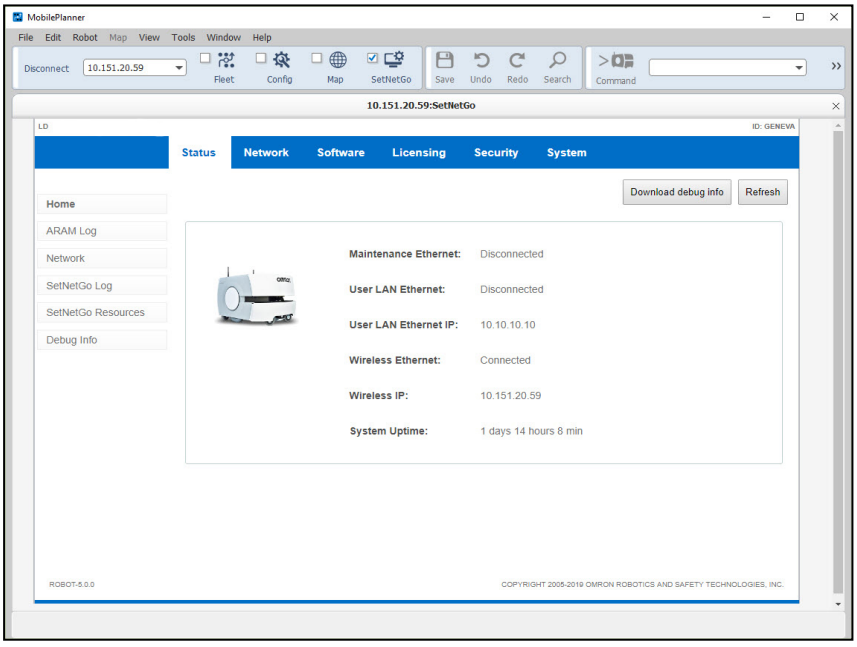


Figure 5-2. SetNetGo Interface

For details on the interface elements, see the remaining topics in this chapter.

5.3 MobilePlanner Operator Account Overview

Some sign-ins to MobilePlanner will be restricted to an Operator account (you can also select the MobilePlanner (Operator Mode) from the Windows Start menu).

An Operator account provides a limited set of tools for interfacing with AMRs or the Fleet Manager. Its main window, the Fleet window, shows the status of all AMRs in your fleet and their jobs, and allows for simple interventions in job execution sequences. Operator Mode does not support any setup operations, and the Map, Config, and SetNetGo windows are unavailable.

MobilePlanner Operator Account Interface

Operator Mode's simplified user interface focuses on monitoring fleet AMRs and jobs. It uses graphical elements to represent AMR statuses, and the status of all jobs (complete, in-progress, canceled, etc.).

To force the launch of MobilePlanner Operator Mode, click the Windows Start menu, and select **Start > All Programs > Omron > MobilePlanner5 > MobilePlanner (Operator Mode)**. When MobilePlanner (Operator Mode) opens, enter the IP address of an AMR or Fleet Manager, and click **Connect**.

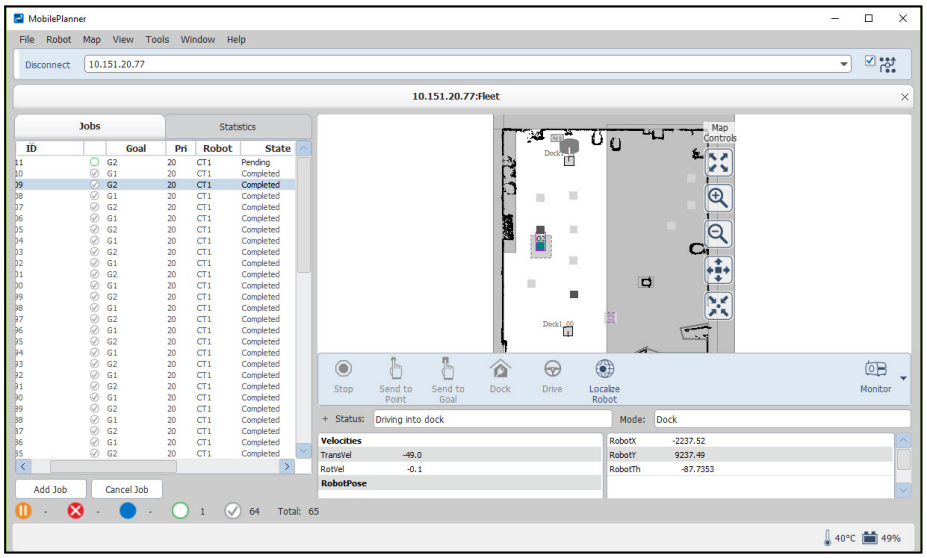


Figure 5-3. MobilePlanner Operator Mode UI

The MobilePlanner (Operator Mode) interface allows you to connect to and monitor multiple AMRs.

MobilePlanner Operator Mode Jobs Tab

The Jobs tab displays all jobs assigned to the AMRs (listed by job ID). For debugging purposes, you can also add a job to the currently monitored AMR by clicking the **Add Job** button (lower right corner of the window), which displays the Add Job window.

> **NOTE:** The Add Job window is not the primary method for submitting jobs to the fleet.

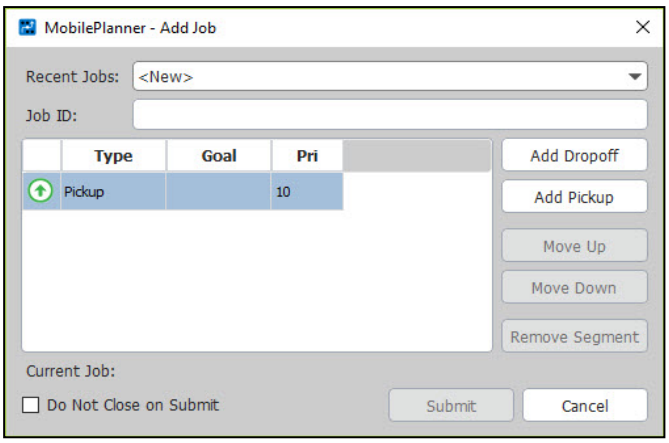


Figure 5-4. MobilePlanner Operator Mode Add Jobs window

Each job consists of multiple segments, and each segment has an associated goal. In this window, you can add or remove segments to or from a job, then submit the entire job to the queuing manager.

In this window, you can also add another job to the current job queue, assign a Job ID, set the job goal (double-click the field below Goal to display a drop-down list of goals), and set the job's priority.

Statistics Tab

The Statistics tab displays relevant statistics for your AMRs. Those statistics include:

- **FleetRobotInformation**: the number of AMRs currently connected to the Fleet Manager; their progress, and which are available and unavailable.
- **JobCounts:** the number of completed, canceled, and modified jobs and job segments.
- **LastTripReset:** the time (in sec), and human-readable date and time since last reset.
- **QueueInformation:** lists information about pending and in-progress jobs.
- **StateInformation:** information about the AMRs' states (driving time/distance, parking time, docking info, etc.).
- **TripJobCounts:** statistics related to the AMRs' job completion (number of completed, canceled, or modified jobs/segments).
- **TripStateInformation:** statistics about the AMRs' trips when completing jobs (distance driven or time spent at a particular job).

5.4 The MobilePlanner Menu

The MobilePlanner interface includes a menu bar to access to the tools for editing the AMR's map file. It also applies to other non-map windows, provides tools for driving the AMR, initiating scans, route building, and searching the Config, and importing/exporting Config files.

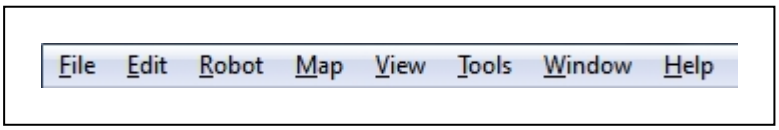


Figure 5-5. Menu Bar

The following table describes the menu bar selections.

Menu Option	Description
File	Allows you to open a local scan or map file, a map, scan, or configuration file on an AMR, save the map file, insert another map into the existing map file, and download or upload a files to/from an AMR. For more details, see File Menu on page 56.
Edit	Allows you to undo or redo your last command. For more details, see Edit Menu on page 58.
Robot	Gives you control over various AMR activities (stop, drive, dock/undock), allows you to monitor the AMR dashboard and/or fleet details, create custom commands, create a fleet message of the day, and reload a configuration or stop the AMR. For more details, see Robot Menu on page 59.
Map	Allows you work with and edit the displayed map file. For more details, see Map Menu on page 60.
View	Allows you to change the units used in the map, and turn the toolbar labels on and off. For more details, see View Menu on page 61.
Tools	Allows you to update preferences. For more details, see Tools Menu on page 62
Window	Allows you to access the different files open in the workspace and change the way the windows in MobilePlanner are displayed. You can choose to tile them in the workspace or have them cascade. For more details, see Window Menu on page 62.
Help	Provides help on the MobilePlanner interface. For more details, see Help Menu on page 63.

File Menu

Menu Option	Description
Open...	Opens a dialog, to search for and select a local map or a scan file to open.
Open on Robot	Opens a submenu, which lets you select and open a file located on a particular AMR or the Fleet Manager. • **Robot Host Name or IP Address** opens the login page for that AMR. This submenu shows a list of the most recently used AMRs or Fleet Managers. • **Select Robot...** allows you to open the login dialog box and choose a file located on a different AMR. Displays the MobilePlanner Robot Login dialog box. Once you select an AMR, you can search for and select a map or scan file (if available) to open. You can also access the Configuration and SetNetGo software on the AMR.

Close	Closes the active file.
Import Config...	(Available when the Configuration Editor is selected.) Opens a dialog to import an AMR configuration file into MobilePlanner.
Insert Map...	(Available when the Map mode tab is selected.) Opens a dialog to search for and select a local map file to open and insert into the active map file. Used for small changes to the physical environment that affect the AMR's route, eliminates the need to rescan the entire workspace. See Inserting a Map File into an Existing Map File on page 104 for more information on this feature.
Save	Writes changes to the active file, and saves either onto an AMR (if opened from an AMR) or disk (if opened from a PC).
Save As...	Opens the Save As dialog. Used to save the active file under a different name and to a particular location on the local PC. Note that you can also save to different file formats (such as JPG or SVG). In those cases, the new file is not displayed in the editor.
Save on Robot	Opens a submenu for saving changes to a particular AMR's map file. • ***Robot Name or IP Address*** opens the login page for the AMR associated with that IP address. This submenu lists the five most recently used AMRs. • **Select Robot...** opens the login dialog box for choosing a different AMR on which to save the map file. If configured for the AMR, the MobilePlanner Robot Login dialog box displays. Once connected to the AMR, you can save the map file. This menu option is only available in Map mode.
Download/Upload	Opens a submenu to transfer a file to or from a particular AMR (most commonly, a sound file to use with 'play,' or playBackgroundSound'). • ***Robot Name or IP Address*** opens the login page for the AMR associated with that IP address. This submenu lists the five most recently used AMRs. • **Select Robot...** opens the login dialog box for choosing a different AMR on which to save the map file. The MobilePlanner Robot Login dialog box displays. Once connected to the AMR, you can upload the map file to the AMR or download a map file from the AMR.
Exit	Closes the application.

Edit Menu

Menu Option	Description
Undo	Lets you undo the most recent action on the map file. This menu option is only available in Map and Config modes. **NOTE:** Undo is unavailable if you saved the map or configuration.
Redo	Lets you repeat the most recent action that you undid in the map file. This menu option is only available in Map and Config modes.
Search	Provides a search of Config parameter fields.

Robot Menu

Menu Option	Description
Stop	Stops the AMR when it is in motion.
Drive	Activates the Drive pad for driving the AMR in its environment.  **CAUTION:** Toggle the Manual Override to **OFF** to prevent the AMR from running into anything while you are driving it. If Manual Override mode is **ON**, the map background turns yellow, indicating "use caution" while driving. **NOTE:** Even in Manual Override mode, the AMR will avoid any obstacle detected by the navigation laser when traveling over 300 mm/s. **NOTE:** With **Show Robot** turned ON, you can access AMR drive icons from the Map view.
Dock	Sends the AMR to a dock.
Undock	Releases the AMR from the dock.
Monitor	(Same as the Monitor button in the map and robot tools menu). Allows you to view and/or configure various AMR details - battery info, digital inputs and outputs, audio, add and execute tasks, macros, and routes.
Debug	Allows you to trace underway tasks for debugging. **NOTE:** This is an advanced feature, used for debugging advanced functionality.
Custom Commands	Allows you to create and send custom commands to the AMR. This is used mainly for debug log file starts and stops.
Map Creation	Allows you to start and/or stop the AMR's scanning process, from which you can build a map file.
Messages	Allows you to create custom Fleet Manager and/or Robot Messages of the Day.
Robot Tools	Provides access to advanced AMR tools, including localizing, reloading configurations, auto-docking, and issuing shutdown commands for a single AMR or all AMRs in the fleet.
Safety Commissioning	Allows testing and commissioning (verification of proper function) of an AMR's on-board safety systems. Uses a wizard to test E-Stop (tests brake activation) and Safety Laser (tests max speed limits and obstacle detection). Per EN-1525, commissioning must be done by specially trained people. See Safety and Regulatory Information on page 18 for details on Safety Commissioning.

Map Menu

Menu Option	Description
Fit in Window	Adjusts the map so it all fits within the map window.
Grid	Displays the grid on in the map window. Grid line spacing is at 1 meter intervals. **NOTE:** The MobilePlanner grid is not the path planning grid or localization grid. It is simply for reference.
Origin	Displays the X/Y coordinates of the overall map. You must zoom the map view out to see the origin lines.
Robot Data	Allows you to control the display of various AMR-related map features such as sonar, laser, path, and localization.
Map Data	Opens a submenu, which lets you toggle the features to view on the active map file: • Points • Lines • Lights (if using Acuity)
Rotate	Opens a submenu, which lets you rotate the entire map in the map window. • Rotate Right • Rotate Left • Rotate Full 180° • Reset to None You can also save the rotated map as the default orientation.
Legend	Keeps track of all of the different features available in the map file. Each feature is identified on the map with a different color rectangle or line. For more details, see Map Modes on page 73.

View Menu

Menu Option	Description
Units	Opens a submenu in which you can change map units. You can select: • Millimeters (default) • Meters • Feet/Inches • Inches The units apply to values displayed in the status bar, in map object edit boxes, and when using a measuring stick. See Advanced Lines and Areas on page 103 for details.
Show Main Toolbar Labels	Toggles toolbar labels ON or OFF. To hide the labels, uncheck this menu option.
Configuration	Submenu allows user to toggle Show Deprecated Parameters.

Tools Menu

Menu Option	Description
Preferences...	Opens a dialog box with tabs for Comm and Computer ID parameters. • **Comm Tab:** Allows you to select Robot Server (from pick list), and set connection attributes for TCP/IP only, or reuse login information when reconnecting. • **Computer ID Tab:** Includes a field that displays the name of the computer on which the MobilePlanner installation exists (e.g., "John Doe's Laptop"), and allows you to select the goal nearest the AMR's current position. Click **OK** after making any configuration changes. Click **Reset...** reverts to initial installation-like state and resets all previous changes. Click **Cancel** to stop without making any changes.

Window Menu

Menu Option	Description
Tab	Arranges the open windows in tabs, just below the main toolbar. This is the default display mode.
Tile	Arranges the open windows as tiles, open next to each other.
Cascade	Arranges the open windows in a cascade, or waterfall, formation.
1:<*IPaddress*>:map	Contains a list of the open map and/or configuration files, or SetNetGo. Select from the list to make that the active window.
2:<*IPaddress*>:Configuration	
3:<*IPaddress*>:SetNetGo	

Help Menu	
Menu Option	**Description**
Fleet Operations Workspace Core User's Guide	Allows you to open a Windows type help version of this guide while using MobilePlanner software.
Document Library (online)	Provides link to: http://www.ia.omron.com/products/category/robotics/mobile-robots/index.html
What's This?	Selecting this menu option, or using the shortcut Shift + F1, and then clicking on the MobilePlanner workspace displays a pop-up containing a brief description of some features.
Open Output Log Folder	Opens the folder containing saved MobilePlanner output logs.
About MobilePlanner...	Provides information on the current version of MobilePlanner and underlying applications/libraries.

5.5 The MobilePlanner Toolbars

There are three toolbars possible in the MobilePlanner interface:

- The main toolbar, which is located at the top of the MobilePlanner interface.

In Map mode only:

- The Map Controls toolbar is a floating toolbar, which you can move within the map area.
- The AMR toolbar, below the map.

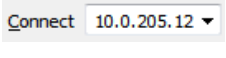
The following sections describe each set of tools.

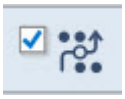
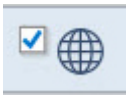
Main Toolbar

The MobilePlanner main toolbar is located at the top of the window, under the main menu.

Figure 5-6. Example of the Main Toolbar, SetNetGo Selected

Table 5-3. Main Toolbar Icons and Their Functions

Toolbar Icon	Description
	Connects to the AMR or server at the specified IP address. Use the drop-down list to select a previously-used IP address, or type a new IP address directly in the field.

	When an AMR or server is connected, this toggles to Disconnect.
	Opens the Fleet window, which shows status and job statistics for all AMRs in your fleet. It uses graphical icons to represent interrupted, canceled, in-progress, pending, and completed jobs. Click the checkbox to have the Fleet window open when you connect to an AMR or Fleet Manager.
	Displays the Configuration mode tab, which is used to set configuration parameters. For details, see Configuring the AMR on page 140. Click the checkbox to have the Config tab open when you connect to an AMR or Fleet Manager.
	Displays the Map mode tab, which is used to edit the map. For details, see Editing a Map File on page 93. Click the checkbox to have the map load when you connect to an AMR or Fleet Manager.
	Displays the SetNetGo mode tab, which is used to access the SetNetGo interface. For details, see Using the SetNetGo Software on page 114. Click the checkbox to have SetNetGo open when you connect to an AMR or Fleet Manager.
	Saves changes to the active map or configuration file on the AMR.
	Lets you undo the most recent action performed on the map or config file.
	Lets you restore the most recent item you undid in the map or config file.
	When MobilePlanner is in the Config mode, allows you to search all configurations for specific key words. Allows you to find parameters by name, or search for a specific word in a parameter's description (searching for 'preferred' in the example below). You can edit the Config values in the main tab or in the search results window. You can restrict the search to Non-Default parameters.

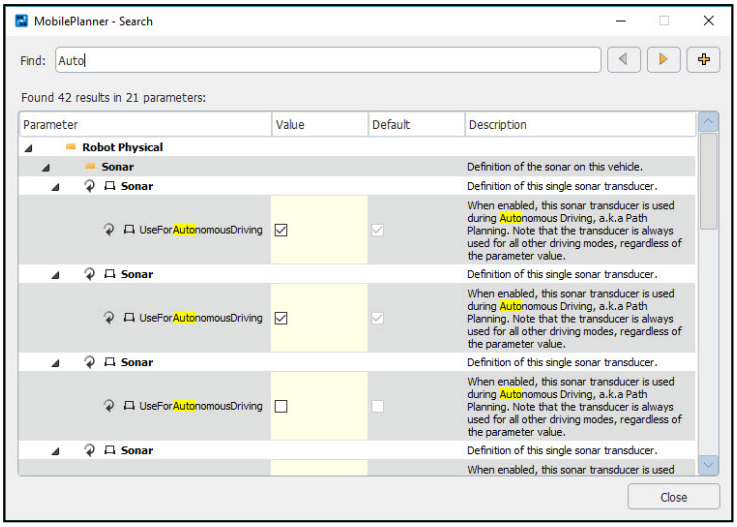


Figure 5-7. Search Window - Searching for 'Auto'

Robot and Map Toolbars

The map toolbars control the view of the map, set a goal at the AMR position, and localize the AMR. (Localizing is telling the AMR where it is on the map of the work area.) There are two different map toolbars available: one when the **Show Robot** button is toggled ON (the AMR is displayed on the map); the other with the **Show Robot** button toggled OFF (the AMR is hidden from the map).

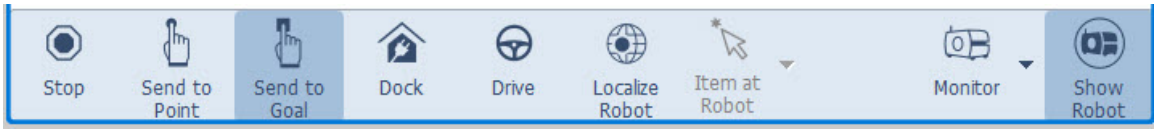
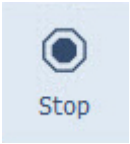
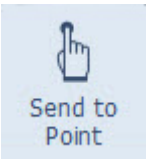


*Figure 5-8. Robot Toolbar (**Show Robot** ON)*

Figure 5-9. Floating Map Toolbar

Table 5-4. Robot and Map Toolbar Icons and Their Functions

Toolbar Icon	Description
Some of the following icons are available when the **Show Robot** button is toggled ON, but are disabled if the AMR cannot service the request because of low state of charge, or if E-Stop is pressed.	
	Stops the AMR any time you click this icon, even when navigating in autonomous mode. **NOTE:** You can also use your keyboard's **Esc** key to stop the AMR.
	Sends the AMR to a point you select on the map.
	Sends the AMR to a goal you select on the map.

	ON when the AMR is on a dock or heading to a dock. Also sends the AMR to a dock. When OFF, releases the AMR from the dock.
	Opens the Drive pad, which is used to move the AMR in its environment. Be sure that you have Manual Override toggled OFF, which prevents the AMR from running into anything while you are driving it. Even with Manual Override turned ON, the AMR will avoid any obstacles detected by its navigation laser when traveling over 300 mm/s. Highlight (click on) the pop-up window, and use the mouse or the arrow keys on the keyboard to move the AMR in the direction you want it to go.  **CAUTION:** When Manual Override is ON, the background of the map turns yellow, indicating "use caution" while driving.
	Opens the Localize Robot dialog, which is used to localize the AMR to a point selected on the map.
	Allows you to create a goal and/or door with goals, place a cart, or place a dock at the AMR's current location.
	The Monitor robot feature is available only when the **Show Robot** button is toggled on. It provides a convenient place to monitor important AMR details (battery info, state, job counts, sensors, and queuing stats), and the status of digital inputs/outputs. It also provides a place for sending an AMR on a route, adjusting audio input/output volumes, and inputting Say commands (phrases that the AMR speaks with its text-to-speech converter).
	Shows the location of the AMR on the map. Several toolbar features won't function unless this is toggled ON. Others won't function unless it is toggled OFF. The background color of the icon turns darker when it is ON.
	Centers the map on the current AMR. This is helpful when you have multiple AMRs in your workspace and you need to locate a specific AMR quickly. It also allows you to watch the AMR as it performs tasks.
	Adjusts the map view to fit in the map window.

	Zooms map out (reduced magnification, more map visible).
	Zooms map in (increased magnification, more details visible).
	Allows you to pan around the map. 1. Click on the **Pan** icon to display the Pan Map box. 2. Click on any of the four arrows of the Pan Map box to move that direction in the map. The keyboard arrow keys perform the same function as clicking on the Pan Map arrows. **NOTE:** If Center on Robot is turned on, you cannot pan the map window. **NOTE:** You can also pan the map by clicking and holding the right mouse button while moving the mouse around the workspace. The Pan Up, Pan Down, Pan Left and Pan Right icons are available when the Pan button is turned on.

5.6 Using Monitor

The Monitor feature provides a convenient place to monitor important AMR and Fleet Manager details (battery info, state, job counts, sensors, and queuing stats), and the status of digital inputs/outputs.

It also provides a place for sending an AMR on a route, adjusting audio input/output volumes, and inputting *Say* commands (phrases that the AMR speaks with its text-to-speech converter).

Monitor can be activated either in single AMR or Fleet mode, when you are attached to a Fleet Manager.

The displayed data and appearance will differ, depending on whether you are connected to a Fleet Manager or an AMR, and whether or not the **Show Robot** button is ON.

To Access Monitor

1. Click **Monitor** on the Robot toolbar to display a sub-menu with various AMR attributes you can monitor.

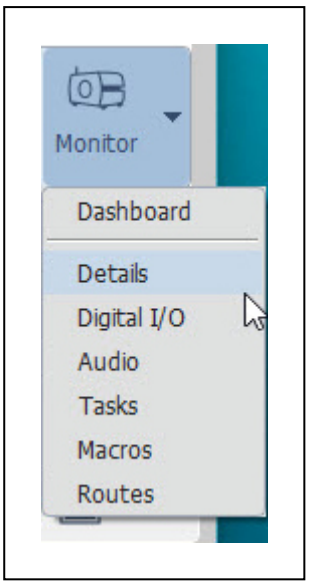


Figure 5-10. Monitor Drop-down Menu

The following table describes the various attributes you can monitor.

Item	Description
Dashboard	Displays an information window listing jobs (number of interrupted, canceled, in-progress, pending, and completed) and AMRs (that need assistance, have E-Stop pressed, busy, available, and unavailable).
Fleet Details	Lists information about AMRs in the fleet - availability, status of assigned jobs, queuing and state information, system status, and memory use.
Details	Lists specific details about the currently monitored AMR - battery/charge stats, path planning and following, AMR pose information, queuing statistics, system data, and wireless data.
Digital I/O	Allows you to monitor custom input/output states, and toggle output states ON (green) or OFF (black).
Audio	Controls incoming and outgoing audio volume. Audio Incoming: MobilePlanner Out: controls the level out (for example, 'sendSpeech'). Audio (Output): Robot Out controls the volume of speech audio files the AMR plays.
Tasks	Lists current tasks assigned to monitored AMR, and allows you to add them to the selected route builder list (normally a goal versus a route).
Macros	Lists and allows immediate execution of all existing macros.

Item	Description
Routes	Lists and allows immediate execution of all existing routes.

Adjusting Audio Levels

The robot monitor also allows you to adjust the incoming and outgoing audio levels. These controls are shown in the following figure.

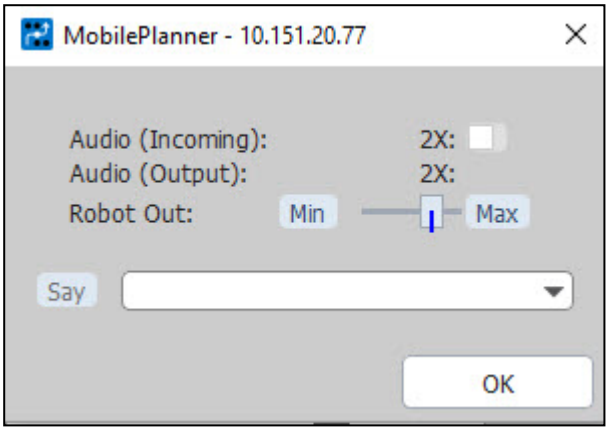


Figure 5-11. Audio Controls

You can adjust audio output level by moving the slide controls to the right (louder) or left (quieter). You can amplify the effect of the incoming audio control setting by selecting the 2X check box.

Making the Robot Talk

The Monitor > Audio window includes a text-to-speech feature. You can use the "Say" field to input a word or phrase that you want the AMR to speak.

When you click the **Say** icon, the text is converted to synthesized speech through the text-to-speech converter.

5.7 The MobilePlanner Map Window

The MobilePlanner Map window displays the map file that you are editing. When you first start MobilePlanner, no map is displayed until you connect to an AMR or Fleet Manager. You can also open a map saved locally on your computer or network. For details on opening maps, see Loading an Existing Map File on page 91.

Below is an example of the MobilePlanner interface with a map file opened. Note that the **Show Robot** button is toggled OFF, which exposes the tools on the Draw function tab.

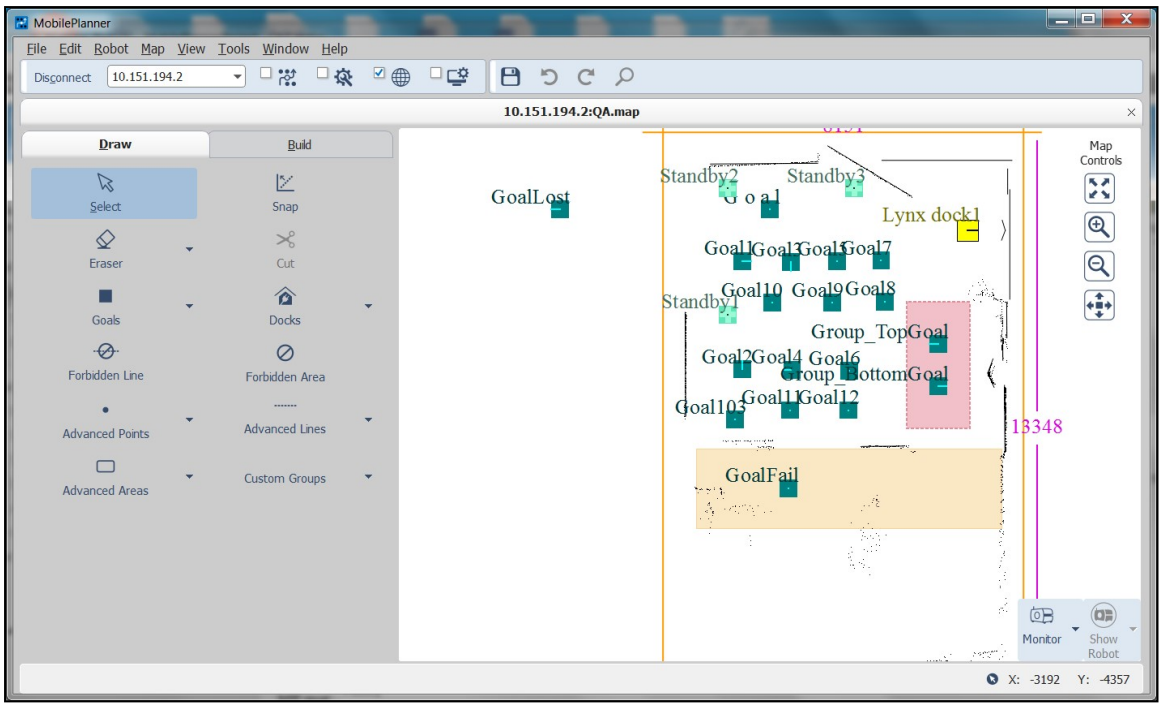


*Figure 5-12. The MobilePlanner Interface, Map Tab, **Show Robot** OFF*

NOTE: To create the initial map, you must first use MobilePlanner to scan the AMR's environment and then turn the scan into a map. For details, see Scanning the Operating Area on page 88.

Map Zoom

Maps initially open zoomed out to give you an overall view of the AMR's environment. To quickly find the current AMR in the map, click the **Show Robot** button, then click Center on Robot. The map zooms in, focused on the AMR.

NOTE: The **Show Robot** button must be **ON** to display the Center on Robot icon.

Map Controls

You can use the mouse or the keyboard to adjust the map view. The following table describes the map controls.

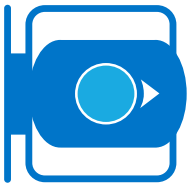
To...	Do this...
Pan	**Mouse:** press and hold the right mouse button (or use the scroll wheel), move the mouse around the workspace. **Keyboard:** use the arrow keys to move right, left, up and down. **NOTE:** You can't pan the map when the Center on Robot tool-bar icon is toggled ON.
Zoom in	**Mouse:** press the Shift key and click the right mouse button; or you can rotate the scroll wheel forward (without the Shift key). **Keyboard:** press the Shift key and the Up arrow.
Zoom out	**Mouse:** press the Shift key and click the left mouse button; or you can rotate the scroll wheel backward (without the Shift key). **Keyboard:** press the Shift key and the Down arrow.

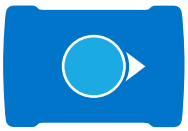
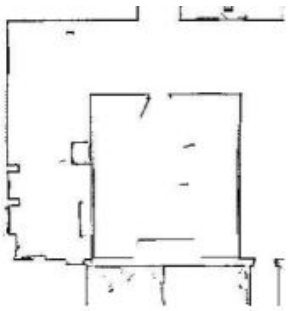
Map Features

Map features can be as simple as the static features of the environment (walls, doors, etc.) or, depending on the features you add to the map, they can be quite intricate. In general, more map detail improves AMR navigation.

To create a detailed map of the environment, you need to scan the environment thoroughly and then edit the map. This is done in the MobilePlanner software. For more information on environment scanning and map editing, refer to Scanning the Operating Area and Editing a Map File on page 93.

The following table describes the different features shown on the map.

Map Feature	Definition
	This represents the LD-60 and LD-90 AMRs. Notice that the white arrowhead indicates the direction that the AMR is currently facing.
	This represents the Cart Transporter. Notice that the white arrowhead indicates the direction that the AMR is currently facing.
	This represents the LD-250 AMR. Notice that the white arrowhead indicates the direction that the AMR is currently facing.

Map Feature	Definition
	This represents the HD-1500 AMR. Notice that the white arrowhead indicates the direction that the AMR is currently facing.
	This is the Legacy representation of a robot. Notice that the black line indicates the direction that the AMR is currently facing. This may still apear in some system maps.
	The black dots and lines on the map are the walls, doors, and other static fixtures in the environment.
	The blue dots and lines are the features the AMR "sees" with its navigation laser. Some AMRs have additional lasers which produce different colored dots.
	The yellow squares represent the location where the AMR should go, and the black line is the direction it should face, when it starts to dock. The dock object should be approximately 1 to 1.5 meters in front of the dock.
	The green squares represent a goal. The line indicates the AMR's desired heading when it reaches the goal. Goals are predefined locations where you can send the AMR.
	The light turquoise squares represent Standby Goals. These can be either buffering or parking.

Map Modes

When **Show Robot** is on, there are several map modes which provide a different AMR function (see the following table):

Icon	Map Mode	Definition
	Send Robot	Allows you to send the AMR to a certain spot on the map. When active, clicking on the map causes the AMR to move to that spot. To activate this mode, click **Send Robot** on the Toolbar, then click on the map with the left mouse button to send the AMR to that point. You can also send the AMR by holding down the **Ctrl** key and clicking on the map. To specify the AMR's desired heading when it arrives at the designated spot, press the mouse button and drag. To deactivate this mode, click the **Send Robot** icon to toggle it off. After you click a point on the map, the AMR (the red oval) autonomously drives to the point you selected.
	Robot Control	Allows you to drive or send the AMR using the keyboard. To activate this mode, hold down the **Ctrl** key and press the arrow keys.
	Localize to Point	Allows you to localize (mark the AMR's location) the AMR on the map. See AMR Localization on page 228 for details.

NOTE: When **Show Robot** is OFF, the cursor shape indicates what your mouse click or movement will do (see the following table). These cursors are visible after selecting an object.

Cursor	Function	Appears when you…
	Open the Edit window (double-click), or drag the object within the map.	Double-click or click-and-hold on an object, other than on a heading marker or endpoint.
	Change the heading of a goal or dock, or resize a line.	Click on the goal/-dock heading marker or either end of a line.
	Resize a rectangular object (the cursor is rotated 90° depending on which corner you pick).	Click on a corner of an area or sector.
	Rotate the object.	Click on the heading arrowhead of an area.

Map Legend

As you edit the map file, you can create goals, lines, forbidden areas, docks and many other features in the environment. Use the Map Legend to keep track of all of the different features that can be added to your map file.

Select **Map > Legend...** from the main menu to open the Map Legend window.

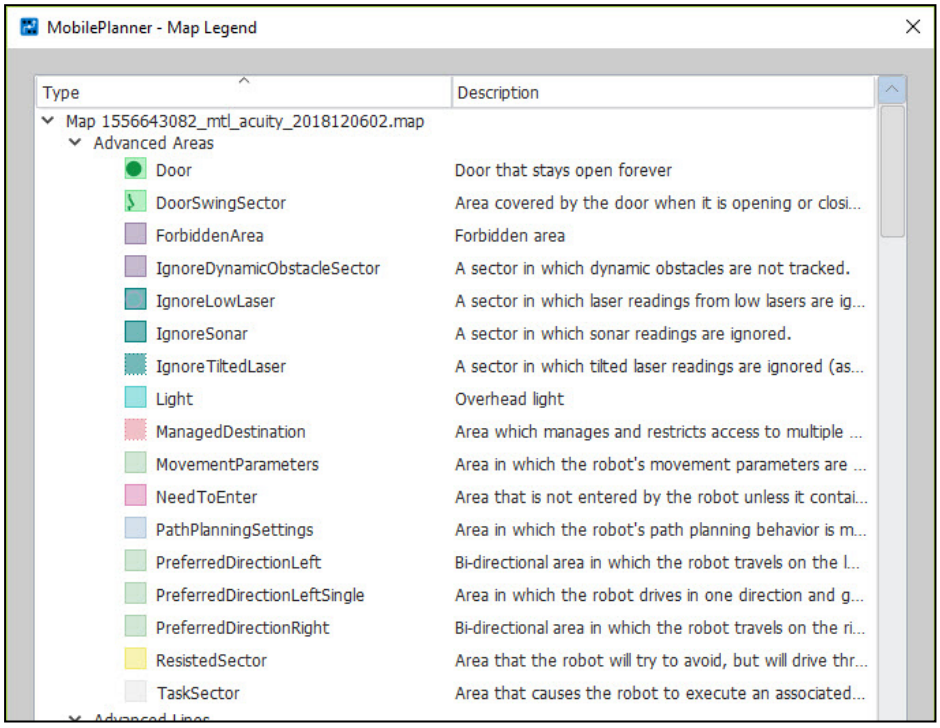


Figure 5-13. Map Legend (Partial)

5.8 MobilePlanner Status and Tray Displays

The status and tray displays allow you to monitor the status of the AMR (or AMRs) directly from the software interface.

Status Information

The status of the selected (red) AMR is displayed directly beneath the map, as shown in the following figure.

> **NOTE:** In MobilePlanner, the Status area is only visible when the Show Robot button is toggled ON.

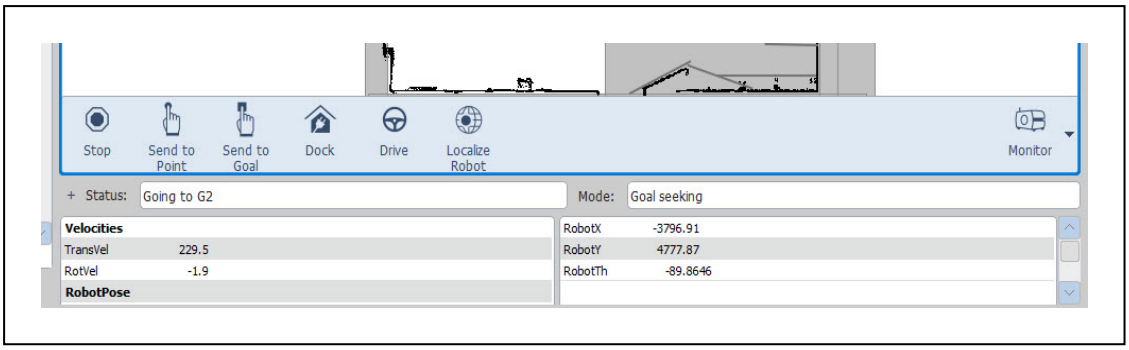


Figure 5-14. Status Information

The following table describes some of the available status information.

> **NOTE:** By default, the status area shows only a small sub-set of available AMR details. To view other data, see Displaying Other AMR-Specific Details (below).

Status Detail	Description
RobotX and RobotY	The current X and Y position of the AMR in its operating space.
RobotTh	Robot theta - the AMR's heading (which way it's facing), in °, measured counter-clockwise. 0 is the x axis.
TransVel	The velocity of the AMR.
RotVel	The AMR's rotational velocity (how fast it is turning).

Displaying Other AMR-Specific Details

There are many other AMR-specific parameters you can choose to display in the status area. To view and/or add other AMR details, in the MobilePlanner main menu, select **Robot > Monitor > Details**.

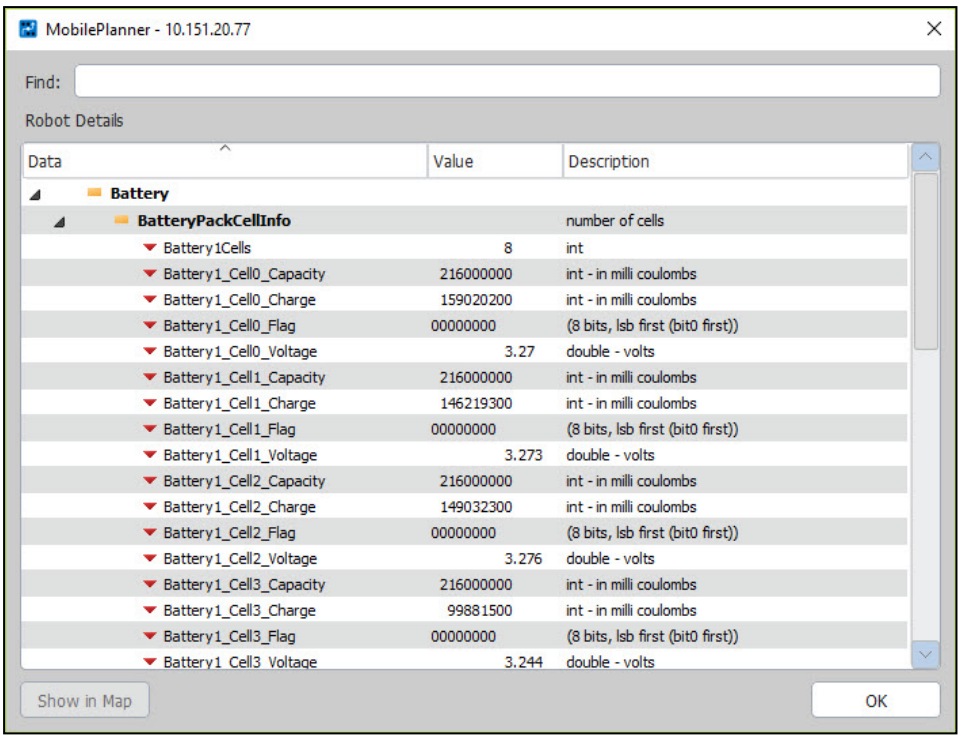


Figure 5-15. Robot Details Window

If you want to add a detail to the status area, click on the detail, then click the **Show in Map** button (lower left corner). Or, you can right-click in the status area to Hide in Map.

Tray Information

Below the status area, there is a tray that contains information such as connection status and the pointer location.

NOTE: The tray information is always visible.

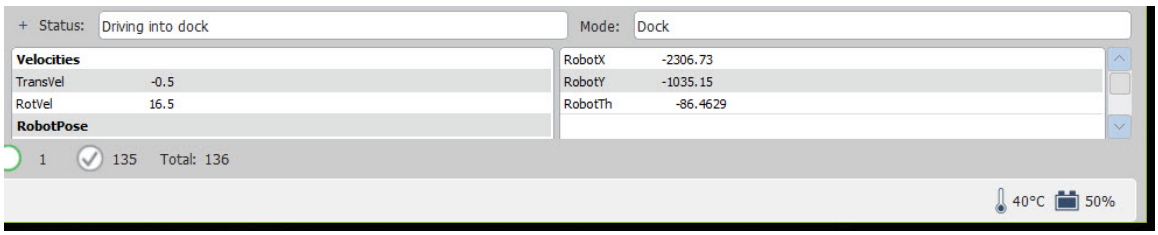


Figure 5-16. Tray Information

The following table describes the items available in the tray.

Tray Icons	Description
	Displays the temperature reading of the current AMR.
	Indicates the state of charge (in %). The icon turns yellow when the charge begins to run low. It flashes red when the battery is low and the AMR needs to dock.
X:	Shows the X position of the pointer.
Y:	Shows the Y position of the pointer.

Chapter 6: AMR Driving Overview

Now that you have installed the MobilePlanner and set up a wireless connection to your AMR, you are just about ready to drive the AMR around your workspace. You can drive the AMR using either the pendant and walking around your environment, or operating it from the MobilePlanner software. Using the mouse and keyboard, you can dock and undock the AMR from its docking station, drive the AMR forward, backward, turn the AMR, and control its speed.

CAUTION: Before attempting to drive the AMR, be sure to read the appropriate AMR user's guide and Mobile Robot Safety Guide so you are familiar with the AMR's operation.

6.1 Before Driving the AMR

Whether you are driving the AMR with the pendant or from MobilePlanner, be sure the AMR is not docked.

6.2 Manual Override

Autonomous Drive mode is the AMR's default driving mode, and ensures the AMR does not run into anything in its environment. When driving the AMR using MobilePlanner, Autonomous Drive mode prevents the AMR from entering forbidden or restricted spaces. If driving the AMR using the pendant, you can have the AMR enter forbidden or restricted spaces, but the AMR always obeys the lasers for obstacle avoidance.

When Manual Override is ON, the map background turns yellow (see below).

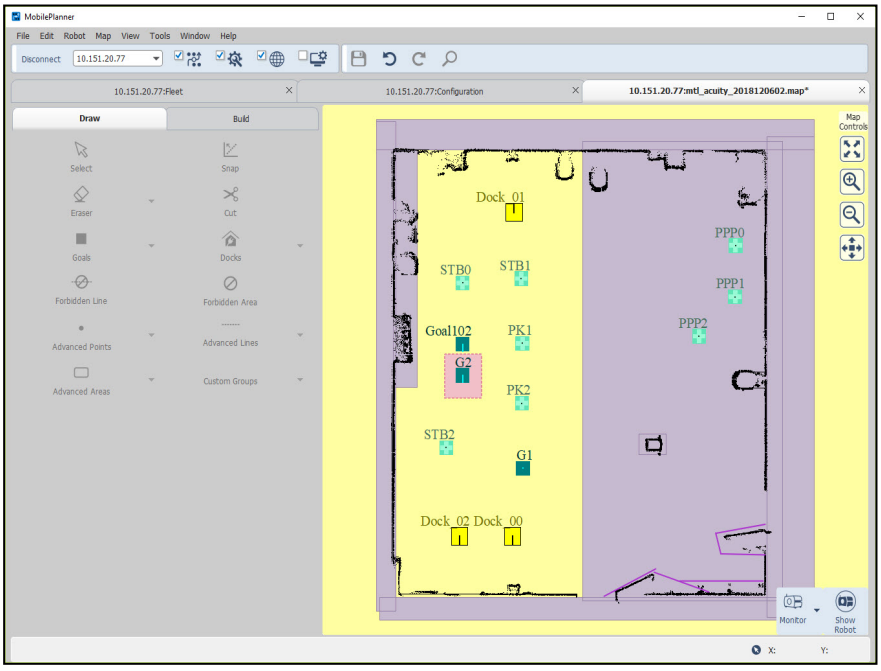


Figure 6-1. MobilePlanner, Manual Override ON

To drive with Autonomous Drive mode OFF:

1. In the MobilePlanner main menu, click **Robot > Robot Tools > Manual Override**.
2. Click **Yes** to acknowledge the Manual Override dialog prompt.

NOTE: If you turn Autonomous Drive mode back ON when the AMR is in a restricted or forbidden area, it will not be able to drive itself out of the restricted area, and will require you driving it out using the pendant (which always ignores location-dependent areas). Also, while an AMR is in a forbidden area, even with Autonomous Drive mode still OFF, pressing the **Send Robot** button will not cause the AMR to drive out of the forbidden area. You must drive the AMR out of a forbidden area using the pendant or your PC's arrow keys. See Driving Using the Software Interface (Drive Pad or keyboard) on page 83.

6.3 Driving Using the Pendant

This section provides information on the pendant. Also see your AMR's user guide.

Preparation

1. If not already done, power up the AMR (press and release the AMR's ON button). The full power-up sequence can take several minutes.
2. Wait for MobilePlanner and/or the AMR to indicate it is ready (via wheel lights, LCD or touch screen).
3. Plug the pendant into the AMR's pendant connection port.

   For LD-series AMRs, this port is under an access panel on the left rear side of the AMR, as shown in the following figure:

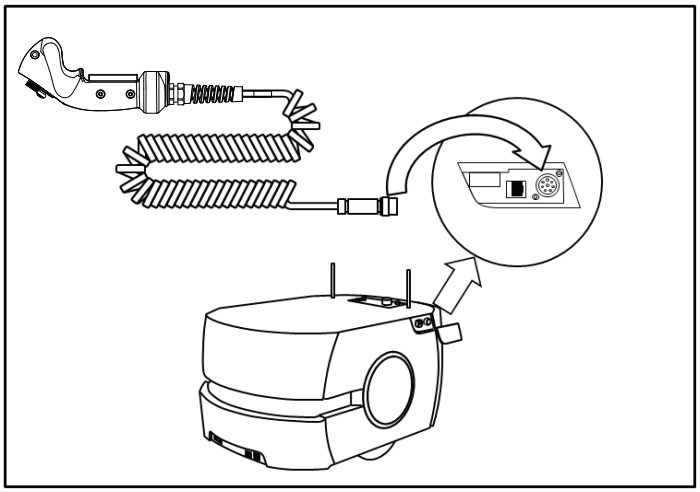


Figure 6-2. Connecting the Pendant to an LD-60

For the HD-1500 AMR, the pendant port is on the right side of the Operator panel, on the rear end of the AMR.

CAUTION: Driving the AMR with a pendant overrides the hardware safety features (E-stop, sonar). Use caution when driving the AMR with a pendant.

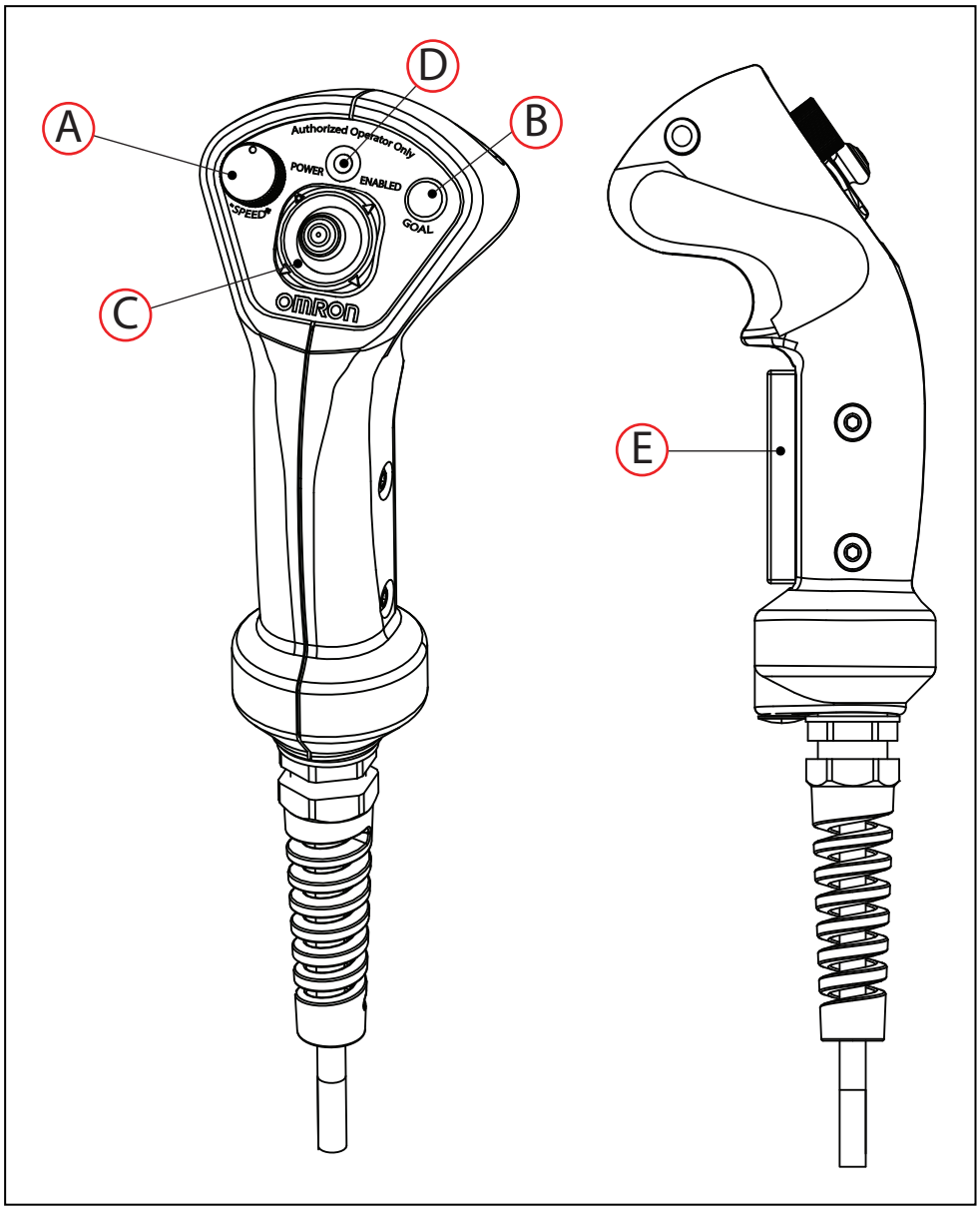


Figure 6-3. Pendant Controls

Callout	Description	Callout	Description
A	Speed Control	D	Power Enabled LED
B	Goal Button	E	3-Position Enable Switch
C	Directional Control		

- The green LED indicates that the pendant is plugged into a live connection.
- Squeeze and hold the trigger in, then:
  - Push the directional control forward or back to drive the AMR forward or back.
  - Push the directional control to the left or right to turn the AMR to the left or right.
- The AMR slows to a stop when you release the trigger. To stop more quickly, continue to hold the trigger down and pull or push the directional control to its limit in the opposite direction of the AMR's travel.
- Speed is related to the positions of the directional control and the SPEED control.
- The pendant's GOAL button is primarily for marking positions while making a map scan, but can be configured to perform other actions while not making a map scan.

NOTE: If driving with the pendant, proceed to Scanning the Operating Area on page 88.

6.4 Driving Using the Software Interface (Drive Pad or keyboard)

NOTE: The Drive Pad functionality is not available for the HD-1500 AMR. The Drive Pad display will be greyed-out. Its operation is not changed for the LD AMRs.

Using MobilePlanner software and your PC's mouse and keyboard, you can:

- Dock and undock the AMR from a docking station
- Drive the AMR forwards, backwards, and turn
- Control the AMR's speed

To drive the AMR using the software:

1. Ensure **Show Robot** is active, then click **Center on Robot** to locate the AMR (shown as a red oval icon) in the map window (shown in the following figure).

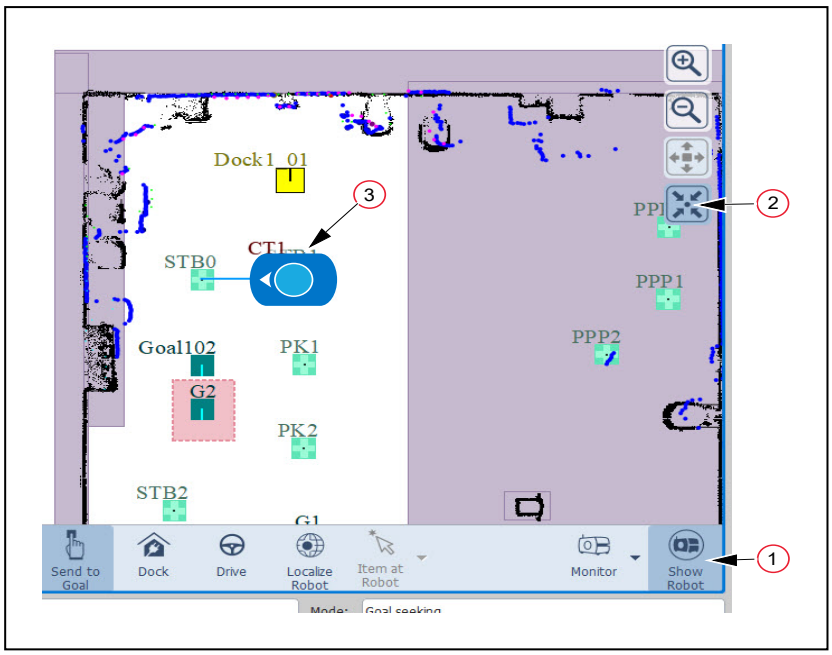


*Figure 6-4. AMR on Map (**Show Robot** Active)*

Table 6-1. AMR on Map Description

Item	Description
1	Show Robot
2	Center on Robot
3	Robot (LD AMR shown)

2. Select **Robot > Undock** from the main menu, or click **Dock** (on the AMR tool bar) to turn docking off. In the map window, you should see the AMR move away from the docking station.
3. If the background in MobilePlanner is yellow (the AMR is not in Autonomous Drive mode), un-check **Robot > Robot Tools > Manual Override** from the MobilePlanner main menu.
4. Click **Drive** to display the MobilePlanner Drive pad with Speed slider (figure below).

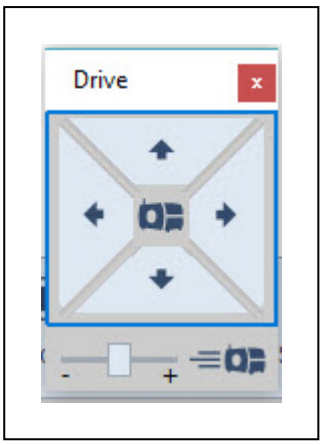


Figure 6-5. Drive Pad with Speed Slider

5. Highlight (click on) the map window, and use the mouse to click on the drive pad buttons, or use keyboard's arrow keys to control the AMR's direction. Use the speed slider (at the bottom of the Drive pad) to control the AMR's speed.

   NOTE: If the speed slider is all the way to the left (-), the speed is set to zero and the AMR will not move.

Chapter 7: Scans and Maps

7.1 Map Overview

With Fleet Operations Workspace Core software, AMRs know where they are and drive from one place to another by themselves, without a human operator. To do this, the AMR must have a prepared map of the static features in its operating environment. MobilePlanner software makes creating maps for one, or an entire fleet of AMRs fast and easy.

Maps are one of the most important features of MobilePlanner. In MobilePlanner, a map is a scanned representation of the floor plan in the AMR's operating space. Maps contain the static features in the AMR's environment, such as walls, doors, permanent shelving, etc. They also contain user-definable sectors, lines, and areas that help the AMR perform its job.

7.2 Scan Overview

The next step is to create a map of the AMR's environment. In general, the process is as follows:

- Read the section on scanning (see Scanning Overview on page 86), and the section on scanning tips.
- Read the section on driving the AMR (see AMR Driving Overview on page 80).
- Scan the AMR's operating space (see Scanning the Operating Area on page 88).
- Use MobilePlanner to generate a map from the scan.

7.3 Scanning Overview

Before the AMR can perform autonomous tasks, it needs to have an accurate map of its environment. It is best to create a scan that includes as many stationary features as possible in the workspace. After scanning, use MobilePlanner to turn the scan into a map, then begin assigning tasks to your AMR.

How Does the AMR Scan its Environment?

The AMR uses its forward laser, which scans in a 240° arc for the LD-series AMRs. The HD-1500 AMR uses only its front laser, scanning in a 270° arc. Note that the HD front (and rear) laser is not centered on the AMR.

What Gets Scanned?

Scans are on a thin horizontal plane. The scan is taken about 7.9 inches (200 mm) for the LD-series and 6.9 inches (175 mm) for the HD-1500 off the floor. So tables appear as four legs; a pedestal appears as a single pole, minus the feet.

Distance From Walls

The AMR's sensing range is 30 meters (about 98 feet). While scanning, keep walls within that range as you drive throughout the workspace. For instance in a large warehouse, run the AMR

along the outer walls as well as through the middle of the space.

Uni-directional Versus Bi-directional Scanning

Uni-directional scanning (or scanning in a single direction) works very well for hallways and small rooms. Bi-directional scanning (or scanning in two directions) will ensure complete scanning of all features (such as vending machines or bookshelves).

Doors and Windows

When scanning environments with doors, ensure the doors are open in places where the AMR will drive. Some glass surfaces, particularly those with dark backgrounds, reflect the range finder signals; others don't or reflect weakly. Consider retrofitting particularly troublesome places with tape or other treatments to obtain proper scans. Additionally, you can designate these features as obstacles in the map using a forbidden zone sector.

Dynamic Features

During scanning, MobilePlanner sees people walking by, swinging doors and other things moving throughout the workspace. If a group forms during scanning, have them follow behind (not stand in front of) the AMR's scanner so they do not become permanent features of your map. For an HD-1500, have them stand behind and to the left, since the laser being used for scanning is on the front-right of the AMR. When editing the map, erase dynamic features (like the group) to improve the map's quality.

Docks

When scanning, scan and press the goal button to mark the AMR's dock so it can recharge when its battery runs low.

Scanning Tips

The following general tips will help increase the AMR's scanning accuracy, and reduce possible map errors:

- Remove any features like chairs, rolling cabinets, etc. that might not be present during normal operations.
- Walk behind the AMR while scanning (and ensure others walking with the AMR also walk behind the laser's sensing area). With an HD-1500, walk behind and to the left of the AMR, so that the laser (on the front right) doesn't see you.
- Drive the AMR into tight corners, down small corridors, and between stationary objects (with enough room).
- Scan in multiple directions - scan clockwise for one scan, counter-clockwise for another.
- If scanning rough terrain (like diamond plate flooring), drive slowly (to reduce the chances of wheel slip) and in multiple directions. This will help minimize introducing errors into the scan.
- Open doors that might be open during normal operations, and doors the AMR will have to drive through.
- Drive the AMR through previously scanned areas.

NOTE: Driving the AMR back through previously scanned areas, and returning to its starting position can help minimize errors.

Scanning the Operating Area

Be sure to drive the AMR to all of the places you would expect it to go on its own. Drive all the way around a room, not just in and out of the doorway. Turn the AMR to point into corners and move around stationary features. In other words, be thorough!

Also, while driving the AMR, orient and stop it along the way to mark important goals (especially a dock object). Later, you can edit these and add additional goals within MobilePlanner software.

1. If not already done, launch MobilePlanner and connect to the AMR.

   NOTE: Before starting these steps, make sure the AMR is not charging. If the AMR is docked, undock it by clicking **Robot > Dock** (in the MobilePlanner main menu bar), or by clicking the Dock button in the MobilePlanner toolbar (only visible if **Show Robot** is active).

2. From the MobilePlanner main menu, select: **Robot > Map Creation > Start Scan**.

3. Enter a name for your scan file in the **New Scan Name** field and click **OK**.

   This initiates the scanning process. Notice that the AMR's LCD changes to map scanning mode.

   NOTE: Before driving the AMR, make sure it is in Autonomous Drive mode (a yellow background in MobilePlanner indicates the AMR is not in Autonomous Drive mode). To enable Autonomous Drive mode, un-check **Robot > Robot Tools > Manual Override** in the MobilePlanner main menu bar.

4. Use the pendant and drive the AMR around its operating space.

   NOTE: Be sure to drive the AMR around the entire operating area to create an accurate scan of your environment.

5. If you want to create a goal at the point where the AMR is stopped, press the pendant's black GOAL button to mark a goal.

6. Continue driving the AMR around until you have a thorough scan of your environment.

7. Return the AMR to its starting position.

8. After you have finished the scan, select **Robot > Map Creation > Stop Scan** from the MobilePlanner menu.

The resulting scan file resides on your AMR, but not on the PC running MobilePlanner. The file name is the name you entered for the scan with the '.2d' extension. If scanning using Acuity, the file name has a ".z2d" extension, and includes additional data such as camera images used to scan overhead lights.

NOTE: Acuity Localization is not yet supported for the HD-1500 AMR.

Convert the Scan into a Map

After the AMR scans the operating environment, you need to turn the scan file into a map file. To do this, open the scan file (.2d) in MobilePlanner.

> **NOTE:** MobilePlanner can process only one scan file at a time. Opening a second scan file disables the toolbar Start button until the first scan is finished.

1. Open the MobilePlanner software.
2. Select **File > Open on Robot,** then select the AMR, either from a list or by IP address.

   The **Open File on Robot** dialog box appears.

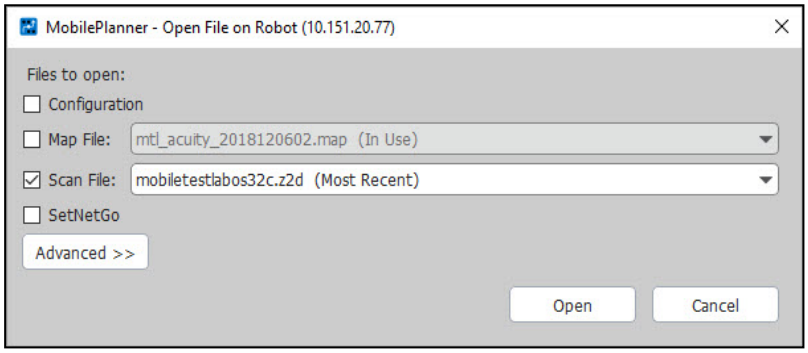


Figure 7-1. Open File on Robot Dialog

3. Check the **Scan File:** checkbox, select the scan file you just created from the pulldown list, and click **Open**.

   A new map window and the Scan Tools toolbar appear, and the conversion (registration) process begins automatically. Initially, the map shows an AMR icon in the map window. During file processing, the software adds scan points to the map window and updates the AMR's position showing a blue trail to trace the AMR's previous positions.

   > **NOTE:** Be patient! Converting a large scan file can take considerable time (and memory), and is based on the size and layout of the area being scanned (for example, a small facility could take 20 seconds, a 20,000 square foot facility could take over an hour). If the small AMR icon in the lower right corner of the map window is still moving, the conversion process is still underway.

   > **NOTE:** PC memory (RAM) is critical when processing a very large scan file. Processing large scan files with insufficient RAM can significantly degrade the performance of all applications. If this occurs, it might be necessary to create smaller scan files and use the Map Insert feature to assemble the pieces (refer to Inserting a Map File into an Existing Map File on page 104 for details).

   When processing is complete, the AMR icon and its trail disappear from the map window, and the scan icon in the status bar stops animating. If the map has too many stray

objects or otherwise does not appear as you need, you can adjust the scan settings and re-process the scan file (for details, refer to Changing the Scan Settings on page 109).

4. **Save** the cleaned map file locally on your PC.
5. In the Scan Tools toolbar, click **Finish** to complete the conversion process.

   NOTE: Unless working in batch mode, you must finish converting one scan before opening and converting another scan.

6. Edit the map file to erase (**Draw pane > Eraser**) stray, non-stationary objects (like chairs, people, etc.). Add forbidden areas and sectors. Create goals and macros, and assign tasks to your AMR. Refer to Editing a Map File on page 93.
7. Select **File > Save on Robot** to save the finished map file on the AMR, then select your AMR from the MobilePlanner menu. Optionally, you can enter a Fleet Manager address so it can be shared between multiple AMRs.

   NOTE: Select **Yes** when prompted to make the new map the AMR's current map so the AMR can localize, and appear on the map (when you click **Show Robot**).

Map Data

The finished map consists of points and lines (vectors derived from points) representing the walls and other real features detected by the scanning laser.

Figure 7-2. Scanned Environment

7.4 Working with Map Files

This section explains map files and how to work with them in the MobilePlanner software.

Making a Map

Before MobilePlanner can create a map of the mobile robot's operating space, you have to drive the robot through the operating space as it scans the area with its laser and (if installed) Acuity. The resulting scan file contains all the raw data for features in the space. To be usable for mobile robot navigation, you have to have MobilePlanner convert the scan file into a map file.

Generally, you only need to make a map when deploying your AMR for the first time in a new environment. Occasionally you might need to rescan if the workspace undergoes extensive structural modifications or lighting changes, cubicles added in what was open space, a new wing to the building, or remodel of an area. For more extensive map updates, MobilePlanner provides the tools to integrate a new map, partially or wholly, into your original application (refer to Inserting a Map File into an Existing Map File on page 104 for details).

The best time to create a map scan is when the environment is least busy, when you can minimize the amount of time spent avoiding people and other non-stationary obstacles, and when you can move about, opening and closing doors, without disrupting normal daily activities.

What Information is Stored in a Map File?

Map files contain four kinds of data about an operating environment that the AMR uses in planning navigation and executing tasks:

- Obstacles and features scanned by a laser, and/or overhead lights acquired by Acuity.
- Objects, such as goals, forbidden lines, and sectors that control AMR behavior.
- Macros and tasks associated with goals.
- Data that defines properties of special goal types and available tasks.

A map file name has an extension of .map. Scan file names have an extension of .2d.

Scan files for light localization have an extension of .z2d (scan file is a zip file referred to as the Scan Package) or .zmp (map file from scan - a zip file referred to as the Map Package).

- For information on creating a map using the scanning laser, refer to Scanning the Operating Area on page 88.
- For information on creating a map using Acuity for light localization, refer to Creating the Light Map on page 235.

Loading an Existing Map File

There is no map to display when you first start up the MobilePlanner software. You must use MobilePlanner, with 'Map' checked, and connect to an AMR or Fleet Manager to open a map file to edit. Or, you can open a map saved locally on your computer or (when the Map button is checked) open a map that is currently in use on a specific AMR. You can also open maps on the AMR that are currently not in use.

Opening a Map saved on your PC

When you use the Map button to open and edit your map files, you can save them locally on your computer until you are ready to upload them to the AMR. Local map information is also written in the debug info files.

Selecting **File > Open** from the MobilePlanner main menu displays a dialog that lets you search for and select a local map file to open.

Opening a Map stored on an AMR

You can also click the Map button to edit a map file that is already in use on an AMR, which is helpful for making quick changes to the map or the AMR's route.

1. In the MobilePlanner main menu, select **File > Open on Robot** to display a submenu that lets you select a particular AMR.
2. Either choose from the displayed AMR IP addresses, or enter a new AMR IP address to open a map on the specified AMR.

   A dialog box appears in which you can choose between Configuration, Map, Scan, and SetNetGo files.

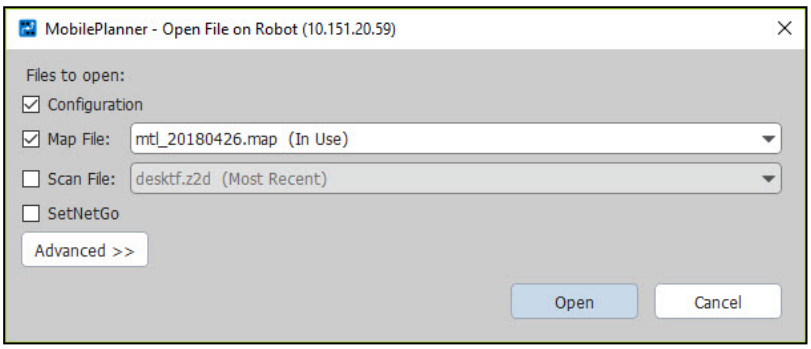


Figure 7-3. Open File on Robot dialog

3. Check **Map File** to choose a map file located on the AMR.

   You can use the Map File list and/or click the **Advanced** button to search for and select a map file to open, as shown in the following figure:

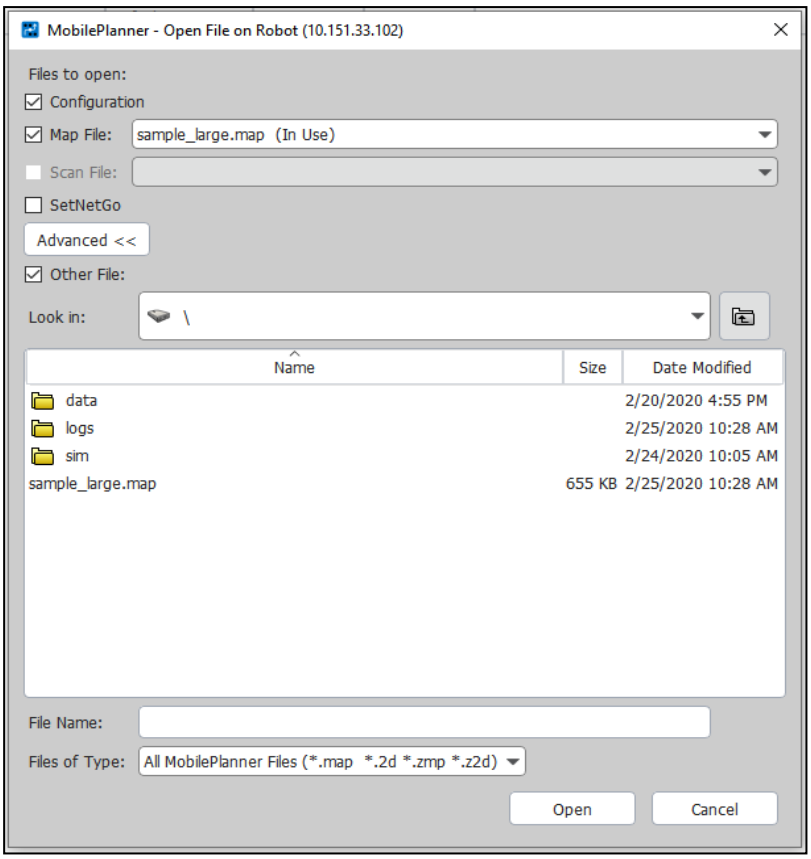


Figure 7-4. Open File on Robot, Advanced dialog

4. Select the map file you want to edit.
5. Click **Open** to load the map file into MobilePlanner.

Editing a Map File

After you create the initial map of your environment, you can use MobilePlanner to edit the map. First, use the Eraser tool (Draw pane) to remove map features that are temporary or moveable fixtures, such as chairs or forklifts.

Using the Drawing Tools

When editing your map file, you use the drawing tools to select and erase objects in the map, add goals, docks, forbidden lines and areas, as well as advanced lines and areas. The drawing tools are shown below.

> **NOTE:** These drawing tools are inactive (grayed-out) if **Show Robot** is active. The Cut icon is inactive until you select something.

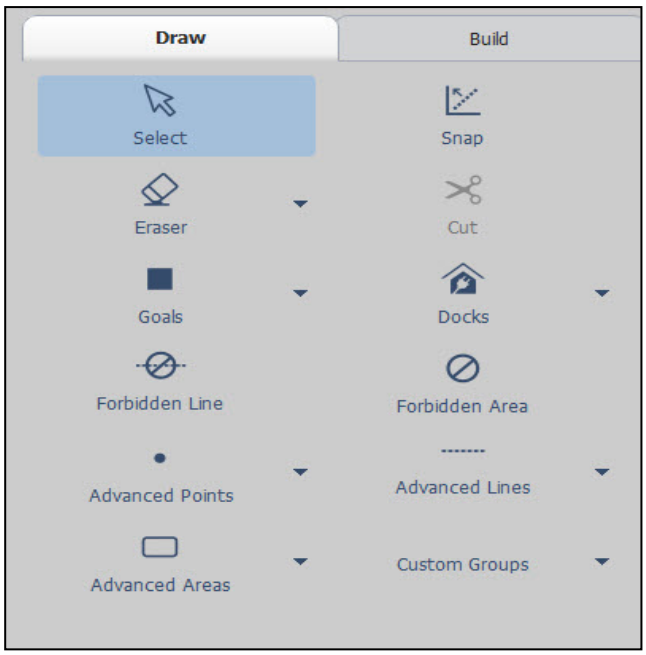


Figure 7-5. MobilePlanner Draw Tab

Selecting and Erasing Objects in the Map

Use the **Select** button to select and highlight objects on the map. Press and hold the left mouse button to move the object around the map window. Click the right mouse button to display a pop-up menu that allows you to edit, duplicate, align, copy and cut the object.

> **NOTE:** If there are overlapping objects on the screen, you can right-click on the overlapping map objects. A sub-menu lists all objects under the cursor so you can select the desired object.

Use the **Eraser** button to remove data points and lines from the map. Press and hold the left mouse button to move the eraser over the data points or lines you want to remove. You can adjust the size of the eraser by selecting the pull-down menu from the Eraser button. Choose an eraser size from 5 to 1000 mm.

Cutting a Selection

Use the **Cut** icon (or **Delete** key) to remove any objects you have selected from the map.

Snapping Objects in Place

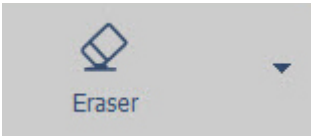
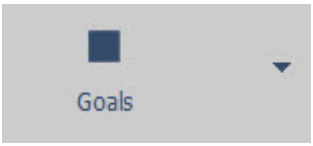
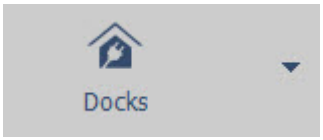
Use the **Snap** button to force rotate objects (goals, docks, lines, and areas) at multiples of 45° angles. Deselect this button to draw or rotate at any angle.

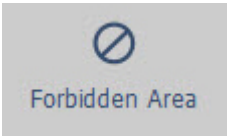
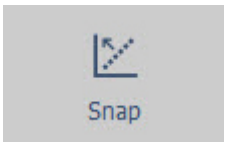
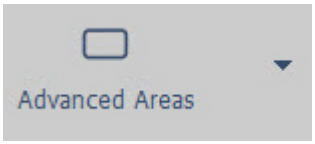
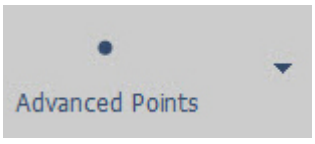
Draw Tab

You can use the Draw tab to add and edit map items (for details on map editing, refer to Working with Map Files on page 90).

NOTE: The Draw tab is only active when the **Show Robot** button is toggled OFF.

The following table lists the toolbar icons and their functions.

Item	Description
	Select a feature (point, line, area, etc.) on the current map. The status bar on the bottom left side of the window displays information about the feature you selected, such as: 
	Remove points or lines from the active map. Does not remove custom/landmark objects. 1. Click on the **Eraser** icon. 2. Use the pull down menu to select the eraser size from 5 mm to 10000 mm. 3. Click and hold the left mouse button, while moving the mouse over the points and lines you want to erase.
	Click **Goal**, then click on a map location to add a goal. In the Edit Goal dialog box you can: • label the goal • provide a description • select the type of goal (if available) • adjust the X/Y position and heading. You can adjust the heading after placement by holding the left mouse button down, and dragging around the goal. The heading will follow the cursor.
	Click **Docks**, then click in the map at the new dock's location. In the Edit Dock dialog box you can: • label the dock • provide a description • select the type of dock • adjust the X/Y position and heading. You can adjust the heading after placement by holding the left mouse button down, and dragging around the dock. The heading will follow the cursor.

	AMRs will not cross forbidden lines, or enter forbidden areas. To add a forbidden line or area: 1. Press and hold the left mouse button. 2. Drag the mouse to create the line or area and to adjust the size. 3. Release the mouse button (the line or area remains selected). 4. Press and hold the left mouse button. 5. Drag the selected line/area to move its location on the map. 6. For an area, click and hold on the heading arrowhead, then drag to rotate the area.
	
	Allows you to measure distances, display a measuring stick, add Preferred or Resisted Lines, or a Map Data Line to your map.
	Place lines and rectangles to the x/y axis (or 45° angles). Deselect this button to draw or rotate at any angle. To temporarily toggle this button while drawing a line or rotating a rectangle, press and hold the Ctrl key. Release the Ctrl key after making the edit.
	Places special areas on the map that the AMRs will avoid entering or crossing (e.g., door swing sectors, need to enter sectors, resisted sectors, etc. To add an advanced area to the map: 1. Press and hold the left mouse button. 2. Drag the mouse to create and size the line or area. 3. Release the mouse button (the line or area remains selected). 4. Press and hold the left mouse button. 5. Drag the selected line/area to move its location on the map. 6. For an area, click and hold on the heading arrowhead, then drag to rotate the area.
	Opens a submenu for adding a label to any advanced feature on the map. 1. Click on **Advanced Points**, then select **Label** from the submenu. 2. Click on a feature in the map you want to label, then use the Edit Label dialog box to enter a label, provide a description, and adjust the X/Y position and heading. **NOTE:** The label box is a special text box that does not scale when zoomed.

Using Advanced Lines and Areas

Advanced lines and areas (in **Config > Robot Operation > Map Features**) control the AMR's behavior. You can alter traffic flow, restrict the AMR from entering an area, and have the AMR use a preferred route. For more information on creating these features and more, refer to Traffic Management on page 202.

Advanced Lines

Advanced Line	Definition
Measuring Stick	Places a line on the map to measure distances in the map. You can change the measurement units by selecting **View > Units** from the main menu.
Preferred Line	Places a line on the map representing the path that you prefer the AMR use.
Resisted Boundary	Places a boundary line that the AMR resists crossing. If there is no other way around an obstacle, the AMR will cross a resisted boundary (though at a higher cost). For more information, refer to Cost-Based Path Planning on page 205. You can adjust the amount of line resistance, which is preferred over a restricted boundary.
Restricted Boundary	Places a boundary line that the AMR will avoid if possible.
Switchable Forbidden Line	Places a boundary line that you can control with tasks or through ARCL.

Advanced Areas

Advanced Area	Definition
Door	Places an area on the map to handle doors.
DoorSwingSector	Places a sector on the map that corresponds to a door's swing arc.
Door Virtual	Places a goal on the map for the AMR to drive to before entering a door.
IgnoreLowLaser	Enables a sector in which the AMR ignores low laser readings (e.g., for driving up and down ramps, crossing the threshold gap in an elevator, etc.).
IgnoreSonar	Places an area on the map that will disable the sonar sensors. This can be useful for crossing known thresholds, so the sonar doesn't prevent the AMR from driving over the threshold. **NOTE:** If you have the low front laser, this section does not apply.

IgnoreTiltedLaser	Instructs the AMR to ignore inputs from side-mounted lasers.
ManagedDestination	Allows use of multiple goals as a single destination to determine AMR occupancy of the sector.
ManagedMotion	Limits the number of AMRs allowed to drive in an area (sector) at the same time.
ManagedMotionOverride	Makes contained AMRs appear to be driving. Used primarily in constricted areas.
Movement Parameters	Places an area on the map where you can change movement parameters, such as velocity, acceleration, and deceleration, in real time.
Need to Enter	Places an area on the map that the AMR can drive to only if it is already in the area or a goal that it needs to drive to is in the area.
PathPlanningSettings	Places a sector that changes path planning settings.
PreferredDirectionLeft, PreferredDirectionRight	Places an area on the map that directs the AMR to travel along the right or left side of the path, unless there is an obstacle in the way. The AMR chooses the preferred side regardless of which way the AMR is traveling. In other words, it follows the preferred side whether it is traveling up the hallway or down the hallway.
PreferredDirectionRight Single, PreferredDirectionLeft Single	Enable sectors that cause the AMR to prefer driving on the left or right, in one direction only. Generally, the bi-directional PreferredDirectionRight/Left should be used instead. If two single direction sectors are placed next to each other, they must be aligned with care so AMRs do not collide. Using a preferred direction single tells the AMR to travel along the right (or left) side of the path unless there is an obstacle in the way. The AMR chooses the preferred direction in one direction only. In other words, the AMR will prefer to travel on the right (or left) side only when it is traveling up the hallway.
SingleRobot	Places an area on the map that only a single AMR can be in at any one time.
SwitchableForbiddenArea	Places an area on the map that can be controlled with tasks or through ARCL.
TaskSector	Places an area on the map that has a task list of what the AMR will do immediately upon entering and exiting the sector.
VolumeAdjustment	Places an area on the map where the AMR's audio output can be changed.

Adding Forbidden Lines and Areas

You can place forbidden lines and areas on the map to prevent the AMR from crossing the line or entering a specified area.

> **NOTE:** Forcing the AMR to cross a forbidden line or enter a forbidden area is a special circumstance discussed in Restricting Traffic on page 215.

1. With the map active, click the **Draw** tab, then click **Forbidden Line** or **Forbidden Area**.
2. Click on the map where you want to place the forbidden line or area. Be sure to add forbidden lines or areas around the AMR's work space so it doesn't try to navigate outside of its space.
3. Hold the left mouse button , then drag the mouse to the location you want the line or area to end.
4. Click the right mouse button to display a pop-up menu that allows you to edit, copy or cut the forbidden line or area.

Creating and Adding Goals and Docks

Goals are virtual destinations that the AMR drives to in its environment. Docks are locations to which the AMR drives to prepare to recharge. You need to add both of these features to the map for the AMR to successfully navigate through the workspace.

You can quickly add a goal or dock to the map using the **Item at Robot** button (robot tool bar), which allows you to add the object at the AMR's location. Once added, you can move goals and docks around by clicking on them with the left mouse button, holding the button, and dragging them to the desired location. You can also click on the heading line and drag it around, or put it in the middle to turn the heading off.

Types of Goals

You can choose from different types of goals:

- **Door Goal:** Doors and virtual doors are spots at which the AMR positions itself before entering or leaving a doorway (see Using a Door Goal on page 101). They appear green on the map, and are only available if the Doors parameter is enabled (click the **Config** button, then click the **Robot Operation** tab, then select **Map Features**).
- **Goal:** This is the default goal. The X and Y positions are automatically entered based on the location you selected on the map. Click on the check box to enable a heading and enter a heading in degrees (you can also do this on the map by dragging the mouse cursor - see Creating and Adding Goals and Docks on page 99.). The goal heading specifies the orientation of the AMR when it arrives at the goal.
- **Standby:** Standby goals serve three purposes, each designed to help keep the AMRs out of the way of traffic and regions of interest (goals, tools, etc.):
  - **Buffering:** waiting at a standby goal for another AMR to clear an occupied goal or sector. Refer to Using Standby-Buffering Goals on page 102.
  - **Parking:** allows available AMRs to drive to a waiting area for assignment to another goal. Other parking goals include Preferred Parking goals (also known as

'park at pickup/dropoff' goals). Refer to Using Standby-Parking Goals on page 102.

- **Multi-Robot Standby (MRS):** (also referred to as Taxi Line) allows (and enforces) sequenced, orderly queuing of multiple AMRs from the same start (standby) position to the same goal. For more information, refer to Traffic Control Concepts on page 202.

To create a goal/dock:

1. With the map active, click on **Draw tab > Goal** or **Draw tab > Dock**.
2. Click the mouse on the map where you want to locate the goal/dock. Then, while holding the left mouse button, drag the mouse around the goal/dock to set its heading.

   NOTE: Place a dock object where the AMR should go to "look at" the dock, not where the dock actually is. The dock object should be 1 to 1.5 meters in front of the dock, pointed at the dock. See the following figure.

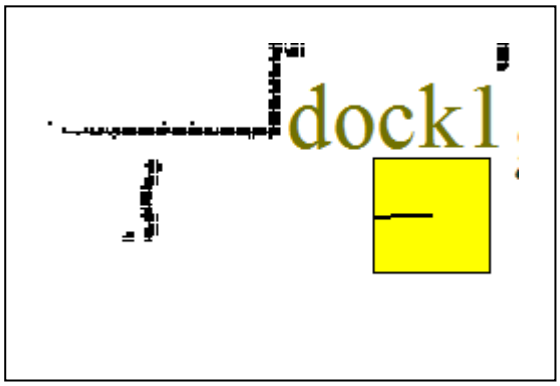


Figure 7-6. Dock as Imaged by AMR

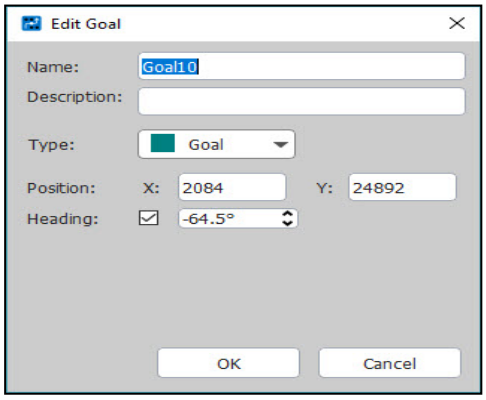


Figure 7-7. Edit Goal Dialog Box

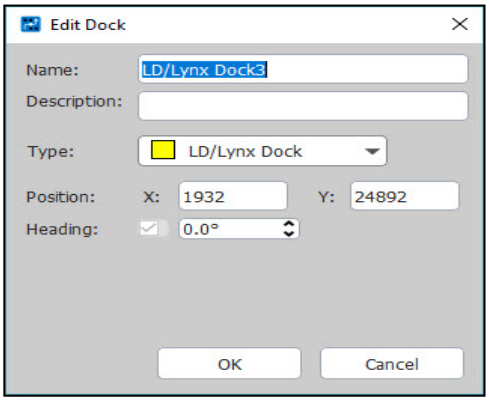


Figure 7-8. Edit Dock Dialog Box

3. In the appropriate dialog box (Edit Goal or Edit Dock), enter the name of the goal/dock you want to add to the map, for example "Reception."
4. Enter a description of this goal or dock (optional).

5. Select the Type of goal or dock you are adding.
6. Enter the X and Y position to adjust the location.
7. Enter a heading value in degrees (required for docks, optional for goals).
8. Click **OK** to place the goal or dock on the map.

Using a Door Goal

The door goals appear as a green square on the map. They allow you to mark a spot for the AMR to position itself before entering or after leaving a doorway. The following dialog box appears when setting up a door goal.

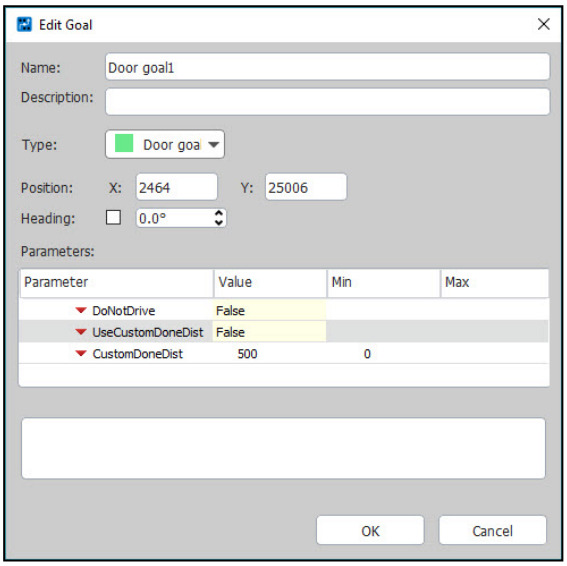


Figure 7-9. MobilePlanner Edit Goal dialog

Click on a parameter to see its description near the bottom of the dialog box.

Door Groups

You can also add a door group, which creates the door items and their dependencies. Click on Custom Groups > DefaultDoorWithGoals to add a door group.

Goals Using High Accuracy Positioning System (HAPS)

If your AMR has one or more optional HAPS sensors installed, you can create goals that require the AMR to approach and position itself closely.

The most simple of these types of installations have a goal on the AMR's map, a length of magnetic tape on the floor (the track), and one marker. The AMR's objective is to approach and proceed down the track, and stop at the marker.

You can also install tracks with multiple locations at which the AMR stops. Each stop needs one track, one marker, one goal per marker, and an Engage task for each goal. Refer to Engage on page 157.

Standby Goals

Standby goals allow you to set up buffering when an AMR's destination is already occupied by another AMR, and send AMRs to a parking area after completing a queuing job.

> **NOTE:** To use standby goals, you must enable them. Click the **Config** button, then click the **Robot Operation** tab, then click **Map Features** (in the left pane), then click the checkbox for the **Standby** parameter.

Using Standby-Parking Goals

It's best to place standby-parking goals in areas out of the way of traffic and other areas of interest.

To place a Standby-Parking goal on your map, do the following:

1. With the map active, click on the **Draw** tab, then click on the **Goals** drop-down list.
2. Select the **Standby** goal type.
3. Place the goal(s) on the map, then change the PrimaryPurpose parameter to **Parking**.
4. Use at least as many Parking goals as AMRs.

Using Standby-Buffering Goals

If an AMR is waiting for another AMR to clear a goal, it will use one closest to its destination. Best practice, then, is to place Standby-buffer goals near tools and areas of interest, in locations that will not block AMRs leaving the goal.

To place a Standby-Buffering goal on your map, do the following:

1. With the map active, click on the **Draw** tab, then click on the **Goals** drop-down list.
2. Select the **Standby** goal type.
3. Place the goal(s) on the map, then change the PrimaryPurpose parameter to **Buffering**.
4. Use at least as many Buffering goals as the anticipated number of waiting AMRs.

Adding a Goal at the AMR's Current Position

You can add a goal (generic, door goal, cart goal, or docking station) at the AMR's current position as follows:

1. With **Show Robot** active, click the drop-down arrow on the **Item at Robot** button (Robot Toolbar).
2. Select the type of goal you want to add.

   If you select one of the default goals (e.g., docking station), information about that goal is pre-populated in the dialog box.
3. If you selected a generic goal, fill in the name, description, and type then click **OK**. For a default goal, click **OK**.

Accessing the Docking Parameters

Docking parameters define the AMR's actions during the docking process. To access the Docking parameters, click the **Config** button, click the **Robot Operation** tab, then click **Docking**.

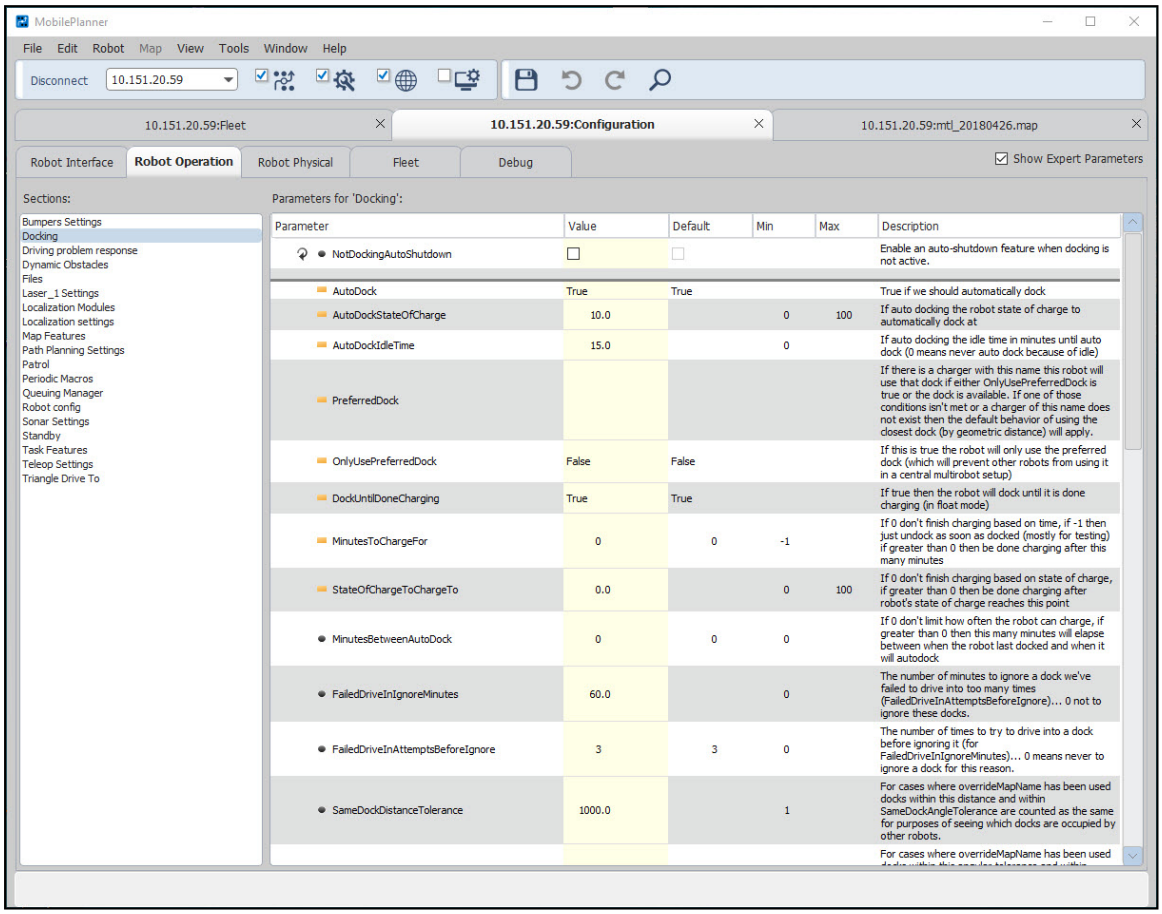


Figure 7-10. MobilePlanner Config - Robot Operations tab, Docking Parameters

NOTE: MobilePlanner software defines the various docking parameters, which will not be repeated here. However, there are some parameters under **Config > Fleet > Fleet Docking** that control docking behaviors.

Advanced Lines and Areas

MobilePlanner has tools for adding special, or advanced, features to your map that perform the following functions:

- **Advanced Areas:** these are areas in which you can add doors (and their swing sector), control speed (Fast or Slow), direct the AMR to ignore laser or sonar inputs, limit the number of AMRs operating in the space at one time (ManagedMotion), set the AMRs' preferred travel direction, and direct the AMRs to enter (or resist entering).
- **Advanced Lines:** these include lines to measure distances on the map (measuring stick), lines representing the AMR's preferred path (preferred line), lines the AMR will resist

crossing unless there is no other way around an obstacle (resisted boundary), lines the AMR will avoid if possible, and lines that can act like forbidden lines (SwitchableForbiddenLine).

Adding an Advanced Area or Line

Advanced lines, points, and areas include features like closed doors, measuring sticks, switchable forbidden lines or areas, one-ways, and many more. You must enable some of these features under the **Config** button, Robot Operations tab, Map features (likewise, you can also disable those you do not want to use). See Restricting Traffic on page 215.

1. With the map active, click the **Draw** tab, click the drop-down menu triangle for either **Advanced Lines** or **Advanced Areas,** to display the available types, then select the type you want to add.
2. Click on the map where you want to start placing the line or area and, while holding the left mouse button down, drag the mouse to where you want the line or area to end.
3. If an Edit Advanced Line/Area dialog box appears, enter the needed information, then click **OK**.
4. Click the right mouse button to display a pop-up menu that allows you to edit, copy and cut the forbidden line or area.

Inserting a Map File into an Existing Map File

The Insert Map feature is helpful, if there have been small or medium changes to the AMR's environment. You do not need to rescan the entire workspace and recreate the map file. To use the Insert Map feature, you can scan the area of the environment that has changed, turn that into a map, and insert it into an existing map.

In certain situations, you might want to insert only a subset of the region's data into the original map. For more information, refer to Using the Advanced Insert Option on page 107.

Inserting a Map Into an Existing Map File

In MobilePlanner, select a map to insert into an existing map.

- Select **File > Insert Map** from the main menu. A dialog box appears, which lets you search for and select a local map file to open.

The new map appears in the active map as a blue rectangle, and the Insert Map toolbar allows you to manipulate the inserted map.

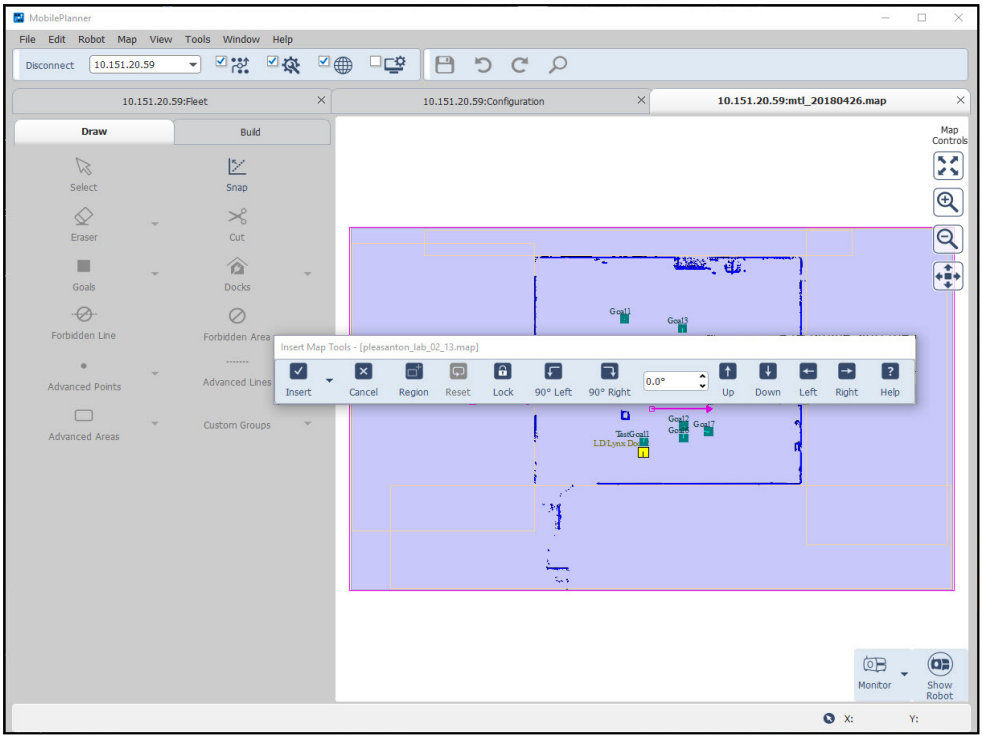


Figure 7-11. MobilePlanner, Insert Map Tools

Using the Insert Map Toolbar

Use the **Insert Map Tools** to position the inserted map into the existing map. After selecting a map section to insert, the toolbar automatically displays.

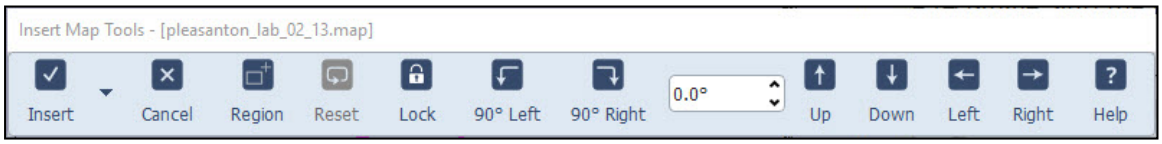


Figure 7-12. Insert Map Toolbar

The following table describes the buttons on the Insert Map Tools toolbar.

Insert Map Toolbar Button	Description
Insert	Works on intrinsic map data (points, lines, lights, etc.), and inserts the new map into the existing map at the blue rectangle. The Advanced insert lets you choose a subset of the previously mentioned data, and make other adjustments like inserting user-created map items (e.g., goals, docks, sectors, etc.). See Using the Advanced Insert Option on page 107 for details.
Cancel	Cancels the insertion.
Region	Defines the region to insert (useful if the default insert region is too big), or to have the newly inserted area properly overlap the old area. See Define the Insert Region on page 106.
Reset	Erases all rectangles and restarts the region definition.
Lock	Locks the inserted map at its current position in the map. This can prevent accidental changes when panning and zooming the map. Turn off the button to enable more changes.
90° Left/90° Right	Rotates the inserted map 90° left or right. Use the Degrees field to set degrees of rotation (as measured from the x-axis in the counter-clockwise direction).
Up/Down/Left/Right	Moves the inserted map up, down, left or right. Allows small adjustments to the inserted map's position.
Help	Opens help information on the insertion process.

Position the Inserted Map

You can adjust the inserted map's location and orientation to position it correctly in the existing map as follows:

1. Hold down the left mouse button and drag the inserted map like any other object.
2. Use the Insert Map Tools' **Up**, **Down**, **Left**, and **Right** buttons to make small adjustments to the insert's position.

Adjustment size depends on the map's zoom. To make a very small adjustment, zoom in; zoom out for a larger adjustment.

Define the Insert Region

The shaded blue rectangle is where the inserted map will replace a portion of the existing map. By default, all black data points on the blue background will be deleted (unless doing an advanced insert with 'retain overlapping,' in which they will remain).

If the default insert region is too big, click the Insert Map Tools' **Region** button to define a new one. The default region clears (and becomes gray) and the insert locks at its current position. Use the mouse to draw a set of blue rectangles over the exact area to be replaced.

You should define the insert region after moving the map insert to the correct location.

You can use **Edit /Undo** and **Redo** from the MobilePlanner main toolbar while defining the insert region (Undo deletes the last added rectangle). To erase all rectangles and restart the whole process, press the Insert Map Tools' **Reset** button.

Complete the Insertion

After correctly positioning the map insert and defining the insert region, click **Insert** to finish the insertion. It might take a few seconds for the original map to update. The process is complete when the shaded blue area disappears and the Map Insert toolbar closes.

If the resulting map is not correct, then press **Edit / Undo** from the MobilePlanner main toolbar to restore the map to its original state (which might take a few seconds).

NOTE: The insertion process is not automatically resumed; you must restart it.

Using the Advanced Insert Option

Occasionally, you might want to insert only a subset of the region's data into the existing map.

To Use Advanced Options

1. In the Insert Map toolbar, left-click on the **Insert** button.
2. In the pulldown menu, select **Advanced**.

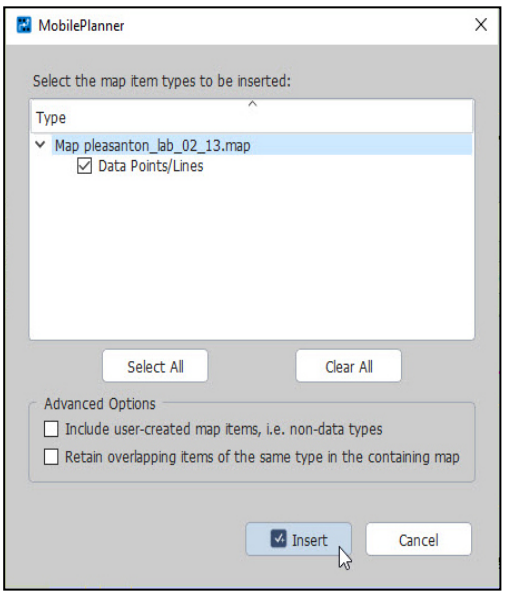


Figure 7-13. MobilePlanner, Advanced Insert Options Dialog

The dialog box has check boxes for each data type in the inserted map. To display non-data types, click the **Include user-created map items...** checkbox (shown checked in the image above).

3. Click the checkbox for each data type that you want to insert. Note that any corresponding map items are displayed in blue.
4. To retain the original map data as well as the inserted data, check the **Retain overlapping items . . .** checkbox.
5. Click the **Insert** button to complete the insertion and close the dialog box.

Saving the Map on the AMR

The scan file that came from your AMR is saved on your local PC until you explicitly save it elsewhere.

To save the map on the AMR, from the MobilePlanner menu, select:

File > Save on Robot

Select the .map file that you just edited, and click **Save** to save the map onto your AMR.

7.5 After the Map

If you need to adjust the scan settings, see the next section. Otherwise, you need to localize the AMR. Refer to Set the AMR's Initial Location on page 111.

Changing the Scan Settings

To adjust the processing, scan, clean, and map settings, click **Settings** from the Scan Processing Tools toolbar.

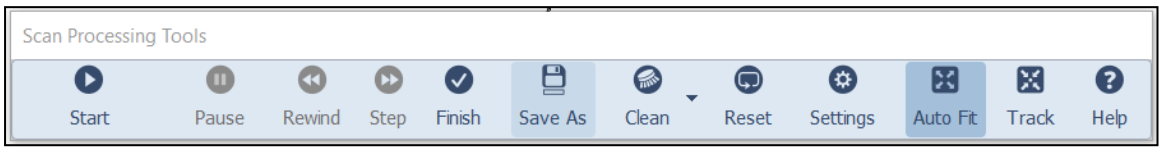


Figure 7-14. Scan Processing Tools Toolbar

Button	Description
Start	Initiates the scan session.
Pause	Temporarily pauses the scan session.
Rewind	Rewinds the AMR's path (blue trail) through the scanned area as shown on the MobilePlanner map.
Step	Allows you to step through the AMR's path, one segment at a time.
Finish	Completes the scan conversion process.
Save As	Allows you to save the newly created map with a specific name and location.
Clean	Allows you to manually remove unwanted scan points from the map.
Reset	Reset "uncleans" any cleaning work you have done on the map.
Settings	Allows you to change scan tool configurations.
Auto Fit	Scales the scan file image to the MobilePlanner map window as you add more information.
Track	Centers the AMR in the scan image - works similarly to 'center on robot' in a normal map.
Help	Opens a help file to search for specific help topics.

The Scan Settings dialog box appears as shown below.

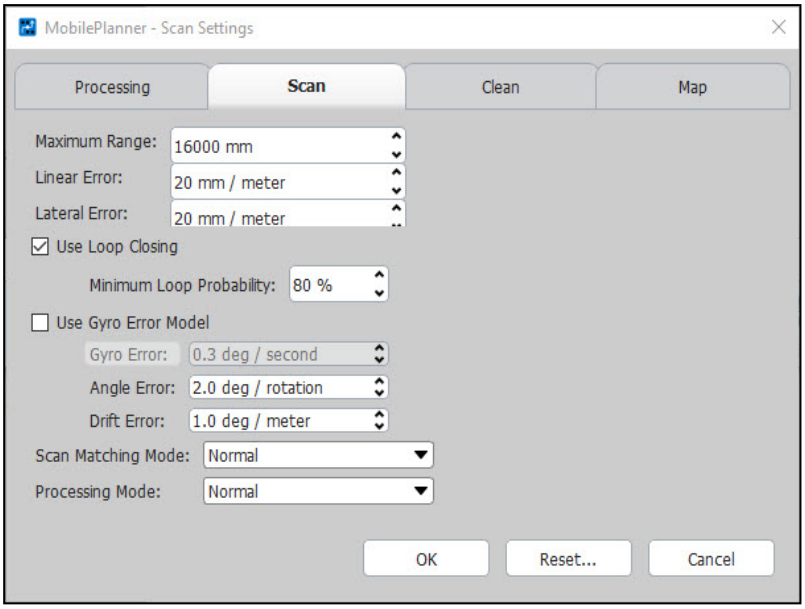


Figure 7-15. MobilePlanner Scan Settings Dialog

The following table describes the settings available from the Scan Settings dialog box.

Processing Settings	**Description**
Start scan when file opened	Disable this option to prevent the scan conversion process from automatically starting when you open the scan file in MobilePlanner. Allows you to adjust the scan settings before conversion. To start the process, click on the **Start** button from the Scan Tools toolbar.
Clean after scans registered	Disable this option to leave all scan points in the map. Any cleaning must be done manually by pressing the Clean button.
Prompt to save after scan complete	If this option is disabled, then the Save Map File As window is not automatically displayed.
Run in batch mode	Enable this option to process multiple scan files at the same time. **NOTE:** The files must all be of the same type. For example, they all must be basic scan files or all must be light localization scan files, they cannot be a combination of the two.
<filename>.map, overwriting any existing files	Select this option to overwrite the file name in batch mode.

<filename>_<currentDateTime>.map, less risk of overwrite	Select this option to have the current date and time added to the filename with each new scan conversion processed in batch mode.
Scan Settings	**Description**
Maximum Range	Specifies the maximum distance, in mm, used for the laser data.
Linear Error	The forward/reverse error, expressed as the average variation (in mm) per meter of travel.
Lateral Error	The left/right error, expressed as the average variation (in mm) per meter of travel.
Use Loop Closing	Used for open areas - indicates that the AMR has returned to a known location. Minimum Loop Probability allows you to set how closely the current position must match a previous scan. Default is 80%.
Use Gyro Error Model	Specifies allowable errors to correct for when registering laser scans collected during mapping.
Scan Matching Mode	Choose between Normal or Fast matching. If you select Fast, the scan match is performed only when MobilePlanner is in the registration phase.
Clean Settings	**Description**
Grid Size	Sets the size (in mm) of grid cells used to check whether the reading represents a real map point. A small value gives more cleaned readings; a large value includes more points in the map.
Max Range	Sets the maximum distance (in mm) from the AMR in which readings are considered for inclusion in the map. This value only affects the cleaning process; it does not affect the range used during the registration phase.
Map Settings	**Description**
Resolution	This adjusts the resolution of the map created from the scan file.

Set the AMR's Initial Location

It is important to establish the AMR's starting location, which is also known as localizing your AMR. When you "localize to a point" on the map, you provide the AMR with location data. This data allows the AMR to match its current location with the same location on the map.

As the AMR attempts to find its location on the map, it provides a localization score, or confidence level. This confidence level should be 80% or better for the AMR to navigate properly.

For more detailed information on localization, refer to AMR Localization on page 228.

To Set the AMR's Starting Location:

1. Click the **Map** button, then click **Show Robot**.

   The Map tool bar displays AMR control icons.

2. Click **Localize Robot**.

   This puts the map into localize-to-point mode (and changes the cursor to indicate the new mode). Refer to Robot and Map Toolbars on page 65.

3. Click and hold on a spot on the map where you want the AMR located. This is where you want the confidence threshold, or Localization Score, to be 80% or better as shown below.

   While still holding the mouse button down, drag the localization mark's direction indicator to the direction the AMR is facing. The AMR will choose the most likely pose near the clicked location. If the initial localization does not look correct, localize the AMR again until it appears in the correct location.

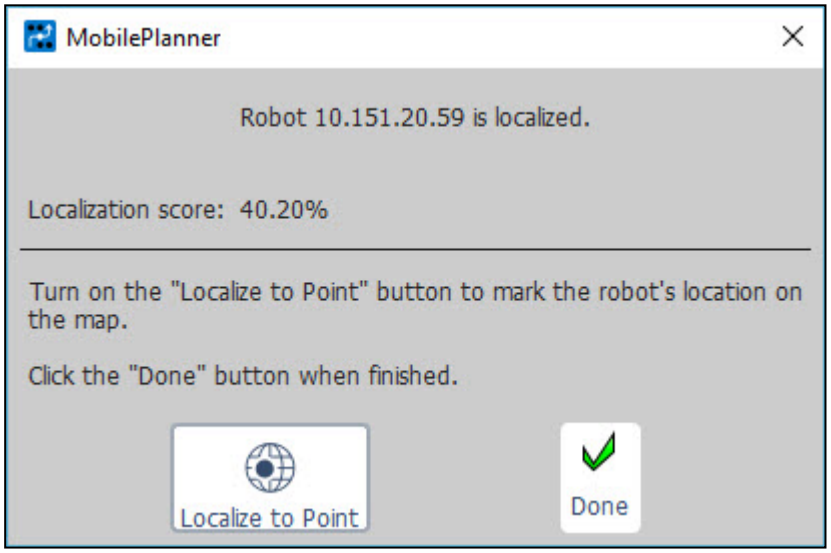


Figure 7-16. Localize to Point Dialog Box

4. Click **Done** when the AMR's localization score is where you want it to be.

   The AMR is now localized and you have successfully set the AMR's current position.

   NOTE: You must set the AMR's current position the first time you put the AMR in a different map.

What's Next?

Now that your AMR is configured, you have scanned its operating space and created a detailed map, you can do any of the following:

- To edit your map further, see Working with Map Files on page 90.
- To learn about and start using MobilePlanner software, see Using MobilePlanner Software on page 50.

- To configure your AMR, see Configuring the AMR on page 140.
- If you are familiar with MobilePlanner and want to set up goals and tasks for your AMR to perform, see Working with Macros, Tasks, and the Route Builder on page 150

After Driving the AMR

After you're done driving the AMR, select **Robot > Dock** from the software main menu, or click **Dock**, to return the AMR to a dock.

Auto Dock

The **Config > Robot Operation > Docking > Autodock** parameter is the primary control for the AMR's automatic docking, and is normally set to True.

If the Autodock parameter is set to False, and you don't want to manually dock the AMR each time, using the Auto Dock menu item (**Main Menu > Robot > Robot Tools > Auto Dock**) will override the configuration parameter. The AMR will return to a dock when the charge is running low.

> **NOTE:** If the Autodock parameter is set to True, you can override that behavior by turning off automatic docking. If you do this, remember to turn it back on when you are done, or the AMR will not recharge and eventually stop running.

Chapter 8: Using the SetNetGo Software

SetNetGo runs on both the AMRs and an EM2100 operating as a Fleet Manager. It sets the configurations for certain onboard systems, such as wireless communication settings.

You can access SetNetGo either from the MobilePlanner SetNetGo interface, or directly on the AMR using a secure web-based server. If needed, your organization's IT group can configure your wireless Ethernet for you.

8.1 Overview of the SetNetGo OS

The SetNetGo software allows you to configure certain on-board systems, such as the Ethernet interface settings, serial and TCP port-forwarding, and to perform systems diagnostics, such as examining and retrieving log files.

Connecting to SetNetGo

Access SetNetGo from MobilePlanner

The recommended way to connect to the SetNetGo OS is through the SetNetGo interface in the MobilePlanner software.

During normal operation, you access SetNetGo through the MobilePlanner software as follows:

1. Start the MobilePlanner software on your PC.
2. Enter the IP address for an AMR or your Fleet Manager, then click Connect.
3. Click anywhere in the SetNetGo selection box, to access the SetNetGo interface.

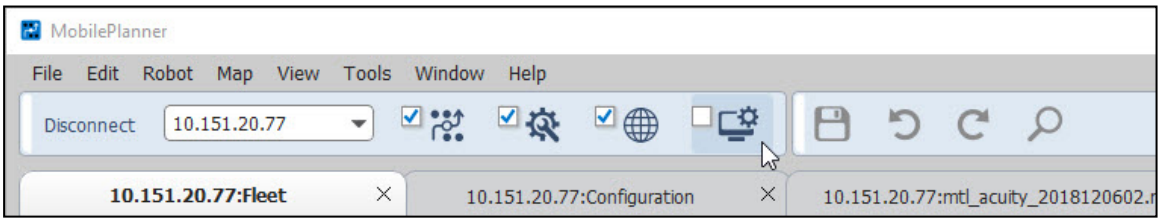


Figure 8-1. Hover Over the SetNetGo Selection Box

Hover over the selection box to reveal its boundaries. (See the cursor in the preceding figure.)

> **NOTE:** It is not necessary to enable (check) the checkbox within the SetNetGo selection box to open the application. The checkbox determines whether the SetNetGo window opens automatically when you open MobilePlanner.

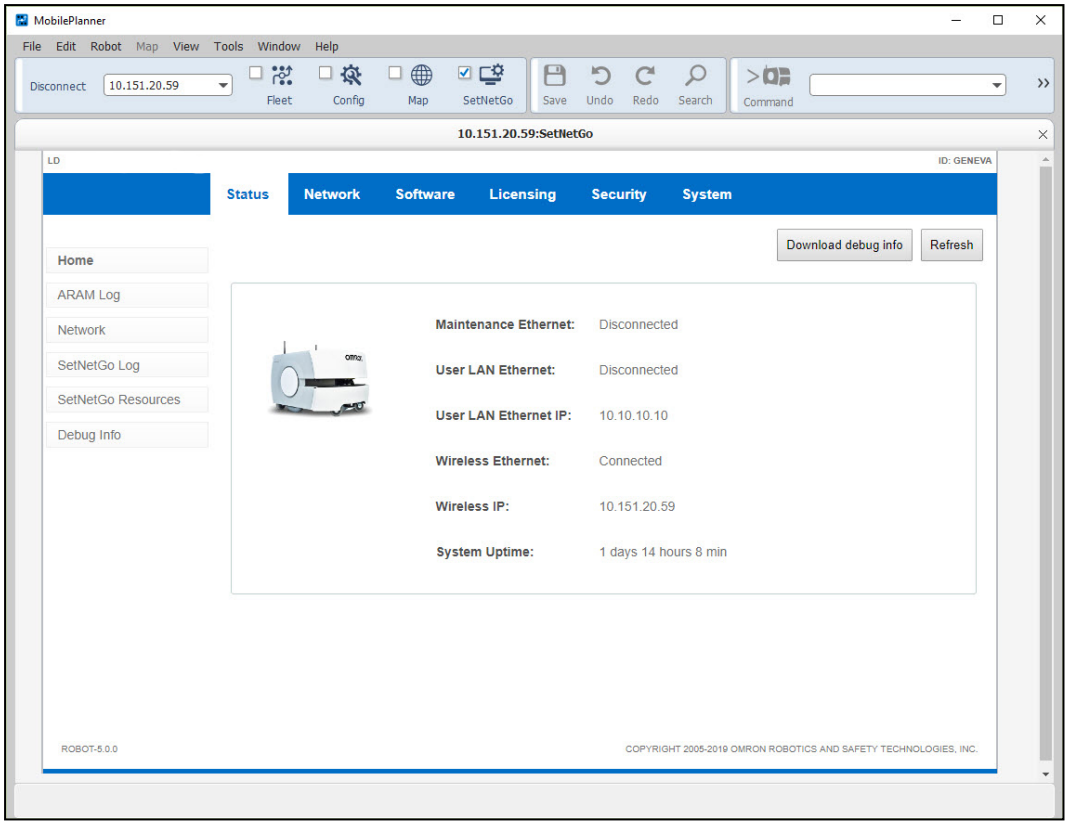


Figure 8-2. SetNetGo Interface—Status Tab, Home Screen

This is the SetNetGo home screen. It provides an overview of link status, IP addresses, and installed software versions.

Connecting to SetNetGo via web browser

You can also access the SetNetGo software via a web browser (such as Chrome, Firefox or Internet Explorer) if, for example, your IT department is helping with network configurations, or you don't have access to your laptop with MobilePlanner installed on it.

> **NOTE:** Web browser access must be enabled in **SetNetGo > Security tab > SetNetGo Access**. To do this, connect one end of an Ethernet cable to your computer and the other end directly to the AMR's Ethernet Maintenance port.
>
> If you have an LD-series AMR, set your IP address to 1.2.3.5 with a subnet mask of 255.255.255.0 and connect to SetNetGo Maintenance port at the URL: https://1.2.3.4.
>
> If you have an HD-series AMR, set the adapter to automatically obtain an IP using DHCP and connect to SetNetGo Maintenance port at the URL: https://169.254.10.15.

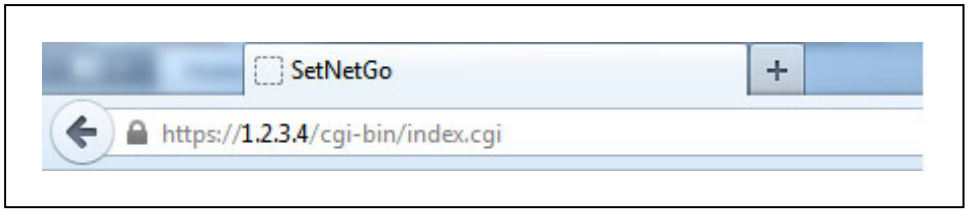


Figure 8-3. Browser URL Address

NOTE: You can ignore the SetNetGo certificate error. Click "**Continue to this website (not recommended)**." to display SetNetGo.

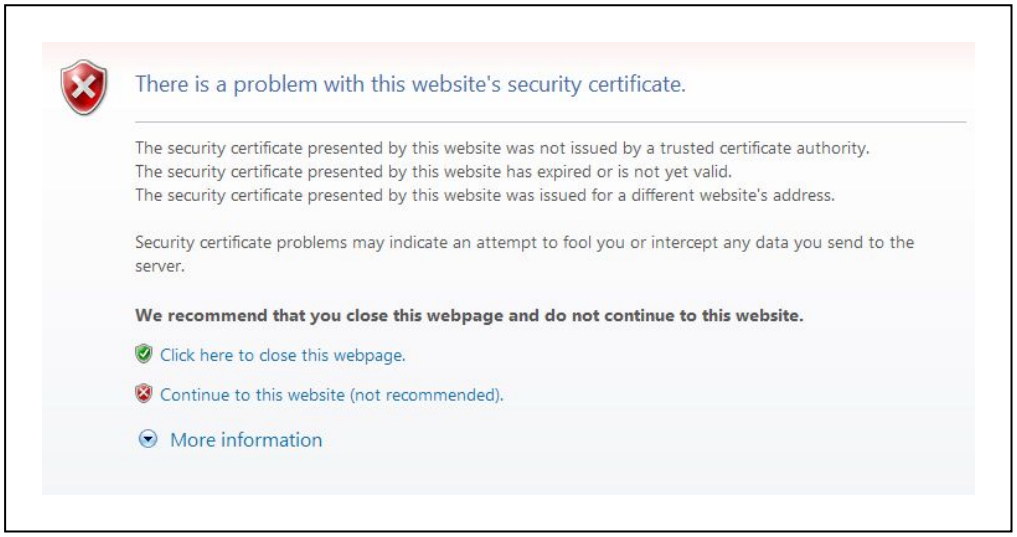


Figure 8-4. Browser Certificate Warning

8.2 Using the SetNetGo Interface

SetNetGo resides on the AMR and any EM2100 operating as a Fleet Manager or Fleet Simulator, and is accessible through the SetNetGo interface in MobilePlanner.

The Fleet Simulator cannot be accessed through MobilePlanner - you have to access SetNetGo through a web interface instead.

NOTE: If you are unable to access MobilePlanner, you can still access SetNetGo by connecting your PC directly to the AMR's Ethernet Maintenance port (using Ethernet cable). To do this, connect one end of an Ethernet cable to your computer and the other end directly to the AMR's Ethernet Maintenance port.

If you have an LD-series AMR set your IP address to 1.2.3.5 with a subnet mask of 255.255.255.0 and connect to SetNetGo Maintenace port at the URL: https://1.2.3.4.

If you have an HD-series AMR then set the adapter to automatically obtain an IP using DHCP and connect to SetNetGo Maintenace port at the URL: https://169.254.10.15

NOTE:

The SetNetGo start-up screen, accessed from MobilePlanner, is shown below.

NOTE: The Download debug info button provides a debug file that can be used for troubleshooting and other support requests.

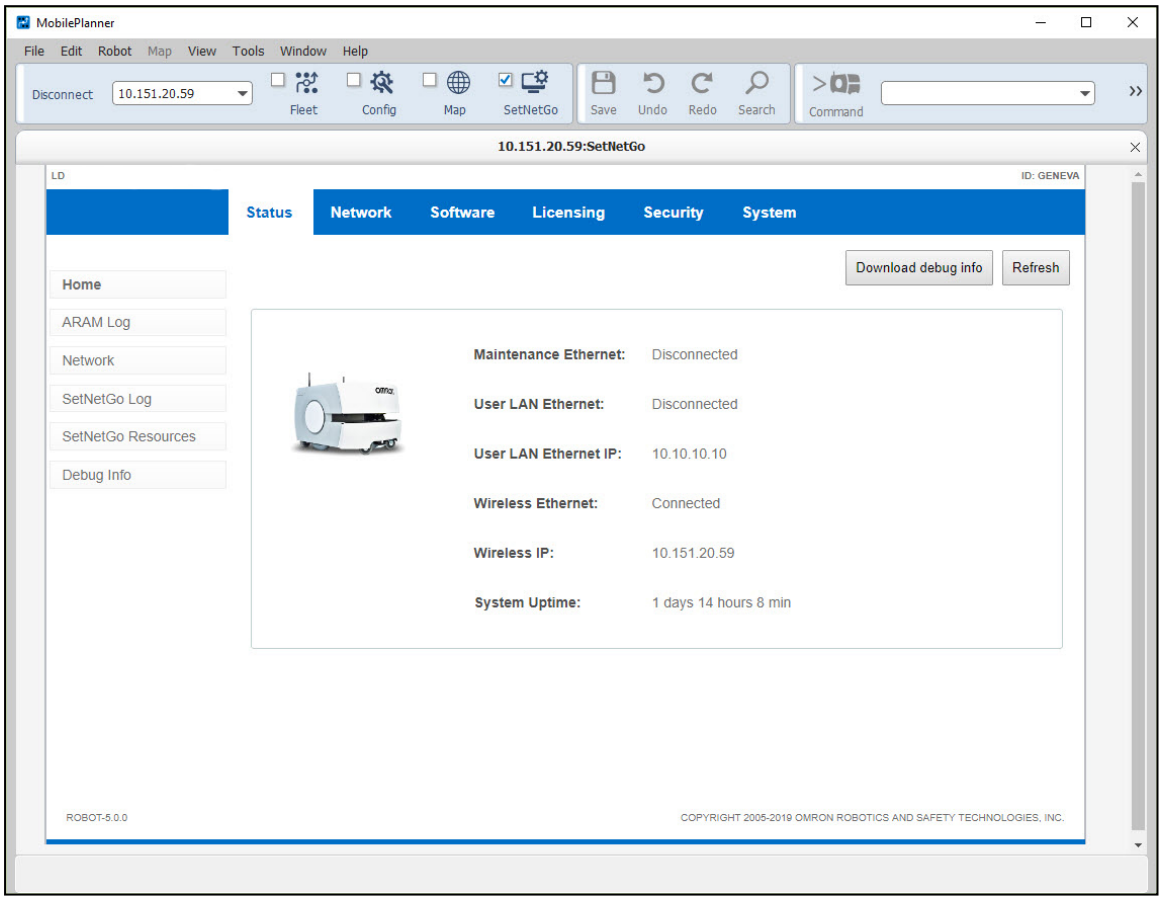


Figure 8-5. SetNetGo Interface

The SetNetGo menu, shown at the top of the screen, consists of the following tabs:

Menu Option	Sub-Menu Option	Description
Status	This menu option displays various logs and status updates. See Viewing the Status Logs on page 121 for details.	
	Home	Returns you to the SetNetGo home screen.
	ARAM (AMR) or ARAMCentral (Fleet Manager) Log	Gives the option to display the entire ARAMCentral log, the last 200 lines, or continuous refresh displaying the last 200 lines of the ARAM log within SetNetGo. It also allows you to view the current log file or download of the last 7 log files.

	Network	Displays the current status of network interface, the wireless interfaces status and the routing table.
	SetNetGo Log	Displays the SetNetGo log file.
	SetNetGo Resources	Displays status of your resources, including processes currently running on the AMR or Fleet Manager, Kernel Log, Disk Usage, Memory Usage, the Interrupts table, IO Memory usage and IO Port usage tables, and USB Devices.
	Debug Info	Downloads a .zip file containing detailed information on system status for troubleshooting. **NOTE:** Download a debug file before requesting support.
Simulator	This heading gives access to the Fleet Simulator option. This is covered in detail in the *Fleet Simulator User's Manual (Cat. No. I641).* This heading will not be displayed if the Fleet Simulator license is not detected on the EM2100 or if SetNetGo was accessed from MobilePlanner. SetNetGo can not be accessed through MobilePlanner in Fleet Simulator mode.	
Network	Configurations for setting up your network. See Network Tab on page 121 for details.	
	AMR Only	
	Wireless Ethernet	These parameters allow you to enter static or dynamic IP settings (IP Assignment and Address, Netmask, Gateway, and DNS1); select a WiFi network; configure security settings (i.e., encryption and authentication); and configure Radio settings, including Watchdog Timer.
	User LAN Ethernet	This screen has settings for interface mode, IP Address, Netmask, DHCP Server for Accessories, and DHCP IP Range. If you are using an EM2100 or a network-based hardware accessory for an AMR, you must set up a wired Ethernet port. Use Accessory mode (default) for individual AMRs, and server mode with an EM2100.
	RS-232 Port Forwarding	Forwards a custom TCP port on the wireless Ethernet interface to an RS-232 port on the AMR's core. The TCP port and serial port settings are configurable.
	Ethernet Forwarding	Supports forwarding a custom TCP port on the wireless Ethernet interface to a custom TCP port on an IP address of a device connected to the User LAN interface. The TCP port numbers and IP address are user-configurable.

	Fleet Manager Only	
	Management Interface	This page allows configuration of the Management (MGMT) Ethernet interface with a static IP address. The network host configured as the "Management Interface" is the primary host for web configuration via a browser.
	Fleet Interface	This page allows configuration of the Fleet Ethernet interface with a static IP address. The network host configured as the "Fleet Interface" is the primary host for all Fleet Management connections, including use of Mobile Planner to connect with a Fleet.
	AMR and Fleet Manager	
	Utilities	On an AMR, use this tab to ping a specific IP address, initiate trace route (display packet path), and display the ARP table (correlate MAC address and corresponding IP address). On a Fleet Manager, this page permits running several network diagnostic tools on the AMR or appliance, including well known tools `ping`, `arp`, and `traceroute`.
Software	Configurations for ARAM/ARAMCentral settings (including install new software versions)	
	ARAM Settings or ARAMCentral Settings	Change advanced settings for recovery, such as reverting the configuration back to defaults.
	Manage Installed Software	This tab displays current versions of installed software, with options to view release notes, restart, uninstall, or disable application(s), and view runtime logs. Also allows you to download MobilePlanner, and update the mobile software.
Licensing	Configurations of existing licensing and upload/download of information for license activation and updates.	
	Information	This page displays license information, including name of the license, current status and expiration date, for any license relative to that specific device, either Fleet Manager or AMR.
	Upload	This page allows upload and provisioning of new licenses or license updates, which are provided by your OMRON representative.
	Download	This page allows download of license information files for this device. This file must be provided when contacting your OMRON representative for license

		updates.
Security	Manage Fleet user accounts and AMR access.	
	Fleet or ARAM Accounts	This page allows you to manage access controls that restrict who can access the AMRs and Fleet Manager with MobilePlanner. Allows you to specify specific access controls for admin, operator, and viewer access, and other users. You can also add new users to the access list. AMR only. This page allows configuration of Fleet Accounts, including usernames, passwords, and permissions. Fleet Accounts are primarily for user privilege separation and must be provided when connecting to a Fleet Manager or AMR through MobilePlanner. Fleet Manager only.
	SetNetGo Access	Allows you to enable or disable Web availability via Wireless/User LAN interface, and set access password.
	Integration Toolkit	This page allows generation and regeneration of the password required for all Integration Toolkit-provided services. This password must be configured in order to access fleet data through the Integration Toolkit-provided services, which include SQL via postgres, AMQP via rabbitmq, and a REST API via HTTPS.
System	Manage date/time, upload new SetNetGo OS, conduct backup and restore operations.	
	Date/Time	Set time, zone, and NTP Server. **NOTE:** The AMRs will automatically synchronize with a Fleet Manager. Use NTP on the Fleet Manager or for single AMR operations.
	Upload SetNetGo OS	Upload and install a new SetNetGo version. **NOTE:** The system can store two different OS images. You can select which version to load into each slot, and choose which is the bootable image.
	Backup/Restore Options (AMR only)	Allows you to configure restore settings (from the same, or a different AMR), set a new backup restore point, or revert to a different restore point.
	Reboot	Allows you to reboot the AMR's computer (core) or EM2100 appliance. Normally not a visible option unless enabled by checking the Remote Reboot radio button in **SetNetGo > Security > SetNetGo**

		Access.  **CAUTION:** Rebooting the AMR's core interrupts all AMR operations, and could cause damage to the AMR. Rebooting the appliance will disrupt all jobs and AMRs.
	Mode (EM2100 only)	This page allows configuration of the appliance operating mode. The mode determines if the appliance will run as a Standalone Fleet Manager, a Paired Fleet Manager, or a Fleet Simulator.

8.3 Viewing the Status Logs

SetNetGo keeps track of various AMR activities, including ARAM, networking, and resource use. This information is stored in status logs that you can view through SetNetGo.

To view the status logs:

1. Connect to SetNetGo through the MobilePlanner SetNetGo interface.
2. Select the **Status** link at the top of the SetNetGo screen.

   The SetNetGo Status screen appears as shown in SetNetGo Interface on page 117.

   > **NOTE:** The Download debug info button is critical for taking a backup of the current configuration, and providing this information when requesting support.

The status logs you can view depend on whether you are connected to SetNetGo through a Fleet Manager or a single AMR. Generally you can view the following type of status logs:

- ARAM (on the AMR), ARAMCentral (on the Fleet Manager)
- Network
- SetNetGo Log
- SetNetGo Resources
- Debug Info

8.4 Network Tab

Use SetNetGo to configure the AMR's network settings. For remote access to your AMR, you should set up a static IP address. If you are not familiar with setting up a network or do not have an assigned IP address for the AMR, please refer to your system administrator.

> **NOTE:** After changing a value in any SetNetGo screen, you must click **Apply** before switching to another sub-screen, or those values will not be saved.

To configure your AMR's network settings:

1. From the MobilePlanner SetNetGo interface, connect to SetNetGo.
2. Select the **Network** link from the top of the SetNetGo screen.

   The SetNetGo Network screen appears as shown in the following figure.

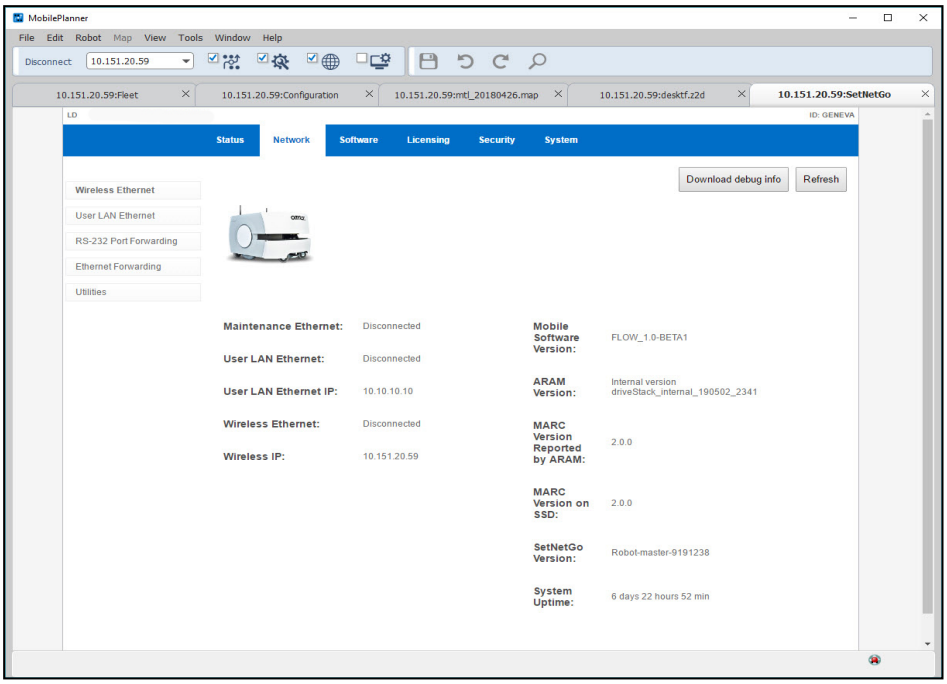


Figure 8-6. SetNetGo Interface - Network Tab

Wireless Ethernet Settings

Select **Network > Wireless Ethernet** to set up the wireless Ethernet interface. The table below describes the parameters that you can modify.

Wireless Ethernet Menu	
Parameter Setting	**Definition**
IP Assignment	Select the Static radio button to set a known IP address. You can also use DHCP, but a static IP address is recommended.
IP Address	Enter the IP address assigned to the AMR you want to access.
Netmask	Enter the Netmask.
Gateway	Enter the Gateway address.
DNS1	Enter the DNS1 address or leave it as 0.0.0.0 to disable.
WiFi Network Settings	
Selected Network	Displays the wireless network to which you are currently connected.

	NOTE: Clicking on a network name in the list will automatically populate the encryption and authentication fields.
Network list	Displays a list of available WiFi networks.
Security Settings **NOTE:** The fields listed below will change based on the security method you select, and could include username, password, private key (download or create new)/key length, hostname, and certificate (choose an existing or upload new). If unsure about settings, ask your IT department for assistance.	
Encryption	Set this to match the encryption method that is used on your network. Options are 64-bit or 128-bit WEP, TKIP/RC4, CCMP/AES, and TKIP/CCMP/AES.
Authentication	Set to match your authentication type. Use OPEN (default) when using no authentication or when using WEP. Select WPA-PSK for WPA Pre-shared key, PEAP-MSCHAPv2, or EAP-TLS.
Pre-Shared Key (PSK)	If using WPA/WPA2-PSK, enter the shared key in this field.
Key Type	Select from (click the radio button) Passphrase (8-63 ASCII only), or Raw Hex (64 Hex only).
Radio Settings	
Radio Mode	Select the mode that your network uses: 802.11a, 802.11b, 802.11g, 802.11n, or 802.11ac. Select Auto to allow the AMR to choose the most suitable channel from 802.11a/b/g (may lead to longer roam times).
Channel Set	Set to match the channels that are used at your site or leave them all selected (default) to allow the AMR to find the most suitable channel. Roam times will be faster if there are fewer channels selected.
802.11b/g Channels (2.4 GHz)	Use this list to select a specific WiFi channel (1 through 13) in the 2.4 GHz range
802.11a Channels (5 GHz)	Use this list to select a specific WiFi channel (36 through 165) in the 5 GHz range
Wireless Log Level	Determines the level of WiFi scanning detail in log files and debug info. Default is Normal. Set to **Verbose** for debugging efforts. If set to Verbose, log files cover a much shorter period of time. Recommend leaving at **Normal**.
RSSI Roam Threshold	Determines the frequency of background scanning. Default is 50. If signal strength is higher than the threshold, scanning happens at 10X the Background Scan Interval. If signal strength is below the threshold, scanning occurs every Back-

	ground Scan Interval seconds.
Background Scan Interval (sec)	Works with the RSSI Roam Threshold to determine how frequently the AMR performs background scanning. Default is 3 seconds (recommend leaving at default)
Watchdog	If enabled, automatically pings the Fleet Manager (if used) or the gateway IP address. If successive pings fail for Watchdog Timer seconds, the AMR automatically resets the wireless interface.
Watchdog Timer (sec)	If pings to the Fleet Manager fail consecutively for Watchdog Timer seconds, the wireless Ethernet interface automatically resets and attempts to reestablish communications.

User LAN Ethernet Settings

User LAN Ethernet Settings	
Parameter Setting	**Definition**
Interface Mode	Use to set up a wired accessory interface (e.g., Acuity or the touchscreen) for the AMR. This mode allows you to connect network-based, hardware accessories to the jack. Onboard accessories will be able to communicate with the software running on the AMR's core, and reach the rest of the network via the AMR's wireless interface.
IP Address	Set the IP address for this interface. Select a subnet that does not conflict with settings on the wireless Ethernet interface.
Netmask	Enter the Netmask.
DHCP Server for Accessories	Disable or enable (default) a DHCP server for an accessory on the AMR. **NOTE:** You must enable this parameter for both Acuity and the touchscreen (for more information on these options, see the *Mobile Robots - LD Platform Peripherals Guide.*).
DHCP IP Range	Allows you to set the DHCP IP range for the address automatically assigned to the accessories.

Port Forwarding

If your AMR's payload has devices connected to the User LAN or Serial (RS-232) port, you can forward those ports and make the payload's device accessible via WiFi. Configure both RS-232 and Ethernet port forwarding in SetNetGo in the **Network** tab.

RS-232 Port Forwarding

Controls forwarding serial data to a TCP port on the wireless and internal wired Ethernet networks. You can link an internal serial device and route it to an external port at a defined baud

rate. This is useful for RS-232 devices connected to the AMR's core, and accessing them over WiFi.

Ethernet Forwarding

These settings forward a TCP port on the User LAN Ethernet interface to a port on the Wireless Ethernet interface. The Internal IP Address is the IP address of the device connected to the AMR core's User LAN connection. Internal and External port setting route the Ethernet connection through WiFi.

Utilities

These tools allow you to view the ARP table, and ping or run a trace route to a specific IP address.

8.5 Software Tab

The SetNetGo software tab offers choices for ARAM Settings and Manage Installed Software.

ARAMCentral/ARAM

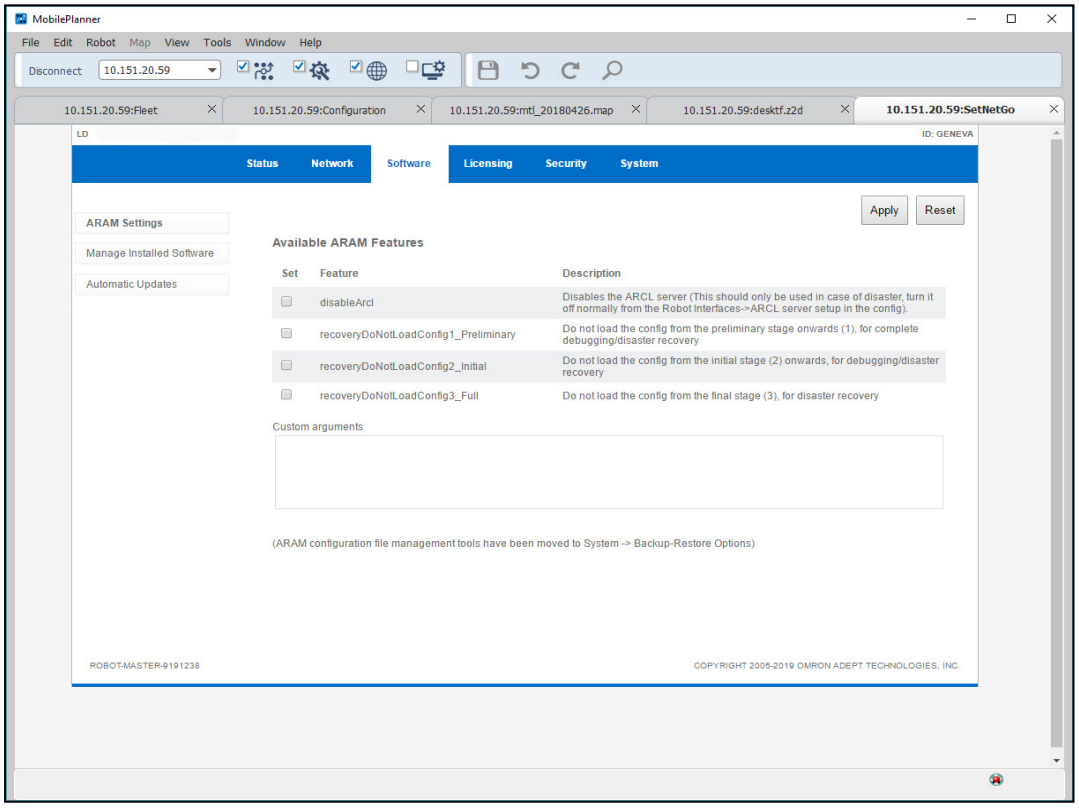


Figure 8-7. SetNetGo, Software Tab - ARAM Settings

- ARAMCentral Settings (main software on the EM) - configure ARAMCentral's features (disabling ASync logging, disabling ARCL, and disaster recovery settings.
- ARAM Settings (main software on the AMR) - configure ARAM's features (disaster recovery settings).

Manage Installed Software

The settings in this section allow you to view current versions and status (for example, Enabled Running, or Disabled Not Running) of software installed on the EM2100 appliance or AMR.

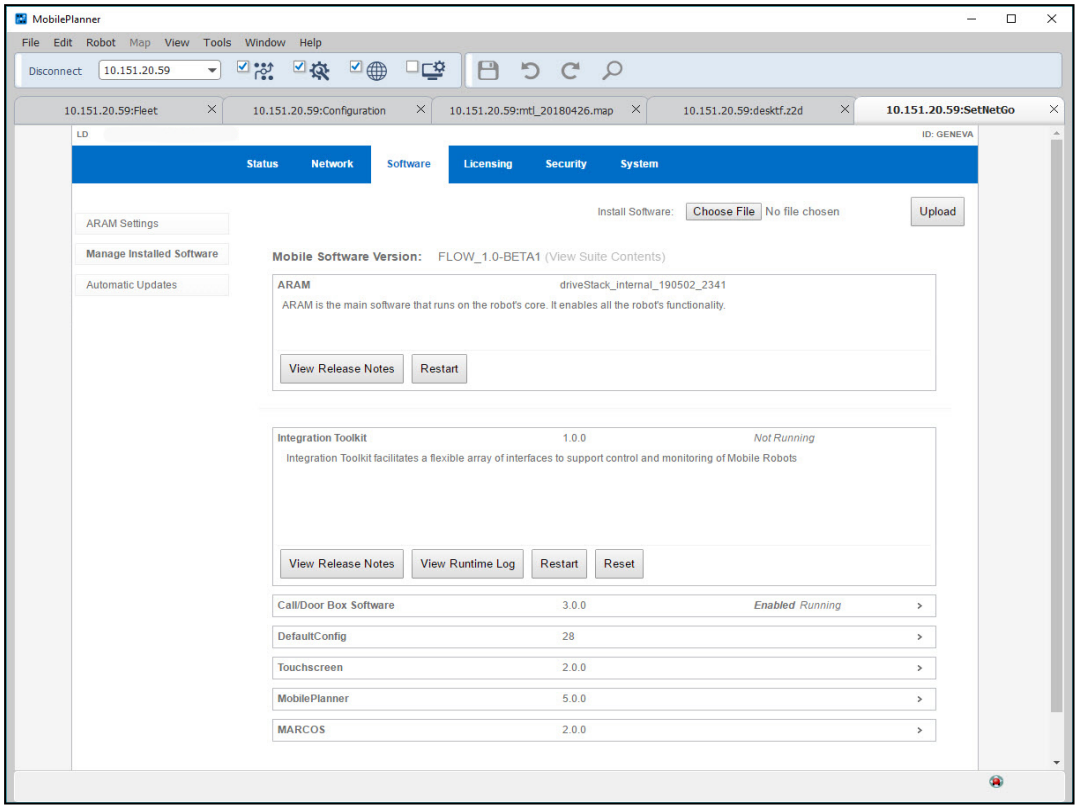


Figure 8-8. SetNetGo, Software tab - Manage Installed Software

You can also use the functions on this tab to restart, disable, install and/or uninstall MobilePlanner software, the MARC or Polo microcontroller firmware.

8.6 Licensing Tab

The SetNetGo licensing tab allows you to get information, including license name, status, and expiration date of any license that applies to the device you are currently connected to. It also allows you to acquire, renew or upgrade any licenses from the field on either a Fleet Manager or an AMR. Follow the following instructions in the given order to do so:

1. Go to the SetNetGo web interface of the Fleet Manager appliance or the AMR and open the Licensing tab. Click on the **Download** option in the left pane.
2. On the download page, click the **Download** button.

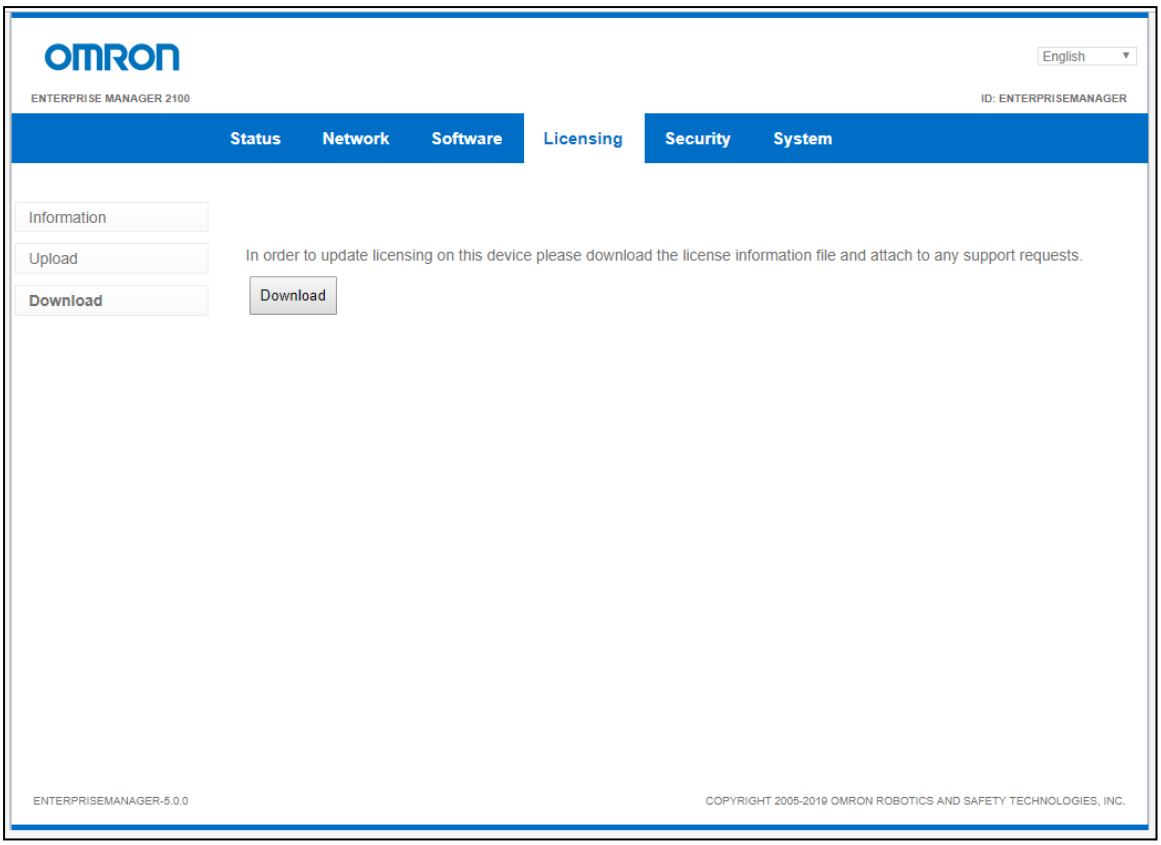


Figure 8-9. Licensing Download Screen

The downloaded C2V file will have the format:

1234567890-MMM-DD-YYYY.C2V

where MMM represents the first three letters of the current month, DD the day of the month, and YYYY the current year.

> **NOTE:** OMRON recommends that you establish a specific location and folder in which to store these license key files, in the event that they need to be accessed in the future. We also recommend that the C2V ID number (the first ten digits in the C2V file name) be referenced to its particular EM2100 or AMR to ensure the matching license key file can be quickly identified and uploaded to that EM2100 or AMR.

3. Send the C2V file to your OMRON representative or integration partner and request the appropriate license for the Fleet Manager mode or for the AMR Advanced Feature that you have selected. You will receive a V2C file with an ID and Date that matches the C2V file that you submitted.
4. Confirm the file names match before proceeding. If the filenames do not match, then contact your OMRON representative or integration partner and report the issue.
5. Go to the SetNetGo web interface of the Fleet Manager or AMR. Select the Licensing tab and choose the **Upload** option from the left pane.

6. Click **Choose File** and select the appropriate V2C file.
7. Once the file is chosen, the SetNetGo Web UI shows the specific filename. Click **Upload File**.

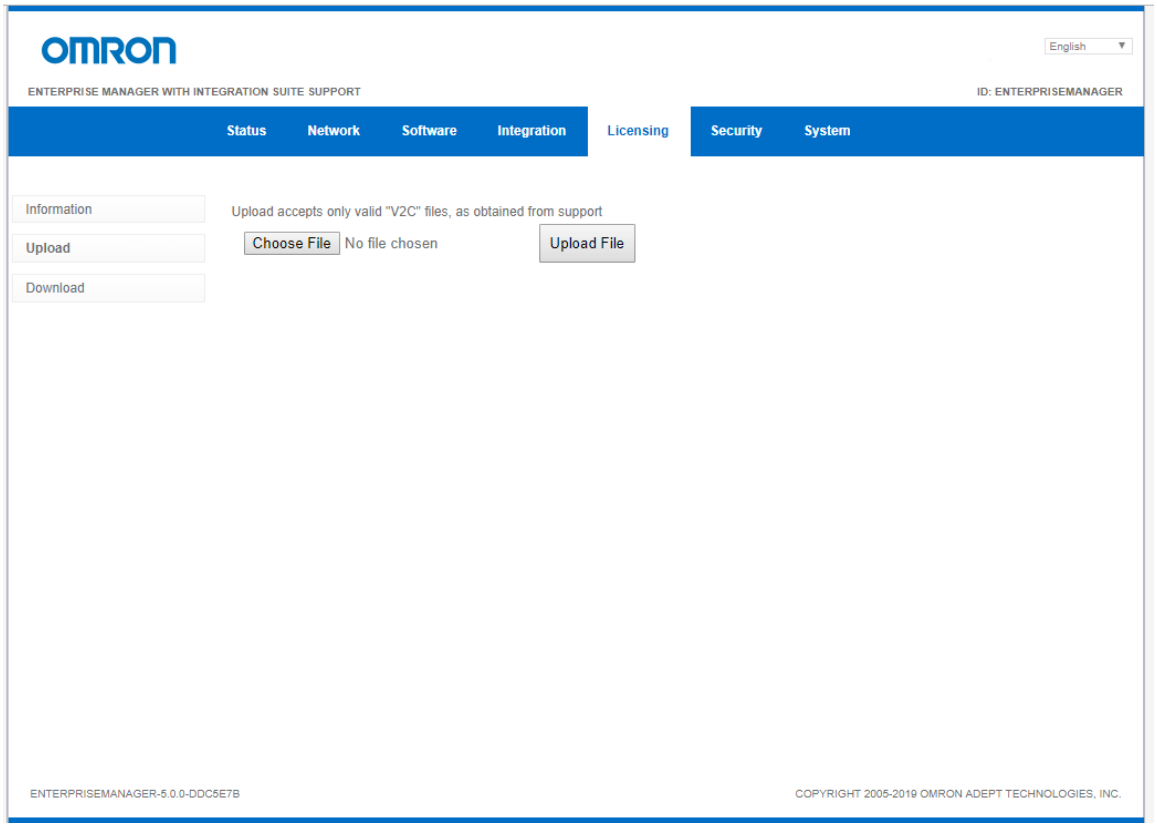


Figure 8-10. Licensing, Choosing a File to Upload

Now that a valid license is activated, SetNetGo will initiate the requested mode by starting the appropriate code on your Fleet Manager or AMR.

> **NOTE:** After a C2V file has been submitted to obtain a license, it can not be reused. If you need another license you have to generate a new C2V file for the request. Likewise, a V2C file can not be reused with SetNetGo, either.

8.7 Uploading, Backing up, and Restoring SetNetGo

Through MobilePlanner, you can upload (upgrade to) a new version of SetNetGo by simply choosing the proper file.

Your upload options allow you to choose whether to upload a new version of SetNetGo into the Boot Image A slot (which is the default image slot), or the Boot Image B slot (which you then have to make bootable), or have versions in both slots.

In case of a software failure, you can also restore SetNetGo from a file maintained on the same (or a different) AMR. You can only restore to a specific restore point on an AMR (identified by its date/time), but only from the last restore point, and only on that AMR.

8.8 Uploading a New SetNetGo OS

1. In the MobilePlanner tool bar, click the **SetNetGo** button, then click the **System** tab, then click the **Upload SetNetGo OS** menu item (left-side pane).

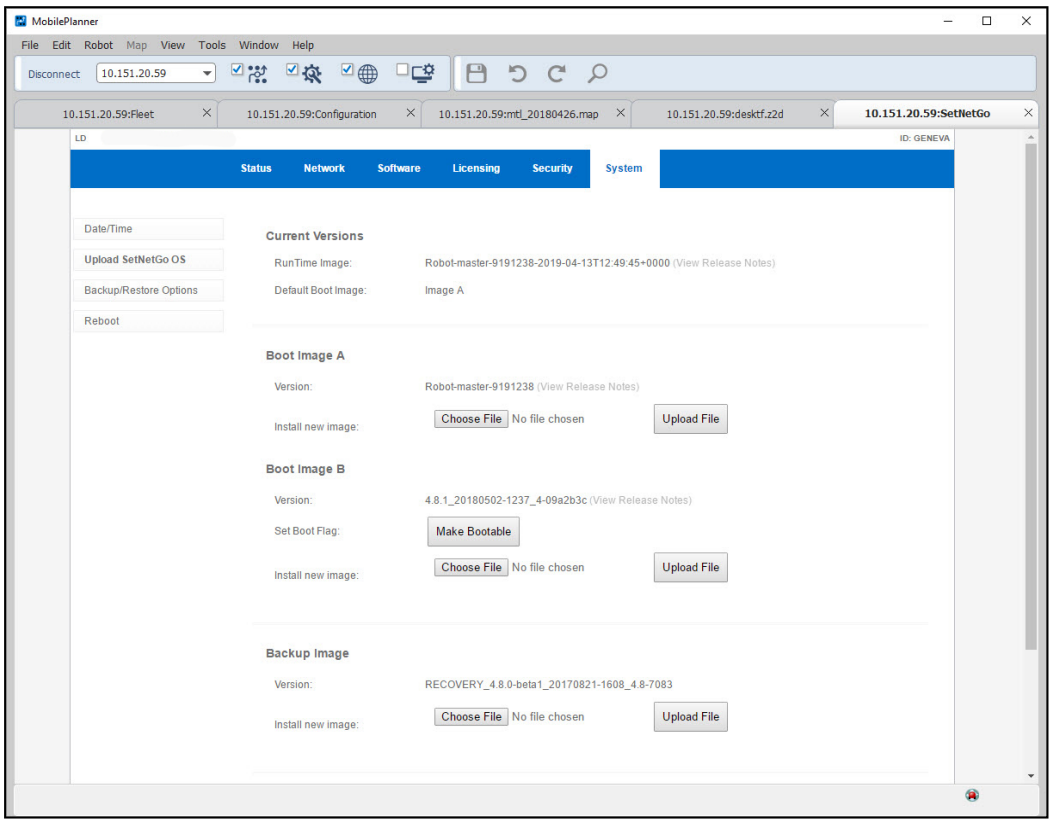


Figure 8-11. SetNetGo, System Tab

The Upload New SetNetGo OS page, Current Versions field, contains information about the current installed version (with option to view its release notes), and which image is the current bootable image (Image A in the example above).

2. To install a new SetNetGo version into the Boot Image A slot, click the **Choose File** button, and browse to the location of the new image file. To upload a file, click the **Upload File** button.

   NOTE: Clicking the Upload File button will upload a new SetNetGo package, which will overwrite the existing image in the Boot Image A slot, and ask you to confirm before proceeding.

3. Click **Open** when done.

4. To install a new image file into the Boot Image B slot (and make it bootable), click the **Choose File** button then, when you've chosen the file, click the **Make Bootable** button.

8.9 Backing Up and Restoring SetNetGo

As with any system, it's a good idea to back up your system files frequently, especially after making configuration changes. After backing up, you then have a file from which you can restore your system back to working condition if a version becomes corrupted, if you swap AMR cores, or add a new AMR to your fleet that's identical to the others.

Creating a restore point

When you back up your system, the resulting file is date and time stamped with the current day and time of backup, and becomes a specific restore point (overwriting the your previously saved restore point).

1. In SetNetGo, click the **System** tab, then click the **Backup/Restore Options** item.
2. In the Restore-Point field, click the **Backup now** button.

   The following advisory dialog appears.

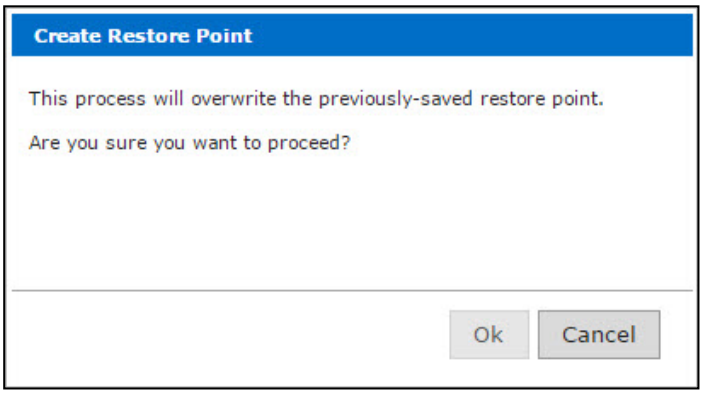


Figure 8-12. SetNetGo Create Restore Point Dialog

3. Read the confirmation then, if sure you want to proceed, click **OK**.

Reverting to a Restore Point

Reverting to a previously saved backup (restore point) takes your AMR's core back to its configuration as of the date and time of the restore point file you select. During the restore, you will lose your connection to MobilePlanner while the restore process resets your configurations.

1. In SetNetGo, click the **System** tab, then click the **Backup/Restore Options** item then, under the Restore-Point heading, click the **Restore Now** button.

The following advisory dialog appears:

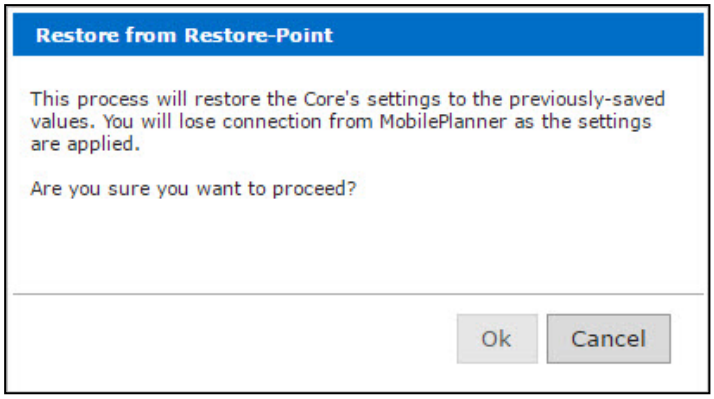


Figure 8-13. SetNetGo Confirm Restore Dialog

2. Read the confirmation then, if sure you want to proceed, click **OK**.

   The selected file overwrites the previous settings in the AMR's core, and the AMR disconnects from MobilePlanner. After the restore is complete, you can reconnect to the AMR.

Restoring Settings from DebugInfo File

If you swap an AMR's core, and want to update the new core with all of the existing configuration info from that AMR onto the new core, you would use the **Restore from same robot** option. This process does not overwrite other software on the core; you should verify those software versions.

> **NOTE:** The Restore from same robot option does not include WiFi credentials (i.e., key, passphrase, certificates) or overwrite currently existing versions of other software (you should determine which versions to use).

If you have a fleet of one type of AMR and are adding another AMR of that type to your fleet, you would use the **Restore from different robot** option. This feature gives a quick method of configuring the new AMR so it performs identically to the others.

> **NOTE:** The **Restore from different robot** option does not change IP address or AMR calibration data (including AMR identifier). After using this option, you will need to re-set your AMR's WiFi, IP address, and identifier.

1. In SetNetGo, click the **System** tab, then click **Backup/Restore Options** from the list on the left.
2. Under the Restore Settings from DebugInfo File heading, click **Choose File** for either the **Restore from same robot** option (see explanation above for example use case), or the **Restore from different robot** option (see explanation above for example use case).
3. In the Open window, browse to and select the file you want to upload, then click **Open**.
4. Verify the correct file name appears next to the Choose File button, then click the **Upload** button.

An advisory dialog will be displayed, asking for your confirmation.

5. Read the confirmation and, if sure you want to proceed, click **OK**.

NOTE: Both of these processes creates a new restore point.

8.10 SetNetGo Recovery Mode

If your system experiences a serious software malfunction, you can recover:

1. In SetNetGo, click the **System** tab, then click on the **Upload SetNetGo OS** item.
2. At the bottom of the window in the Recovery Mode field, click the **Reboot and Enter Recovery Mode** button.

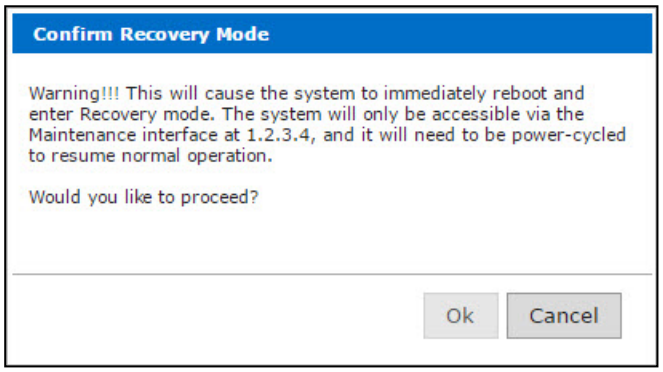


Figure 8-14. SetNetGo Recovery Mode

3. If you are certain you want to proceed, click **OK**.
4. After the system reboots into recovery mode, power down the AMR, and follow normal start-up procedures.

8.11 Configuring ARAM

This section covers using the SetNetGo to set up and manage accounts, and to update the ARAM software.

Setting Up User Accounts

The SetNetGo Security tab allows you manage access control for accessing AMRs and the Fleet Manager via MobilePlanner. This allows you to restrict users from performing specific tasks.

NOTE: At least one account must be enabled at all times. SetNetGo will enforce this.

1. From MobilePlanner, click the **SetNetGo** button, then click the **Security** tab.

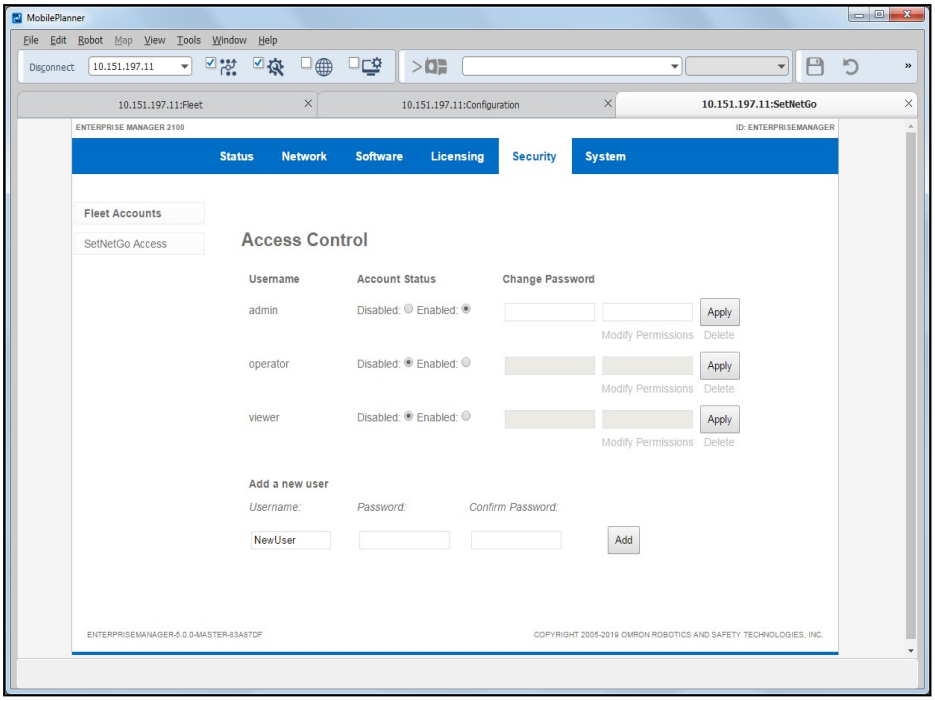


Figure 8-15. SetNetGo Interface - Security Tab

By default, access control for connecting to AMRs and/or Fleet Manager is enabled.

2. To change the access password for the admin, operator, or viewer accounts, click the associated **Enabled** radio button, then click **Apply** next to each modified username.

   Any change to account information will force a restart of ARAMCentral or ARAM.

3. Continue to the next section to set up user accounts.

To Set Up and Manage User Accounts

1. In MobilePlanner, open SetNetGo.
2. Click on the **Security** tab to display the page for Fleet Accounts (on the Fleet Manager) or ARAM Accounts (on the AMR).
3. Follow the instructions in the table below to add, delete, or edit a user account.

To...	Perform the following steps
Add a user account	1. Enter a Username in the **Add a new user** field. 2. Enter a password in the first Password field (on the same line as the username). User names and passwords can have letters, numbers, special Unicode marks, underscores, and periods (.). Do not use spaces or other special characters. 3. Re-enter the same password in the Confirm Password field. 4. Click **Add**, and verify the new user account appears under the User-name column.
Delete a user account	1. Click Delete in the line of the username you want to delete. 2. Click **Apply** to remove the user account from the list in the Username column.

Permission Groups

For each user account, you can enable and disable access to various features in MobilePlanner. For example, enabling FileUploading allows the user to upload and download files from MobilePlanner to the AMR.

1. To modify account permissions for each user (for example, admin user), click **Modify Permissions** (to the left, and below the **Apply** button) to display the Change Account Permissions page.

   The example below shows account permissions page for the admin user who, by default, has all permissions assigned. Other users have different sets. Use the side scroll bar to see all permissions.

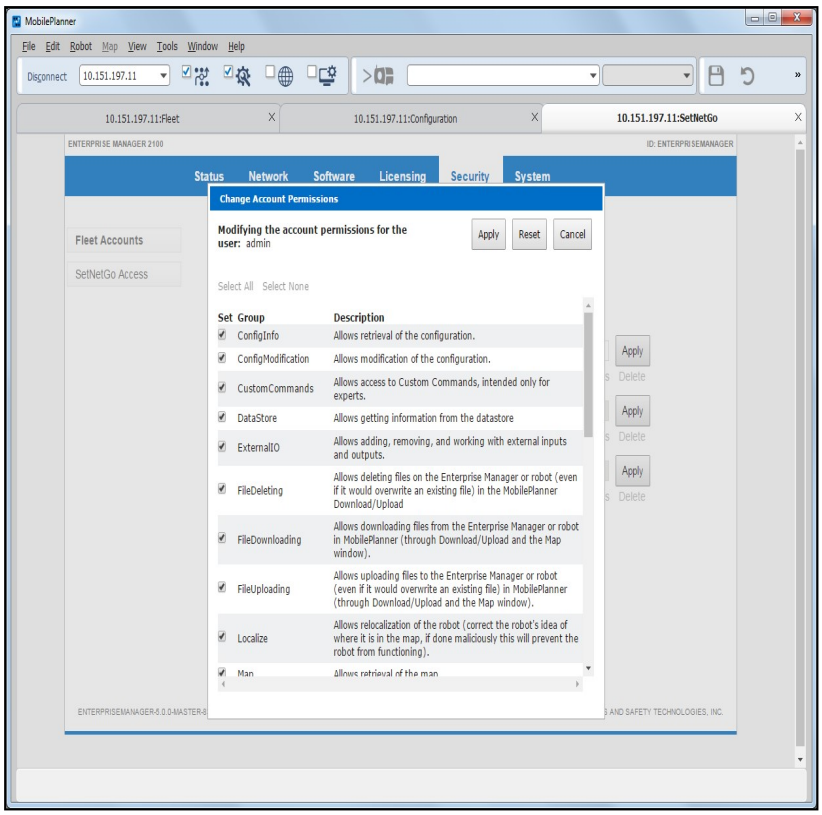


Figure 8-16. Change Account Permissions Page

2. Check the box(es) for the permission(s) you want to grant to the selected user account.

   You can quickly assign all permissions by clicking **Select All**, or click **Select None** to clear all assigned permissions.

3. Click **Apply** to set the selected account's permissions, and return to the ARAM Accounts page.

Operator Account

The Operator Account, by default, has the following privileges:

- CustomCommands
- Localize
- Map
- Movement
- Motors
- Navigation
- NavigationInfo
- RobotInfo

- SensorInfo
- Shutdown
- SoundFromRobot
- SoundOutRobot
- Stop
- MovementUnprotected
- QueueInfo
- QueueModification
- FileDownloading

Updating Fleet Operations Workspace Core

For an updated Fleet Operations Workspace Core package, contact your OMRON representative.

To Update the Fleet Operations Workspace Core

1. In MobilePlanner, click the **SetNetGo** button, then click the **Software** tab, then click **Manage Installed Software** from the left side list.

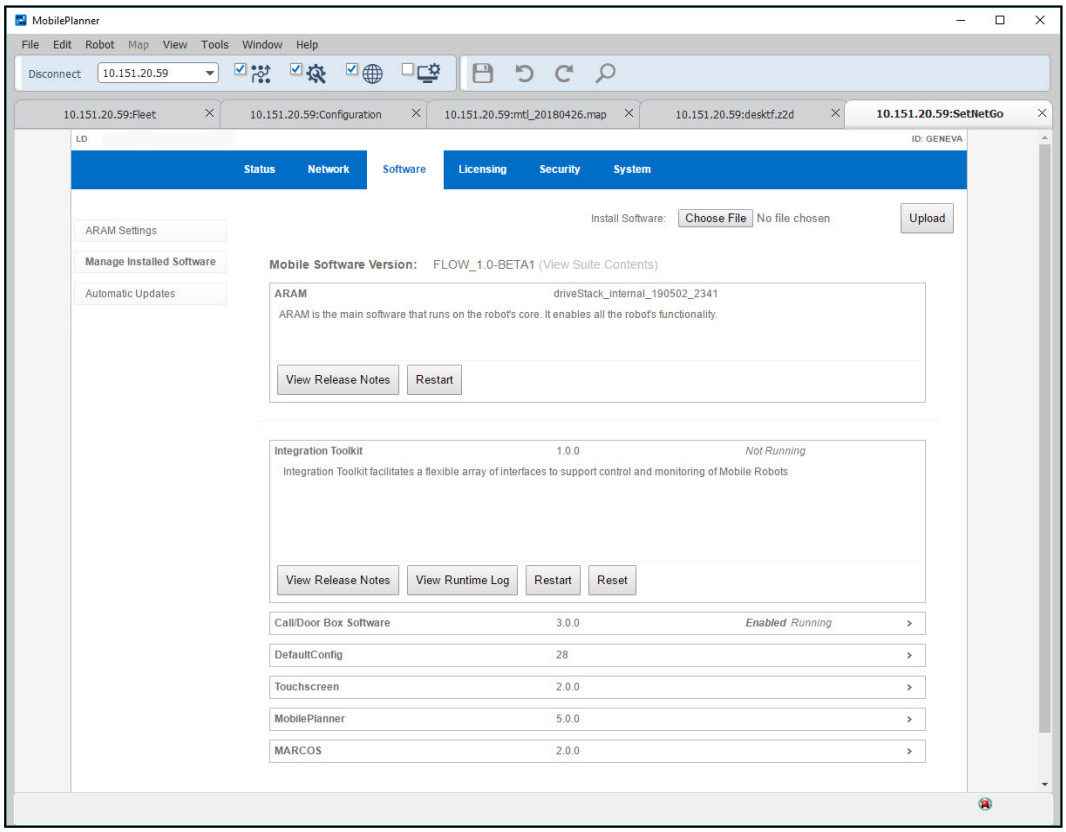


Figure 8-17. SetNetGo Interface - Software Tab

2. Click the **Choose File** button to access the directory where the update file is located, and click **Open**.
3. Confirm the correct file name is listed next to the Choose File button, then click **Upload**.

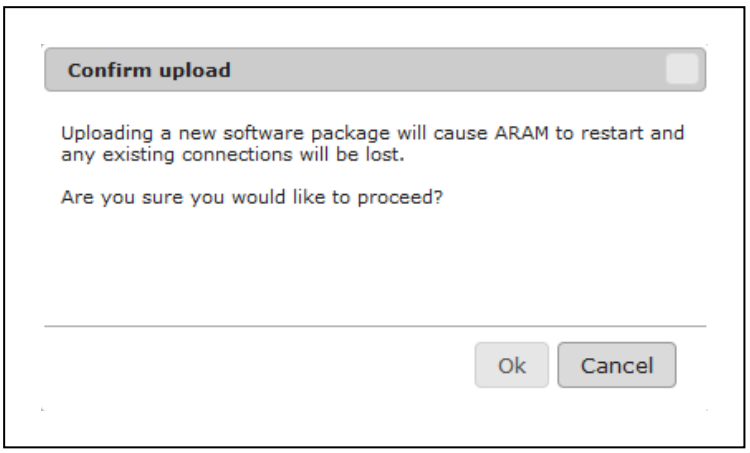


Figure 8-18. Confirm Upload Dialog

4. If you are certain you want to proceed, click **OK**.

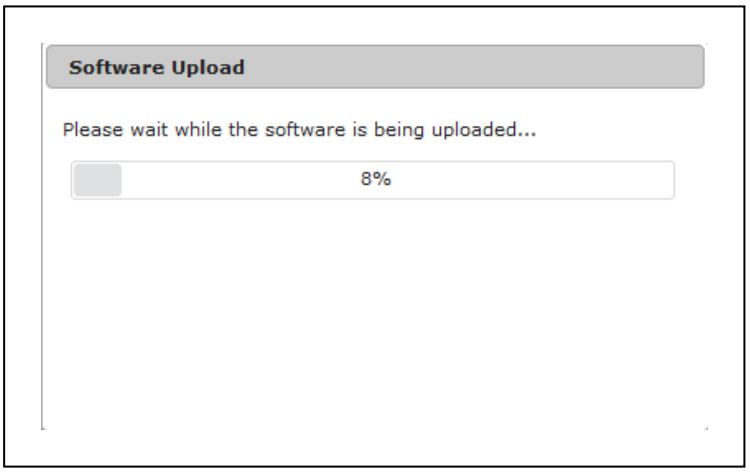


Figure 8-19. Software Upload Status

The AMR will be unavailable as it goes through its restart sequence (a status window shows restart progress).

If the installation was successful, the new Mobile Software version appears in Manage Installed Software.

Viewing Software Packages

Clicking a package name expands the selection and shows the options for that package, which can include:

- Release notes.
- The option to enable or disable the package (if the package is executable).
- Log files.
- Uninstall (if available).

Restarting ARAM

ARAM automatically stops when any changes are made, but you can click the **Restart** button to force ARAM to restart.

Chapter 9: Configuring the AMR

There are hundreds of parameters you can set in MobilePlanner to customize your AMR's operation in your environment. Other sections in this manual describe localization and mapping parameters. This section describes AMR operation parameters.

This section covers the following topics:

9.1 AMR WiFi Capabilities

OMRON's AMRs have multiple network interfaces, including a built-in wireless communications capability to enable their autonomous operations. The on-board wireless card can use 802.11a, 802.11b, 802.11g, 802.11n, or 802.11ac wireless standard on 2.4 GHz or 5 GHz channels, and the AMR will automatically switch between wireless access points as it moves through its environment.

> **NOTE:** If the AMR has difficulty connecting to a wireless access point, switches between 2.4 GHz and 5 GHz channels, frequently disconnects, or has weak signal strength, try disabling the 2.4 GHz channel. If the problem discontinues, inform your IT department of your finding.

The AMRs' wireless system can use the majority of the most common personal and enterprise-grade security methods and encryption, including:

- Open
- 64-bit or 128-bit wireless equivalent privacy (WEP)
- WiFi-protected access (WPA2)-pre-shared key (PSK) ASCII or HEX passphrase
- Extensible authentication protocol-tranport layer security (EAP-TLS)
- Protected EAP-Microsoft challenge handshake authentication protocol version 2 (PEAP-MSCHAPv2), or
- Advanced encryption standard/temporal key integrity protocol/counter mode with Cypher block chaining message authentication code protocol (AES/TKIP/CCMP) encryption.

The AMRs can also use certificates (small files containing identifying information that allows the AMR to connect to secure networks that require explicit identification and pre-authorization for access) with the following extensions:

- .pem - a privacy enhanced mail (PEM)-encoded X.509 certificate
- .pem/.cer/.crt - a PEM or distinguished encoding rules (DER) encoded X.509 certificate
- .p7b - a Public Key Cryptography standards (PKCS7) file containing one or more certificates (contains no private key)
- .p12 - a PKCS12 file containing one or more certificates (includes private key)

Your certificate authority (CA) server generates these certificates based on a certificate request (.csr) file. You manually install the certificates on the AMR. The AMRs can generate their own 1024-bit or 2048-bit RSA keys, or use keys generated by the CA.

9.2 Available Options and Peripherals

The following options and peripherals are available for your AMR (for more details, see the Peripherals Guide for your AMR):

Pendant

The pendant is an optional hand-held input device for driving the AMR. It attaches directly to the AMR's pendant port, and has controls to move the AMR forward and backward, turn left or right, and adjust its speed. It also has a configurable goal button for adding goals while mapping.

Acuity

In addition to using a safety scanning laser (navigation laser) to create a map of its environment, the AMR can, with an upward-facing camera mounted on top of the platform, use overhead light localization for navigation (the laser then provides obstacle avoidance). Called Acuity, this peripheral add-on is ideal for dynamic environments, such as warehouses, in which objects on the floor undergo frequent location changes. For more information on localization, see What is Localization? on page 228.

> **NOTE:** If not installed by the factory, Acuity requires installation of the Acuity Support Package software via the MobilePlanner software. For information, see the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)*, found in the OMRON corporate website.

> **NOTE:** Acuity Localization is not currently available with the HD-1500 AMR.

High Accuracy Positioning System (HAPS)

The HAPS peripheral uses a sensor (called GuideSensor_Front in the Robot Physical configuration) installed in the AMR to detect and follow magnetic tape applied to the floor. HAPS allows you to position the AMR at pick-up and drop-off locations with a high degree of accuracy. For more information, refer to the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)* and the *Mobile Robots - HD Platform Peripherals Manual (Cat. No. I646)*.

Side Lasers

Certain AMRs have side lasers to detect obstacles on either side (such as overhangs, tables, etc.) to help the AMR navigate through tight areas, such as office spaces.

Touchscreen

The Touchscreen allows interaction with the AMR at any location. You can check the AMR's status, send the AMR to goals, pause or release the AMR, or localize a lost AMR.

Call Buttons and **Door Boxes**

Call buttons issue a request for the AMR to go to the call button's associated goal. Door Boxes act as remote I/O, and can issue requests to open closed doors equipped with a door activator so AMRs can pass through it. For additional information, see *Mobile Robots - LD Platform Peripherals Guide.*

9.3 Types of Configurations

MobilePlanner allows you to view, modify, save, and import various AMR and fleet, and debug configurations. You can set AMR interface, operation, and physical configurations,

EM2100 configurations (queuing tasks, fleet features, and connection), and debug configurations that control the output of debug log files.

General Configurations

General configurations include site-specific parameters for the AMR interface (A/V config, connection timeouts, language/location, speech synthesis, etc.), AMR operation (bumper settings, docking behavior, localization settings, path planning settings, task features, etc.), EM2100 features and connection, and debug information. General configurations are consistent across your site. If you have a fleet of AMR, the general configurations reside on the EM2100. If you have a single AMR, the general configurations reside in the AMR's core.

Model and Calibration Configurations

These configurations relate to the AMR itself. Model configurations include AMR model-specific parameters like movement maximums, battery information, Acuity camera configurations, the MARC configuration, AMR type, sensor type(s) and location(s), fleet queuing tasks, etc. Calibration configurations include general physical AMR information and parameters. Model and calibration configurations always reside in the AMR's core.

9.4 Setting the Configuration Parameters

Configuration parameters determine the available features on your AMR. You can enable or disable them, or assign them a value. You can set these parameters in MobilePlanner.

Using the tabs listed here, you can set parameters for everything from audio feeds, to docking, mapping, localization, server setup, move settings, and many more.

There are five AMR parameter tabs:

- Robot Interface
- Robot Operation
- Robot Physical
- Fleet
- Debug

Click on a tab, such as Robot Interface, to open and view its sections. Clicking on a section name displays the individual parameters in that section. The following graphic shows the A/V Config section selected:

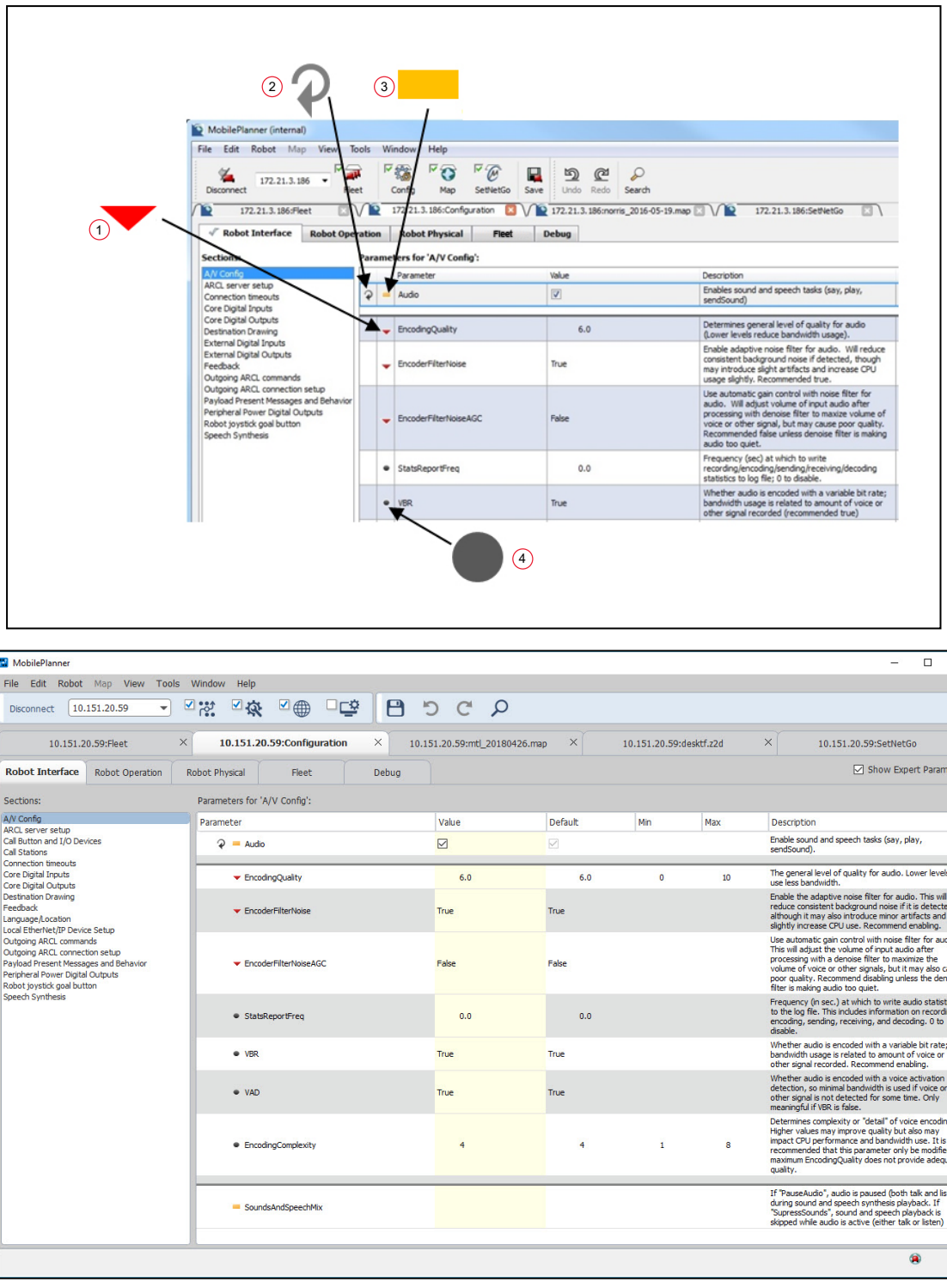


Figure 9-1. Robot Interface Pane, A/V Config Parameters (not all shown)

Table 9-1. Robot Interface Pane Description

Item	Description
	Automatic software restart if changed.
	Parameter for intermediate users. It may need to be changed, but should not have side effects (or else, very obvious side effects that are explained).
	Parameter for advanced users. It might need to be changed, but not often and any side effects are obvious and explained.
	Parameters for expert users. It is likely to have side effects, which may be subtle.

Most configuration windows in MobilePlanner software describe most of the parameters, and most are not repeated here. Where needed, this user guide explains more complex parameters.

> **NOTE: [?, for more]** in the description column of a parameter indicates that more information is available by pressing the '?' key on your keyboard when that parameter is selected. The following figure is an example.

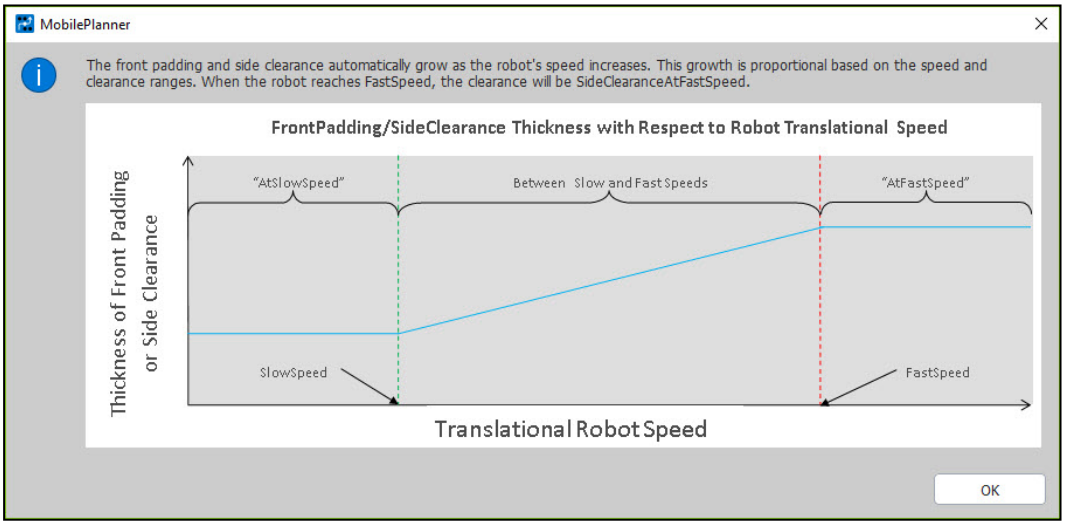


Figure 9-2. Pop-up Window for SideClearanceAtSlowSpeed when '?' is Pressed on the Keyboard

To set a parameter, select one of the tabs in MobilePlanner, then select a Section in that tab to see the available parameters. You can then modify the specific parameter in the parameter table.

In this table's Value column, you can enter a value (numeric or text), choose a value from a drop-down selection, or click a checkbox. Most text fields have drop-down menus for selection.

Most parameters are not stand-alone and interact with other parameters. This user's guide discusses various parameters. For example, if you are localizing the AMR, you will find the parameters related to localization in the Using Laser Localization on page 231 section of this guide.

If you change any parameter settings, you have to click **Save** for those changes to take effect. When MobilePlanner sends the update to the AMR, a small spinning icon and "Update Pending" message appear in the MobilePlanner status bar until the AMR applies the changes (at its next idle period). You can also stop the AMR if you want the changes to be applied more quickly.

> **NOTE:** ARAM automatically restarts automatically after some parameter changes.

If the parameter has a restart icon then, after ARAM writes the change, it displays the following dialog indicating the configuration change:

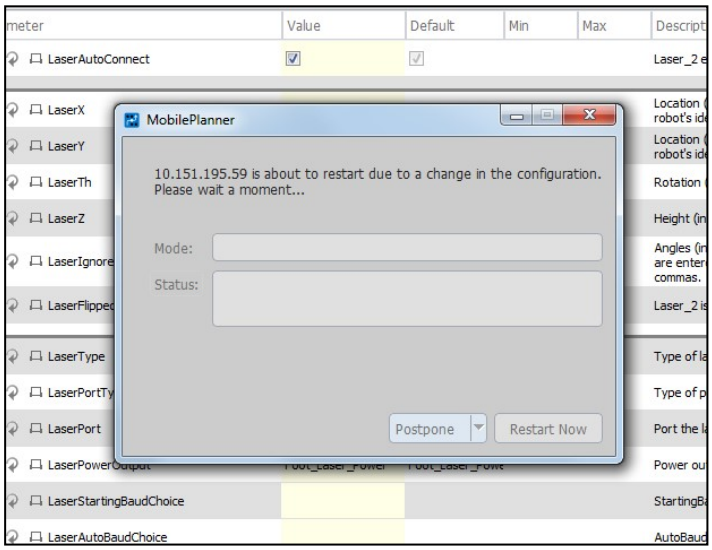


Figure 9-3. Robot Configuration Change

9.5 Saving and Importing the Configuration Parameters

You can save parameter settings on either an AMR or in the Fleet Manager:

1. In MobilePlanner, click the **Config** tab.
2. In MobilePlanner's main menu, select **File > Save As**, and give a file name and location for the file on your local PC.

   The Save <robot IP address> Configuration window opens.

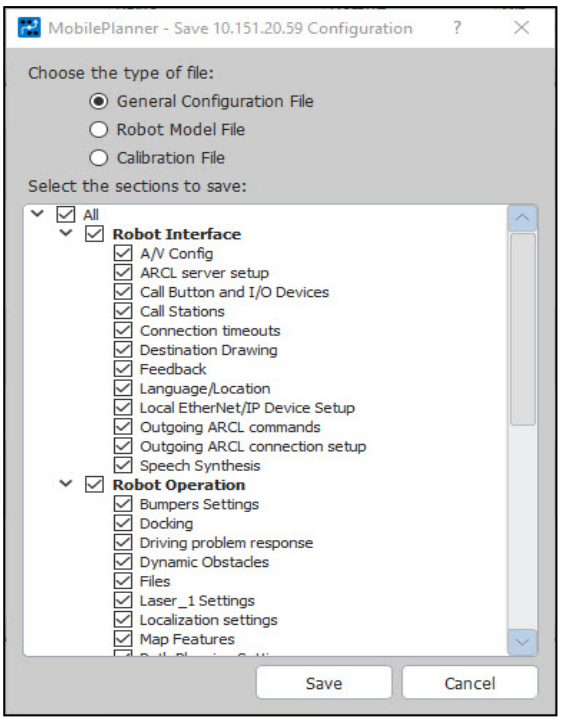


Figure 9-4. Save Robot Configuration Window

3. In the Save <robot IP address> window, select the type of file you want to save (General, Robot Model, or Calibration), then either accept all checked configurations (default), or de-select the individual configurations you do not want.
4. Click **Save** when done.

Importing

You can import parameter settings from your PC to either an AMR or the EM2100 appliance:

1. Select **MobilePlanner > Config.**
2. From the main menu, select **File > Import Config ...**, then select the file from your local PC.
3. Click **Save** from the main toolbar.

NOTE: If ARAM restarts after saving a configuration, you will need to repeat the above steps until the software no longer restarts.

9.6 Managing Files

MobilePlanner allows you to manage files associated with Fleet Operations Workspace Core, including:

- raw map-scans (.2d or .z2d) files
- maps (.map) files
- log files
- data files

Downloading, Uploading, and Saving Files

You can upload and download map, scan, log, and data files using **File > Download/Upload** from the top bar. Select the AMR you want to use, and then select the file or folder on the AMR and the file or folder on the PC that you want, and click either **Upload** or **Download**.

You can save map files using **File > Save As...** or, if the file already exists and you just want to save modifications, use **File > Save** (Save only affects the previously saved file).

You can also simply click the **Save** icon in the Toolbar.

You can import a configuration file onto the current AMR using **File > Import Config...**

> **NOTE:** Import Config applies to the config copy on MobilePlanner, and must be saved before it is on the current AMR.

9.7 Setting Up Data Logging

The ARAM software can log all kinds of data into one or more files. These data logs allow you to manipulate the data, using your own third-party data-processing software.

> **NOTE:** Log Config is a Section of parameters you can set in MobilePlanner. These logs are not the same as the files generated with data logging.

To set up data logging, click the **Config** tab, then click the **Debug** tab. When checked, the Show Expert Parameters checkbox displays advanced parameters that, by default, do not appear in the parameter list.

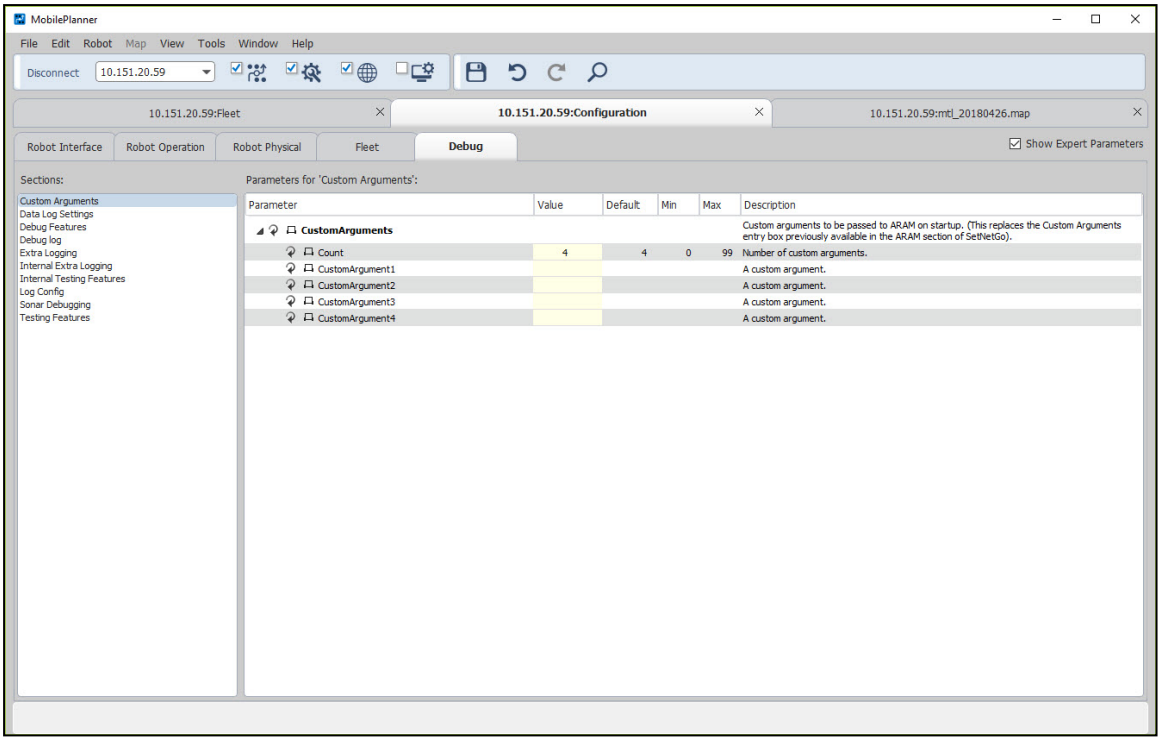


Figure 9-5. MobilePlanner Config, Debug Tab (Show Expert Parameters Checked)

The Debug tab has sections for configuring debug files and setting logging parameters.

> **NOTE:** Each section has a description of what it does (though some parameters are not visible until you check the "Show Expert Parameters" checkbox).

Chapter 10: Working with Macros, Tasks, and the Route Builder

MobilePlanner gives you the flexibility to manually program a complex series of tasks for the AMR to perform at a goal before moving on to the next goal and performing additional tasks.

Or, instead, you could create macros that include all of the tasks the AMR is to perform at a given goal. You can add tasks and goals to macros, then use the macros within a route or several routes. In other words, macros are "reusable." You can also have individual tasks call a macro and execute the sub tasks within the macro.

For example, you could create a macro in which the AMR heads to Goal1, speaks a phrase and waits for a human action, after which it then heads to Goal2, where it waits for a specified time, then heads to Goal3.

You can use the MobilePlanner software to add tasks, goals, and macros into your facility's map, associate tasks with routes and goals, and assemble series of goals, tasks, and macros into routes.

This chapter discusses the following topics:

10.1 AMR Tasks

Tasks are activities that the AMR can perform, such as going to a goal or checking sensors. The AMR executes tasks at goals to accomplish useful work, such as enabling Digital IO and telling the AMR to move. These tasks are already available on the AMR but need to be defined and associated with the map that you are creating.

There are both instant and non-instant tasks available for the AMR to perform. Instant tasks allow other tasks to be started before the instant task finishes. Non-instant tasks force the next task to wait until they are completed.

You can add tasks to goals and routes. For details, see Using the Route Builder on page 180.

> **IMPORTANT:** Use of AMR tasks or ARCL commands to remotely or automatically re-enable motor power is not permitted. Doing so could result in unexpected AMR motion. Motor power may only be enabled by intentional, manual action at the AMR.

Assigning Tasks

You can assign tasks to a route or goal, or use them in macros. You can find available tasks under the Robot Tasks tab in the Source Lists pane. See Setting Up Special Tasks on page 174.

Many tasks need to have their corresponding ARAM parameters enabled to be available. For more information on enabling ARAM parameters, refer to Configuring ARAM on page 132. If you do not see a task displayed in the Source Lists pane, it might have previously been turned off. To display the task, enable (or re-enable) the appropriate ARAM parameter.

Assigning tasks

1. In MobilePlanner, click the **Map** button, then click the **Build** tab.

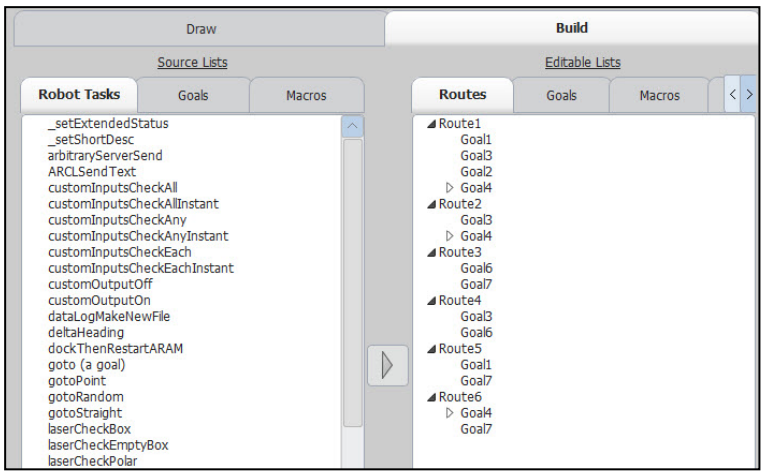


Figure 10-1. The Map Build Tab

2. In the Source Lists pane, click **Robot Tasks** tab to view tasks that are available on the AMR.
3. In the Editable Lists pane, click the **Routes**, **Goals**, **Macros**, or **Special** tab that corresponds to where you want to assign the task.
4. To assign a task to a route, goal, macro, or special item, in the Source Lists, Robot Tasks tab:
    a. Click on the task you want to assign, and drag it over to the desired route, goal, macro, or special item, or
    b. Highlight the task, then highlight the desired goal, macro, special item or route, and click the **Add** button (the arrow between the lists).

        NOTE: By default, tasks added to goals become part of the goal's "after" list (the AMR will perform the task after it arrives). The process also creates a "before" list for tasks the AMR will execute before driving to the goal (you can also move tasks to the “before” list).

    If the task has associated parameters, the dialog box shown below (for a "sayInstant" task) opens:

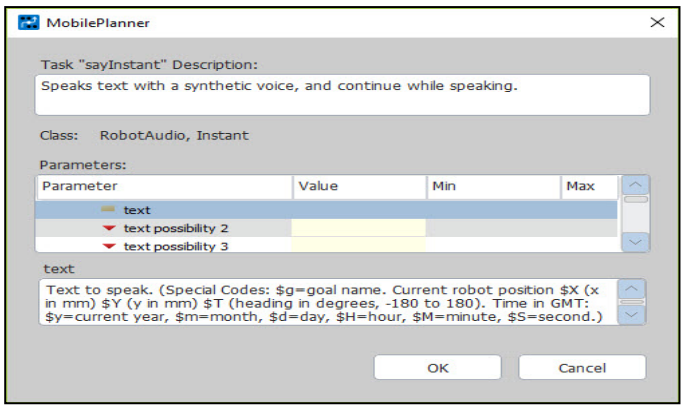


Figure 10-2. MobilePlanner Task Description Dialog

5. Click inside the **Value** field to add and edit each parameter's values.

   For more information on using individual tasks, refer to the task type (such as wait, driving, etc.) in the following section.

Using Instant and Non-Instant Tasks

In general, there can be only one sequence of non-instant tasks running at a time. AMRs can start an instant task without waiting for a previous instant task to finish. Non-instant tasks must finish before the AMR starts another task. In other words, both kinds of tasks are on the task list, but the non-instant tasks must finish before the AMR starts next task on the list. When an instant task runs, the task after it can start right away, without interrupting whatever else is happening.

Instant Tasks

Instant tasks allow the next task in the list to start while the instant task is still running, so the AMR can be running two tasks at once. The following are examples of instant tasks available in the software. The complete list of instant tasks and descriptions are available directly in the software.

Instant Task	Description
ARCLSendText	Sends a given string to the ARCL server.
customOutputOff	Turns a custom output OFF.
customOutputOn	Turns a custom output ON.
playBackgroundSound	Plays a random background sound (at 'Least Important') from a set of prefixes and suffixes (wild cards do NOT work), waiting a length of time between sounds, optionally resuming interrupted sounds, and with the ability to stop playing in some different circumstances. **NOTE:** To interrupt this sound, set the audio task **Cancel less important** to **True**.
playInstant	Plays a sound file and then continue while the sound plays.
popupSimple	Requests client applications to show a simple pop-up message (Client applications include MobilePlanner).
sayInstant	Speaks text with a synthetic voice.
sendSoundInstant	Sends sound from an AMR sound file to all clients and continue immediately.
sendSpeechInstant	Sends synthesized speech to all clients and continue immediately.

Non-Instant Tasks

Non-instant tasks run in their own time slot (the AMR must wait for them to complete before starting the next task in the list).

The following are examples of non-instant tasks. The complete list of non-instant tasks and descriptions are available directly in the software.

Non-Instant Task	Description
arbitraryServerSend	Sends the given text to a specified server and port.
cartCapture	Task to capture a cart.
cartRelease	Task to release a captured cart.
customInputsCheckAll/Any/Each	Checks whether all/any/each specified custom inputs properly triggered and executes a macro.
deltaHeading	Changes the heading by the specified relative amount.
followGuide	Used with HAPS - task to follow a magnetic guide strip on the floor.
gotoRandom	Drives to a random goal (could be optionally constrained by a matching name prefix).

Non-Instant Task	Description
laserCheckBox	Waits for something to enter the rectangular area surrounding the AMR. Macros may be triggered upon detection or timeout.
laserCheckEmptyBox	Waits for the rectangular area surrounding the AMR to be empty. Macros can trigger upon detection or timeout.
macroRepeat	Repeats the specified macro a given number of times or until it fails.
move	Moves forward by the specified distance, provided that no obstacles are encountered.
play	Plays a sound file and waits until it finishes playing.
say	Speaks text with a synthetic voice and waits until it is finished.
sendSound	Sends sound from an AMR sound file to all clients, continues when done.
sendSpeech	Sends synthesized speech to all clients.
setHeading	Turns to a specified global orientation / heading.
wait	Waits for the specified number of seconds. The wait may be interrupted by an explicit continue command.
waitActive	Calls a macro, and optionally waits a given number of seconds or until told to continue by command and control.
waitIndefinitely	Waits until commanded otherwise.

To verify if a task is instant or non-instant, right-click on the task and select **Description**. Or, go into 'custom responses' (**Build** tab **> Editable Lists > Special** tab) and click on one of them. The non-instant tasks are grayed out, instant tasks are active. Task classification appears in the "Class" category, as shown in the following figure.

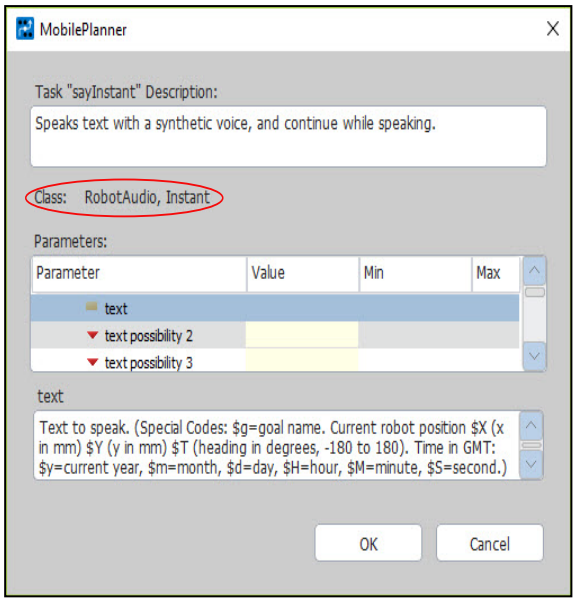


Figure 10-3. Task Class Category

Using a Wait Task

A wait task tells the AMR to wait a given number of seconds (or until told to continue by another command), before continuing. A wait task is not an instant task.

1. Open the map you want to edit. For details, refer to Using MobilePlanner Software on page 50.

   NOTE: Ensure that Show Robot is **OFF**, or you will not be able to proceed.

2. Click the **Build** tab.
3. Click the **Robot Tasks** tab in the Source Lists pane to view the tasks currently available on the AMR.
4. Add the Wait task to the route, goal, or macro where you want the AMR to pause before continuing its route. Refer to Assigning Tasks on page 150 for details.
5. Enter the number of seconds you want the AMR to wait in the Value field of the seconds to wait parameter, as shown below.

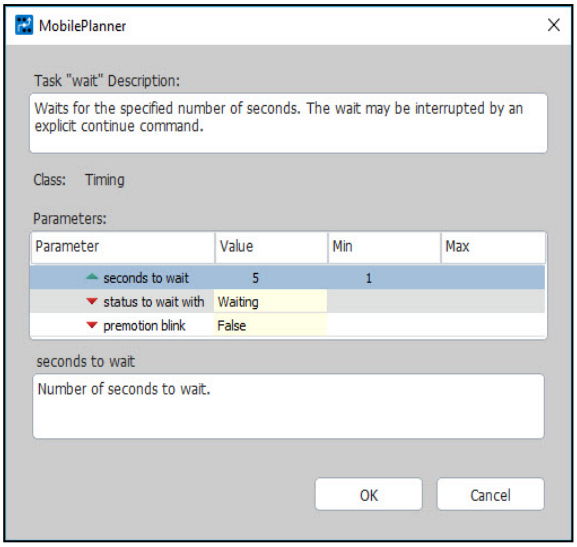


Figure 10-4. Parameters for Wait Task

6. Click **OK** to close the parameter dialog box and save your changes.

Using Driving Tasks

Driving tasks cause the AMR to move about its environment, carrying out various tasks at each goal. Driving tasks can include the following:

Task	Task Description
move	Tells the AMR to move the specified distance.
deltaHeading	Changes the AMR's heading.
setHeading	Turns the AMR toward a specified heading.

Step 1: Enable Movement Tasks

Not all available tasks are enabled by default. Before you can use those tasks, enable them in MobilePlanner by clicking the **Config** button, then clicking the **Robot Operation** tab, then clicking **Task Features**. After clicking the checkboxes you want to enable, click **Save** to save your changes.

The following table lists some examples of the driving and movement parameters that you can enable.

> **NOTE:** Some of the parameters in the following table require checking the Show Expert Parameters checkbox.

ARAM Parameter	Description
Engage	When used with HAPS, calls a macro when the AMR arrives at the goal, so the AMR can be sent on a series of tasks, such as a followGuide task to go to a marker on the magnetic strip.
MovementParametersTempTasks	Enables tasks for temporarily changing movement parameters.

Step 2: Assign Movement Tasks

Driving tasks are non-instant, but the MovementParametersTempTasks are.

1. Open the map you want to edit.
2. Click the **Build** tab to display Source and Editable Lists panes.
3. In the Source Lists pane, click the **Robot Tasks** tab to view available tasks.
4. Add the driving task to the route or macro (for details, see Assigning Tasks on page 150.
5. Enter the parameter values for the assigned task.

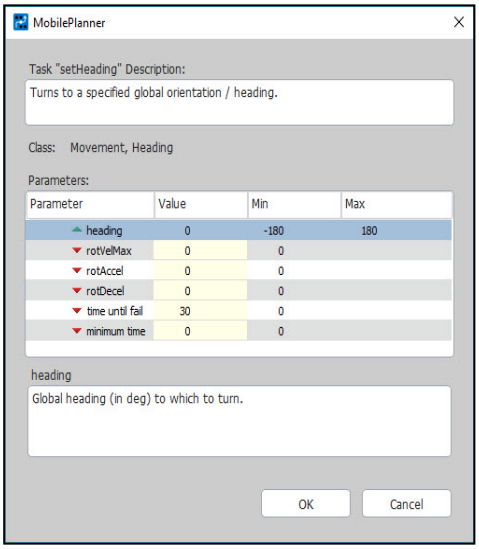


Figure 10-5. Parameters for setHeading Task

The following table shows examples of some of the task parameters and the tasks that use them.

Task Parameters	Parameter Definition	Associated Task(s)
heading	(Integer) The number of degrees to turn the AMR. Positive values turn the AMR left or counterclockwise. Negative values turn the AMR right or clockwise. For deltaHeading, if the absolute value exceeds 360, the AMR makes at least one full rotation.	deltaHeading, setHeading
distance	(Integer) The distance (in mm) the AMR should move from the current position.	move, move2, moveProx[1]
speed	(Integer) The speed (in mm/sec) the AMR should move from the current position.	move, move2, moveProx[1]

[1] moveProx and other "Prox" tasks are not supported for the HD-1500 AMR

6. Click **OK** to accept the parameter value and save any changes you made.

Cell Alignment Positioning System (CAPS)

The Cell Alignment Positioning System (CAPS) is a set of advanced features that provide improved destination alignment accuracy without requiring additional peripheral hardware on the AMR. These features are intended for use in applications that require better alignment accuracy than the standard solution.

CAPS now uses the PrecisionDrive task for improved alignment. Legacy versions of FLOW CAPS used the task TriangleTargetDrive and related tasks. These can still be used, but are not covered in this manual. Contact your OMRON representative for information on legacy tasks.

PrecisionDrive

PrecisionDrive is a software task designed to increase the final position accuracy of the OMRON AMR platforms. It forms the basis of the Cell Alignment Positioning System (CAPS). PrecisionDrive uses the onboard OS32 Scanning Lidar. It requires the user to place a reference target in the operating space. The AMR will locate and drive relative to this target.

PrecisionDrive is configured using the MobilePlanner user interface. It is a robotic task that can be scheduled before or after a map goal.

Normal Setup

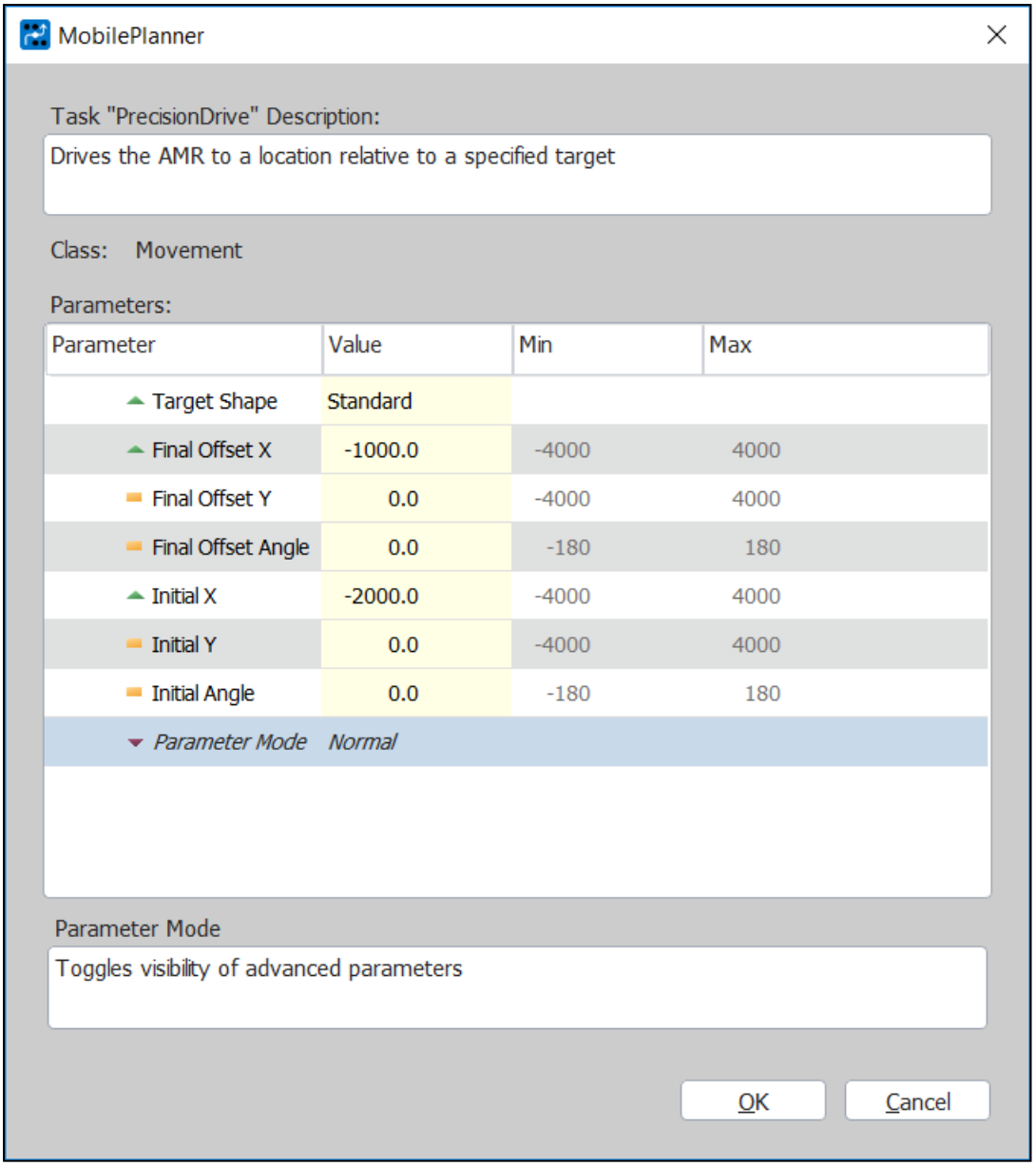


Figure 10-6. PrecisionDrive Normal Parameters

Target Shape

This dropdown controls which target the robot will locate and move relative to in the operating space. The Standard shape is the default and is defined in Standard Target on page 167. Other shapes can be used based on need and space requirements. Users should give preference to the Standard shape when designing and setting up an application. Both legs of the target must be in the field-of-view of Laser_1 (the front navigation laser) at the beginning of the task – the robot will not rotate to find the target.

NOTE: The Standard target is the only target with listed accuracy specifications.

Final Offset X

Final Offset Y

Final Offset Angle

These three settings (X, Y, Angle) specify where the AMR will attempt to stop at the end of the task execution. They are 2D spatial coordinates and the diagrams for setup are provided in Standard Target on page 167.

> **NOTE:** These values are relative to the target, not the robot. This is to simplify setting up tasks as they correlate directly to measurements taken from the target in geometric space.

Initial X

Initial Y

Initial Angle

These three settings (X, Y, Angle) specify the position for the AMR, from which it will attempt to locate the target when first starting the task. From the Initial position, the AMR should be able to see both legs of the target from the concave side. There is an associated search area to account for real world position uncertainty after arriving at the pre-goal. These are described in more detail under the Advanced Setup section. They are 2D spatial coordinates, and the diagrams for setup are provided in Target to Robot Coordinate Frame Transformations on page 167.

> **NOTE:** These values are relative to the target, not the robot. This is to simplify setting up tasks as they correlate to measurements taken from the target in geometric space.

These three parameter sets are all that are needed to successfully set up and use the PrecisionDrive task in most applications. Users should use the Normal setup whenever possible. All other parameters (listed in the Advanced Setup section) are optimized for most use cases with the Normal setup setting.

Parameter Mode

This parameter toggles the Normal and Advanced setting menus. Normal only shows the parameters previously described in this section. Advanced shows the parameters listed in the Advanced Setup section that follows.

Advanced Setup

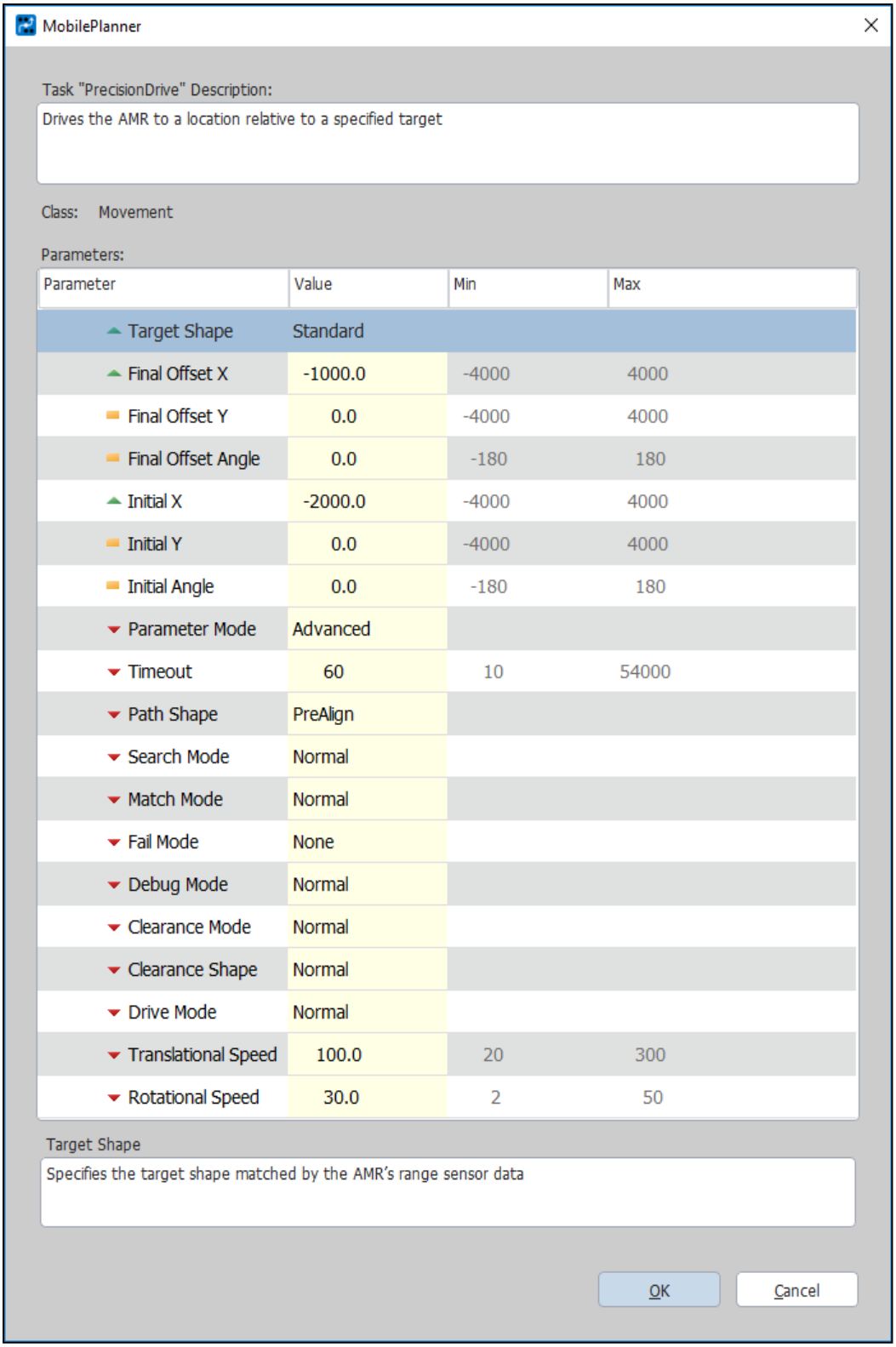


Figure 10-7. PrecisionDrive Advanced Parameters

Timeout

This controls the duration of the failure timeout. The timer begins at the time the task first starts looking for the reference target. If the tasks has not reached the desired ending position before the specified time, the system will come to a stop, and signal failure of the goal task.

Path Shape

This parameter selected the desired path to the end position.

PreAlign: This shape uses an arc-shaped path to first align with the vector path defined by the X,Y, and Angle Final position components, then follows the rest of the way moving straight with generally little or no final rotation required to achieve the desired final position. Some PreAlign moves may start and end with a straight path.

Straight: This shape draws a straight line between the Initial position of the AMR and the desired Final location. In-place rotation at the beginning and end of the straight path is performed as necessary.

Search Mode

This parameter controls the amount of initial tolerance allowed. The general guideline is that larger tolerances are more likely to find a target, but more likely to choose the wrong item as the target. Smaller tolerances are more likely to fail to find a target, but less likely to choose the wrong target.

> **NOTE:** The Search coordinate frame is relative to the target, not AMR reference frames.

Mode	Tolerance		
	X	Y	Angle
Normal	500 mm	500 mm	15°
Wide	250 mm	750 mm	20°
Tall	750 mm	250 mm	20°
Minimum	200 mm	200 mm	8.5°
Max	750 mm	750 mm	30°
Rotation	350 mm	350 mm	45°

Match Mode

This parameter specifies how closely the laser data must match the selected TargetProfile.

Normal: Balanced behavior between allowing for minor match errors with a reasonable guarantee that the target was correctly matched.

Lenient: This behavior allows more error in the final line fit to decrease risk of failing the task due to sensor noise or poor geometry. This mode should only be used when the target is in open space to decrease the likelihood of an incorrect match.

Strict: This behavior allows very little error in final data fit, but has a higher guarantee that the target was correctly matched. This mode should only be used when incorrect target matches will have very detrimental effects on the application. Using this mode will result in more

failed tasks, especially when operating large fleets as each scanning LIDAR has its own intrinsic errors and noise profiles that affect the final match quality.

Fail Mode

This parameter controls the different failure modes that would cause the task to immediately fail instead of attempting recovery to finish the task within the FailTime timeout.

> **FailOnSafetyStop:** Any Safety stop (either from Estop buttons or Safety LIDAR) will cause the task to immediately fail.

Clearance Mode and **Clearance Shape**

These two parameters control how the AMR deals with obstacles (both real and virtual) that are detected in close proximity to the AMR.

Clearance Mode controls how the clearances behave.

- Normal: uses the default settings

  Approach Distance = 400 mm away from sensed obstacles

- Variable: allows two difference clearance sets to be used

  Parameter "Clearance Switch Distance" controls when, during the task, the clearances switches from the initial clearance to the final clearance. This parameter is defined by the distance to the final location.

  This also allows control of the Approach Distance parameter.

- Custom: allows control of the Approach Distance parameter

Clearance Shape is the footprint of the clearance.

This parameter allows control over the size of the clearances around the AMR. All of the clearances are defined from the front, rear, and side edges of the robot.

In general, clearances should be set to fairly low values (<100 mm). Clearances are a supplement to the Safety system but do not in any way replace the hardware Safety.

- Normal: Clearances sizes and definitions are set to give a good compromise between staying a safe distance away from the obstacle and still completing the required task.

Front Clearance	Side Clearances	Back Clearance
50 mm	75 mm	20 mm

- Tight: Clearances sizes and definitions are set to minimize likelihood of task failure. The AMR will be allowed to drive slowly past obstacles very close to the physical footprint of the AMR. Using this setting will result in fewer task failures, but an increased chance of failure upon leaving the area (AMR can get into a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
20 mm	20	5 mm

- Expanded: Clearances sizes and definitions are set to maximize the likelihood of being able extract itself from the situation. The AMR will stop sooner due to the increased size

of the clearances areas. Using this setting will result in more task failures, but an increased chance of success upon leaving the area (AMR will stay out of a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
100 mm	250 mm	20 mm

- Custom: You can specify the area around the AMR for obstacle protection while moving to the final location. These parameters are only visible when Clearance Shape is set to Custom. Refer to the following figure.

  Allows control over Front, Left, Right, and Back Clearances.

  Negative clearances (clearances that allow obstacles internal to the defined shape of the AMR) can also be programmatically set. Use with Caution!

PrecisionDrive Clearance Differences

NOTE: The clearances used in PrecisionDrive have a few key differences compared to other Clearance parameters within the FLOW Core software.

- The slowdown/stop behavior is different. The Approach Distance controls how far away the platform should stop instead of the Front Clearance (or Front Padding depending on the Task). This results in allowing smaller front clearances in most applications.
- Obstacles near the clearances but not within the clearances will cause the AMR platform to slow down.

Drive Mode

This parameter controls the driving behavior of the AMR.

- Normal: A balanced optimization giving the best all-around driving behavior.
- Precise: Minimizes Path and final error at the expense of being slower and with increased jitter in its motion.
- Fast: Minimizes time to goal at the expense of being less precise and increased jitter in its motion.
- Smooth: Minimizes motion jitter at the expense of being slower and less precise in its motion.

Table 10-1. Drive Mode Behaviors

	Precise	Fast	Smooth
Cycle Time	Increased	Decreased	Increased
Smoothness	Decreased	Decreased	Improved
Precision	Improved	Decreased	Decreased

Forward Speed

This parameter controls the maximum forward translation velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The Drive Mode will dictate the local speed based on the

optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Reverse Speed

This parameter controls the maximum reverse translation velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Rotational Speed

This parameter controls the maximum rotational velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The DriveMode will dictate the local speed based on the optimization chosen. Depending on the DriveMode setting and the application, increasing this parameter will have no effect on the resulting motion.

OffsetCorrection

> **NOTE:** This feature is only available to PrecisionDrive if there is a CAPS license available.

MobilePlanner allows a user to configure a custom offset for each AMR. The primary purpose is to compensate for minor mechanical tolerance differences between individualvehicles across a “uniform” fleet. Users should first verify that Laser_1 is well-aligned and in good condition before trying to use OffsetCorrection as a quick fix for a potentially larger problem.

> **NOTE:** This is a part of MobilePlanner > Robot Configuration > Robot Physical . It is not a part of the PrecisionDrive task.

Only one OffsetCorrection (X, Y, and Angle) is allowed for each AMR. This will be applied to all PrecisionDrive tasks for that AMR - it is not task- or target-specific. In most applications the overall approach and motion generally stay consistent and a single offset (if needed) is sufficient. The OffsetCorrection is added to the final position requested in the PrecisionDrive task (Final Offset X, Final Offset Y, and Final Offset Angle values). The OffsetCorrection values are relative to the target using the same coordinate reference frame for the Final Offset values as shown in Standard Target on page 167. For example, if the Final Offset X in the task is –1000, and the individual AMR needs to have a Final Offset X of –1005, Offset X for that AMR would be set to –5. The same approach is used for Offset Y and Offset Angle.

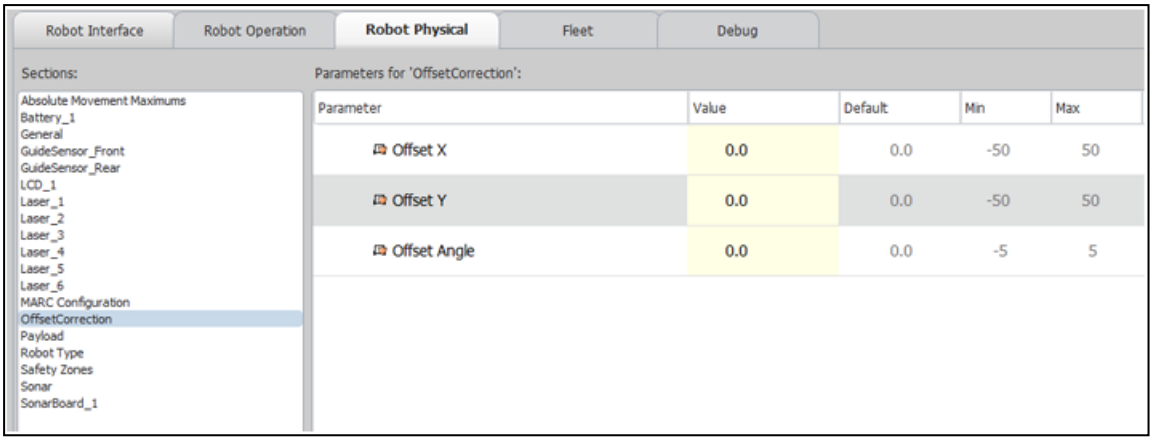


Figure 10-8. OffsetCorrection Parameters

The Descriptions of the Parameters shown in the preceding figure are in the following table:

Parameter	Description
Offset X	AMR specific axial offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)
Offset Y	AMR specific lateral offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)
Offset Angle	AMR specific rotational offset in degrees in the coordinate system of the specified target (used in all PrecisionDrive Tasks)

Standard Target

The target must be constructed to accurately reflect the dimensions shown below. The local flatness of the two segments and the 90° angle must be strictly observed for repeatable motion.

Notes for Drawing:

- All general tolerances ISO 2768 - Class M (Medium)
- Material: 5052-H32 Aluminum
- Finish: Paint matte gray. Option gray Cardinal X-Press polyester TGIC powder coat, P/N X041-GRW02871, 0.127- 0.254 mm thick (0.005 - 0.010 inches)
- Deburr and break all sharp edges between 0.10 mm - 0.25 mm max.
- Use minimum bend radius 1.5 max.

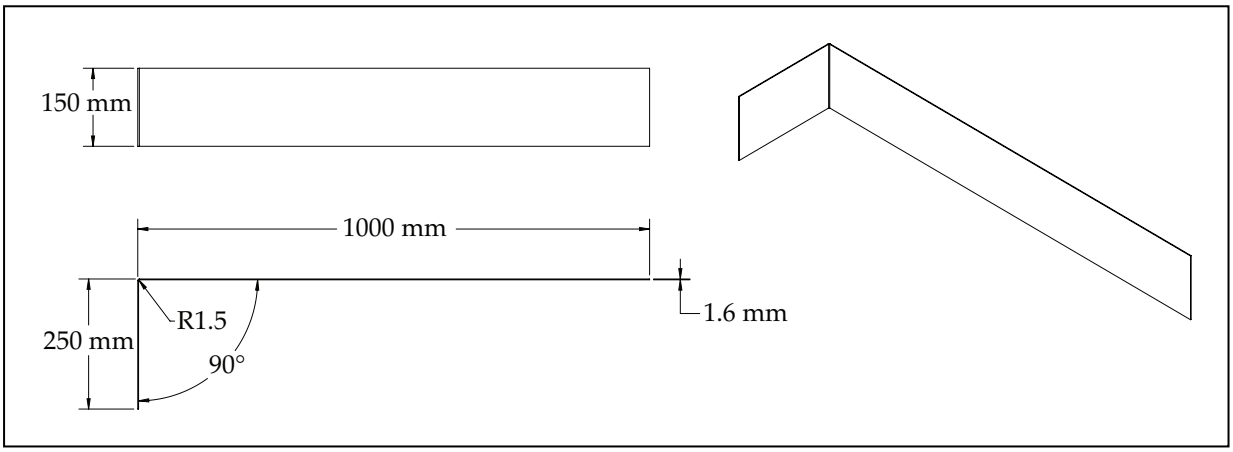
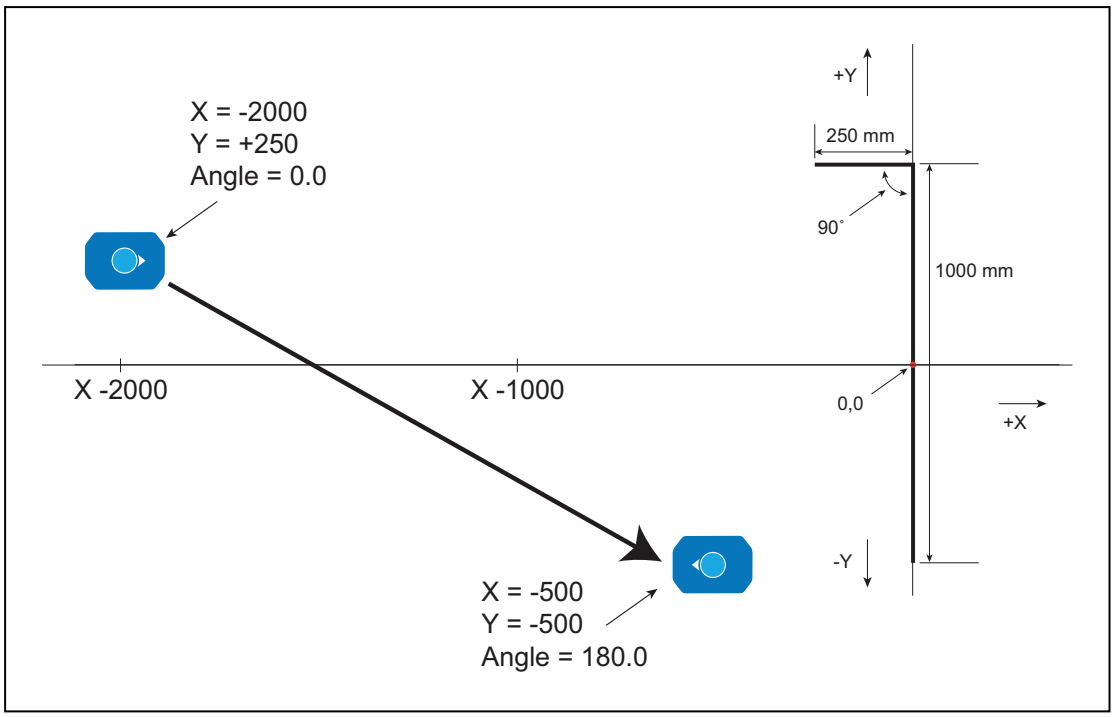


Figure 10-9. Standard Target

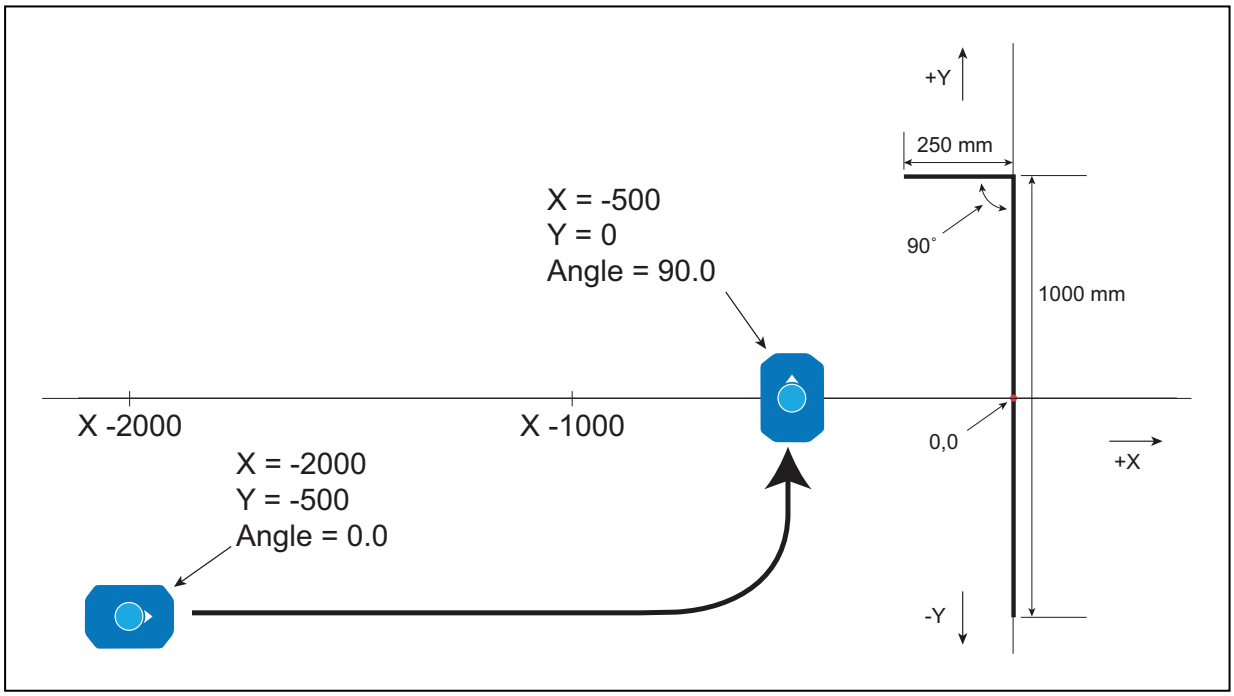
Target to Robot Coordinate Frame Transformations

These examples illustrate how to set the Initialn and FinalOffsetn parameters to achieve the desired behavior. The values shown by each AMR in the drawings represent the values that would be set in the PrecisionDrive task for each use case.

Example 1: The graphic below shows the results of a move with a MotionProfile of Straight, starting at (-2000, +250, Th 0) and moving to (-500, -500, Th 180). The AMR has to rotate in place at both the Initial and Final locations. The target is a Standard target. The AMR icons are for LD-250.



Example 2: The graphic below shows the results of a move with a MotionProfile of PreAlign, starting at (-2000, -500, Th 0) and moving to (-500, 0, Th 90). The AMR only turns for a part of the path. The target is a Standard target. The AMR icons are for LD-250.



CAPS License

CAPS is a licensed feature, and requires a license key file that must be loaded onto the AMR before CAPS takes effect. Licenses are granted to individual AMRs, minimizing cost by

applying this feature only to those AMRs that require the higher accuracy it provides. Contact your OMRON representative for instructions on ordering and obtaining the license key files for this feature.

The PrecisionDrive task can be used with or without a CAPS license. If PrecisionDrive detects a license, its alignment accuracy will improve significantly.

With or without the CAPS license, the setup, configuration, and use of PrecisionDrive does not change. With the license, the accuracy improves. The CAPS license is p/n 20271-805.

> **NOTE:** The TriangleDrive version of CAPS is legacy but can still be used if a CAPS license is detected. Contact your OMRON representative.

The relative alignment accuracy of OMRON AMRs, with and without these features, is presented in the following table:

Table 10-2. FLOW Core Goal Alignment Features

Feature	Alignment Accuracy	Condition
Standard	± 100 mm	Standard FLOW Core Feature
PrecisionDrive without CAPS license	± 25 mm ± 2.0°	Standard FLOW Core Feature
PrecisionDrive with CAPS license	± 8 mm ± 1.0°	Licensed Feature (CAPS)
Hign Accuracy Position System (HAPS)	± 10 mm	Not licensed, requires optional hardware (sensors) to work

Using Speech and Sound Tasks

Speech and sound tasks control the AMR's audio. As the AMR navigates the operating space, it can (for example) play a sound file while driving, make a noise to alert anyone in the area that it is entering a room, or announce what task it intends to perform next.

The speech and sound tasks combine instant and non-instant tasks, as shown in the following table.

Instant Tasks	Non-instant Tasks
• playInstant • sayInstant • sendSoundInstant • sendSpeechInstant • playBackgroundSound	• play • say • sendSound • sendSpeech

Instant tasks send audio to the AMR as it continues on its path. Non-instant tasks cause the AMR to wait until the speech or sound is done playing. For example, if you want the AMR to announce that it is entering a room and then wait for a moment to allow people to get out of its way, use the *say* task rather than the *sayInstant* task.

The AMR speaks *say* tasks with a computerized voice. *Play* tasks play a sound file on the AMR. *Sound* tasks encode a file from the AMR and send it out to all MobilePlanner instances connected to that AMR.

To Use Speech and Sound Tasks

NOTE: Speech and sound tasks are normally enabled by default.

1. Click the **Config** button, then click on the **Robot Interface** tab, then click on **A/V Config,** and enable the **Audio** parameter (click the checkbox). For more details, see Configuring the AMR on page 140.
2. For sound tasks, ensure the sound file is stored on the AMR. You can use **File > Upload/Download**.
3. Click the **Map** button, then click the **Build** tab.

   NOTE: Ensure **Show Robot** is OFF, or you will not be able to draw or edit objects in the map pane.

4. In the Source Lists pane, click the Robot Tasks tab to view tasks currently available on the AMR.
5. Add the speech or sound task to the goal, route, or macro. For details, see Assigning Tasks on page 150.
6. Enter the parameter values for the assigned task. If using a *speech* task, enter the text for the AMR to speak in the **Value** field. If using a *sound* task, enter the name of the sound file in the **Value** field. If needed, click the **Browse** button to search for the sound file.
7. Click **OK** to accept the parameter value and save any changes.

Using Sound Files with Tasks

Both the *play* and *sound* tasks use sound files. *Play* tasks play a file on a specified AMR. *Sound* tasks encode a file from the AMR and send it out to all the MobilePlanner instances connected to that AMR.

All sound files must be in AIFF WAVE (.wav files), .ogg files, or MP3 format.

Adjusting the Audio

You can use the MobilePlanner software to adjust the audio input and output (if turned ON), and adjust both the software and AMR audio using the audio slide bars.

1. Click the **Map** button from the main window to display the map window.
2. Click the **Monitor** icon to display the list of available items to monitor (see below).

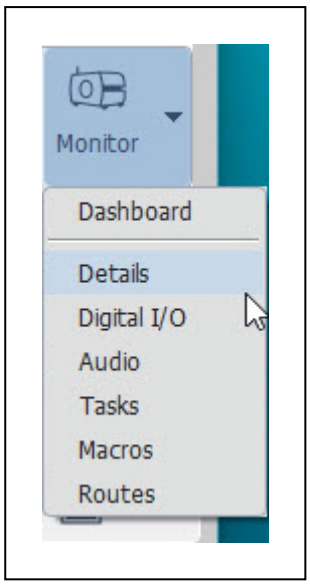


Figure 10-10. MobilePlanner Monitor Drop-down Menu

3. Click **Audio** to display the Audio dialog.

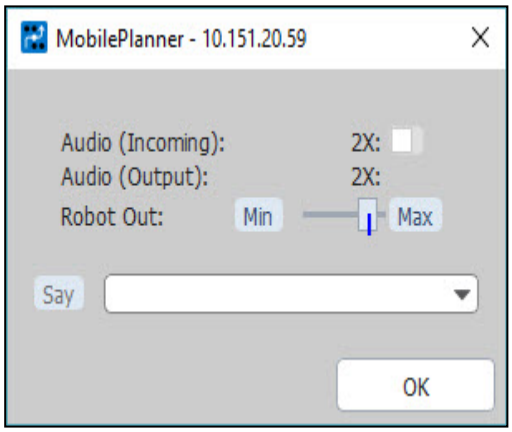


Figure 10-11. MobilePlanner Audio Dialog Box

4. Click on the slider bar and drag it left or right to adjust output volume.
5. If desired, you can enter a text string the AMR will speak (when configured to do so).
6. Click **OK** when done.

Accessing and Adjusting the Audio Parameters

1. Click the **Config** tool, then click the **Robot Interface** tab.
2. Select **A/V Config** from the Sections column to display audio and video parameters.

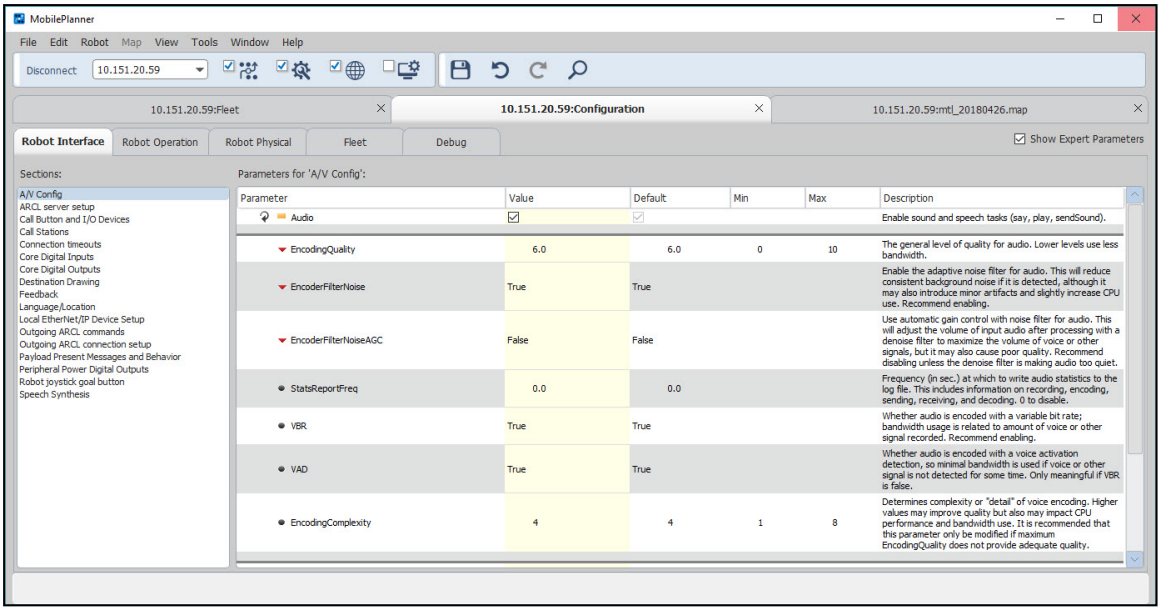


Figure 10-12. MobilePlanner A/V Configuration Page

I/O Tasks - LD-series AMRs

Digital Input/Output (I/O) provides an interface between the AMR's equipment and sensors and the payload which often requires power (I/O inputs and outputs can, for example, control conveyor rollers). If you have an AMR with a conveyor payload aboard, you can use digital I/O to turn the rollers ON and OFF, check sensor inputs, and execute one or more macros based on a tote's location (whether the tote is on the AMR's conveyor or on the feed conveyor).

The LD-60, LD-90, and LD-250 AMR cores provide 16 digital inputs and 16 digital outputs, and have a User Interface connection for creating custom user interfaces with the AMR's E-Stop, ON, OFF, keyswitch, and brake-release buttons.

With MobilePlanner, you can:

- Configure core digital inputs and outputs, and give these inputs and outputs aliases which make it easier to use them when needed.
- Create custom I/O tasks that turn payload power on or off to activate automatically-toggled proximity sensors.
- Detect single inputs and execute specific macros.

Using I/O Tasks

Custom inputs and outputs are digital inputs, outputs, and peripheral power outputs. You make them custom by setting their input type to custom and (optionally) giving them an alias.

1. Click the **Config** button, click the **Robot Interface** tab, then click **Core Digital Inputs** or **Core Digital Outputs** in the **Sections** column.
2. Configure the devices, then click **Save**.
3. In MobilePlanner's main menu, click **File > Open** to open the map you want to edit.

NOTE: Ensure that Show Robot is **OFF**, or you will not be able to proceed.

4. Click the **Map** button, then click the **Build** tab.
5. In the **Source Lists** pane, click the **Robot Tasks** tab to view the tasks currently available on the AMR.
6. Add the task to the route, goal, or macro. See Assigning Tasks on page 150 for details.

Digital Inputs

To configure the digital inputs, click the **Config** button, then click the **Robot Interface** tab.

Tasks: customInputsCheckAll and **customInputsCheckAllInstant**

These tasks check whether all specified custom inputs trigger and properly execute a macro.

Parameters	Description
timeout	Duration (in sec) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
triggerMacro	Macro to invoke if all inputs are triggered before the timeout.
input<n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.

Tasks: customInputsCheckAny and **customInputsCheckAnyInstant**

These tasks check whether any of the specified custom inputs trigger and properly execute a macro.

Parameters	Description
timeout	Duration (in sec) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
triggerMacro	Macro to invoke if any of the inputs are triggered before the timeout.
input<n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.

Tasks: customInputsCheckEach and **customInputsCheckEachInstant**

These tasks check the custom inputs and executes a particular macro for each triggered input (on only if 'tasksForBetterCustomIO' is ON).

Parameters	Description
timeout	Duration (in sec) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
input <n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.
input <n> macro n = 1 to 8	Macro to invoke if input <n> is triggered before the timeout.

Digital Outputs

To configure the digital outputs in MobilePlanner software, click the **Config** button, then click the **Robot Interface** tab.

Task: customOutputOff

This task turns off the specified custom output.

Parameters	Description
output	Name of the custom output to turn OFF.

Task: customOutputOn

This task turns on the specified custom output.

Parameters	Description
output	Name of the custom output to turn ON.

I/O Tasks - HD-1500 AMRs

If I/O tasks need to be configured for the HD-1500 AMR, contact your OMRON representative.

Setting Up Special Tasks

You can set up and use tasks for the AMR to perform in certain situations, such when docking or at every goal. You can also make the AMR say a phrase when an specific event occurs (e.g., when path planning is failing, replanning has happened, or the AMR failed at a goal, etc.). These Special tasks allow you to define custom responses to events that the AMR might encounter.

Special tasks can include:

- Performing a task before or after every goal.
- Performing a task at a dock.
- Custom responses.
- Queuing Manager tasks.

  NOTE: Special events don't have to be unusual. Going to a Goal or Point can be a special event.

To Customize AMR Operation:

1. In MobilePlanner, click the **Map** button, then click the **Build** tab.
2. In the Editable Lists pane, click on the **Special** tab.

   Since you cannot assign a goal to a Special task, the Goals tab is grayed out. Also, selecting one of the special events in the Special tab only enables instant tasks. All custom responses have to be instant, but other lists in this tab can allow non-instant tasks.

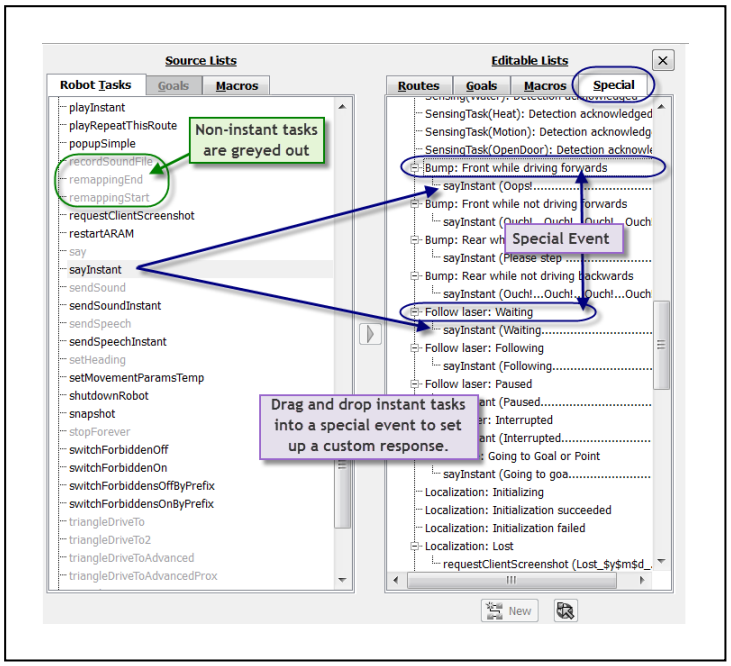


Figure 10-13. Build Tab Lists - Details

3. In the Source Lists pane, highlight a task from the **Robot Tasks** tab and drag it to the desired special event in the **Special** tab.

   NOTE: Most custom responses (e.g., Dock responses) have to be instant; all others can be non-instant.

Custom Responses

You can customize the AMR's operation using the Custom Responses found in the Special tab. The predefined conditions or events that trigger a custom response include:

NOTE: The following list is not an exhaustive list. The Custom Responses defined for a particular AMR depend on the parameters that you enabled or disabled. For configuration details, see Setting the Configuration Parameters on page 142.

- Fault responses.
- Localization.
- Path Planning (Failed, replanning).
- 'sayInstant' tasks (such as 'excuse me').

- Bumping into something (has four sub-events, based on what the AMR is doing when the bump occurs).
- Map Creation (has two sub-events, for starting and stopping a scan).
- Patrolling a route (has four sub-events).

Using custom responses, you can make the AMR talk when it encounters one of these events, and tell the people around the AMR what to expect.

All custom responses must contain instant tasks, such as *sayInstant*. Although the conditions that trigger a custom response are predefined for the AMR, you can customize the AMR's operation by adding one or more instant tasks to these events. For example, if the AMR bumps something in front of it, the AMR can respond appropriately (for example, the AMR could speak a phrase when it bumps into something).

Events automatically trigger the custom responses that make the AMR respond to its environment.

If there is no task associated with a specific Custom Response, the AMR will not do anything special when that condition occurs.

Performing a Task Before/After Every Goal

Special tasks can include instant and non-instant tasks the AMR performs before the AMR departs for a goal or after it reaches any goal.

Drag instant tasks from the Source Lists pane to either event in the Special tab in the Editable Lists pane.

> **NOTE:** You can override these tasks for specific goals within specific routes by un-checking the before/after this goal checkbox.

Performing a Task at a Dock

Special tasks can include instant tasks the AMR performs when docking. The AMR already has a set of defined docking events, including:

- Forced dock
- Idle dock
- Requested dock
- Driving to dock
- Driving into dock/docked
- Dock now unforced
- Dock now forced
- Undocking/undocked

You can add instant tasks to these docking events (e.g., have the AMR announce it is going to dock because it is 'idle.'). Drag instant tasks from the **Source Lists** pane to the appropriate event in the Special tab in the **Editable Lists** pane.

Queuing Manager List

AMRs can perform a variety of special tasks when they reach goals. For example, you can use the JobTypeCheck task to specify different macros depending on whether a goal is pickup, dropoff, or neither. Other examples of special tasks include:

- Before/After Pickup
- Before/After Dropoff

Drag instant tasks from Source Lists to a queue-related event in the Special (Editable Lists pane).

Editing a Special Task in the Editable Lists Pane

1. Right-click on the task you want to edit.
2. In the pop-up window, click **Edit**.

   If the task has associated parameters, the following dialog box opens:

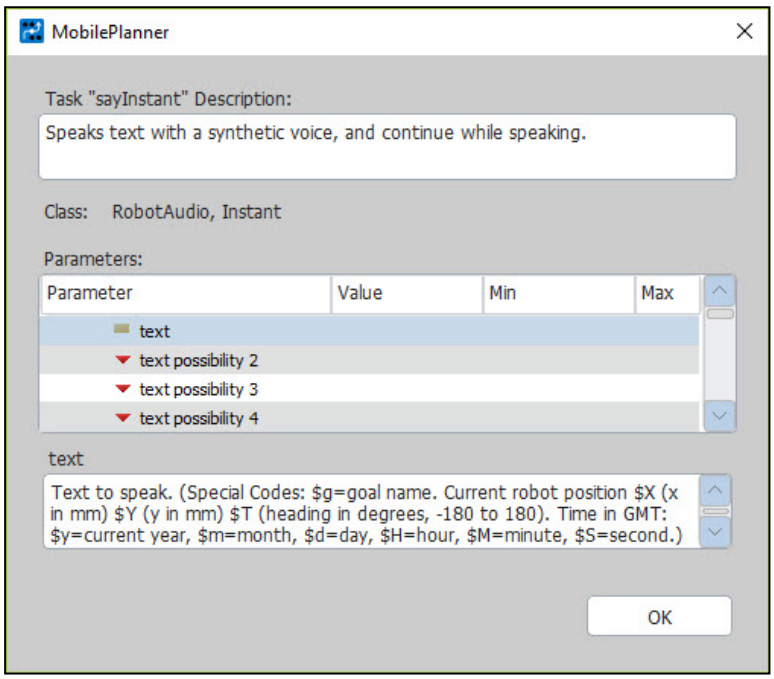


Figure 10-14. MobilePlanner Parameter Description Dialog

   Click in the **Value** field to add and edit the parameter's value . Click on a parameter to see its description.

3. Click **OK** when done.

Copying a Special Task from the Editable Lists Pane

1. Right-click on the task you want to copy.
2. In the pop-up window, clicking **Duplicate** creates a copy of the task.
3. Drag the copied task anywhere within the current tab.

Deleting a Special Task from the Editable Lists Pane

1. Right-click on the task you want to delete.
2. In the pop-up window, click **Cut** (or press the **Delete** key) to remove the selected task.

Editing a Task

To edit a task, from the Editable Lists pane:

1. Right-click on the task you want to edit.
2. In the pop-up window, click **Edit**.
3. Click inside the Value field to edit the value for each parameter.

> **NOTE:** You can reorder or move tasks to another goal/macro/route by dragging them there.

Copying a Task

To copy a task, from the Editable Lists pane:

1. Right-click on the task you want to copy.
2. In the pop-up window, clicking **Duplicate** adds a copy of the task.
3. Drag the copied task to any position within the current tab.

Deleting a Task

To delete a task, from the Editable Lists pane:

1. Right-click on the task you want to delete (or click, the press the Delete key).
2. In the pop-up window, clicking **Cut** removes the selected task.

10.2 AMR Jobs Overview

Jobs are basic activities for the AMR(s) to execute. ARCL and protocols within the Integration Toolkit (ITK) can send job requests to the Fleet Manager for assignment to an AMR.

> **NOTE:** Jobs are the recommended method for commanding the AMR or fleet of AMRs.

Jobs typically have one or two job segments (if queueMulti is enabled). All segments are classified either as PICKUP or DROPOFF.

- **PICKUP:** A PICKUP job request tells the Fleet Manager that any available, appropriate AMR can be assigned a PICKUP task.
- **DROPOFF:** A DROPOFF job request tells the Fleet Manager that only a specific AMR can be assigned a DROPOFF task.

Once the Fleet Manager receives the job request from ARCL or the ITK, it assigns a job ID and unique job segment ID (or, you can optionally assign a job ID).

Job Priorities

MobilePlanner prioritizes submitted job requests either by Non-First-In-First-Out (Non-FIFO) or First-In-First-Out (FIFO) priority. The requestor can specify the job priority, or jobs can use the default value for queuePickup, queuePickupDropoff, and queueDropoff commands. You can enable this in **Config > Fleet tab > Fleet Features**, *FleetQueuingConsumptionMethod.*

- **Non-FIFO:** Non-FIFO executes the highest priority jobs first, followed by lower priority jobs. Its goal is to minimize the AMRs' driving distance.
- **FIFO:** In FIFO, the system prioritizes jobs by which was submitted first, second, and so forth.

The default PICKUP priority is 10, and the default DROPOFF priority is 20. You can expedite a job by raising the pickup priority, while keeping the dropoff priority the same. For example,

- queuePickupDropoff goal1 goal2 10 20
- queuePickupDropoff goal3 goal 4 10 20
- queuePickupDropoff goal5 goal6 11 20

If you queued all of the above jobs at the same time, the third job's higher priority means the AMR will execute the third job before jobs 1 and 2. Otherwise, job1 or job2 will start.

Job vs. Job Segment

All submitted jobs carry a specific JobID (also referred to as the "job). Each part of a job is a 'job segment,' even if the job has multiple parts to it (for example, a Pickup-Dropoff sequence).

Custom Job ID

MobilePlanner uses the jobID to track the status of a request. A job ID must be unique among active jobs. Active jobs can share a jobID with previously completed or cancelled jobID still in the system. You can use a custom job ID that matches some other information in your automation system when submitting the pickup or pickupDropoff request.

Basic Job Commands

The following are some basic example job commands:

- "queuePickup goal1": submits a request to send any available AMR to "goal1."
- "queuePickupDropoff goal1 goal2": requests that any available AMR first drives to "goal1," then, once completed, drives to "goal2."
- "queueCancel jobid JOB7": immediately cancels job7, regardless of whether an AMR is performing that job.

Basic Job-Supporting ARCL Commands

The following ARCL commands support job queuing:

> **NOTE:** In ARCL command syntax, commands are not case sensitive, values in angle brackets < > are required, and values in braces [ ] are optional. Refer to the *Advanced Robotics Command Language Reference Guide (Cat. No. I617)* for more information.

- queuepickup <goal_name> [priority] [job_id]
- queuepickupdropoff <PICKUPgoal_name><DROPOFFgoal_name> [PICKUPpriority] [job_id]
- queuecancel <canceltype> <cancelvalue> [echo_string] [reason]
- queuedropoff <goal_name> [priority] [job_id]
- queuequery <querytype> <queryvalue> [echo_string]
- queueshow [echo_string]

Refer to the Fleet Operations Workspace Core Integration Toolkit User's Guide (Cat. No. I637) for information about using RabbitMQ, REST, or SQL to submit jobs.

10.3 Using the Route Builder

With MobilePlanner Route Builder, you can set up tasks for the AMR to perform and goals for it to drive to. You can also customize AMR operation and build routes for the AMR to follow. All of this information is embedded into the map file. Once you download the map file to the AMR, you can use MobilePlanner to drive the AMR in its operating environment, and perform tasks.

NOTE: Jobs are preferred over routes in industrial environments.

Use the Route Builder to set up the following:

- **Tasks:** Activities that the AMR can perform, such as going to a goal or checking sensors. Tasks give the AMR useful work to perform. These tasks are already available on the AMR, but need to be defined and associated with the map that you are creating.
- **Goals:** Virtual destinations that the AMR drives to in its environment. These goals are defined in the map, and represent real-world places in the operating environment.
- **Macros:** Containers for sequences of tasks and goals. Once these macros are created, you can select the macro, rather than all of the individual tasks and goals, for the AMR to perform. You only have to define a macro once, but can use it as many times as necessary. You can also use macro templates, which are special macros that can accept simple parameters. You define parameter types when you create a new macro template, and specify the values when you use the template in another macro, route, etc.
- **Custom responses:** Actions such as making the AMR talk (e.g., when its path is blocked, fails the path, or does global replanning, etc.), performing a particular or sequence of tasks at all goals, when docking, or when a special event (such as a bump or E-Stop) occurs.
- **Routes:** A "to do" list or a series of tasks, goals, or macros for the AMR to follow. An AMR can execute a route continuously, unlike macros.

The Route Builder Interface

MobilePlanner's Route Builder allows you to set up macros, tasks, goals, and routes for the AMR to follow.

Click the **Map** button, then click the **Build** tab.

The Route Builder (Build tab) appears in the window, as shown in the following figure.

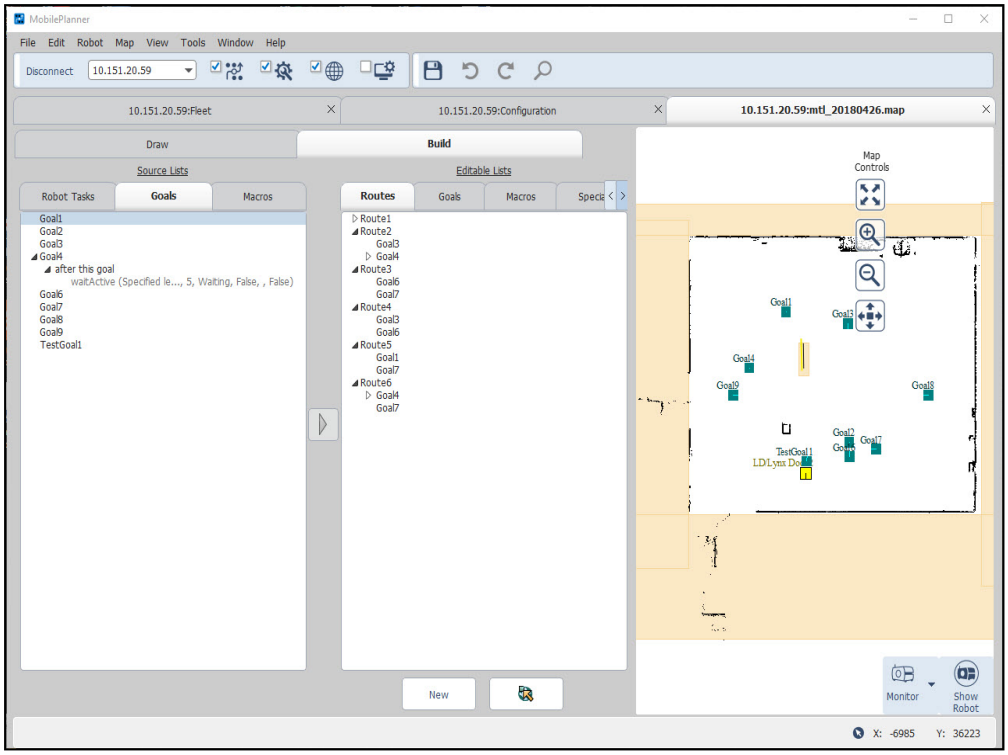


Figure 10-15. The MobilePlanner Map Workspace with the Route Builder Open

The Route Builder Elements

The Route Builder has two panes: Source Lists and Editable Lists. Each section uses tabs to switch between the different available options.

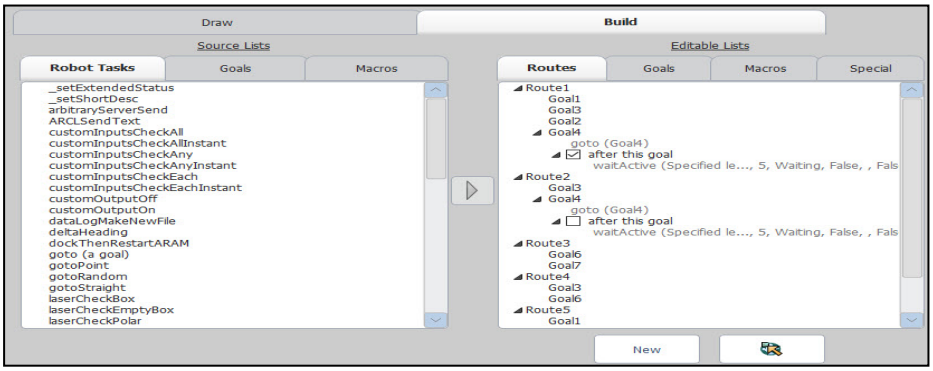


Figure 10-16. The Route Builder Elements

The Source Lists pane lists available AMR tasks, goals, and macros you can add to new routes, goals, macros, and special tasks.

The Editable Lists pane displays routes, goals, macros, or special tasks. The tabs allow you to switch between the different types of objects that you can build.

You can drag Source Lists objects into any of the Editable Lists routes (or macros) you are working on, or use the arrow icon between the lists.

Source Lists: Robot Tasks, Goals, and Macros Tabs

The tabs in the Source Lists pane display the tasks, goals, and macros you can use in building new routes, adding tasks to goals, and building macros and special tasks.

> **NOTE:** Some of the Robot Tasks listed below need to be specifically enabled by clicking the **Config** button, then clicking the **Robot Operation** tab, and the **Task Features** section.

- **Robot Tasks:** Lists the tasks available for creating new objects (routes, macros, etc.) on the map. Tasks are AMR and accessory-related operations, such as moving the AMR, talking, or playing a sound. These tasks are already available on the AMR, however you must include them in one of the Editable List items for the AMR to know when and where to perform them. For more information on using tasks refer to AMR Tasks on page 150.
- **Goals:** Lists the goals available for creating routes or macros. Goals are locations on the map that are destinations for the AMR. For more information on using goals, see Creating and Adding Goals and Docks on page 99.
- **Macros:** Lists available macros which you can add to tasks or goals. Macros are reusable containers for multiple tasks. For more information refer to Creating Macros on page 185.

For detailed information about a task, goal, or macro, right-click on the item and select **Description**.

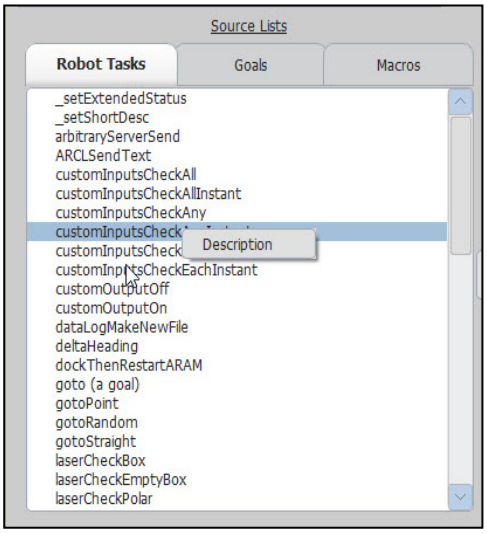


Figure 10-17. Accessing the Task Description

Click on the task parameter to read a brief description of the selected task. The figure below shows an arbitraryServerSend task. To set up different tasks and their parameters, refer to the specific task (Using Audio Tasks, for example).

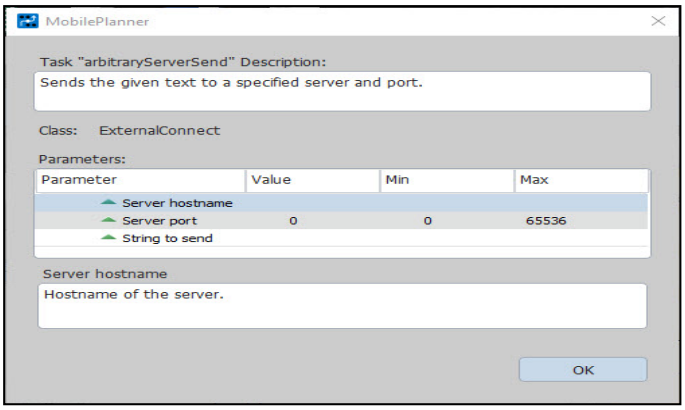


Figure 10-18. arbitraryServerSend Task Description

Editable Lists: Routes, Goals, Macros, and Special Tabs

- **Routes:** Lists created routes, and allows you to build new routes. For details, see Creating Routes on page 193.
- **Goals:** Lists created goals or destinations. You can add tasks for the AMR to perform at the specified goal. For more information on using goals, refer to Creating and Adding Goals and Docks on page 99.
- **Macros:** Lists created and defined macros, and allows you to create new macros. Refer to Creating Macros on page 185 for more information.
- **Special:** Used to customize AMR operation. Custom tasks allow you to have the AMR perform certain activities at every goal or at a dock. They also allow you to program the AMR to take special actions when specific events happen. For more information, refer to Setting Up Special Tasks on page 174.

Macros

Macros are reusable sequences of tasks that have their parameters set when you add them to the macro. So every time you use a macro, the tasks inside use the same settings. Macros are extremely effective if you have groups of tasks that you need to repeat in multiple places.

For example, you might have an AMR delivering parts to various places. At each of the multiple delivery locations, it needs to navigate to each, pause, announce its arrival, wait for the part recipient to retrieve the part, then move on to the next delivery site. Instead of manually programming each of these tasks at each goal, you can use macros to replicate this same functionality across multiple goals.

You can create macros in Editable Lists (in the Build pane) by clicking the **New** button. Then, drag the appropriate tasks from the Robot Tasks list (under Source Lists) into the macro in the desired point. After adding the tasks to the macro, you can reorder and reconfigure them as needed.

Macro Templates

Macro templates are simple, text-only features for adding simple parameters to macros. Allowed parameters for macro templates are named $1 to $9. They do not allow variables or expressions.

To create a macro template, click the **Map** button, **Build** tab, then use the **New** dropdown menu directly below the Editable Lists pane and select **Macro Template**.

For details, see Macro Templates on page 188.

The Build Tab

The Build tab allows you to create macros, and add tasks for the AMR to perform.

To display the route building tools, click the **Build** tab. The Build tools, shown in the following figure, are displayed on the left side of the map window. The Build tab displays two scrollable panes, each using tabs to organize the lists available for use.

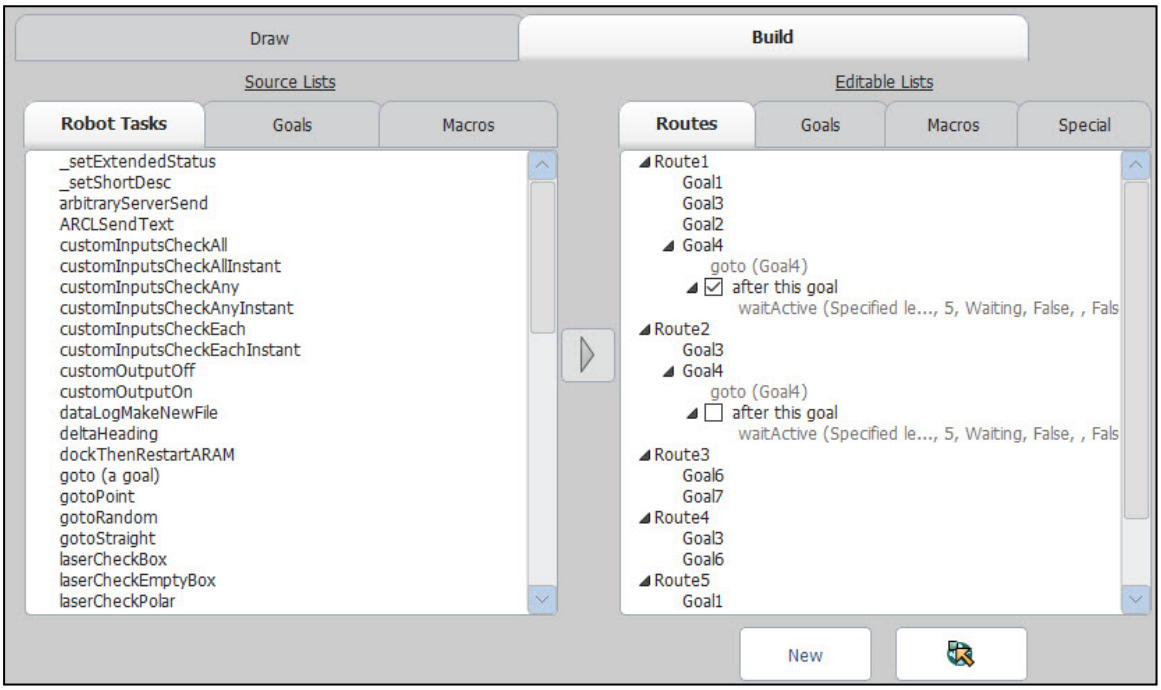
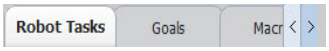
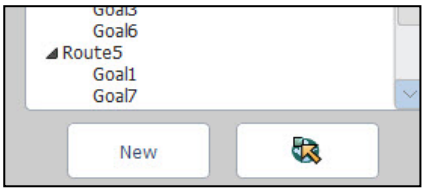
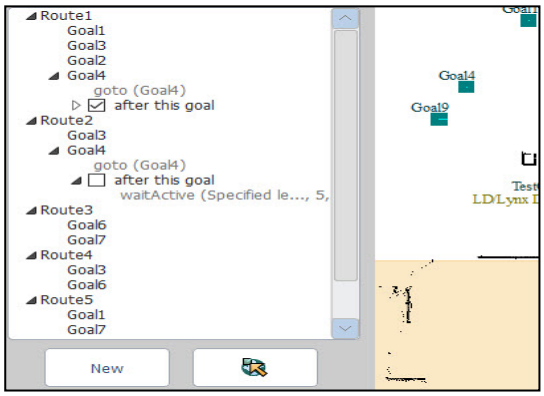


Figure 10-19. The Source Lists and Editable Lists Pane

The following table lists the toolbar icons and describes their functions.

Item	Description
Source Lists pane	Contains lists of AMR tasks and goals that you can use to create macros or routes for the AMR to navigate. You can also put macros in other macros as well. To view the different lists, select the appropriate tab.
Editable Lists pane	Contains lists of all current routes, goals, and macros. You can also add new tasks the existing lists that tell the AMR what to do in certain circumstances, such as after reaching a goal, when docking, and when specific event occur, such as bumping into something.

Item	Description
	If the MobilePlanner workspace is filled with multiple windows and some tabs are not visible, move between tabs using the arrows.
New Route/Macro Button 	Creates a new route and/or macro (depending on the window in which you are working), and adds it to the Routes tab. 
Pick Goal Button 	When ON and a route is selected, lets you click goals on the map, to add to the route. After adding the goals to the route, you can drag the goals up/down to set their order. 

For more information on creating tasks, goals, routes and macros, see Using the Route Builder on page 180.

Creating Macros

Macros are containers that hold a series of tasks, goals, and other macros. After you create a macro, you can reuse it as many times as needed. Macros can hold goals and use tasks with conditionals, and they can be embedded within macros and other tasks. As a result, macros are very versatile.

To Create a Macro:

1. Click the **Map** button, then click on the **Build** tab.

   The Source and Editable Lists appear on the left side of the map.

2. Under Editable Lists, click the **Macros** tab.

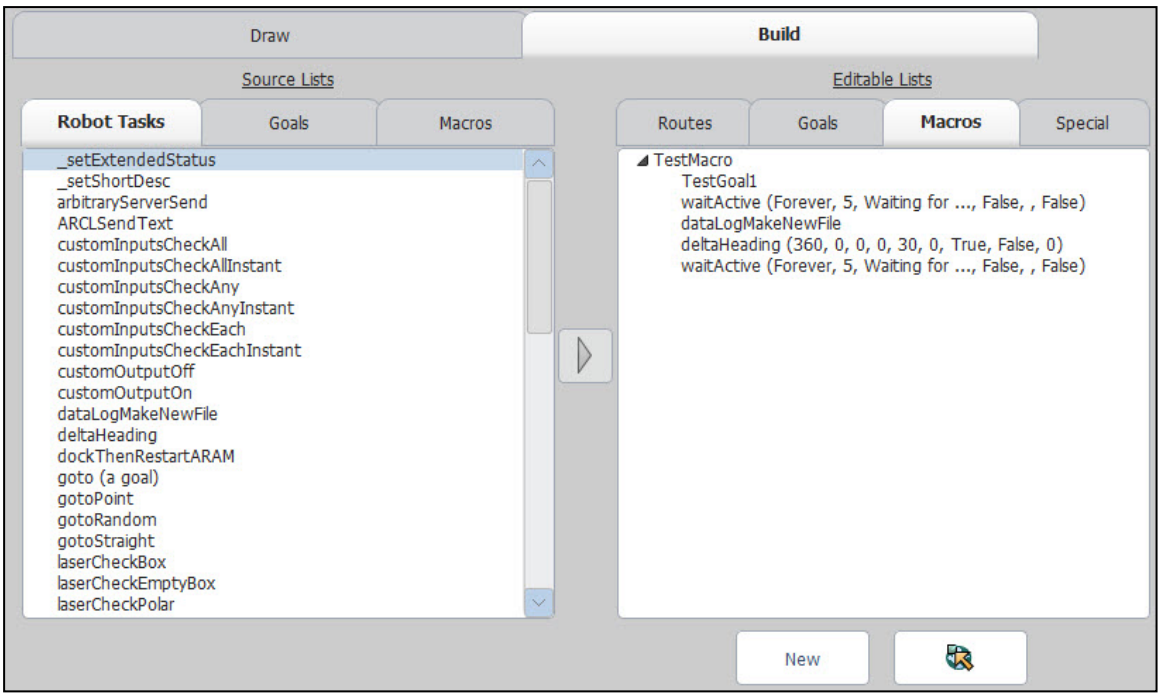


Figure 10-20. MobilePlanner Build Tools - Macros Tab

3. Click on the **New** button an the bottom of the Editable Lists pane.

   This adds a new macro to the Macros tab which, by default, has the name "Macro1." This new macro name increments by 1 with each new added macro. See Renaming the Macro on page 188 for directions on changing the macro name.

4. Highlight a task from the Robot Tasks list and either drag it to the desired macro in the Macros tab or click the **Add** arrow (between the two panes).

   The new macro expands with each added task, as shown the following figure.

Figure 10-21. Macro Detail

5. Click the **Goals** tab to access the goals available to add to the macro, then drag the desired goal into the new macro you are creating. You can also pick a goal from the displayed map to add to the macro (see Picking a Goal from the Map on page 187 for details).

6. Click the **Macros** tab to access existing macros. You can then drag an existing macro into the new macro.

The macro below shows an example of tasks, a goal, and a macro named "Greeting" added to the new Macro1 macro.

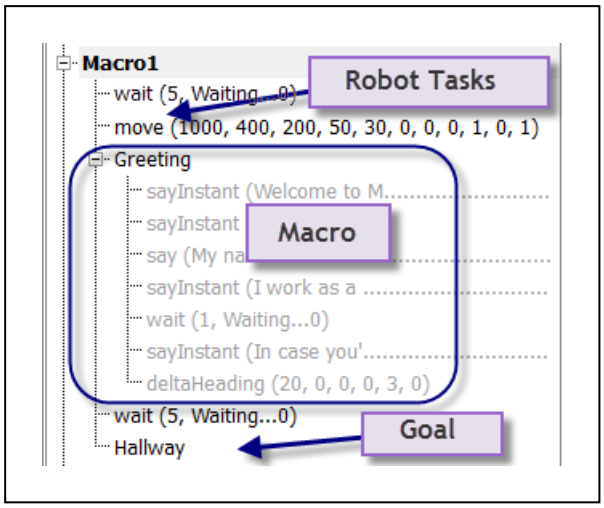


Figure 10-22. Macro Details

Using the Add Button

In addition to dragging a task, you can use the arrow (Add) button to add a task to the macro.

1. Click on the **Macros** tab in the Editable Lists pane.
2. Highlight the macro to which you want to add a task, goal, or macro.
3. Click on the **Robot Tasks**, **Goals**, or **Macros** tab from the Source Lists pane.
4. Select the task, goal or macro you want to add to the new macro.
5. Click the **Add** button to add the task, goal, or macro.

   If parameters are associated with the task, a dialog box appears that allows you to adjust parameters appropriately.

   For specific parameter information, refer to the task type (such as a wait task) for more information.

Picking a Goal from the Map

You can add goals to macros by clicking the goal on the map. This allows you to add multiple goals within the same vicinity.

1. Be sure that the goals you want to add to the macro are visible in the map window. For details, see Using MobilePlanner Software on page 50.
2. From the Editable Lists pane, select the **Macros** tab, then select the appropriate place in the desired macro to add the goal.
3. Click the **Pick Goal** button at the bottom of the pane (next to the New button).
4. In the map, click on the goal to add the goal to the macro (you can select multiple goals without having to click on the Pick Goal button each time).

To Move the Goal within the Macro:

1. Click on the goal name in the macro list.
2. Drag it to the position you want the goal to be.

Renaming the Macro

1. Right-click on the macro you want to rename.
2. In the pop-up window, click **Rename** to change the macro name to editable text.
3. Type in the new name for the macro.

Copying a Macro

1. Right-click on the macro you want to copy.
2. In the pop-up, click **Duplicate** with the left mouse button.

   A copy of the macro appears in the Macros tab.

Deleting a Macro

1. Click the macro then hit the **Delete** key, or
2. Right-click on the macro you want to delete then, in the pop-up window, click **Cut** with the left mouse button to delete the selected macro.

Macro Templates

Using macro templates, you can easily add a variable to a set of tasks. This makes reusing macros or task sets with slight differences (depending on the goal or application) fast and easy. For example, you can create macro templates for changing wait times, status to wait with, line to log, activating a different IO, etc.

> **NOTE:** To use macro templates, you must have (at minimum) MobilePlanner 4.4.0 and ARAM 4.8. If you are using a map created under an older version of MobilePlanner, you will need to update it. After updating, it will not be backwards compatible with older MobilePlanner versions.

To update your map

1. In MobilePlanner's main menu, click on **Tools > Update Map Features**.

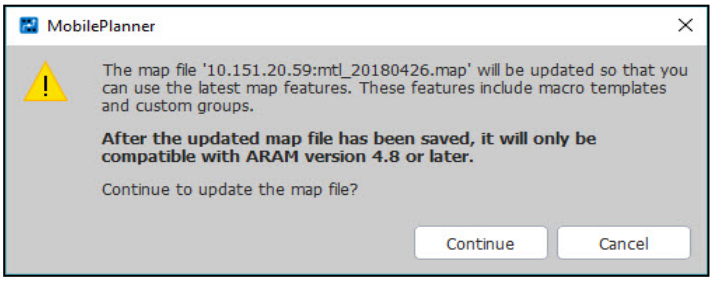


Figure 10-23. Update Map Dialog

2. Read the notes and information in the pop-up window, then click **Continue** to update the map.
3. After updating the map, you will need to save and reload the map.

   Macro Templates and Grouped Items will then be available for use, and there will also be a few default group items like door goals, docks, and cart transporters.

Creating a New Macro Template

1. In the Build pane, Editable Lists, click on the **Macros** tab, then click the **New** button drop-down arrow, and select **Macro Template**.

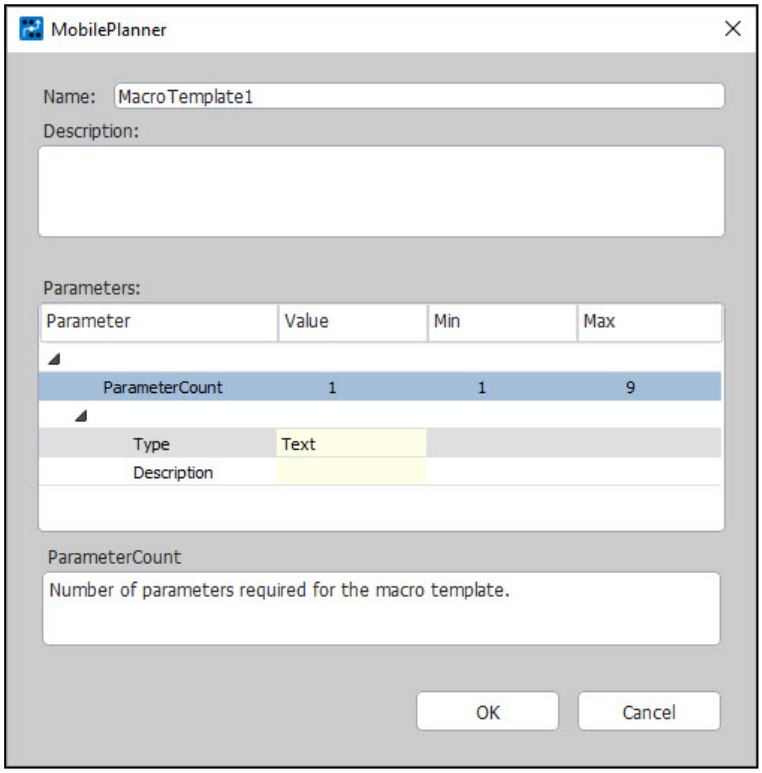


Figure 10-24. New Macro Template Dialog

2. Enter a name and description for the template, and set variable number(s), type(s), and descriptions.

   Types can be Text, Integer, Double, or Boolean.

Type	Allowed Value	Default
Text (or String)	Any letters or numbers	Zero
Integer	Number without decimal	Zero

Double	Number either with or without a decimal	Zero
Boolean	True or False	False

3. Enter up to nine parameters in the macro template.

   Parameter names use '$1' to '$9.' You can enter a text description of each '$#' variable in the Description field.

4. Add tasks to the template.

   Add '$#' to call a variable ('#' is limited to previously defined parameters).

5. To add the new macro template, drag and drop from the Source list into the Editable list.

Custom Groups

Using custom groups, you can define a reusable group of complex map objects, such as goals, sectors, etc. This allows you to place repeatable tasks (e.g., cart goals) on your map quickly and consistently, which helps to speed up application building time. Custom groups can interface with macro templates. Once created, you can add grouped items from the build tab as you would an advanced area.

Notes on using custom groups:

- You cannot edit or delete custom group definitions.
- You cannot modify originally selected map items, and they do not automatically become members of a new group instance.
- You cannot nest groups. The software ignores groups already in the original selection list.
- You cannot ungroup groups (i.e., you cannot convert them to top-level objects).

Custom groups also contain all tasks and macros (which you can individually edit) from every goal and sector that you included in the group.

Creating a New Custom Group

> **NOTE:** Update the map format, then create a backup of your map before creating the custom group.

1. Ensure **Show Robot** is OFF.
2. Highlight all map objects (goals, sectors, etc.) you want to include in the group.
3. Right-click on the map location that is the group's anchor point (its origin), and select **Advanced > Create Custom Group**.

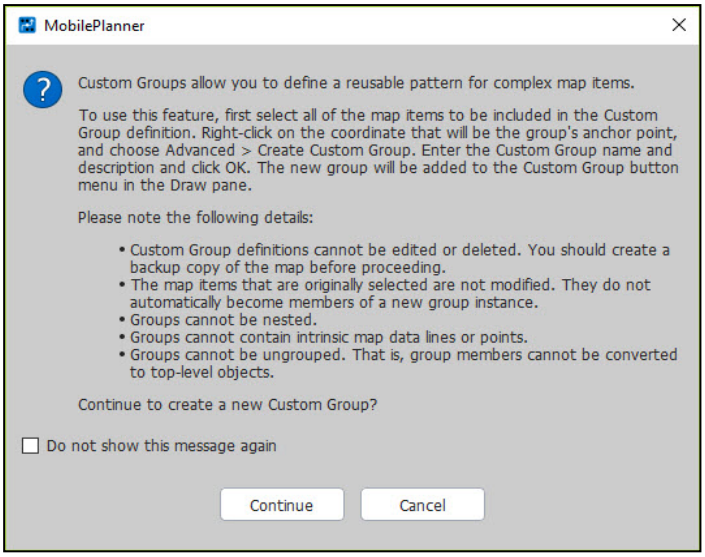


Figure 10-25. Create Custom Group Explanation Dialog

4. Read the information in the pop-up, then click **Continue** to create the custom group.

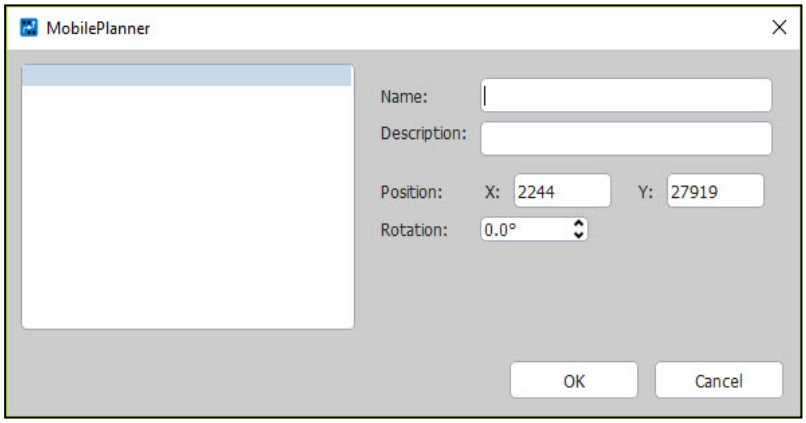


Figure 10-26. Create Custom Group Dialog

5. Enter the custom group's name and description.
6. Click **OK**.

   The new group will appear under the Custom Groups button drop-down menu in the Draw pane.

To edit a single item in the group, right-click and select the component you want to edit.

Adding a Grouped Item

After you create a grouped item, you can add it to the map as follows:

1. Verify that **Show Robot** is OFF.
2. In the Draw tab, click the **Custom Groups** drop-down arrow, and select a grouped item.

3. Move the cursor (appears as a ‘pencil’) to the grouped item’s intended location, and click to place the item on the map.

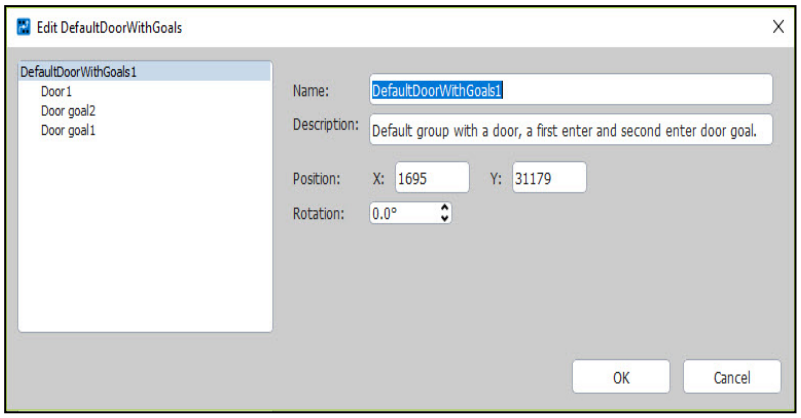


Figure 10-27. Add Grouped Item Dialog

4. Click **OK** to add the grouped item.

Adding New Goals to the AMR’s Current Location

MobilePlanner software's AMR monitor allows you to interact with the AMR (for example, you can move the AMR to a new location or goal, then add a new goal where the AMR is located).

1. Drive the AMR to the location where you want to add a goal or task (for details, see AMR Driving Overview on page 80).
2. When the AMR is at the desired position, click the **Item at Robot** button (in the toolbar), and select **Create Goal**.

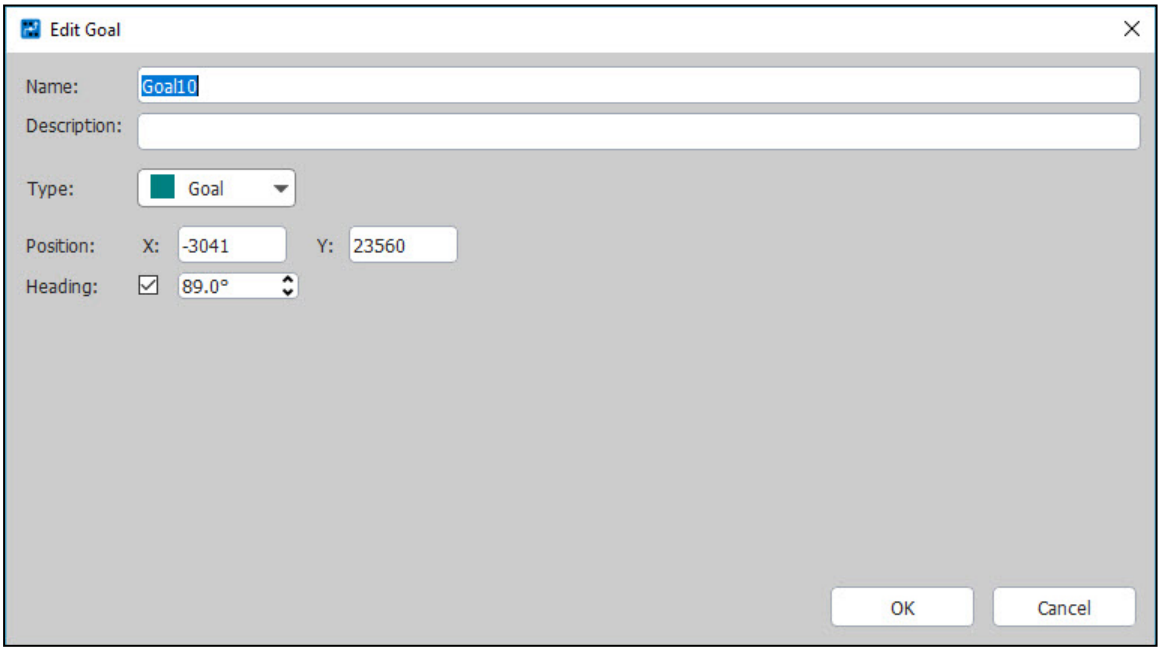


Figure 10-28. Edit Goal Dialog

3. In the Edit Goal dialog, enter the information, then click **OK**.

Creating Routes

A route is essentially a "to do" list for the AMR. It is a series of ordered tasks, goals, and macros for the AMR to complete. Tasks are AMR and accessory-related operations, such as talking or playing a sound, reading inputs, and triggering outputs.

Building Your Route

To build routes for the AMR, simply drag a task, goal, or macro from the Source Lists to the **Editable Lists > Routes** tab, as described in the following procedure.

To Build a New Route:

1. Click the **Build** tab to display the Route Builder.
2. Click on the **Routes** tab in the Editable Lists pane.
3. Click on the **New** button on the bottom of the Editable Lists pane to add a new route to the Routes tab.

   The default name for this new route is "Route1," and each new route name increments by 1. See Renaming the Route on page 194 for details on renaming a route.
4. Highlight a task from the Robot Tasks tab (in the Source List pane) and drag it to the desired route in the Routes tab.

   The new route expands with each added task, as shown below.

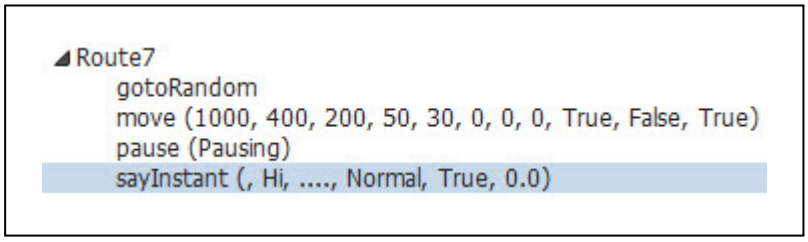


Figure 10-29. Route Detail

5. Click the **Goals** tab to access the goals available to add to the route, then drag the desired goal into the new route you are building. You can also pick a goal from the displayed map to add to the route, see Picking a Goal From the Map on page 194 for details.
6. Click the **Macros** tab to access the macros available to add to the route, then drag the desired macro into the new route you are building.

Using the Add Button

In addition to dragging a task, goal or macro into your route, you can use the arrow button to add the task to the route.

1. Click on the **Routes** tab in the Editable Lists pane.
2. Highlight the route to which you want to add a task, goal or macro.
3. Click on the **Robot Tasks**, **Goals** or **Macros** tab from the Source Lists pane.
4. Select the task, goal or macro you want to add to the route.
5. Click the **Add** button to add the task, goal or macro to the route.

   If parameters are associated with the task, a dialog box appears in which you can adjust parameters appropriately. For specific parameter information, refer to the task type (such as a wait task) for more information.

Picking a Goal From the Map

You can add goals to routes simply by clicking the goal on the map. This allows you to easily add multiple goals to the route that are in the same vicinity on the map.

1. Be sure that the goals you want to add to the route are visible in the map window (see Using MobilePlanner Software on page 50 for details on using the workspace).
2. From the Editable Lists pane, select the Routes tab.
3. Click on the **Pick Goal** button at the bottom of the pane.
4. Highlight the route in which you want to add the goal.
5. In the map, click on the goal you want to add to the route.

   This adds the goal to the route. You can select multiple goals without having to click on the **Pick Goal** button each time.

To Move the Goal within the Route:

1. Click on the goal name in the route list.
2. Drag it to the desired position.

Renaming the Route

1. Right-click on the route you want to rename.
2. In the pop-up window, select **Rename** to change the highlighted route to editable text.
3. Type in the new name for the route.

Copying a Route

1. Right-click on the route you want to copy.
2. In the pop-up window, select **Duplicate** with the left mouse button.

   A copy of the route is displayed in the Routes tab.

Deleting a Route

1. Right-click on the route you want to delete.
2. In the pop-up window, select **Cut** (or use the Delete key) with the left mouse button to delete the selected route.

10.4 Managing Queuing

This section describes how to manage AMR job queues.

Queuing and Job Definitions

- **Job** - a single command issued to the Fleet Manager, consisting of one or more related, ordered moves (job segments). Each job has a unique job ID.
- **Job segment** - one discreet move assigned to an AMR. A segment consists of a single goal name, and you can define it as either a PICKUP or a DROPOFF job segment. The goals might have tasks that are assigned to the AMR, which count as part of the job segment. Each job segment has a unique ID.
- **Queue** - a collection of requested jobs and job segments, stored on the Fleet Manager, that are either assigned or waiting to be assigned to AMRs.
- **Assigned Job** - a job segment becomes assigned after the Fleet Manager has allocated an AMR to perform the job. A job segment transitions from Pending to InProgress after assignment.
- **Pickup** - a job segment that ends at a goal so that a payload is loaded onto the AMR. If the first segment of a job is a PICKUP, then the Fleet Manager assigns this job to whichever AMR it decides is most appropriate.
- **Dropoff** - a job segment that ends at a goal so that a payload is removed from the AMR. A DROPOFF segment is handled only by the required AMR.
- **Required Robot** - certain job segments are serviced only by a specific AMR. For example, the DROPOFF segment of a PICKUP-DROPOFF job must be handled by the same AMR that performed the pickup. Thus, whichever AMR handles the initial PICKUP job is the *required AMR* for the DROPOFF.

The Fleet Manager enables you to queue jobs. It can accept multiple requests for AMRs, and then select the best AMR for each job, based on the criteria you specify. It sends the selected AMR to the requested location. It tracks the status of jobs and AMRs as they perform their assigned jobs.

The requests that are queued include:

- a request for any AMR to be sent for a pickup (PICKUP) for which the delivery destination (DROPOFF) is not yet known (queuePickup ARCL command).

  It is assumed that the delivery destination is communicated directly to the AMR that responds, prior to completion of the pickup.
- a request that a specific AMR drive to a particular goal (DROPOFF) (queueDropoff ARCL command).

This is communicated directly to the AMR, but is queued and tracked by the Fleet Manager.

- a request that an AMR be sent for a job that has predetermined pickup and dropoff destinations (queuePickupDropoff ARCL command).

  To complete the job the AMR requires no further job commands.

The Fleet Manager manages jobs associated with either a PICKUP or a DROPOFF goal. Any AMR tasks that are associated with the goals are executed at the proper times, though they are not managed as separate jobs in the queue.

We recommend that you use the task *pause* when an AMR arrives at its destination, although this is not managed by queue. Use the associated *pauseTaskCancel* task to signal dismissal after the AMR is loaded or unloaded. You can trigger this task either by a manually-activated button, or by an automated system event.

When the Fleet Manager receives a request, it does the following:

1. Queuing
   - The request is assigned a default priority (unless another priority is specified) and put into the queue.

     Pickup/Dropoff requests are entered as two separate jobs - a pickup, and a dropoff.

     Each segment has a unique queue ID, as well as a job ID that tracks the entire pickup/dropoff sequence.
   - Queuing enables job cancellation.
2. Dispatching
   - An AMR is selected, based on the criteria you specified.
   - The AMR is sent to the goal.
3. Tracking
   - The queuing manager monitors the AMR and job status.
   - The job is deleted from the queue when the request is satisfied, or is requeued if the job fails.

   Jobs might be in one of six states:
   - Pending - new, unassigned jobs.
   - In Progress - jobs that are being actively processed.
   - Completed - jobs that were successfully processed.
   - Failed - jobs that failed, due to reasons such as a blocked path or E-Stop.
   - Canceled - jobs that were manually canceled with the queueCancel command.
   - Interrupted - jobs that have been interrupted by an Operator manually controlling the AMR. These jobs are reassigned after a brief pause.

Queuing Examples

The following flowcharts represent sample usage scenarios, and require some application-layer support to fully implement.

The following flowchart illustrates a simple pickup and delivery cycle. Other factors, such as state of charge, can alter this flow.

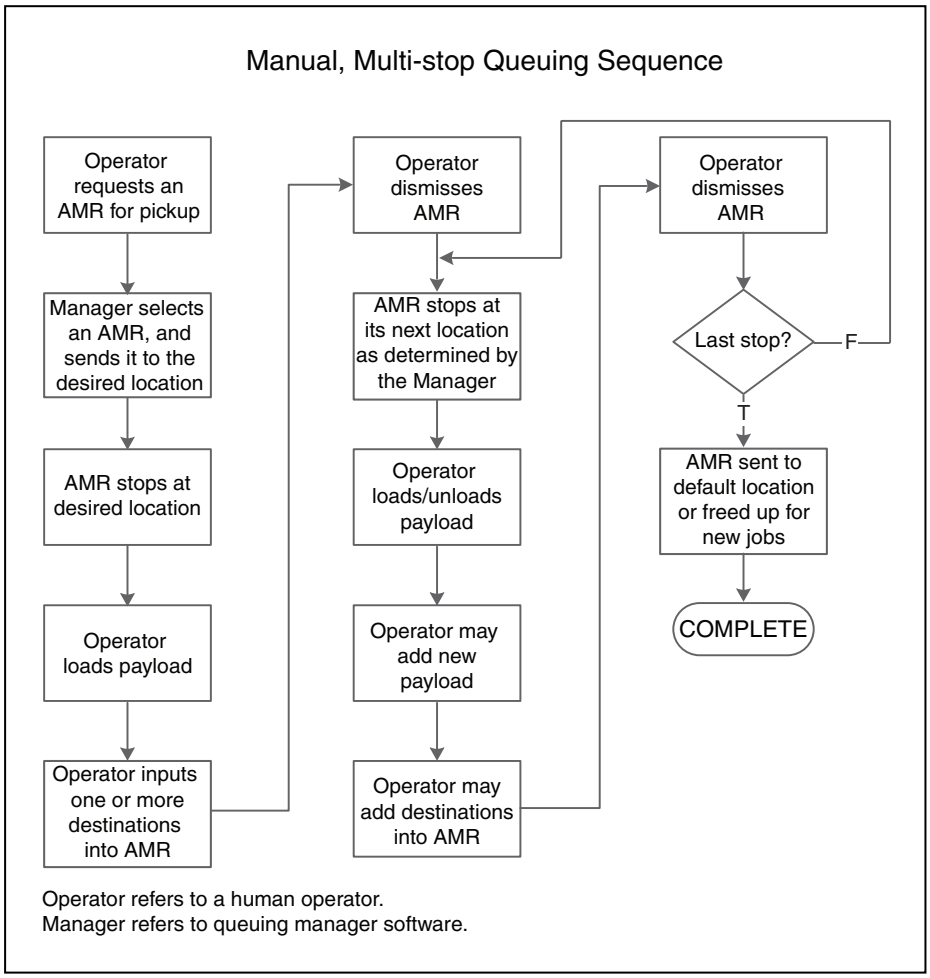


Figure 10-30. Manual Queuing Cycle

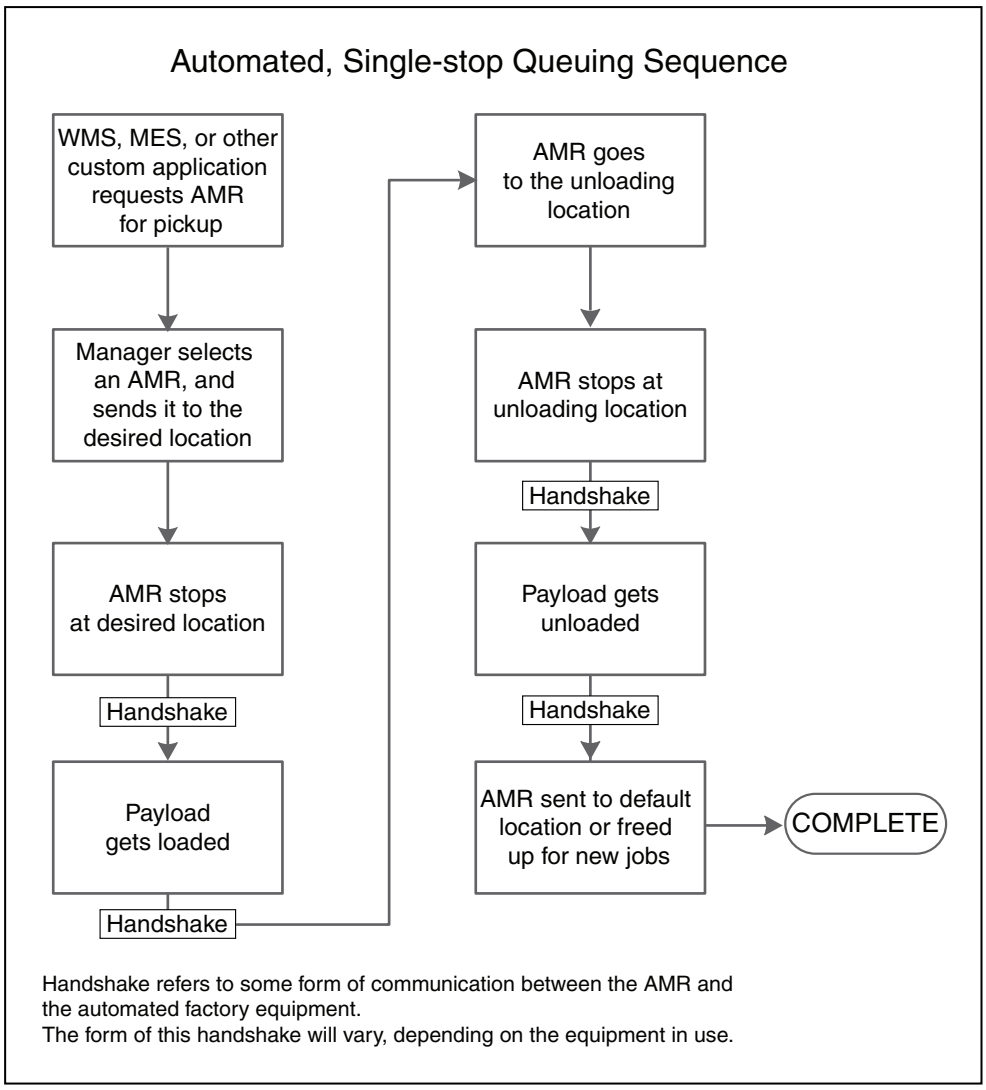


Figure 10-31. Fully-automated Queuing Cycle

Queuing Parameters

You configure various parameters to specify how the Fleet Manager processes queued requests. You set most of these parameters from within MobilePlanner. See Using MobilePlanner Software on page 50.

To access these parameters from the Fleet Manager:

1. In MobilePlanner, open the **Config** tab.
2. Select **Robot Operation** and then **Queuing Manager**.

The parameters that control the way that the Fleet Manager handles queuing are:

- **IdleTimeUntilResume** - Number of minutes to wait, after an AMR becomes available, before automatically resuming an interrupted job.

If an AMR has recently booted, or recently operated manually, then this is the number of minutes that the queuing manager waits before assigning any new jobs to this AMR. The parameter supports decimal numbers (such as 0.1 minutes for 6 seconds).

- **LowStateOfCharge** - This is the state-of-charge (SOC) below which the queuing manager no longer assigns new jobs to that AMR. If an AMR is below this state of charge when it completes a job, it is sent to dock.

  The AMR continues its assigned jobs until it reaches the SOC limit set by the value of the **AutoDockStateOfCharge** parameter. Consider the following constraints:

  - An AMR drives to a docking station any time that its state of charge falls below the limit set for **AutoDockStateOfCharge** even if it is performing a job. This is an AMR-level parameter, not visible or settable on the Fleet Manager.
  - We recommend that at least a 10% difference between LowStateOfCharge and AutoDockStateOfCharge, to make sure that the AMR does not drive to a docking station while performing a job.
  - An AMR docks only if you set AutoDock to True.

- **DefaultDropoffPriority** - The default priority to use in all dropoff requests to the queuing manager.
- **DefaultPickupPriority** - The default priority to use in all pickup requests to the queuing manager.
- **DeleteCompletedItemsMinutes** - Number of minutes to keep completed jobs.
- **MaxNumberOfCompletedItems** - Maximum number of completed jobs to keep.
- **EnableParking** - Sends the AMR to a standby goal after it completes its jobs.

The following screen shows configuration parameters for queuing:

Parameters for 'Queuing Manager':

Parameter	Value	Default	Min	Max	Description
QueuingManager	☐	☐			Enable the Queuing Manager for single robot. This feature is beta.
EnableParking	False	True			When enabled (true), robots are sent to parking goals after they complete their job assignments. Applicable only when Map Features > Standby is enabled.
InterruptParkingForNewJobs	True				When enabled (true), robots that are en route to a parking goal can be interrupted and assigned new jobs. Otherwise, the robots must reach the parking goal before they can be assigned new jobs.
InProgressUnAllocWaitTime	60		0		Seconds to wait for in-progress unallocated items.
IdleTimeUntilResume	1.0		0.1		Number of minutes to wait before a robot transitions its status from IdleButNotAvaliable to Available. Robots will not take queued jobs until they are Available. Fractional minutes are allowed.
ParkLowStateOfCharge	40.0		0	100	State of charge for which to send robots to dock rather than parking. If the robot is below this state of charge when it completes a queue item it will be sent to dock
LowStateOfCharge	20.0		0	100	State of charge below which not to use a robot for queue items. If the robot is below this state of charge when it completes a queue item it will be sent to dock

Figure 10-32. Queuing Manager Parameters

The following list shows the commands available for queuing.

- CancelQueueId
- CancelQueueJobId
- DisplayDeliveryQueue - Presents a pop-up window showing the delivery queue.
- DisplayShowRobot - Presents a pop-up window that shows the status of all AMRs in the fleet.
- QueuingLog
- QueuingStats

To find these parameters in MobilePlanner, click **Config** and **Robot Operation** and then **Queuing Manager**.

> **NOTE:** A red plus sign (+) preceding a command indicates that it accepts an argument.

Manually Clearing (Flushing) the Entire Queue

Use MobilePlanner to set the configuration parameters that apply to your fleet. For some parameters, you must also make corresponding changes to the configuration on the individual AMRs. Use these parameters only in limited circumstances, typically when working with your OMRON representative. For some parameters, you must also make corresponding changes to the configuration on the individual AMR.

To clear the entire queue, temporarily add a special startup argument to MobilePlanner. The following procedure clears the queue:

1. In MobilePlanner select the **Config** tab.
2. Select **Fleet** and then **Fleet Config Management**.
3. Under SectionsToSeparate, increment Count if there are no empty SeparateSectionX rows, where ‘X’ is a number, with an empty Value fields.
4. Enter the string "EnterpriseManagerFlush" in an empty Value field.
5. Click **Save**.

6. Wait for MobilePlanner to restart.
7. Use the command in MobilePlanner to verify that the queue is cleared.
    a. Select EnterpriseManagerDisplayDeliveryQueue from the Command field drop-down list.
    b. Click the **Command** icon.

    The queue should now be empty.
8. Reconnect to MobilePlanner, and remove the "EnterpriseManagerFlush" entry.
9. Click **Save**.
10. Wait for MobilePlanner to restart.

Chapter 11: Traffic Management

This section describes managing traffic flow in your operating environment. Whether you are using a single AMR or a fleet of AMRs, defining how the AMR moves within the space allows you to better control the AMR's behavior. As a result, you can prevent the AMR from running into problems, allowing it to complete the tasks assigned to it more efficiently.

In MobilePlanner, you can add objects and areas to the map and manage how the AMR moves through its environment. You can add areas that direct or restrict traffic, and that control speed and docking behavior.

11.1 Understanding Traffic Control

MobilePlanner provides traffic control guidelines for the AMR to determine the best path through the operating space. You can control AMR traffic by adding areas to the map that tell the AMR which direction to go, how fast to drive, or how many AMRs you want to allow in an area at one time. With MobilePlanner, you can add these features and more to the map.

This section discusses the following traffic control features:

- Using Preferred Lines on page 209
- Using Preferred Directions on page 211
- Using Forbidden Lines and Areas on page 216
- Adding Switchable Forbidden Lines and Areas to the Map on page 217
- Using Resisted Lines and Sectors on page 220
- Using Need-to-Enter Sectors on page 223
- Using Single AMR Sectors on page 225
- Controlling AMR Speed on page 214

11.2 Traffic Control Concepts

In environments with more than one AMR, managing traffic becomes increasingly more critical. The main goals in managing traffic flow are safe and efficient operations, and minimizing traffic jams and collisions. The following sections describe some of the more important traffic control concepts.

Taxi Line (Multi-Robot Standby Goal)

Much like a row of taxis waiting outside the airport, the concept allows multiple AMRs to approach and arrive at the same Standby goal (called a 'Multi-Robot Standby' goal), in sequence, without bunching up and causing a traffic jam.

The Multi-Robot Standby (MRS) goal acts as a traffic control tool. The MRS goal extends the standard Standby map object to enforce sequenced queuing for multiple AMRs at a single start-

ing point, each of which then moves linearly, in sequence to an end point. Along the way, the AMRs become available as they reach the end of their 'after' task.

The following figure shows the general design. The MRS start point is at the left, the MRS end point is on the right.

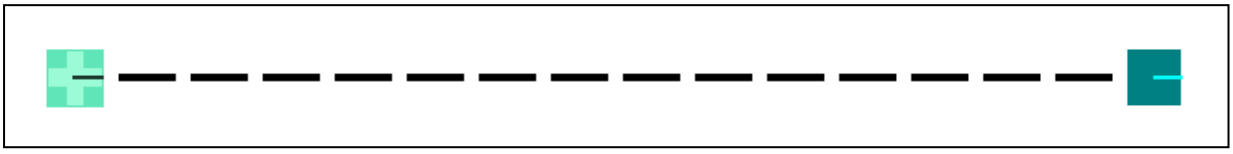


Figure 11-1. Taxi Stand (Multi-Robot Standby) Goal Design

An ideal implementation is at a map corridor that frequently becomes congested with multiple AMRs. By placing the start point some distance from the goal (for example, at the corridor entrance), the AMRs move through the corridor in sequence and reach the end point of the 'after' movement near the corridor's exit. Another ideal implementation is for high throughput sources of parts that need to go to many places (like a plant that has a few gantries serving a few hundred goals. The AMRs waiting in line near the source means a much higher throughput.

Implementing Taxi Line

Using this feature requires setting the Boolean 'AllowMultipleRobots' on standard standby objects (standbys with this Boolean flag active become Multi-Robot Standbys), and each goal using a nearby MRS must also have a Managed Destination sector placed over it, with the 'AlwaysBuffer' parameter enabled, and the sector's ReservedBuffer parameter set to the name of the MRS.

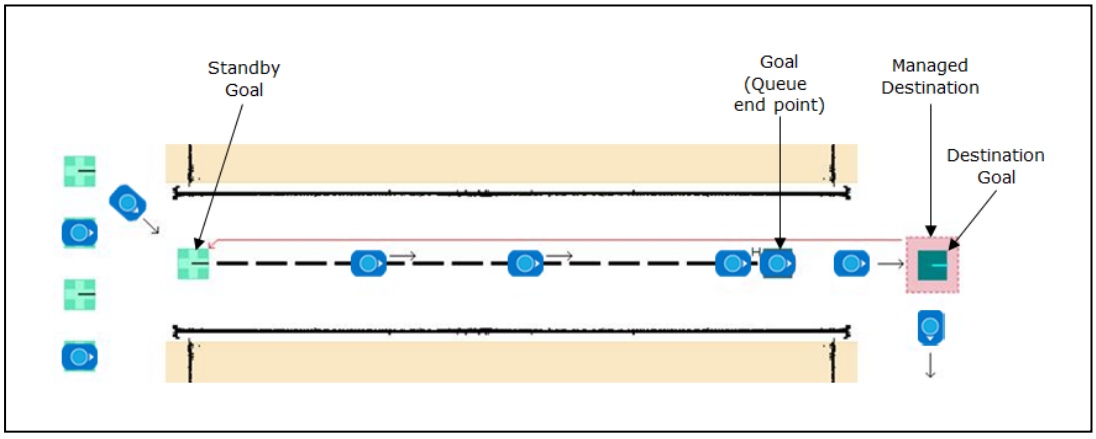


Figure 11-2. Taxi Stand Implementation Example

> **NOTE:** You can only use MRSs as ReservedBuffers. An MRS with no sector referencing it as a ReservedBuffer will display an error when saving the map, and will be ignored during normal operations. Each MRS can only be reserved by one map object.

A typical implementation is to place a standard goal on the map to use as the end point of the buffering line. The figure below shows how this would work with a single AMR (the dashed lines are for illustrative purposes only - they do not appear in the map).

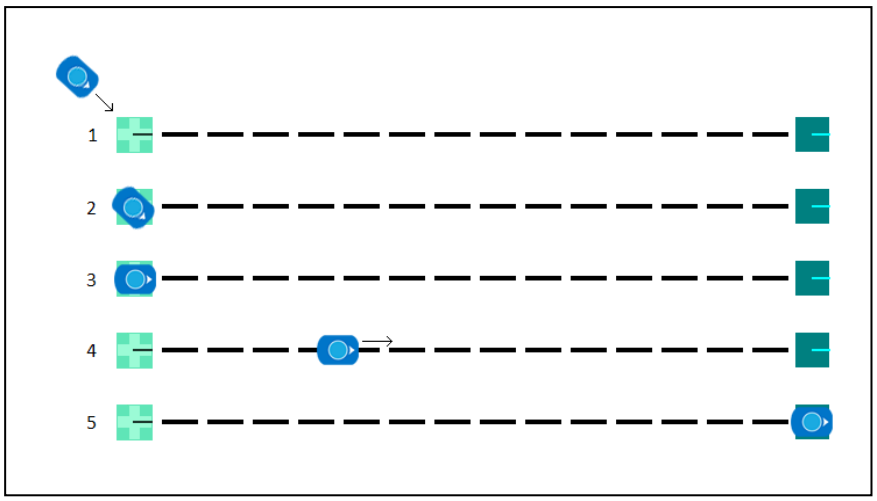


Figure 11-3. Taxi Stand (Multi-Robot Standby) Goal Design, Single AMR Use

As shown above, each AMR drives to the MRS start point (line 1), rotates to the correct pose (line 2), signals the Fleet Manager of its arrival, then executes an 'after' task (in this case, a 'gotoStraight') to the associated goal (lines 4 and 5).

With multiple AMRs, the sequence works as shown below. In line 1, a second AMR is moving towards the end goal, which is already occupied by another waiting AMR. It assumes a position behind the first AMR (line 2), and is then joined by two more AMRs (line 3).

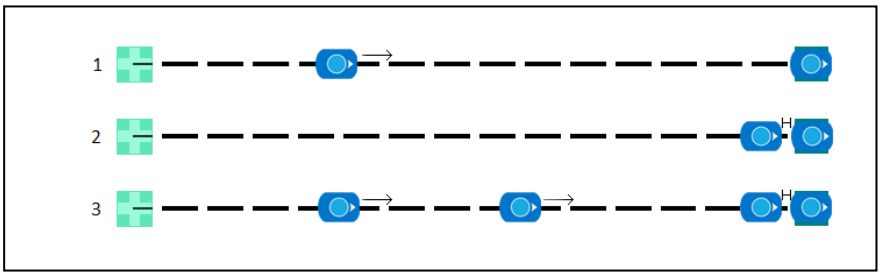


Figure 11-4. Taxi Stand (Multi-Robot Standby) Goal Design, Multiple AMR Use

Managed Motion Sectors

Certain situations might require that multiple AMRs drive in narrow spaces, like hallways and aisles. Without proper management, the AMRs could bunch up and cause traffic deadlocks. The Fleet Manager uses managed motion sectors to control AMR traffic flow in difficult areas, by directing the AMRs to wait at standby goals while awaiting permission to enter the sector. It allows only one AMR to drive autonomously through the sector at a time, while still performing tasks (such as pickup/dropoff) without requesting Fleet Manager permission. Managed Motion can use Taxi Line queuing, with each sector capable of having up to four reserved buffers.

Standby Buffering

Standby buffering is another type of 'StandBy' behavior in which an AMR must wait for another AMR to clear a sector or goal. The awaiting AMR can automatically select and move to a nearby 'StandBy' goal to wait.

Preferred Lines and Directions

You can specify preferred lines, and directions that govern how your AMRs move through their environment. Once placed on a map, the AMRs will, if possible, use the preferred areas. If something prevents an AMR from keeping to the preferred line or direction, it will seek out another path.

Resisted Areas and Lines

You can also place areas and lines on the map that you want your AMRs to avoid If the AMR is unable to complete a goal without moving into, or crossing over, one of these areas, it will do so, with a higher cost. Typically, resisted areas, lines, or directions are for special cases, such as setting up travel lanes in which moving is allowed but should be avoided. For an explanation of cost-based path planning, see Cost-Based Path Planning on page 205.

Forbidden Areas and Lines

As the name implies, these areas, lines, and directions are areas or lines the AMRs must never enter or cross over. These could be loading docks (or other areas that might lead outside), stairs, internal structures with walls, or other areas where the AMR could pose a hazard. Refer to Using Forbidden Lines and Areas on page 216.

DistanceUncrossable and DistanceAdjustment Lines

If the path between the AMR and its goal intersects a DistanceUncrossable line, the AMR will alter its path. You can use these lines to guide an AMR to the appropriate dock or standby goal. The DistanceAdjustment line artificially increases the distance calculation between two points. Queuing uses the distances to determine actions such as which dock to go to.

11.3 Path Planning and Collision Avoidance

MobilePlanner's tools allow you to plan the most expedient routes for your AMRs, while keeping them from running into objects in your facility and each other. There are may traffic control mechanisms associated with path planning.

This section discusses cost-based path planning, difficult spaces, and virtual doors.

Cost-Based Path Planning

ARAM uses a path planning scheme called Cost-Based Path Planning. In this scheme, an AMR instructed to proceed to a goal searches the map for the most efficient path from its current location to the goal, based on what it knows about the map. This path, called the global path, is the optimal path from point a to point b. The AMR then follows that path to the goal while avoiding unmapped obstacles. If the AMR detects unmapped obstacles, it alters its local path to avoid them. If unable to proceed along the global path, the AMR can re-plan a new global path.

The Path Planning Grid

The 'cost-based' aspect of this path planning scheme breaks a map into discrete 100 mm squares (typically sufficient), called the path planning grid (which is not the same as MobilePlanner's 1000 mm (1 meter) reference grid), and assigns a cost to each square. Free (empty) squares (those not close to any obstacles) have a cost of 0.1. The cost for squares con-

taining walls and other fixed objects is infinite (meaning the AMR will never enter those squares because the cost is far too high).

> **NOTE:** Although you can improve path planning accuracy by decreasing the path planning grid squares (done in the PlanRes parameter), doing so increases AMR processing time. For example, changing the PlanRes parameter (**Config > Robot Operation tab > Path Planning Settings** section) from 100 mm to 50 mm quadruples processing time.

Using cost-based path planning, the AMR plans a path with the lowest cost, and follows that path to its goal. If it detects any unmapped obstructions, it alters its path to avoid them. And while the resulting path deviation might be longer, the AMR will always choose the path of lowest cost.

Factors Affecting Cost

Generally, a grid's cost increases as its distance to an obstacle decreases, and occupied grid squares have infinite cost. Preferred lines and directions generally have the lowest cost, while resisted lines and areas have higher costs. Forbidden lines and areas (like those with walls or other fixed obstructions, loading docks, etc.) have an infinite cost, meaning the AMR will never cross or enter them.

For more information about preferred, resisted, restricted, and forbidden lines and areas, see Understanding Traffic Control on page 202.

Path Planning Parameters

MobilePlanner has dozens of path planning-specific parameters that control how the AMR moves through its environment, including (not an all-inclusive list):

- The AMR's maximum traveling and rotating speed
- Turning radius (radius needed to safely pivot in place, without forward or backward movement)
- Grid resolution
- Fast and slow speeds
- AMR padding and clearances (at fast and slow speeds)
- AMR rotational speeds at goals
- The amount of resistance for resisted sectors and lines
- Preferred and resisted lines, areas, and directions

To view and set these path planning parameters (when connected to an AMR), click the **Config** button, then click the **Robot Operation** tab, and select **Path Planning Settings**.

> **NOTE:** MobilePlanner has the most complete and up-to-date descriptions of all path planning parameters, which will not be repeated here.
>
> **Version Information:** The default values of the two following Path Planning Parameters have changed from Mobile Software Suite 4.9.x to FLOW Core:
>
> - SmoothingWt
>
> Default value for FLOW should be 1.0 (ARAM 4.9x was 0.0)

- ObsThreshold
  Default value for FLOW should be 0.3 (ARAM 4.9x was .33).

Robots running FLOW Core will drive poorly if you copy your existing 4.9x path planning configuration values to a new FLOW Core robot, as the default values of the two parameters listed above have changed.

Dealing with Difficult Spaces

Clearance settings limit how close the AMR can move to detected obstacles. You can increase or decrease the required clearance based on the AMR's speed, and have the software stop the AMR if it will come too close to an obstacle in its path before it can stop by decelerating.

Changing clearance settings alters the AMR's behavior if it moves very slowly through doorways or other tight spaces, or stops too quickly when it senses an approaching obstacle. Conversely, if your AMR moves too close to obstacles or doesn't slow down rapidly enough, these settings can improve its behavior.

You can set the clearance and padding parameters in MobilePlanner by clicking the **Config** button, then clicking on the **Robot Operation** tab, and selecting **Path Planning Settings**.

- Front Clearance: a narrow (100 mm/ 3.9 inches default), fixed buffer zone at the front of the AMR that does not change with AMR translational velocity.

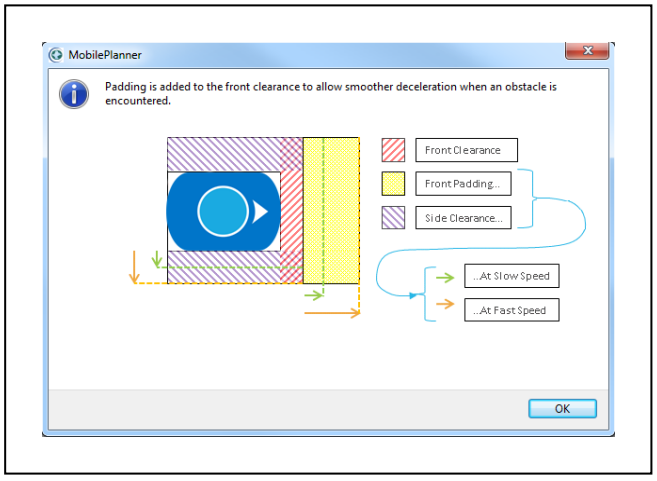


Figure 11-5. Front Clearances

- Side Clearance at Slow Speed (75 mm/ 2.9 inches default) is the minimum side clearance applied at any translational velocity.

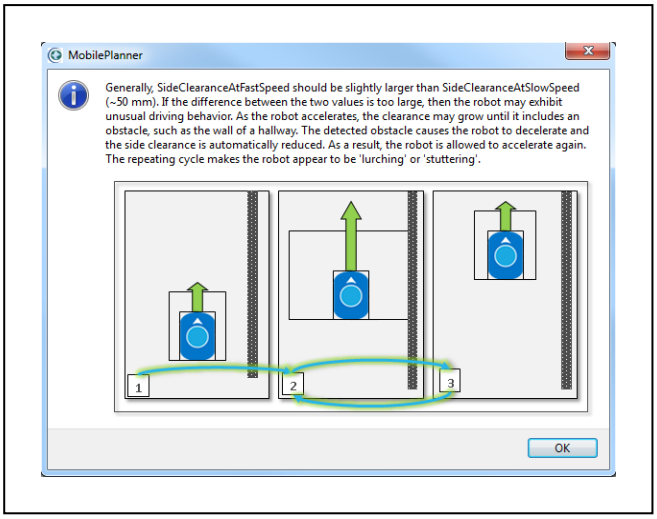


Figure 11-6. Side Clearances

- Front Padding and Side Clearance grow as AMR speed increases if you set these parameters. This is done as a safety precaution for faster-moving AMRs. The values for Front Padding at Slow and Fast Speeds, as well as Side Clearance at Slow and Fast Speeds can be set larger or smaller than the values shown in the figure above based on your facility, the expected level of traffic, and the general nature of the environment the AMR will be working in.

  As the AMR accelerates, Front Padding and Side Clearance increase from Slow Speed size towards Fast Speed size.

  > **NOTE:** If side clearance at high speed is set too large, the AMR will speed up and slow down in hallways and similar spaces. This is because the side clearance grows until it touches the wall, forcing the AMR to slow down until its side clearance shrinks. It is best to have a small gap between sideClearanceAtSlowSpeed and sideClearanceAtFastSpeed.

Virtual Doors

Virtual doors (DefaultDoorWithGoals, for example) are areas on the map that allow the AMR to drive, automatically and seamlessly, through special areas. For instance, they allow an AMR to drive through plastic curtains that it would normally avoid.

When an AMR plans a path through a virtual door, it instead drives to a specified goal beforehand, and optionally to another specified goal afterward. As with normal goals, tasks can be done at the goals associated with virtual doors.

The following dialog opens when you insert a virtual door in a map:

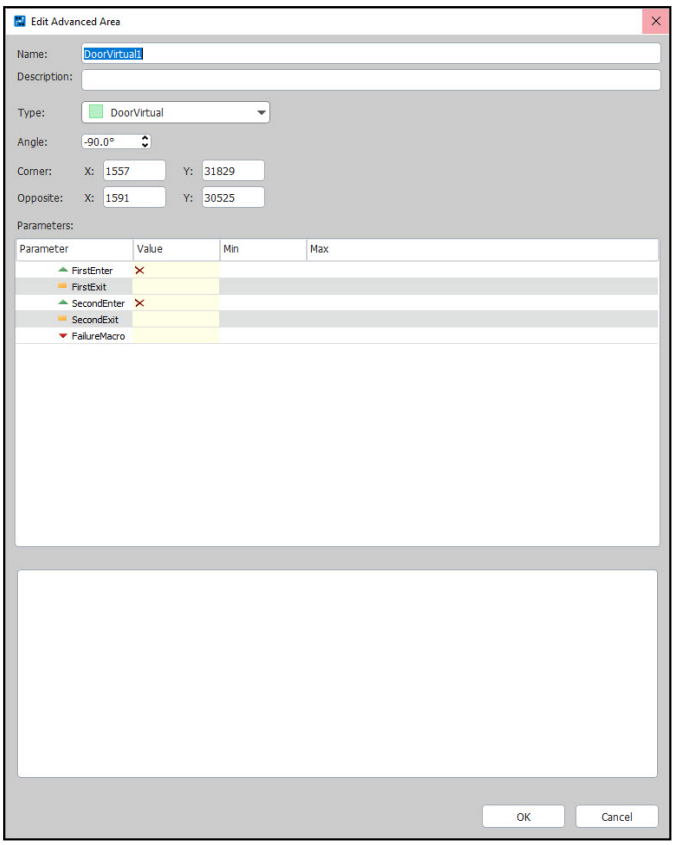


Figure 11-7. Edit Advanced Area, DoorVirtual

11.4 Directing Traffic

With MobilePlanner, you can direct AMR traffic by adding preferred lines and directions to your map.

Preferred lines make the AMR drive as though it's on a virtual rail, and reduce the 'cost' of grid squares it crosses. Though a preferred line might be longer than a straight path from Point A to Point B, the preferred line reduces the cost of each cell it crosses (the Preference parameter divides the cost of each cell the line crosses by 2, which means it costs half as much to drive close to the line), so it could be the least expensive in terms of the cost.

Using Preferred Lines

Before adding a preferred line to the map, enable (click the checkbox for) the PreferredLine parameter (in **Config** > **Robot Operations** > **Map Features**, PreferredLine row):

1. Click the **Map** button to open the map you want to edit (see Using MobilePlanner Software on page 50 for details).

   NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**.

2. In the Draw pane, click **Advanced Lines,** then select **PreferredLine** from the list (the

cursor changes to indicate it is in drawing mode).

3. Place the mouse cursor on the map where you want the preferred line to start.
4. Click and hold the left mouse button, drag the mouse to where you want the preferred line to end, then release the mouse button.

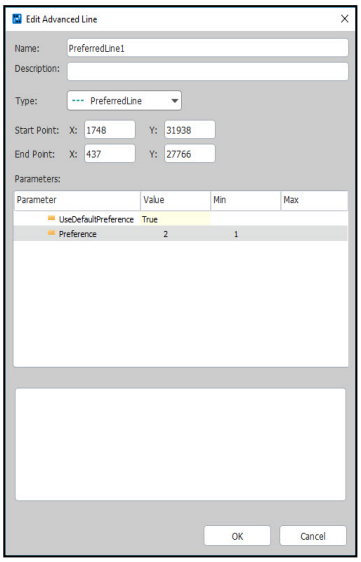


Figure 11-8. Edit Advanced Line, PreferredLine

The following table describes the parameters available on the Edit Advanced Line dialog box.

Parameter	Definition
Name	An optional name for the preferred line.
Description	An optional description for the preferred line.
Type	Set to PreferredLine. Selecting a different type from the pull-down menu changes the map's highlighted area to the selected type and updates the dialog box.
Start Point	X and Y coordinates of the PreferredLine starting point.
End Point	X and Y coordinates of the PreferredLine end point.
UseDefaultPreference	True or False (Boolean) value. If set to: • **True:** uses the default preference setting, ignores the Preference value. • **False:** the AMR overrides the path planning settings with the value of the Preference parameter. Use Path Planning Settings to specify default settings (see Path Planning and Collision Avoidance on page 205 for details).
Preference	Integer representing the line's preference. A normal line has a cost of '1', so a setting of '1' turns off the line's preferred behavior. A line with a preference of '2' means driving on the line costs half as much. Higher preferences yield a lower cost. Applies only when UseDefaultPreference is false. See Cost-Based Path Planning on page 205 for more information.

Using Preferred Directions

Preferred directions cause the AMR to attempt to drive on the specified side. In the image below, the AMR does not move directly down the center of the hall, but along the right wall (the preferred directions).

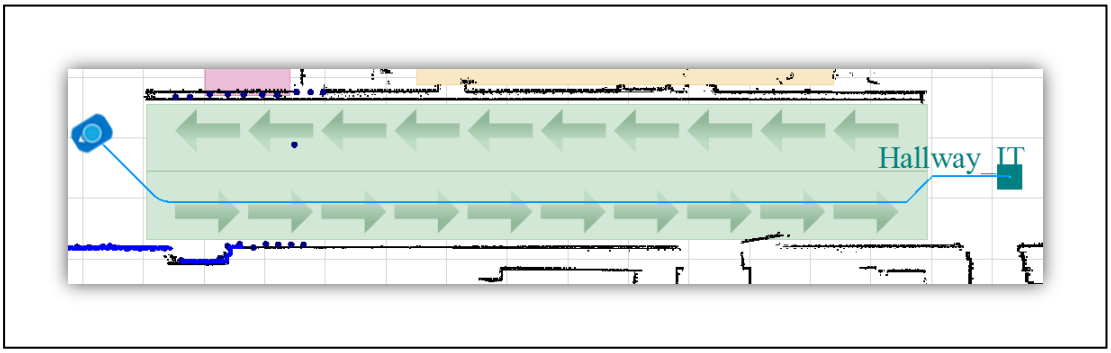


Figure 11-9. Preferred Direction

If the AMR cannot drive in the preferred direction for some reason, it will change its path to reach its goal, including driving against the preferred direction on the left side of the hallway (above). MobilePlanner allows you to add the following preferred directions to the map:

NOTE: You must enable each of the preferred directions listed below (**Config** button **> Robot Operation** tab **> Map Features**) and **Save** before they will appear in the Advanced Areas pulldown menu (in the Draw tab).

- **PreferredDirectionLeft:** Places an area on the map that tells the AMR to drive on the left, in both directions.
- **PreferredDirectionLeftSingle:** Places an area on the map that tells the AMR to drive on the left, in one direction only. If you use this option and have two of these areas next to each other, align the two areas carefully. This is an advanced option. Use **PreferredDirectionLeft** for most applications.
- **PreferredDirectionRight:** Places an area on the map that tells the AMR to drive on the right, in both directions.
- **PreferredDirectionRightSingle:** Places an area on the map that tells the AMR to drive on the right, in one direction only. If you use this option and have two of these areas next to each other, align the two areas carefully. This is an advanced option. Use **PreferredDirectionRight** for most applications.

Adding a Preferred Direction to the Map

1. Click the **Config** button, then click on the **Robot Operations** tab, and select **Map Features**.
2. In the PreferredDirection (Right or Left) row, enable the PreferredDirection parameters you want to use, then **Save** the map.
3. Click the **Map** button to open the map you want to edit (see Using MobilePlanner Software on page 50 for details).

   NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**.

4. In the Draw pane, click **Advanced Areas**, then select the **PreferredDirection** from the list.
5. Place the mouse cursor on the map where you want the preferred direction to start.
6. Click and hold the left mouse button, drag the mouse to where you want the preferred area to end, then release the mouse button.

   The new area appears on the map, and the Edit Advanced Area dialog box appears.

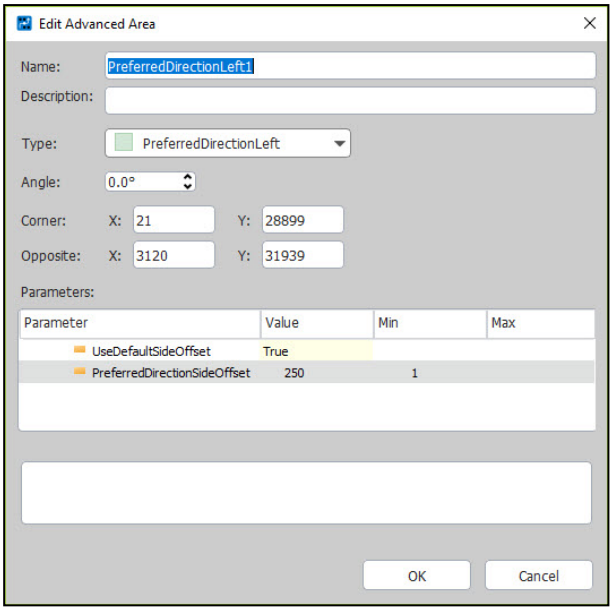


Figure 11-10. Edit Advanced Area, PreferredDirectionLeft

Edit Advanced Line Parameter	Definition
Name	Optional name for the preferred area.
Description	Optional description for the preferred area.
Type	Set to the type of preferred area you selected.
Angle	The preferred area's rotation angle.
Corner	The X and Y coordinates of the preferred area's starting corner.
Opposite	The X and Y coordinates of the preferred area's ending corner.
UseDefaultSideOffset	True or False (Boolean) value. If set to: • **True:** uses the default side offset. • **False:** the AMR overrides the path planning settings with the value of the PreferredDirectionSideOffset parameter. Use Path Planning Settings to specify default settings (see Path Planning and Collision Avoidance on page 205 for details).
PreferredDirectionSideOffset	(Integer) Represents how far away from the edge of the preferred direction area the AMR can drive.

Edit Advanced Line Parameter	Definition
	 **CAUTION:** Setting this value too low can cause the AMR to drive out of the preferred area.

11.5 Controlling AMR Speed

You can control the AMR's speed in certain areas by adding Movement Parameter Areas to the map.

Adding Movement Parameter Areas to the Map

NOTE: Movement parameters take effect after the AMR is in them.

1. In MobilePlanner, click the **Config** button, then click the **Robot Operations** tab, then select **Map Features**, then scroll down and click in the checkbox to enable MovementParameterSector.
2. Click the **Map** button to open the map you want to edit (see Using MobilePlanner Software on page 50 for details).
3. In the MobilePlanner main menu bar, click **Map > Grid** to display the grid lines on the map.

   NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately.

4. In the Draw pane, click **Advanced Area**, then select **MovementParameters** from the pull-down menu.

   The cursor changes to indicate it is in drawing mode.
5. Place the mouse cursor on the map where you want the area to start.
6. Click and hold the left mouse button, drag the mouse to where you want the sector to end, then release the mouse button.

   The new area appears on the map.

Editing Movement Parameter Areas

1. In the Draw pane, click **Select**, then click on the area you want to edit to highlight it.
2. Right-click on the highlighted area, and select **Edit** from the pop-up menu.

   The Edit Advanced Area dialog box appears.

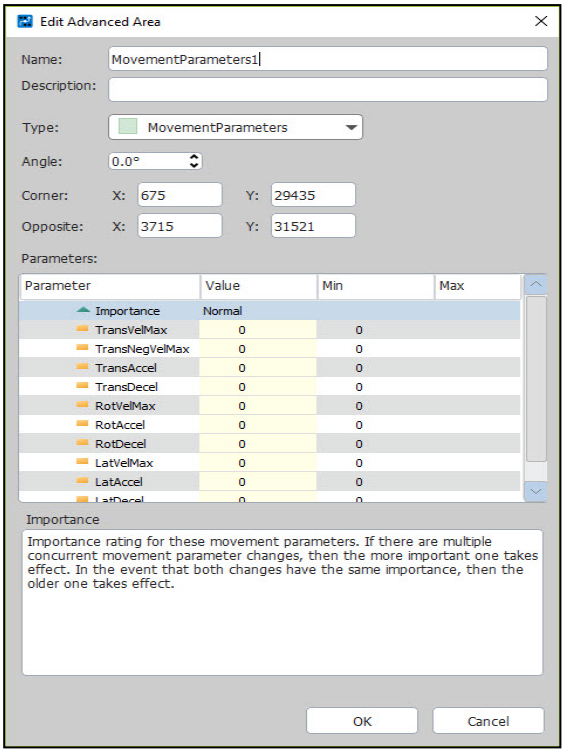


Figure 11-11. Edit Advance Areas, MovementParameters

The following table describes the parameters available in the Edit Advanced Area dialog box.

Parameter	Definition
Name	An optional name for the area.
Description	An optional description for the area.
Type	Set to **MovementParameters**. If you select a different type of advanced area, the highlighted area on the map changes to the selected type and the dialog box updates.
Angle	The angle the area is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the area.
Opposite	The X and Y coordinates of the ending corner of the area.
Parameters	Parameters that affect the AMRs' behavior in the sector you drew on the map. A value of 0 means use defaults.

11.6 Restricting Traffic

You can restrict the AMR's movement by adding forbidden lines and areas to the map. These areas typically correspond to an area of the operating environment that you don't want the AMR to enter, or in which you want to restrict the number of AMRs operating at the same time (managed motion sectors). You can also add advanced features to the map that control traffic flow based on certain conditions. For example, you might want the AMR to avoid an area during monthly maintenance. You can set that up using switchable forbidden areas. You might also have an area in which you want only one AMR at a time.

You can set the parameters for these features in MobilePlanner by clicking the **Config** button, then clicking the **Robot Operations** tab, and selecting **Map Features**.

The following features allow you to restrict AMR traffic in your operating space:

- Adding Switchable Forbidden Lines and Areas to the Map on page 217
- Using Resisted Lines and Sectors on page 220
- Using Need-to-Enter Sectors on page 223
- Using Single AMR Sectors on page 225 (helpful when you have multiple AMRs operating in the same environment)

Using Forbidden Lines and Areas

You can place lines and areas on the map that correspond to places in your operating environment where you do not want the AMR to go. You can also add lines and areas that can be temporarily forbidden.

Forbidden lines are invisible barriers (virtual walls) in the operating space that the AMR will not cross when driving in Autonomous Drive mode (the default driving mode). The cost of map squares under a forbidden line is infinite. For more information see Manual Override on page 80.

Forbidden areas are places in the map that you do not want the AMR to enter. For example, if your operating environment has a loading dock that is open to the outside you might not want the AMR to accidentally drive outside, and off the loading dock. The area might be accessible on three sides, so you could place forbidden areas on the map corresponding to the loading dock.

You can also add forbidden lines and areas that you can turn on and off (switchable forbidden lines and areas).

Adding Forbidden Lines and Areas to the Map

> **NOTE:** There are no required parameters for Forbidden Lines and Areas, which are always enabled.

1. Click the **Map** button to open the map you want to edit. Refer to Using MobilePlanner Software on page 50 for details.

   > **NOTE:** MobilePlanner can add grid lines to the map to help you place lines and areas more accurately (main menu, click **Map > Grid**). Also, ensure **Show Robot** is OFF.

2. In the Draw pane, click on either **Forbidden Line** or **Forbidden Area**.

   The cursor changes to indicate it is in drawing mode, using a box around the icon to indicate an area.

3. Place the mouse cursor on the map where you want the forbidden line or area to start.
4. Click and hold the left mouse button.
5. Drag the mouse to where you want the line or area to end and release the button.

   The new forbidden line or area is selected and displayed in the map.

Adding Switchable Forbidden Lines and Areas to the Map

You can have certain tasks activate switchable forbidden lines and areas. These tasks can toggle individual lines and areas or they can toggle groups of switchable forbidden lines and areas.

1. To enable the **SwitchableForbiddenAreaAndLine** parameter, click the **Config** button, click on the **Robot Operation** tab, select **Map Features**, and click the checkbox to the right of the SwitchableForbiddenAreaAndLine parameter.

   NOTE: The server will automatically restart when you change the parameters.

2. Click the **Map** button to open the map you want to edit. See Using MobilePlanner Software on page 50 for details.

   NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**. Also, ensure **Show Robot** is **OFF** to enable the Draw tools.

3. In the Draw pane, click **Advanced Lines** or **Advanced Areas**, depending on what you want to add to the map.
4. Select **SwitchableForbiddenLine** or **SwitchableForbiddenArea** from the corresponding pull-down menu.

   The cursor changes to indicate it is in drawing mode, using a box around the icon to indicate an area.

5. Place the mouse cursor on the map where you want the line or area to start.
6. Click and hold the left mouse button, drag the cursor to where you want the line or area to end, then release the mouse button.

   The new switchable forbidden line or area appears on the map, and the Edit Advanced dialog box appears.

Editing Forbidden and Switchable Areas

NOTE: The following procedures only apply if you want to edit an existing advanced area.

1. Verify **Show Robot** is OFF then, in the Draw pane, click **Select**.
2. Either double-click on the area or line in the map, or right-click and select **Edit** from the pop-up menu.

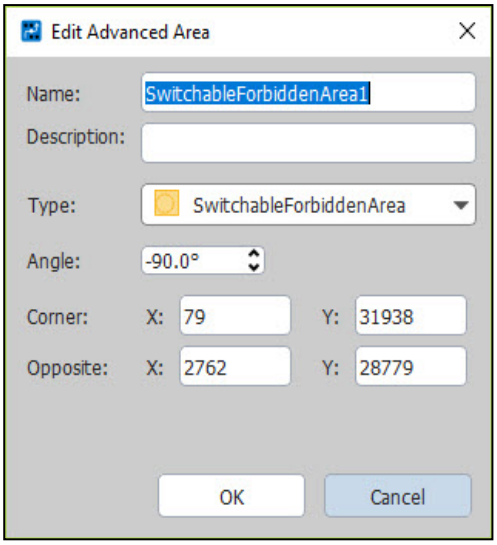


Figure 11-12. Edit Advanced Area, SwitchableForbiddenArea

The following table describes the options available in the dialog box.

Parameter	Definition
Name	A name for the forbidden area. **NOTE:** Since you switch forbidden areas by name, it's useful to use a common prefix when naming the ones you want to group together.
Description	An optional description for the forbidden area.
Type	Not displayed for ForbiddenLine. If you select a different type of advanced area in the drop-down list, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The forbidden area's rotation angle (in degrees) in the map.
Corner	The X and Y coordinates of the forbidden area's starting corner.
Opposite	The X and Y coordinates of the forbidden area's ending corner.

Editing a Forbidden Line or a Switchable Forbidden Line

1. Verify **Show Robot** is OFF then, in the Draw tab, click **Select**.
2. Either double-click on the line in the map, or right-click and select **Edit** from the pop-up menu.

   If you selected a forbidden line, the Edi Forbidden Line dialog box appears. The Edit Advanced Line dialog box appears if you selected a switchable forbidden line.

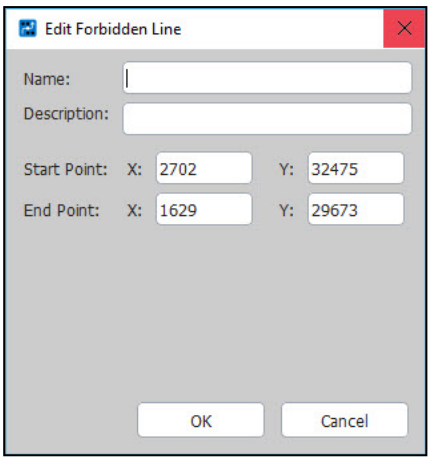


Figure 11-13. Edit Forbidden Line Dialog

Edit Forbidden Line Parameter	Definition
Name	An optional name for the forbidden line.
Description	An optional description for the forbidden line.
Type	Displayed for SwitchableForbiddenLine. If you select a different type of advanced line from the drop-down menu, the highlighted line changes to the selected type and the dialog box updates.
Start Point	The X and Y coordinates of the starting point of the forbidden line.
Opposite	The X and Y coordinates of the ending point of the forbidden line.

Switchable Forbidden Lines and Areas

There are two ways to turn on or off a Switchable Forbidden Line or Area:

- Tasks
- ARCL

  NOTE: ARCL is outside the scope of this manual. Refer to the corresponding reference guides for those products.

There are four tasks you can use to turn a Switchable Forbidden Line or Area ON or OFF:

- switchForbiddenOff
- switchForbiddenOn
- switchForbiddenOffByPrefix (you can specify a text prefix that turns all switchable areas with that prefix OFF)
- switchForbiddenOnByPrefix (you can specify a text prefix that turns all switchable areas with that prefix ON)

Driving into a Forbidden Area

Occasionally you might need the AMR to drive into a forbidden area. You can make the AMR do this by turning ON Manual Override mode, or using the pendant (even with Autonomous Drive mode ON).

1. Click the **Map** button to open the map containing the forbidden area.
2. Attempt to drive the AMR into the forbidden area from multiple sides - the AMR should slow down and stop just before the forbidden area.
3. Click **Robot > Robot Tools > Manual Override** to turn Autonomous Drive mode OFF.

WARNING: Turning Autonomous Drive mode OFF disables the AMR's obstacle-avoidance (of obstacles detected by the navigation laser) at speeds under 300 mm/s. Use extreme caution when driving the AMR under these circumstances.

4. Select **Yes** to turn Autonomous Drive mode OFF.
5. Drive the AMR into the forbidden area. This time the AMR should drive into the area.

NOTE: Manual Override must remain ON to drive the AMR out of the forbidden area. Notice that the background color of the map changes to yellow when Manual Override is turned ON.

Using Resisted Lines and Sectors

You can add lines and areas to the map, called resisted lines and sectors, that the AMR will attempt to avoid because they cost more to drive through. The AMR's path planning system is similar to a GPS system that recalculates a route to avoid road construction. However, if another route is not available, the AMR follows the original. Similarly, the AMR will resist entering a sector or crossing a boundary if it is possible to avoid it; however, if it needs to drive through a resisted sector to reach its goal, it will.

Adding Resisted Boundaries and Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable ResistedSectorAndLine. See Setting the Configuration Parameters on page 142
2. **Save** your change to the AMR.
3. Click the **Map** button to open the map you want to edit.

NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**.

4. Ensure **Show Robot** is OFF, then click **Draw > Advanced Lines** or **Draw > Advanced Areas**, depending on what you want to add to the map.
5. In the pull-down menu, select **ResistedLine** or **ResistedSector**, and note that the cursor

changes to indicate that it is in drawing mode (has a box around the icon to indicate an area).

6. Place the mouse cursor on the map where you want the resisted line or sector to start.
7. Click and hold the left mouse button.
8. Drag the mouse cursor to where you want the line or sector to end and release the button to display the new resisted line or sector in the map, and the Edit Advanced Area dialog box.

Editing Resisted Sectors

1. Verify that **Show Robot** is OFF and, in the Draw tab, click **Select**.
2. Either double-click or right-click on the sector in the map and select **Edit** from the pop-up menu.

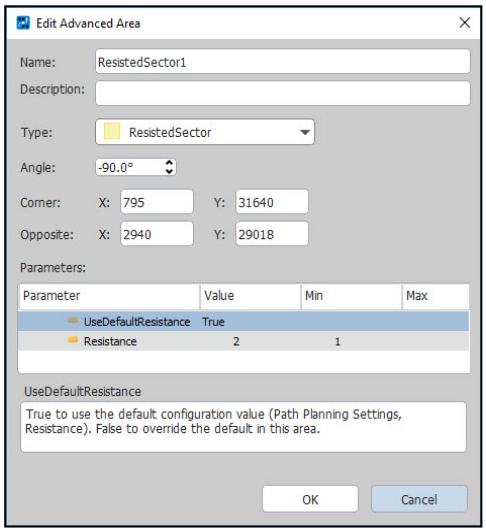


Figure 11-14. Edit Advanced Area, ResistedSector

Edit Advance Area Parameter	Definition
Name	A name for the resisted sector.
Description	An optional description for the resisted sector.
Type	Set to **ResistedSector**. If you select a different type of advanced area, the highlighted area changes to the new type and the dialog box updates.
Angle	The rotation angle of the resisted sector in the map.
Corner	The X and Y coordinates of the resisted sector's starting corner.
Opposite	The X and Y coordinates of the resisted sector's ending corner.
UseDefaultResistance	(Boolean) value. A True setting uses the default resistance setting , and ignores the Resistance value (default settings are set using the Path Planning Settings - see Path Planning and Collision Avoidance on page 205). If this is False, the AMR overrides the path planning settings with the value of the Resistance parameter.
Resistance	(Integer) Determines the cost of crossing the area. Defines how much the AMR will resist driving through a particular sector, and find an alternative path. The cost of driving through a resisted sector is multiplied by its resistance value. A normal area or sector has a cost value of 1. Set this value to 1 to turn off the resistance behavior.

Editing Restrictive Lines

1. Verify that **Show Robot** is OFF and, in the Draw tab, click **Select**.
2. Double-click (or right-click) on the boundary in the map, and select **Edit** from the pop-up menu.

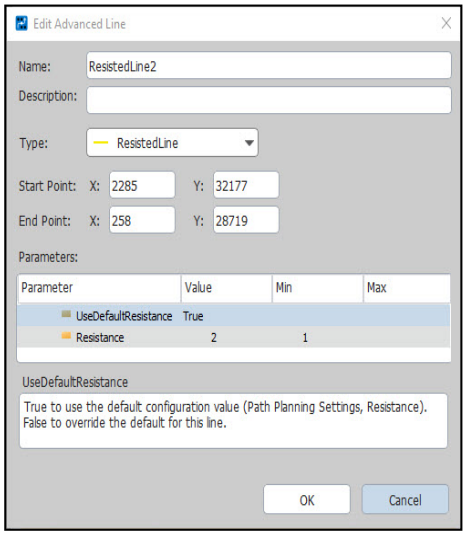


Figure 11-15. Edit Advanced Line, ResistedLine

Edit Advanced Line Parameter	Definition
Name	A name for the resisted boundary.
Description	An optional description for the resisted boundary.
Type	Set to **ResistedLine**. If you select a different type of advanced area, the highlighted area changes to the new type and the dialog box updates.
Start Point	The X and Y coordinates of the starting corner of the resisted boundary.
End Point	The X and Y coordinates of the ending corner of the resisted boundary.
UseDefaultResistance	(Boolean) A True setting uses the default resistance setting (set in the Path Planning Settings in the Advanced Areas pull-down menu). See Path Planning and Collision Avoidance on page 205 for details. If False, the AMR overrides path planning settings with the Resistance parameter value.
Resistance	(Integer) Determines the cost of crossing a boundary, how much the AMR resists driving across it, and finds an another path. The cost of driving across a boundary is multiplied by its resistance value. A normal area has a cost of 1, so set this value to 1 to turn off the resistance behavior.

Using Need-to-Enter Sectors

You can add areas to the map that only allow the AMR to enter if the goal the AMR is trying to reach is inside the sector. These are referred to as need-to-enter sectors. If the AMR is already in a need-to-enter sector, it can drive around in the sector or drive out of it.

Need-to-enter sectors are useful in (for example) cases in which there are loading or unloading areas where another AMR could cause congestion if it tries to pass through.

Adding Need to Enter Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable NeedToEnterSector. For details on how to do this, see Configuring the AMR on page 140.
2. **Save** your change to the AMR.
3. Click the **Map** button to open the map you want to edit.

   NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid.** Also, ensure that **Show Robot** is OFF to enable the Draw tools.

4. Click **Draw > Advanced Areas**.

5. Select **Need to Enter** from the pull-down menu, and note the cursor changes to indicate it is in drawing mode.
6. Place the mouse cursor on the map where you want the sector to start.
7. Click and hold the left mouse button.
8. Drag the mouse cursor to where you want the sector to end and release the button. The new need-to-enter sector highlights and appears in the map, and the Edit Advanced Area dialog box appears.

Editing Existing Need-to-Enter Sectors

1. Click **Select**.
2. Either double-click on the resisted sector in the map, or right-click on the sector and select **Edit** from the pop-up menu to display the Edit Advanced Area dialog box.

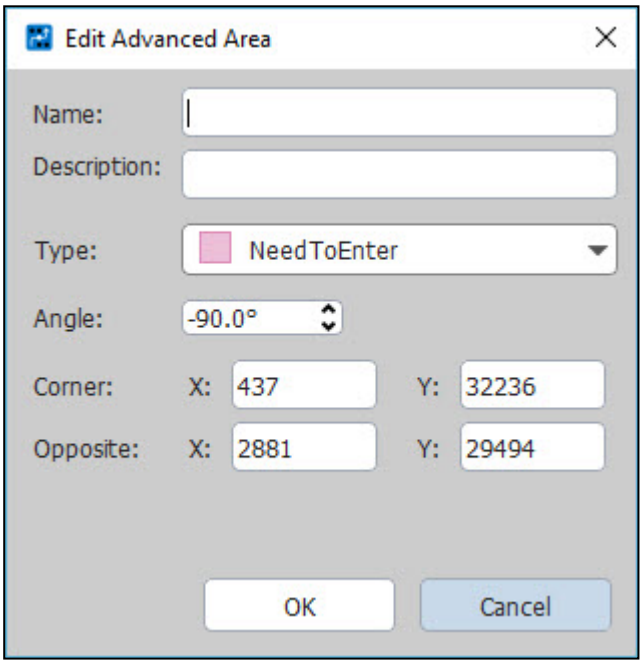


Figure 11-16. Edit Advanced Area, NeedToEnter

The following table describes the options available on the Edit Advanced Area dialog box.

Parameter	Definition
Name	A name for the need-to-enter sector.
Description	An optional description for the need-to-enter sector.
Type	Set to **NeedToEnter**. If you select a different type of advanced area, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The angle the sector (rectangle) is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the sector.
Opposite	The X and Y coordinates of the ending corner of the sector.

Using Single AMR Sectors

Single AMR sectors allow you to add areas to the map that only allow one AMR at a time to be in the specified area. This is useful for narrow hallways or narrow areas with only one entry/exit.

Adding Single AMR Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable **SingleRobotSector**. See Configuring the AMR on page 140 for details.
2. **Save** your change to the AMR.
3. Open the map you want to edit. See Using MobilePlanner Software on page 50 for details.
4. Ensure **Show Robot** is **OFF**, then click on the **Grid** toolbar icon to display the grid lines on the map. This helps you to place the lines and areas more accurately.
5. Click **Draw > Advanced Areas**.
6. Select **SingleRobot** from the pull-down menu (the cursor changes to indicate that it is in drawing mode).
7. Place the mouse cursor on the map where you want the single AMR sector to start.
8. Click and hold the left mouse button.
9. Drag the mouse cursor to where you want the sector to end and release the button to highlight the new area in the map.

Editing Existing Single AMR Sectors

1. Click **Select**.
2. Either double-click on the sector in the map, or right-click on the sector, and select **Edit** from the pop-up menu to display the Edit Advanced Area dialog box.

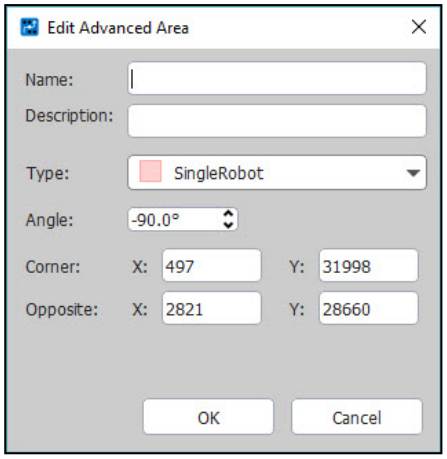


Figure 11-17. Edit Advanced Area, SingleRobot

The following table describes the options available on the Edit Advanced Area dialog box.

Parameter	Definition
Name	A name for the single AMR sector.
Description	An optional description for the single AMR sector.
Type	Set to **SingleRobot**. If you select a different type of advanced area from the pull-down menu, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The angle the sector is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the area.
Opposite	The X and Y coordinates of the ending corner of the area.

Chapter 12: AMR Localization

When a moving AMR is operating in an environment such as an office building or a warehouse, it must have some way of tracking its position and orientation on a map. This tracking is called localization. Accurate localization is a prerequisite for autonomous navigation.

This section discusses the types of localization your AMR uses. For more information, refer to the following:

12.1 What is Localization?

Localization is the way in which the AMR knows its location on the map. It is a process the AMR uses to estimate its position in its environment based on data collected during operation. Currently, the AMRs can use two types of localization:

- Laser localization uses data from the AMR's laser in conjunction with the map to calculate the AMR's position. This is the default way the AMR keeps track of its position in the operating space and is most useful in a static environment such as an office building or hospital.Using Laser Localization on page 231.
- Optionally, an AMR can use overhead lights to track its position in the environment. This localization process is often used in dynamic environments, such as a warehouse, where objects move too frequently for the AMR to localize based on their past positions. Using Acuity For Light Localization on page 235.

The key to localization is obtaining an accurate map of the environment (see Working with Map Files on page 90). The AMR compares the map to the data collected from its sensors to correct its position. With this information, the AMR knows its position on the map.

> **NOTE:** The AMR combines data collected with either of these methods with data from encoders on its wheels and the gyroscope in its core to determine its location.

Overview of Localization Process

Localization requires an iterative process of correcting for errors in the AMR odometry. When an AMR is powered up, it must determine its initial position (which could be its last position when it shut down). During operation, the AMR calculates the current position based on its last known position, along with the AMR's speed and direction. The AMR periodically recalculates its position to make sure it knows where it is. If the AMR cannot calculate a reliable pose, it is lost and must stop. After the AMR recalculates its position, the current location becomes the last known location.

12.2 Comparing Laser and Light Localization

The AMR can use data from its laser or from an upward-facing camera viewing the position of overhead lights (or a combination of the two), to accurately determine where it is in its physical space and in the map.

The following table highlights the differences between laser and light localization. For more information on each localization process, refer to the appropriate section.

	Laser Localization	Light Localization
Description	Uses a laser range finder located on the AMR to perform localization.	Uses a camera located on the AMR to monitor overhead lights in the environment as points of reference to perform localization.
Equipment	Laser range finder (standard)	Upward-facing camera option.
Accuracy vs. Reliability	Provides more accurate location data, but the AMR cannot deal with highly dynamic environments.	Provides more reliable localization in a dynamic environment, because there is less chance for the AMR to get lost, but the AMR positioning is less accurate.
Recommended Environment	Static (such as an office building)	Dynamic (such as a warehouse)

12.3 What Causes the AMR to be Lost?

When an AMR no longer has enough confidence in its position, it broadcasts that it is lost, and stops driving until a human intervenes. When an AMR is lost, it stops moving and broadcasts a notification (in the form of the dialog box below) that it needs attention.

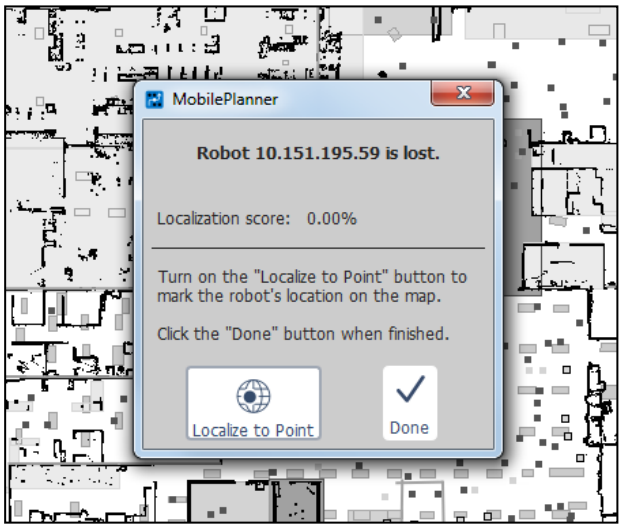


Figure 12-1. Localization Dialog - Lost Robot

Localizing a Lost AMR

1. Click **Localize to Point** in the lost AMR dialog box.
2. Click and hold the mouse on the map where you want to localize the AMR (at the AMR's current physical location) and, while holding the left mouse button, drag the mouse cursor to set the AMR's heading.

The Localization Score (or confidence threshold) should be 80% or better for optimum navigation.

3. Click **Done** when the AMR's localization score is where you want it to be.

Adjusting the Confidence Threshold

The PassThreshold and LostThresholdDistance parameters (**for laser localization**) and LockThreshold and LostLockUncertaintyThreshold parameters (**for light localization**) set the criteria for when an AMR is lost. With each localization, the AMR generates a localization score. The AMR is not considered lost until the localization score drops 20% below the PassThreshold parameter (**for laser localization**) or -100 on the LostLockUncertaintyThreshold (**for light localization**), and fails to recover. Once the localization score drops below PassThreshold-/LockThreshold, the AMR will move up to LostThresholdDistance/LostLockUncertaintyThreshold, trying to raise its score. If it fails, it is considered lost. You can adjust the parameter values as needed.

LostThresholdDistance is the maximum distance (in mm) that the AMR will move from the last localized pose before the AMR will be considered lost. This parameter will only come into play if none of the samples during the sensor correction is higher than PassThreshold. As soon as this happens, the position uncertainty distance will grow based on the movement from the last localized pose.

1. In MobilePlanner, click the **Config** button, then click the **Robot Operation** tab, and select **Localization settings** (or **Light Localization settings**).
2. Click on the **PassThreshold Value** (or **LockThreshold value** for light localization) field and enter a new threshold value (the minimum score to consider the AMR localized).
3. Click on the **LostThresholdDistance Value** (or **LostLockUncertaintyThreshold value** for light localization) field and enter a new distance value if desired.

12.4 Optimizing Localization

Localization accuracy depends on the accuracy of the map and sensor measurements. Typically, the AMR should be able to localize in most indoor environments. Occasionally, however, the AMR encounters situations in which it has trouble localizing, which can impact its ability to navigate.

The most common problem with localization is map accuracy. It might not have been accurate enough to begin with, or the environment might have changed enough (partitions moved, etc.), that the map no longer reflects the working environment.

You can improve localization accuracy, to some extent, by adjusting the localization parameters. However, changing one parameter generally affects other parameters. Therefore you will likely need to adjust several parameters to fine tune the localization score.

Laser and Light Localization use different parameters that you can adjust. Those parameters are discussed in Localization Parameters on page 232 and Light Localization Parameters on page 238 respectively. However, there are a few general guidelines to consider before you change parameter values.

Before Changing Parameter Values

Before changing any parameters (localization or other), make sure your map contains as much accurately scanned data as possible. The more static features the map has (walls, doors,

shelves, etc.), the better the AMR is at navigating its way through the space.

- Don't erase any data from the map unless those points really do not correspond to any real, fixed object.
- Re-scan areas where features have been removed from or added to an area in the environment.
- If there were errors in the map-making process, and your map does not match the real space, re-scan the area again more carefully.

CAUTION: Before changing parameters, save a copy of your current config file. When experimenting with parameters, try one parameter or a small combination of parameter changes at a time. Revert to your saved config file if the AMR's performance does not improve. See Configuring the AMR on page 140.

12.5 Using Laser Localization

OMRON AMRs use one of two methods to locate their position in their environment: laser or light localization. For more information on using light localization, refer to Using Acuity For Light Localization on page 235.

Laser localization uses a laser range finder, located on the AMR, to detect walls and other objects in the environment. The data collected from the laser is combined with the AMR's odometry information and the map, which enables the AMR to determine its location.

Overview of Laser Localization

The most common way to localize an AMR in a given space is to use a laser range finder. The laser range finder takes a planar snapshot of the environment, then compares this with the map of the environment to determine the AMR's position. This is a relatively accurate method of localization for environments that tend to be static, such as an office space.

If the laser localization cannot match the laser readings to the map, it does have some logic that allows the AMR to drive for a while before reporting that it is lost. However, this is only useful in temporary situations, such as the AMR driving through a small area where a group of people have gathered.

In a dynamic space where unmapped cargo and equipment move in and out of the area (such as in a warehouse), data from the unmapped objects can easily overwhelm the mapped data, causing the laser localization to fail. In these situations, it is better to use light localization. See Using Acuity For Light Localization on page 235 for details.

Key Features

- Laser localization gives accurate positioning data for precise navigation, particularly in a relatively static environment.
- No potentially expensive retrofitting required to use laser localization.
- The map only needs to be updated if there is a change in the static environment.

- The AMR continues to operate even if some of the map features have changed, resulting in a flexible solution.

Limitations of Laser Localization

Laser localization is an accurate method of localization in a static environment such as an office, but has some limitations to consider:

- The laser cannot see glass, mirrors, or shiny objects. Environments with a lot of these objects make it difficult for the AMR to localize.
- In dynamic environments in which objects frequently change positions (such as a warehouse), laser data might not match mapped data closely enough for the AMR to localize. In these areas, the map won't contain objects added or moved after you created the map.
- In an environment with a lot of high racks for the AMR to navigate through, the confidence threshold could fall below 20% and cause the AMR to become lost.

Localization Parameters

In MobilePlanner, you can access the AMR's localization parameters and adjust them as needed.

To access the laser localization parameters, click the **Config** button, then click the **Robot Operation** tab, and select **Localization settings**.

Improving Accuracy and CPU Usage

For laser localization, two settings directly affect the CPU usage for each localization:

- **GridRes** represents the size of the grid used for localization. The smaller the value is, the more accurate the localization score.
- **NumSamples** represents the number of poses sampled (or checked) each time the AMR moves; this number scales linearly, so adjusting a value of 2000 to 3000 takes up 1.5 times more processing power.

Other factors, such as TriggerDistance and TriggerAngle determine how often it attempts to re-calculate (or re-localize) its position. Recalculating uses a lot of CPU so, if the value of NumSamples is set too high, the AMR will localize less often. This can actually cause more problems than an AMR that localizes less accurately, but more often.

The K parameters (KMmPerMm, KDegPerDeg and KDepPerMm) are error parameters, and are explained below.

Using Laser Localization Parameters

With MobilePlanner, you can access the AMR's configuration parameters and adjust them as needed.

To access the laser localization parameters, click the **Config** button, then click on the **Robot Operation** tab, and select **Localization settings**.

In general, high CPU use for one laser scan might prevent the AMR from scanning as often as needed. Setting these parameters requires balance.

You can change parameters that affect the level of detail in an AMR's scan, how many possible locations (poses) the AMR will compare those results with, and how frequently, both in time and travel, it rechecks its location. There are also parameters to adjust the amount of expected error, both linear and rotational.

Localization Parameters and Effects on CPU Use

Parameter	Description	Effect(s) on Localization
AdjustNumSamples Flag	Varies the number of samples based on the localization score.	When enabled, lowers the number of samples when the AMR is moving and the localization score is high. Reduces CPU demand.
AngleIncrement	Separation (in degrees) required between laser settings used for localization.	Discards readings too close together. Reduces CPU demand.
GridRes	Resolution (in mm) of map grids.	Scan resolution. Decreasing this value increases localization accuracy, but increases demand on RAM.
KMmPerMm	Millimeters of linear error per linear millimeter of travel.	Allowed percentage error (in mm) of the AMR's linear odometry readings. If set too high, sample poses are too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
KDegPerDeg	Degrees of error per degrees rotated.	Allowed percentage error (in deg) of the AMR's rotational odometry readings. If set too high, sample poses too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
KDegPerMm	Degrees of error per linear mm traveled.	Allowed error (in deg) of the AMR's rotation per one mm of linear travel. If set too high, sample poses too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
NumSamples	Number of pose samples AMR uses for localization.	Scan resolution. Increasing this value increases localization computations. If too low, the AMR fails to localize.
TriggerDistance	Distance AMR travels (in mm) before localizing.	How often to localize – helps reduce CPU demand. The AMR only localizes when it travels beyond listed value.
TriggerAngle	Angle (in deg) AMR turns before triggering localization.	How often to localize – helps reduce CPU demand. The AMR only localizes when it rotates beyond the listed value.

12.6 Using Acuity For Light Localization

Light Localization uses a wide-angle camera mounted on the AMR to detect the fixed overhead lights in the operating environment. After combining light position data with its odometry readings and map data, the AMR knows where it is in physical space on its map.

> **NOTE:** The navigation laser remains active for obstacle avoidance even when not being used to for navigation.

> **NOTE:** Acuity Localization is not yet available for the HD-1500 AMR.

Overview of Light Localization

Using overhead lights as landmarks, the AMR is able to reliably calculate its position within its environment.

Light Localization allows the AMR to localize in a dynamic environment where change is frequent. A warehouse, for example, includes many boxes, pallets, vehicles and people that move frequently. In this situation, the AMR can use the overhead lights to determine its position in the environment. The AMR uses both camera and odometry data to calculate its current position.

Key Features

Key features of light localization include:

- No expensive retrofitting required to use light localization.
- The lights do not require special maintenance.
- Because the lights are overhead, they are not blocked by ground level obstructions that could prevent laser sensors from working.
- The map does not need to be updated because the light positions typically do not change.
- Even if some lights have failed, the AMR still has a reliable solution and continues to operate.

> **NOTE:** Using light localization in spaces with lights at different heights, or places with lights visually behind others, can require different scanning techniques not covered in this guide. For details, see the Mobile Robots - LD Platform Peripherals Guide.

Creating the Light Map

Before creating a Light Localization map, be sure you are familiar with creating an initial map scan. Refer to Scanning the Operating Area on page 88 for more information.

> **NOTE:** When scanning the operating environment using Light Localization, be sure to drive under the lights or as close to the lights as possible. You need to do this in more than one direction, to make sure the camera sees the lights from all angles, collecting pan and tilt data along the way.

Compared with laser localization scan files, Light Localization scan files contain additional information about the AMR's operating environment and, therefore, require extra processing steps. The resulting map files also contain information about the location and height of overhead lights detected during the scanning process.

Light Localization is only available on AMRs equipped with the Acuity option, and you must enable the LightLocalization parameter in the MobilePlanner software to activate it. Refer to Configuring the AMR on page 140 for details.

Adjusting the Light Analysis Parameters

1. In MobilePlanner's **Config** window, select **Robot Configuration**.
2. Click on the **Light Analysis** section from the left window pane to view parameters associated with the light analysis in the right window pane.
3. Select **Show Expert Parameters** to access the main light analysis parameters.

The following table describes the most important parameters for light analysis:

Parameter Name	Description
3d:MinLightHeight	Minimum height (in mm) of the lights above the floor. This value is approximate and should be lower than the real value. It is used to establish a valid range and eliminate false positives (Double).
3d:MaxLightHeight	Maximum height (in mm) of the lights above the floor. This value is approximate and should be higher than the real value. It is used to establish a valid range and eliminate false positives (Double).
3d:MinLightLength	Minimum length (in mm) of the lights. This value is approximate and should be slightly lower than the real value. If -1, then this value is ignored (Double).
3d:MaxLightLength	Maximum length (in mm) of the lights. This value is approximate and should be slightly higher than the real value. If -1, then this value is ignored (Double).

Set the 3d:MinLightHeight and 3d:MaxLightHeight parameters to a range that encompasses the ceiling and light heights, but not too large.

If the lights are fluorescent tubes or the lights are partially hidden from the camera's view, you may also need to adjust the 3d:MinLightLength and 3d:MaxLightLength parameters.

After making these adjustments, reprocess the light scan in MobilePlanner. This does not require redoing the laser portion of the map creation, just reprocessing the light data.

Creating the Light Map

1. Turn all lights **ON** in the operating environment.
2. Open MobilePlanner and start the scan process. See Scanning the Operating Area on page 88 for details.
3. Drive the AMR around the environment, paying special attention to the overhead

lights. Drive under the overhead lights in several directions.

4. Stop the scan.
5. Turn the scan into a map (see Convert the Scan into a Map on page 89 for details).
6. Verify the scanned map shows overhead lights in the correct position and with the correct height.

   You can view the height data by moving the mouse over the light icon on the map. The overhead lights appear as blue squares, rectangles or points (depending on the type of light), as shown below.

Figure 12-2. MobilePlanner Light Map - Detail

7. If the light map looks correct, click **Finish** on the Scan Tools toolbar.
8. If the light map does not look correct, you will need to adjust the light analysis parameters and reprocess the scan. See Adjusting the Light Analysis Parameters on page 236 for details.

By default, the overhead lights are hidden from the map after turning the light scan into a light map. You can view the lights by selecting **Map > Map Data > Light Items** from the MobilePlanner main screen.

The light map contains data (such as height) about the lights seen by the camera, but does not contain images of the lights themselves.

Limitations of Light Localization

Light Localization is a reliable method of localization, even in a dynamic, frequently changing environment such as a warehouse. The number of lights visible lights affects the accuracy of the AMR's estimated position and, if the AMR travels for a long time in a sparsely lighted area, it will end up with a low localization score. However, in general, the AMR tends not to

get lost as often using light localization which is, therefore, more reliable in a dynamic environment.

Consider the following limitations:

- The lights must be on and visible for light localization to work.
- Skylights can be problematic.
- Currently, light localization works with LED lights, can lights (displayed as squares on the map) and fluorescent tube lights (displayed as rectangles).
- The more lights visible to the AMR, the better. Light localization does not work well with only one or two lights in an area.
- The lighting must be direct. The AMR must see a bulb or diffuser, not just a light reflection off of another surface.
- An environment that has lights of varying brightness might have problems.
- The tilt of the camera is assumed to be fixed. A change to this, such as when the AMR is on a tilted floor in the building, adversely affects the light localization.
- The accuracy of the localization depends on the accuracy of the light map. If the lights in the map are incorrect due to mapping errors, the localization will show a similar offset.
- The vertical distance from the camera to the lights should be at least a couple of meters for the light localization to work well. If the lights are too close to the camera, the error will be more than when the lights are farther away.

Light Localization Parameters

In MobilePlanner software, you can access the AMR's configuration parameters and adjust them as needed.

Accessing Light Localization Parameters

1. Select **Config > Robot Operation** from the main menu.
2. Click on the Light Localization settings section from the left pane to see parameters associated with the light localization in the right pane.

   NOTE: The parameters for light localization are described in the software, and are not repeated here.

Chapter 13: Glossary and Definitions

The following table lists acronyms and abbreviations, and defines key terms found in this user guide:

Term	Definition
802.11a, b, g, n, or ac	Standard for wireless local area networks (WLAN) in the 2.4GHZ and 5GHz frequency bands.
Acuity	AMR-mounted camera system for localizing the AMR using overhead lights versus its laser.
AES	Advanced encryption standard
AIFF	Audio interchange file format
AMR	Autonomous mobile robot
ARAM	Advanced robotics automation management
ARC4	Alleged Rivest Cipher 4 (RC4)
ARCL	Advanced Robotics Command Language. A simple, text-based, command-and-response operating language. Used with the Fleet Manager, ARCL can help manage a fleet of AMRs.
ARP	Address resolution protocol
A/V	Audio/Visual
Boolean	A type of data with two possible values, usually 'true,' or 'false.'
CA	Certificate Authority
CAPS	Cell Alignment Positioning System. A software option that uses a fixed-mount target in the workspace to provide more accurate AMR positioning when approaching a destination.
CCMP	Counter mode with Cipher block chaining message authentication code protocol.
Cost	An arbitrary numeric value assigned to map grids, lines, routes, etc. to determine the cumulative, net effect of an AMR's actions. Breaks maps into discrete squares called grids. Squares with walls, etc. have an infinite cost, and free squares, by default, have a value of 0.1. By design, AMRs always seek to execute their assigned tasks and goals at the lowest possible cost.
Cost-Based Path	A method of planning optimal, 'least expensive' paths from "point a" to

Planning	"point b" for the AMR to follow.
CPU	Central processing unit
DER	Distinguished encoding rules
DHCP	Dynamic host configuration protocol
DNS	Domain name service
Dock	Map location where the AMR "looks for" the charging station. Dock map icon should be 1 to 1.5 meters in front of the charging station, with the dock icon's black line pointing to the charging station.
DROPOFF	Job segment classification - tells the Fleet Manager that only a specific AMR can be assigned to the job segment.
EAP	Extensible authentication protocol
EAP-FAST	EAP flexible authentication via secure tunneling
EM2100	A network appliance that hosts the FLOW Core software. All fleet management capabilities of the FLOW Core software run on the EM2100 appliance.
Ethernet	A type of computer network used in local area networks. Typically uses a Category 5 (CAT5) or (CAT6) Ethernet cable; supports data speeds up to 100 MHz.
FIFO	First-In-First-Out - refers to the method used to prioritize jobs (higher number equals higher priority).
Fleet	A group of AMRs that operate in the same area, share the same map, and are controlled by one standalone Fleet Manager or a Paired Primary Fleet Manager, operating with a Paired Secondary Fleet Manager.
Fleet Manager	The set of capabilities within the FLOW Core software that executes all fleet management activities. These include the management of maps, AMR configuration, job queue management, and traffic coordination.
Forbidden (lines, areas)	Lines or areas onto or into which the AMR must not drive or enter on its own. In special cases, you can manually drive an AMR into a forbidden area.
Goal	Map-defined virtual destination(s) for AMRs (e.g., pickup or drop-off points).
GUI	Graphical User Interface
HAPS	High accuracy positioning system. Uses add-on sensors which detect and follow magnetic tape applied to the floor. Allows for very precise AMR positioning.
IP	Internet protocol. IP address is a computer's unique internet "address".

Job	An AMR activity, usually consisting of either one or two "job segments". (either PICKUP or DROPOFF). The Fleet Manager receives all job requests from ARCL.
LAN	Local Area Network
LEAP	Lightweight EAP
License Dongle	A USB device that contains the software (license key) required to run a licensed program.
Localization	The process by which AMRs determine their location in their operating environment. Laser localization uses the AMR's laser to scan its environment which it compares to its internal environment map. In light localization, the AMR uses overhead lights to determine its location.
Macro	A virtual "container" with a series or sequence of nested tasks and/or goals. Similar to routes. You can use macros as many times as needed to perform the same sequence of discrete functions in different tasks.
MARC	The Mobile Autonomous Robot Controller (MARC) firmware computes and reports the AMR's odometer (X. Y, and heading) readings and other low-level operating conditions to ARAM.
MobilePlanner	The primary software application for programming AMR actions.
MobilePlanner (Operator Mode)	A limited-functionality version of the MobilePlanner software. Has tools to monitor AMRs, AMR statistics, monitor and add jobs. Does not have tools to create or edit maps.
MSCHAPv2	Microsoft challenge handshake authentication protocol version 2
MP3	Moving picture experts group (MPEG) -2Audio Layer III
OS	Operating system (e.g., Mac OS, Windows OS, MARC, SetNetGo OS, etc.).
Path	The manner in which the AMRs drive from place to place in their environment.
PEAP	Protected extensible authentication protocol (EAP)
PEM	Privacy enhanced mail
Pendant	A handheld, external input device for manually driving AMRs. Connects to the AMR's pendant connection port.
PICKUP	A job segment classification - tells the Fleet Manager that any available, appropriate AMR can be assigned to the job segment.
PKCS	Public key cryptography standards
Platform	The base AMR (with or without payload) – includes chassis, drive train, suspension, wheels, battery, safety scanning laser, sonar, on-board core with gyroscope and software to navigate, interface connections for payload, and covers.

Pose	An AMR's position (location and heading).
PrecisionDrive	Using a target in the environment to aid in more accurate maneuvering. Targets can be placed on charging stations and other locations where you need accurate positioning. Associated with certain tasks.
Preferred (lines, directions)	Lines, directions you want the AMR to travel.
PSK	Pre-shared key
RC4	Rivest Cipher 4 (aka ARC4 – Alleged RC4)
Resisted (lines, areas)	Lines and/or areas the AMRs resist (attempt to avoid) crossing or entering, unless it must drive over/through resisted lines/areas to reach a goal.
Route	A "to do" list or series of tasks, goals, or macros for the AMR to follow.
Safety Commissioning	Allows testing and commissioning (verification of proper function) of an AMR's on-board safety systems. Uses a wizard to test E-Stop (tests brake activation) and Safety Laser (tests max speed limits and obstacle detection). Per EN-1525, Commissioning must be done by specially trained people.
Sector	Map areas that direct specific AMR actions, like ignoring sensor readings, driving on the right or left, limiting the number of AMRs in the area at one time, etc.
SetNetGo	Software OS, resides on AMRs and the Fleet Manager appliance. Used to configure AMRs' communication parameters. Accessed via the SetNetGo tab in MobilePlanner.
SNG	SetNetGo.
Spline	Mathematical function for smoothing arcs and curves.
SSID	Service Set IDentification – identifies a wireless LAN
Tasks	Instructions for the AMR to perform certain actions like reading inputs, setting outputs, movement commands, talking, waiting, etc. Tasks have adjustable parameters, which can be individually set for each copy of the task. There are two types of tasks; instant (allows concurrent processing of tasks while original task is executing), and non-instant (can interrupt a currently running task).
TCP	Transmission control protocol
TKIP	Temporal key integrity protocol
TLS	Transport layer security
Virtual Doors	Specially designated areas on the AMR's map which the AMR performs certain tasks (like 'move' or 'say' tasks, flashing lights, etc.) and/or allow the AMR to drive through special areas (e.g., plastic curtains).

WAVE	Waveform audio file format with an extension of .wav.
WEP	Wireless equivalent privacy
WPA	WiFi protected access

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