

## System User Manual

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Improper handling or use of RF equipment can result in damage to property or injury to personnel.

### **FCC Compliance**

This equipment has been tested and found to comply with the limits for Class B digital device, pursuant to Part 15 of the FCC Rules. Any change or modification to this product voids the user's authority to operate per FCC Part 15 Subpart A. Section 15.21 regulations.

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## Introduction

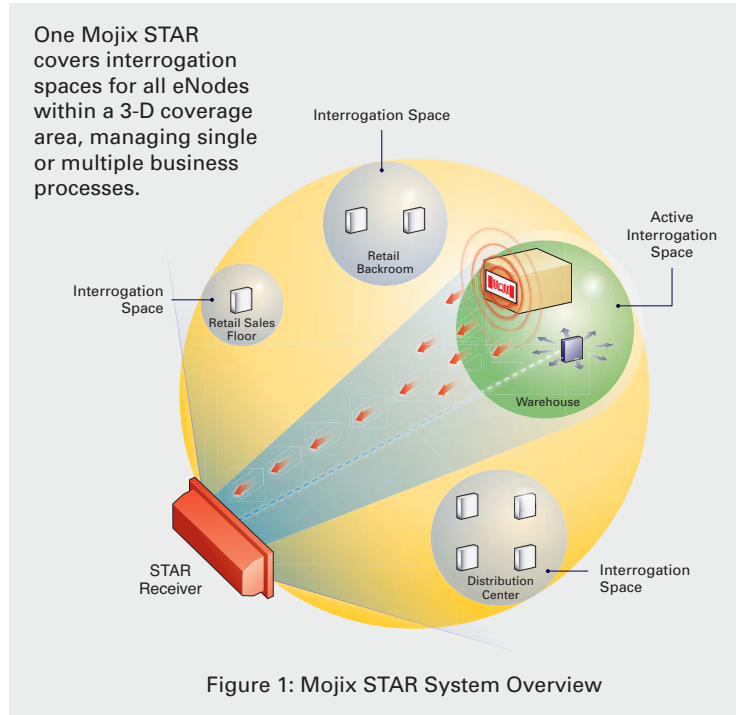
In 2004, a team of advanced signal processing and deep space communications scientists and engineers led by Dr. Ramin Sadr formed Mojix® Inc with the vision of applying the technical breakthroughs in deep space communications to the commercial wireless infrastructure industry. The result is a commercial passive RFID reader system with capabilities orders of magnitude beyond previous RFID reader offerings, and a new generation of RFID system technology that eliminates the economic and technical barriers to large-scale, high-volume RFID deployment to deliver on the full promise of RFID.

The Mojix family of products can be configured to transmit and receive across the UHF band and can operate in both the near and far fields which make it possible for a single system to read tags at the pallet, carton or item level. The UHF or ISM band as it is commonly referred to, is partially allocated for public use and is heavily utilized by many different devices and applications which make operating in this spectrum especially challenging.

The STAR Receiver is powered directly by its power supply and in turn powers each Mojix eNode™. Each eNode is connected to the STAR by coaxial cable and receives supply voltage, command and control signals, and baseband RF over this medium. The STAR Receiver is typically connected to the enterprise via the LAN or an optional WLAN.

An eNode, as depicted in Figure 1, creates and is associated with a single interrogation space, which is individually addressed and controlled by the STAR Receiver. eNodes are physically positioned according to business process needs to provide optimal performance in exciting Gen2 RFID tags. The STAR Receiver is ordinarily positioned with a vantage point to all eNodes in the system — this can be line of sight (LOS) or non-line of sight (NLOS) but always within the rated Rx range.

This document is intended to assist developers integrate Mojix systems. Please also see Mojix STAR 1000 User Guide for assistance deploying Mojix systems.



## Mojix STAR System Specifications

<b>MOJIX STAR Receiver Array Technical Specifications</b>	
Operating Frequency	UHF Band, 902-928 MHz, FHSS
Tag Protocols	EPC Gen2
Dimensions STAR reader	AIA (30 3/8)in L x (10 7/8)in Wx (4 3/4) in H 77 cm L x 27.6 cm W x 12 cm H
Weight STAR reader	12.6 lb 5.7 Kg
Power Supply	220/110 VAC
Power consumption	200 Watts operational, 100 Watts in standby
Dimension Power supply	Power supply 11in L x 18in W x (2 5/8) in H 28 cm L x 45.7 cm W x 6.6 cm H
Weight Power supply	11.4 lb 5.2 Kg
External RF Connector	N type Female
External I/O	DB-15 (8 Dry relay contacts 4in / 4 out)
Temperature	Operating: -25° to +50° C (+32° to +122° F) Storage: -40° to +70° C (-4° to +158° F)
Humidity	5-95% non-condensing
Indicators	LED's for power, standby and transmit
Compliance	Regulatory: FCC Part15 EPC Class 1 Gen2
Firmware Upgrade	Remotely upgradeable
Application User Interface	HTTP
IP Addressing – STAR reader	Static
Network Interface	Ethernet, Base-T, RJ-45 Interface
<b>Mojix STAR Master Controller Technical Specifications</b>	
Network Interface	Ethernet 10/100/1000 Base-T
Operating System	Linux
Logical interface	TCP/IP Interface HTTP Application Programming Interface
IP Addressing	Static and Dynamic

<b>Mojix eNode Technical Specification</b>	
Operating Frequency	UHF Band, 902-928 MHz, FHSS
Dimensions eNode	12in L x 12in W x 2.5in H ; 30.5 cm L x 30.5 cm Wx 6.35 cm H
Weight eNode	4.8 lb 2.1 Kg
Humidity	5-95% non-condensing
Compliance	Regulatory: FCC Part15 EPC Class 1 Gen 2
Indicators	LED's for Power, Calibration and Transmit
External I/O	TWO TNC connectors for RF & one DB-9 for external sensors
Transmit power	Per FCC Part 15 Transmit power: 1 Watt (30 dBm) Maximum Antenna: 6 dBi integrated patch antenna
Power supply	Powered through coaxial cable (24 volts DC)
eNode Addressing	Static at Factory
Warranty	1 year from date of shipment
Extended Warranty	Available

<b>Mojix eNode Multiplexer Specifications</b>	
Parameter	Specification
Signals Present at Input/Output	DC, RF and Control
RF Frequency Range	902-928 MHz
RF Signal Level (Max.)	+20 dBm (output)
Input Connector	TNC
Output Connector	4 TNC's
Input Impedance	50 Ohm
DC Input	24 V
DC Input Connector	Male Power Jack



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# 1. System Components

A Mojix STAR system is a single network element at the enterprise edge. Based on Mojix’s innovative distributed architecture, a single system consists of one or more STAR receivers managing up to 512 low-cost Mojix eNode transmitters. Mojix eNodes provide energy to all passive RFID tags within their specified interrogation spaces, while the centralized, high-sensitivity Mojix STAR receiver reads the resulting tag signals from across the system’s potentially vast coverage area - up to 250,000 sq. feet.

## 1.1. Mojix eNodes: Distributed Transmitters

Each Mojix eNode excites all passive RFID tags within its designated interrogation space and can be fixed, wireless or handheld, and can be deployed as needed to shape discrete, overlapping or contiguous interrogation spaces, as well as to create virtual fences for securing tagged items.

Mojix eNodes are reliable, autonomously operated RF repeaters designed to excite all EPC UHF Gen2 RFID tags within their designated interrogation spaces with an excite range – depending on the tag being used - of over 30 feet and a coverage area of more than 2,500 square feet. Up to 512 eNodes are controlled by a single Mojix STAR Receiver, able to manage a mixed population of single and multi-port eNodes, as well as sensors in support of numerous concurrent business processes.

## 1.2. STAR Receiver: Centralized Read and Control point

The STAR Receiver functions as a single point of data collection, provisioning, command and control, and integration with enterprise systems. With the ability to detect extremely faint signals and free from conventional RFID’s line-of-sight restrictions, the STAR receiver works in concert with its satellite eNodes to support one or many business processes across the entire coverage. The STAR-1000 Receiver contains a 1 x 4 array assembly, and digital and RF processing assemblies. The STAR Receiver utilizes classical, fully active, phased array antennas for enabling the visibility into the space dimension. The smart array approach adopted by Mojix is based fully on digital processing techniques, thereby providing very high resolution for estimation of direction of arrival of the signal of interest (SOI), enabling the system to provide accurate location information on the tag position in the three dimensional Euclidean space. The STAR Receiver hardware overview is shown in the following figure:

- a) RF / IF sub system
- b) Digital Subsystem – including ADC, DAC
- c) Digital Signal Processing subsystem
- d) Ethernet interface

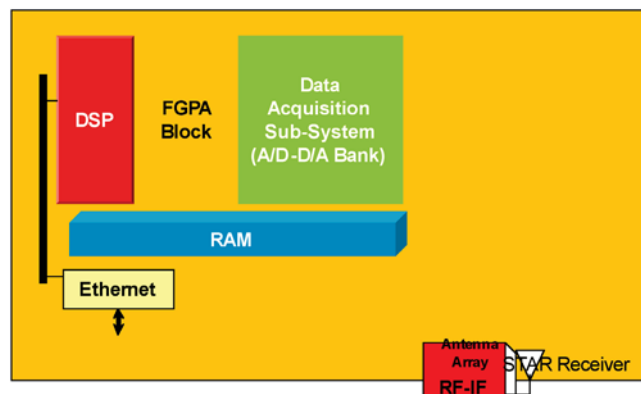


Figure 2: STAR Receiver Hardware overview

### 1.3. STAR interrogation spaces

Fixed or mobile, STAR interrogation spaces are business process-specific and can be optimized for tag density or coverage. Each individually controlled interrogation space is created by the deployment of single or multiple eNodes and is dynamically sized by the STAR system, which controls each node's power output.

### 1.4. Master Controller

The STAR-1000 STAR Receiver signal processing platform is linked to an edge appliance called a Master Controller (MCON), and communicates via a standard Ethernet 10BaseT (RJ45)-connector. The MCON can drive an arbitrary number of STAR-1000 systems and includes interfaces to the enterprise middleware. In a larger enterprise deployment, multiple STAR domains would exist in various locations and would require one or more controllers, which are generic, Linux based edge appliances.

### 1.5. System Topology

Figure 3 illustrates the components of the STAR system topology. These items are as follows:

- a) STAR Receiver
- b) STAR Power Supply
- c) eNodes – single or 4-port
- d) Master Controller
- e) LAN

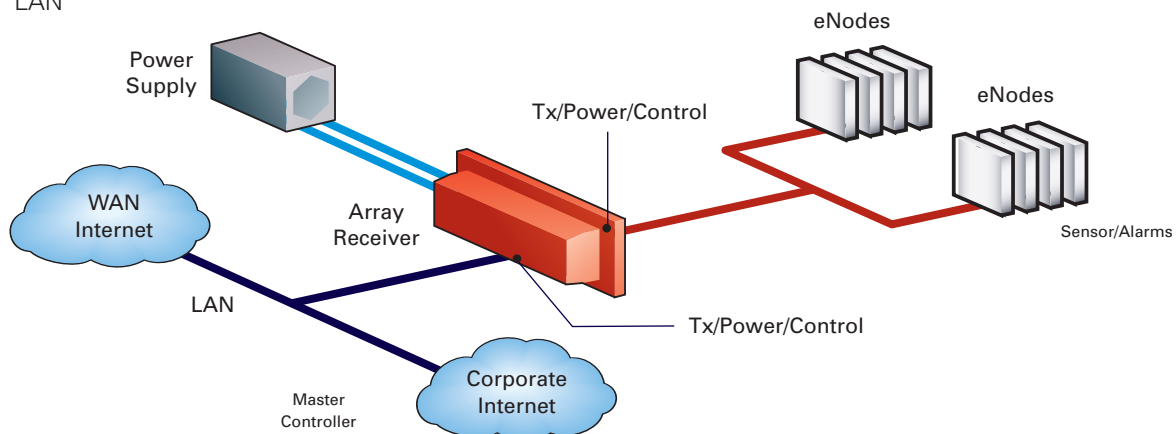


Figure 3: STAR System Topology

Figure 4 illustrates a total system topology with cabling, showing the following elements:

1. STAR Receiver
2. eNodes
3. eNodes with DC-Block & 50 Ohm Termination
4. eMux
5. Sensor
6. MCON

From the figure, the STAR RF output is cabled to the four (4) eNodes in a daisy chain configuration, followed by an eMux. In this example only two out of the four available eMux outputs are use to further connect to two strings of daisy chained eNodes. Lastly, there are the two eNodes at the end of each chain with a 50 Ohm termination.

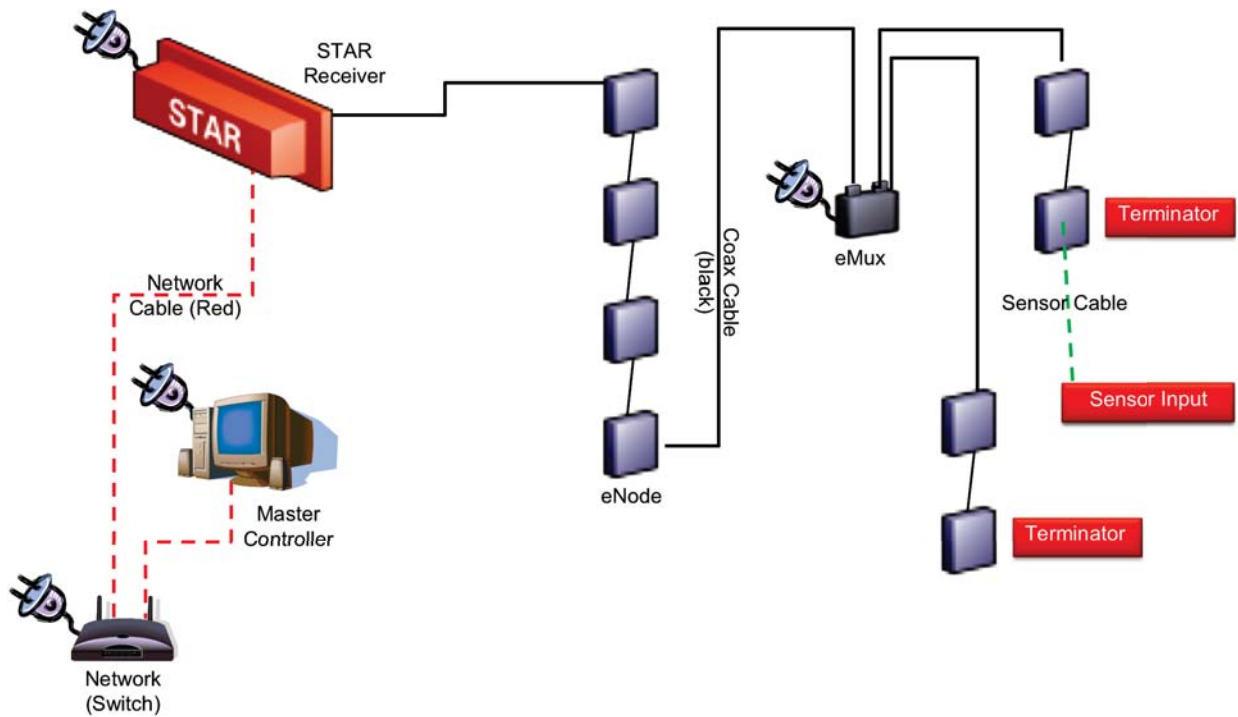


Figure 4: Cabling Overview – STAR, eNode and eMux

In what follows the Mojix STAR system will be described, including installation, and operational guidelines. Also described will include the user interfaces, as well as hardware configuration procedures.

The required equipment for installation of the STAR System includes:

- 1 Master Controller (MCON)
- 2 STAR Receiver
- 3 STAR Power Supply
- 4 Power supply cable - Length: 20 ft Max.
- 5 eNodes
- 6 eMux (optional)
- 7 eMux Power Supply (optional)
- 8 Coaxial Cable – Connecting the STAR to an eNode or eMux
- 9 Coaxial Cables – Connecting eNodes to eNodes or eMuxes
- 10 STAR Receiver Mounting Hardware (post mount kit)
- 11 eNode Mounting Hardware
- 12 eMux Mounting Hardware (optional)
- 13 Ethernet Cable



## 2. STAR Receiver Installation

### 2.1. STAR Receiver Positioning

Figure 5 illustrates the STAR Receiver and the respective view angle. The following list indicates the key environmental considerations for installing the unit.

- a) Building Height
- b) Obstructions such as racking, shelves, walls, and staged product
- c) AC power drops
- d) Network drops
- e) Targeted interrogation spaces
- f) Orientation and pointing of the unit with respect to the interrogation spaces

The view angle of the STAR receive array is:

- 120 degrees (+/- 60 deg) in the X direction (horizontal)
- 90 degrees (+/- 45 deg) in the Y direction (vertical)

The read range — i.e. the furthest point that the interrogation space can from the reader is approximately 600 feet.

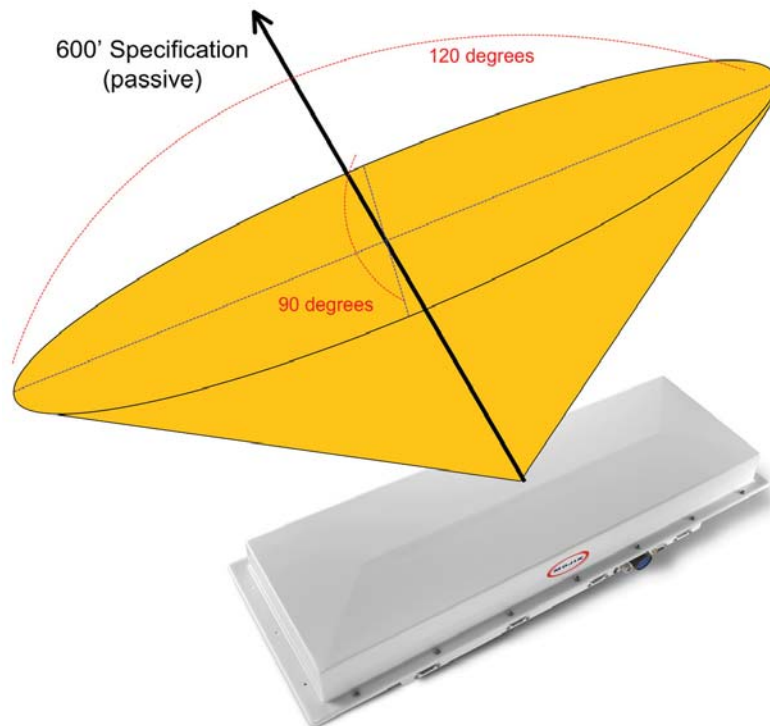


Figure 5: STAR Positioning Guidelines

## 2.2. STAR Receiver Installation

The STAR is mechanically designed for post and wall mounting. Figure 6, illustrates the assembly drawing for installing the unit on a post (i.e. installation kit is provided)

From the figure the mounting bracket is installed directly on the STAR Receiver back plate. Figure 6, Figure 7, Figure 8, and Figure 9 show the required hardware, installation steps and final assembled and installed unit. Table 2 and Table 3 details the required hardware, which is included with shipping.

### Installation instructions:

1. Product installation shall be conducted by a qualified installer. The appropriate local engineer or architect shall be consulted to ensure the wall and/or pole mount is capable of safely supporting up to 4 times the weight of the product.
2. Should the customer select to mount the STAR unit to a flat surface (e.g. wall), holes are provided in the main mounting bracket to accommodate a family of hardware (customer supplied).
3. When mounting STAR unit to a flat surface, a minimum of 4 fasteners are recommended, though the exact type is a function of the wall material and construction. Best industry practice is recommended.
  - a. For example: toggle bolts or Molly bolts would be the first choice on hollow walls. Lead lag shields would be recommended on solid (cast) concrete or brick. Nails are not recommended, but could be used only if the wood material of the wall was at least 1.5" thick.
4. The recommended mounting procedure would be as provided before for mounting to a mast, pole, pipe or post. When securing the unit to a flat surface, it is recommended that the two end brackets be mounted to the STAR Receiver.
5. The main bracket is mounted and (leveled if desired) to the wall using one of the techniques described above. The STAR Receiver is then secured to the main bracket using the 1/4-20 hex bolts, washers and nuts as illustrated in the same drawing as for mast mounting, though it is recommended that the pivot bolts be secured first, and then the arc positioning hardware secured.

Tightening hardware, be it machine screws in Molly and Toggle bolts, Drywall Screws, 1/4-20 screws or the U-Bolts is to be done with the appropriate tool: screwdriver or wrench. The hardware is to be "tight" to best construction standards. For those that may have a torque wrench, the following values are recommended:

Screws: nominal 3 ft-lb +/- .5

1/4-20 hardware: 6 ft-lb +/- .5

U-Bolts: 20 ft-lb +/- 1

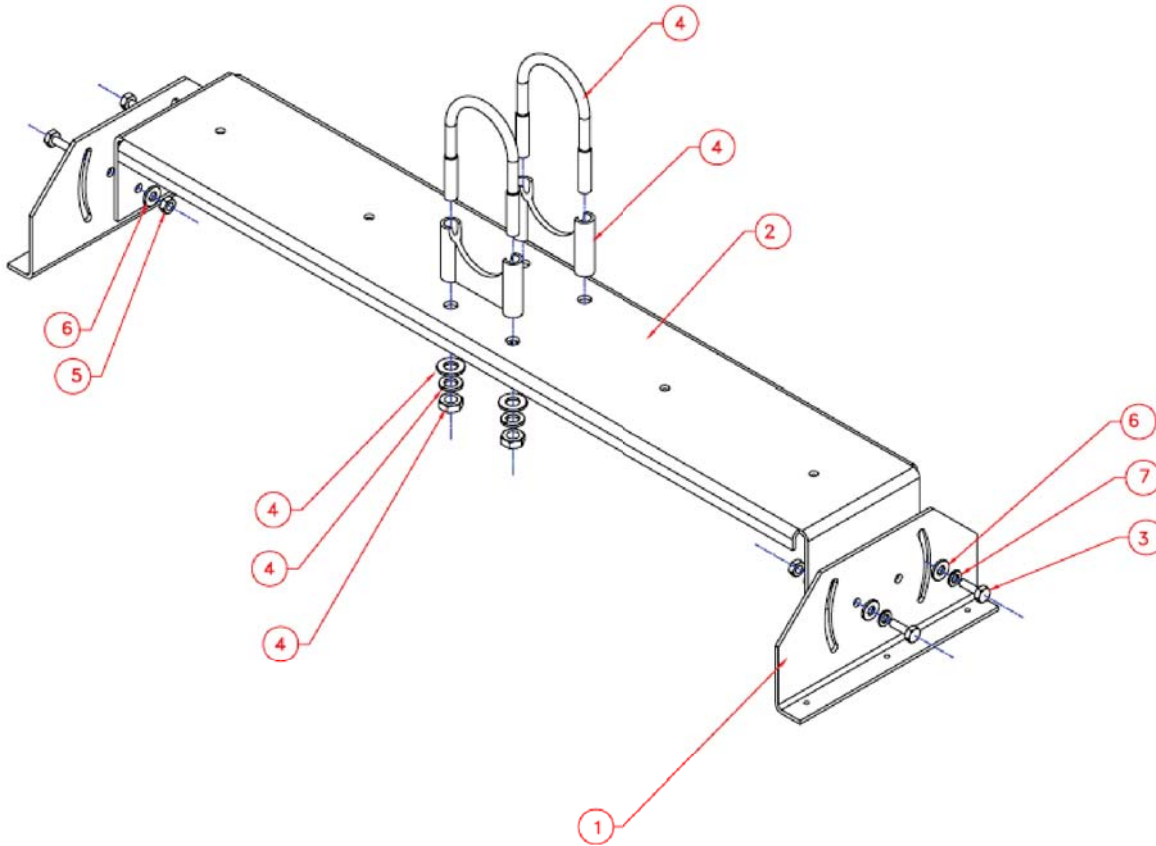


Figure 6: STAR Receiver Post Mount Installation kit

4		303-0004-000	Washer, Split Lock, .25"	MCM 91102A750	7
8		303-0003-000	Washer, Flat, .25"	MCM 90108A413	6
4		302-0015-000	Hex Nut, .25-20	MCM 91841A029	5
2		302-0012-000	U-Bolt Assembly, 2"	MCM 3042T31	4
4		301-0015-000	Screw, Hex Head Cap, .25-20X.75	MCM 92240A540	3
1		309-0002-000	Mounting Support		2
2		309-0001-000	Mounting Bracket		1
	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPECIFICATION	ITEM NO.
QTY REQD					
PARTS LIST					

Table 1: Parts List for STAR Receiver Pole-Mount Installation Kit

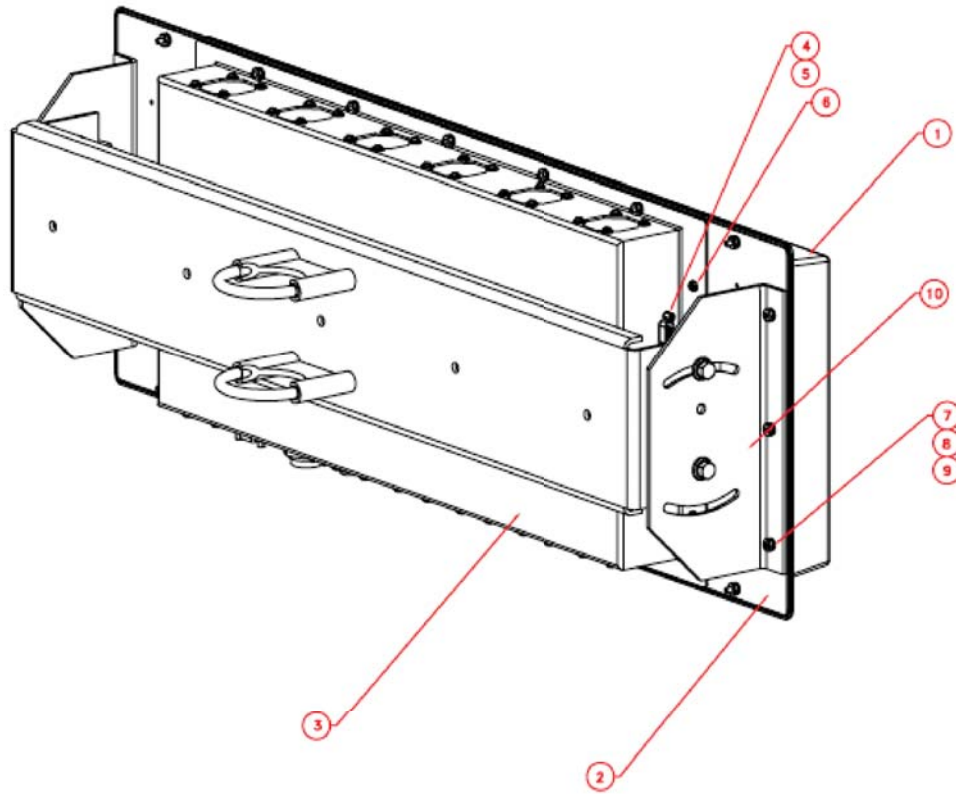


Figure 7: Pole Mount Installation, showing STAR Receiver and bracket

4		303-0004-000	Washer, Split Lock, .25"	MCM 91102A750	15
4		303-0003-000	Washer, Flat, .25"	MCM 90108A413	14
4		302-0015-000	Hex Nut, .25-20	MCM 91841A029	13
1		TBD	Vesa Mount Assembly		12
2		TBD	Production Handle		11
1		800-0102-000	Bracket Assembly		10
20		800-0001-000	Screw, Phillips Pan Head, 6-32X.625		9
40		300-0005-000	Flat Washer, #6		8
20		300-0003-000	Lock Washer, #6		7
6		300-0004-000	Screw, Phillips Pan Head, 6-32X0.25		6
4		301-0002-000	Female Screw Locks, 4-40X.312	AMP 205818-2	5
4		303-0002-000	Lock Washer, #4		4
1		302-0009-000	Rear Cover Assembly		3
1		800-0105-000	AIA / AFA Board Subassembly		2
1		301-0020-000	Radome		1
	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPECIFICATION	ITEM NO.
QTY REQD					
PARTS LIST					

Table 2: STAR Receiver Pole Mount and Reader Parts List

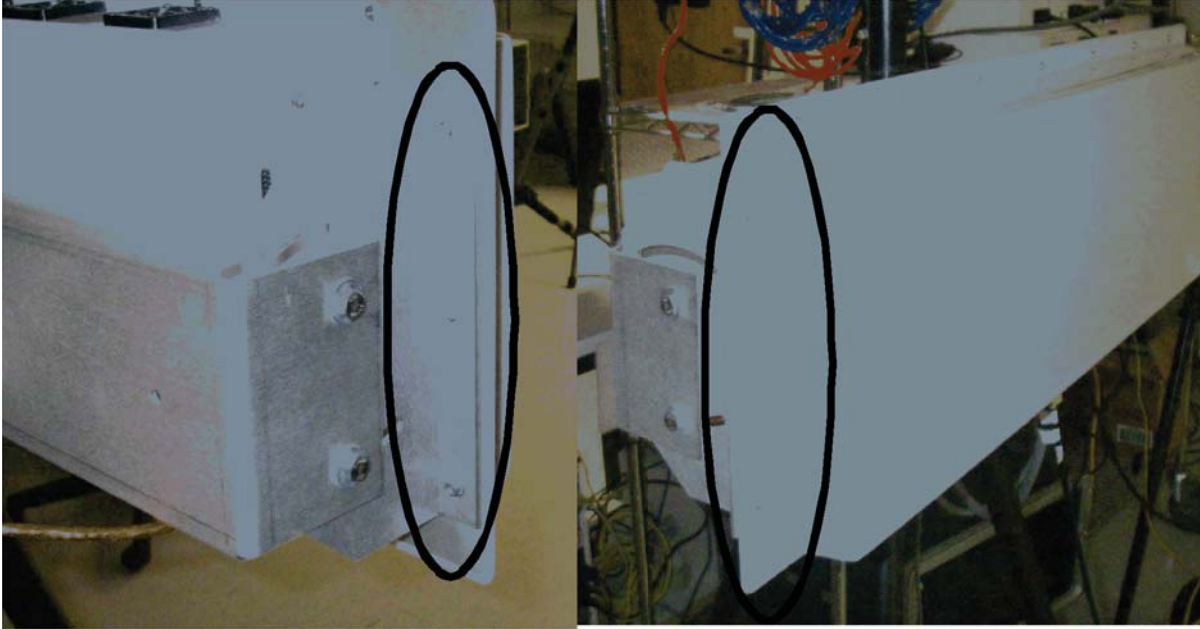


Figure 8: STAR Receiver Mount



Figure 9: STAR Receiver Pole Mount

### 2.2.1. STAR power supply installation

Recommended installation of the power supply is “platform mounting”, where the unit is secured flat on a platform, co-located within “20 feet” from the STAR Receiver. Power supply installation guide is as follows.

### 2.2.1.1. Wall Mount Power Supply

Figure 10 shows the power supply mechanical drawing and key holes to be used when mounting it on the wall. Note:

- As shown in Figure 11, when mounted on the wall –unit shall be installed within “3 feet” from the ground, and within 20 feet from the STAR Receiver
- The keyholes are designed for either
  - #6 Drywall (bugle head) or #6 wood screws if the unit is being fastened to a wooden surface.
  - For a solid wood mount, box nails can be used, providing the head diameter is more than .28” and less than .30” in diameter and the shank of the nail is at least 2” long.
  - If the unit is being fastened to a metal surface that is at least .1875” thick, 6-32 pan head machine screws may be used.
  - If the unit is being fastened to drywall/plaster, 1/8 Molly or Toggle bolts must be used.

The recommended mounting procedure is:

1. To use drywall mounts (“Molly Bolts” are preferred) for that purpose (these, or toggle bolts, offer a pull-down force more than 4X the industry-standard, and are highly recommended in areas prone to seismic activity).
2. Bugle-head #6 Drywall screws (coarse thread) are acceptable, if all 3 tie down points are used, offering an industry-standard of a pull-down strength of at least 4X the weight of the unit.
3. If the walls are of at least 1/2” wood (plywood, for example), nails can be used.

In addition, the cable must be properly dressed and supported. The cables, both AC and DC, are to drop down from the power supply with a drip or service loop. They are to be supported at least once within 18” of the unit, and according to best industry practice (and NEC) at intervals of no more than 36”. Cables can be run in conduit, providing (a) the conduit is not hanging on the cables, (b) the service loop exists, and (c) there is at least one support/tie-down on the cables between conduit and power supply.

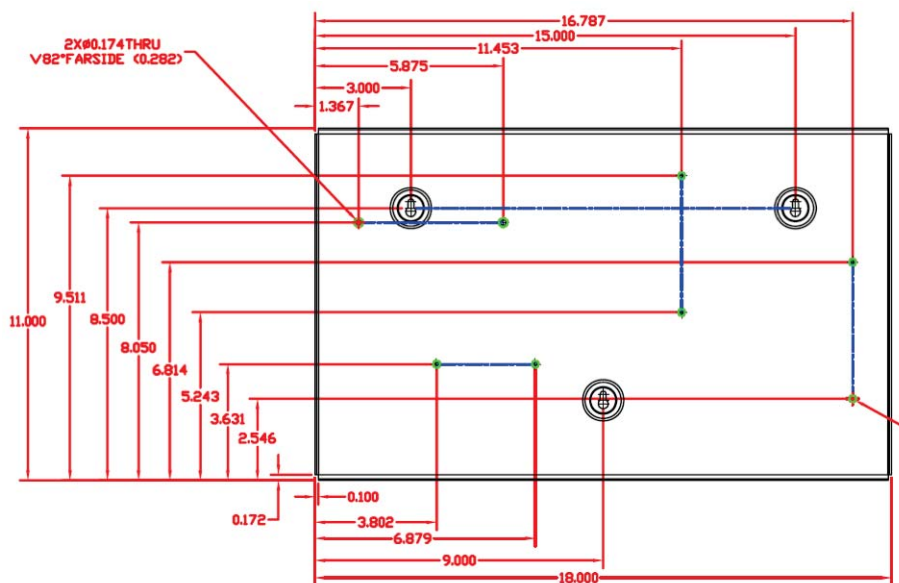


Figure 10: Power Supply — showing key holes for wall mounting

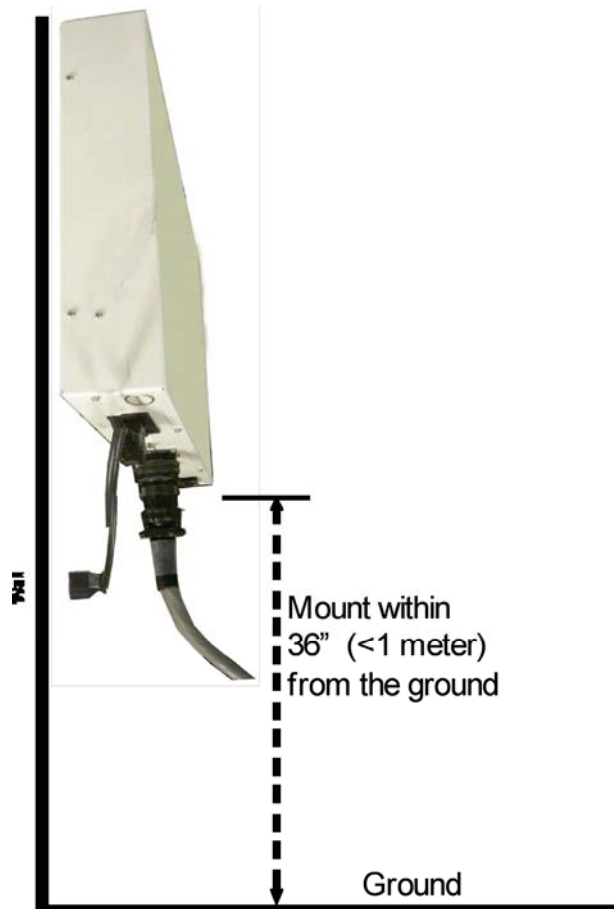


Figure 11: Power Supply – showing wall mount

### 2.2.1.2. Platform Mount

When mounting the power supply on a platform, it shall be strapped and secured, as shown in Figure 12. Additionally, ensure that the connectors are facing out for easy access.

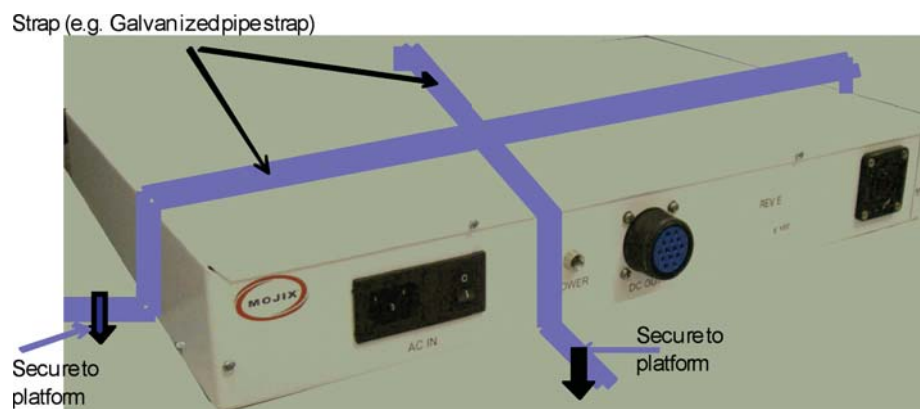


Figure 12: Power supply platform mount



### 2.3. STAR Receiver cabling

The cabling specification for the STAR unit is shown in Figure 13, and details are described in Table 3 and Table 4.

Receiver Specifications	Comment
Power supply connector	Input from STAR power supply
Ethernet connector	RJ-45
TX RF coaxial connector – to eNode or eMux	N-Type connector — see Section 2.2 for details

Table 3: STAR Receiver cabling specifications

Power Supply Specifications	Comment
Power supply connector	Circular DIN Connector
AC connector	100-240V AC

Table 4: Star power supply cabling specifications

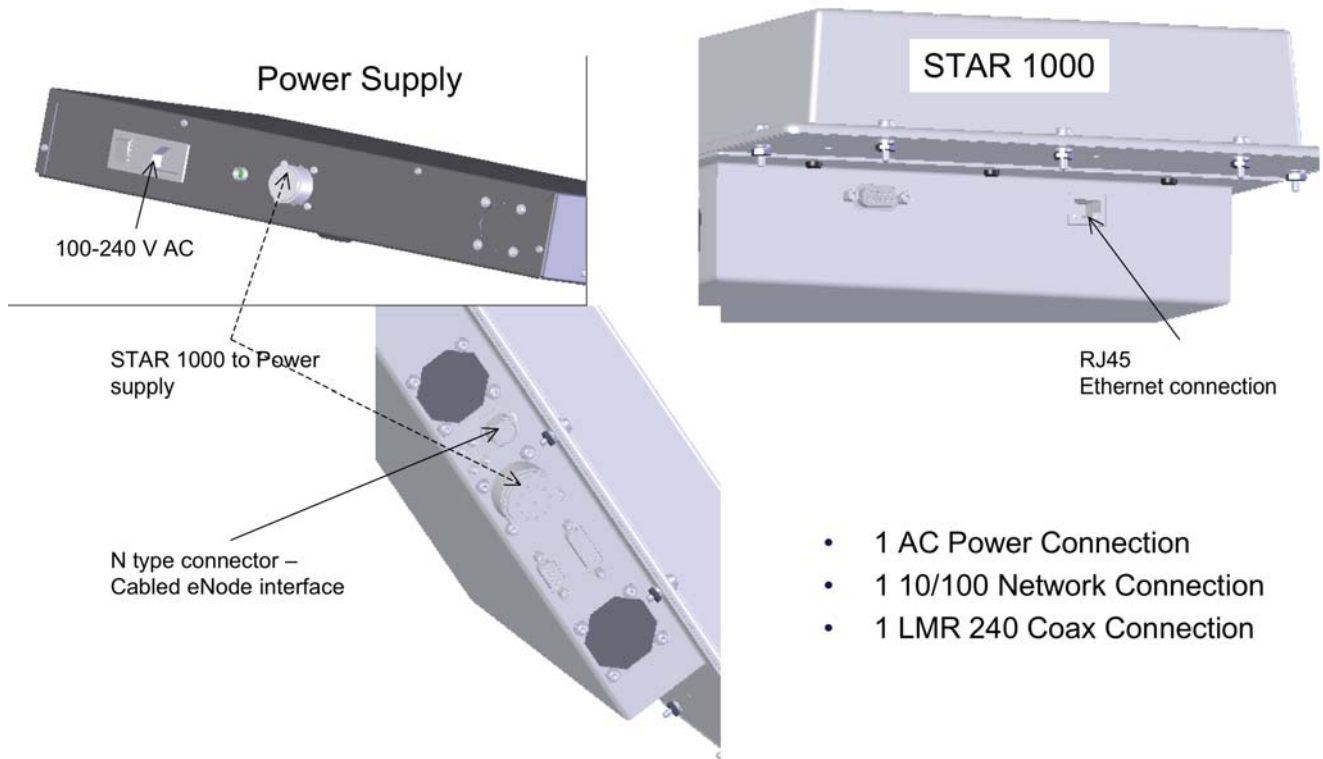


Figure 13: STAR Receiver and power supply – showing connections



## 3. eNode Installation

### 3.1. eNode Positioning

Figure 14 illustrates the eNode, and its corresponding view angle. Following are the key considerations to review when installing eNodes:

- Distance between the eNode and tags in the interrogation space
- Size of the interrogation space
- Obstructions – between eNode and interrogation space
- Orientation and pointing of the eNode with respect to the interrogation space

The view angle of the eNode is in compliance with FCC & ETSI specification. The excitation range of the tags is highly dependent on tag manufacturer, tag placement, tag orientation, and the content of the tagged material. Typical tags receive sufficient power to turn on at greater than 30 feet (9.1 meters) of the eNode in free space, meaning that the tag is held in mid-air and not attached to any material.

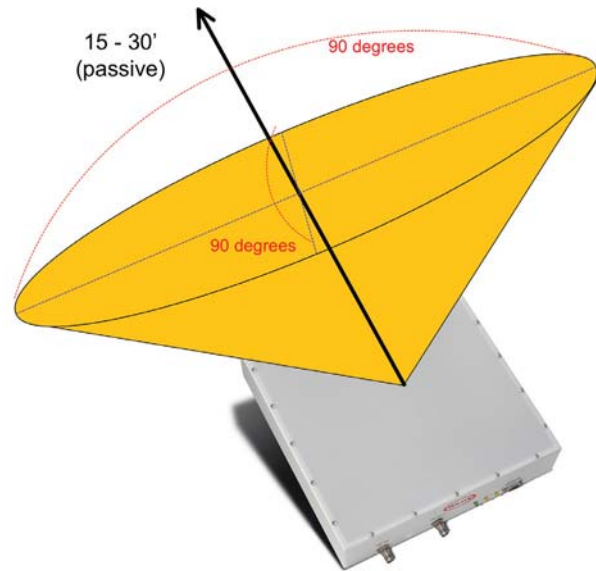


Figure 14: eNode Positioning Guidelines

### 3.2. eNode Cabling

Figure 15 illustrates the Single-Port eNode, showing the RF and I/O connectors. Connector specification is provided in the following table.

eNode Specification	Comment
RF input connector	TNC connector
RF output connector	TNC connector
External I/O	HD-15 connector 4 in /4 out
NOTE: The last eNode in the chain must have a DC Block with 50 Ohm termination on the RF output port.	

Table 5: eNode Cabling specifications

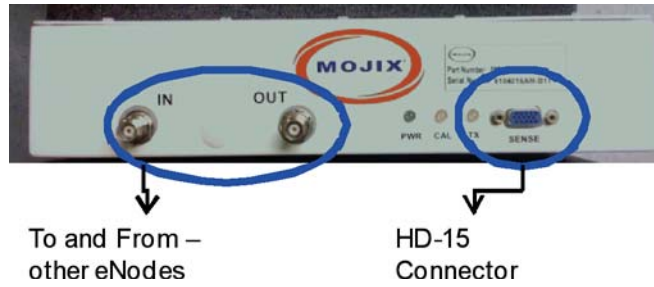


Figure 15: Single-Port eNode

### 3.3. 4-port eNode cabling

Figure 16 depicts the 4-port eNode and its connectors, which are specified in the following table.

4-port eNode Specification	Comment
RF input connector	SMA connector
RF output connector	SMA connector
Antenna – 1 output connector	R-SMA connector
Antenna – 2 output connector	R-SMA connector
Antenna – 3 output connector	R-SMA connector
Antenna – 4 output connector	R-SMA connector
External I/O connector	HD-26

Table 6: 4-Port eNode cabling requirements

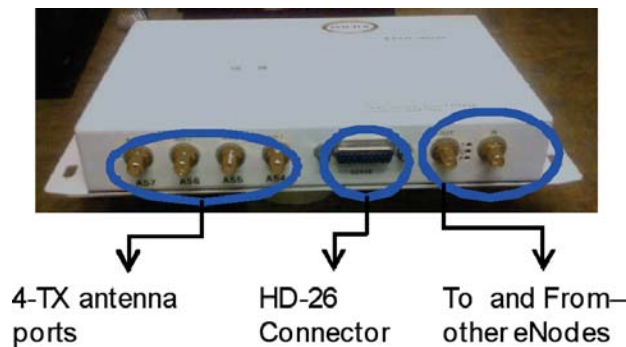


Figure 16: 4-port eNode, showing the cabling requirements



eMux Specification	Comment
RF input connector	TNC connector
RF output connector – 1	TNC connector
RF output connector – 2	TNC connector
RF output connector – 3	TNC connector
RF output connector – 4	TNC connector
Calibration Pin	See eMux Calibration (Section 7)
Power supply connector	External power supply

Table 7: eMux Cabling Specification

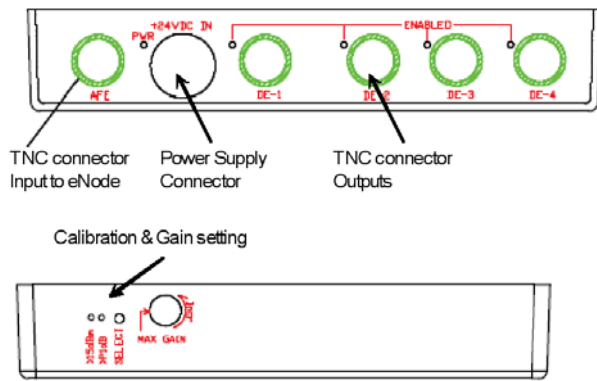


Figure 18: eMux Physical Diagram

Mojix eNode Multiplexer Specifications	
Parameter	Specification
Signals Present at Input/Output	DC, RF and Control
RF Frequency Range	902-928 MHz
RF Signal Level (Max.)	+20 dBm (output)
Input Connector	TNC
Output Connector	4 TNC's
Input Impedance	50 Ohm
DC Input	24 V
DC Input Connector	Male Power Jack

Table 8: eMux Operating Specification

Additional information about eMux calibration can be found in Section 6.3: eMux Calibration. However this step should be done after initially setting up all system components.

## 5. Master Controller Installation

### 5.1. Master Controller (MCON) Hardware requirements

MCON requirements (supplied by Mojix) are:

- Linux Operating System
- Memory : 4 Gigabytes
- Hard disk : 150 Gigabytes
- Processor: 3.0 GHz Intel Xeon Dual-Core

Please note that this hardware is currently only available through Mojix as a turnkey appliance.

### 5.2. MCON Deployment overview

The MCON is connected to the STAR via its Ethernet interface. Figure 18 illustrates a typical deployment scenario. The figure illustrates that a single MCON can interface with and manages one or more STAR Receivers.

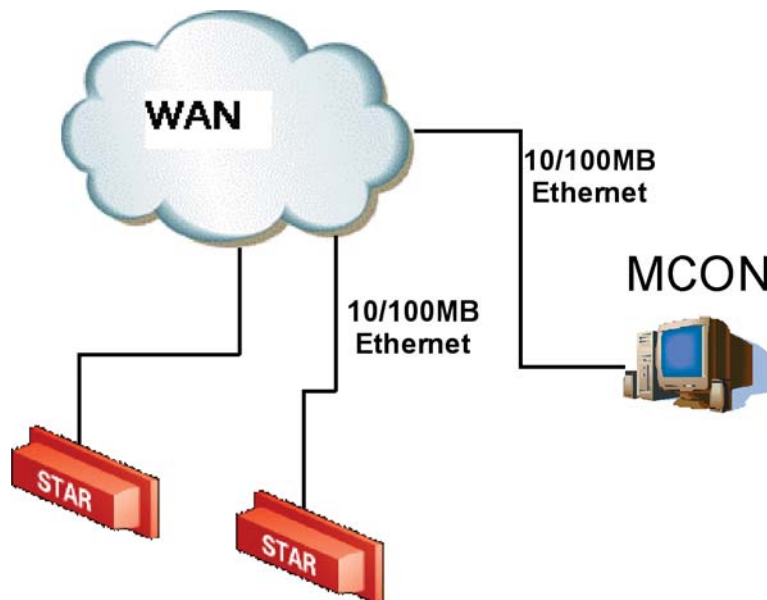


Figure 19: STAR System Network Configuration

## 6. System Configuration

The MCON has the flexibility to configure and manage the STAR unit through 2 very specific interfaces. The utilities for these interfaces are primarily the Web Graphical User Interface and secondly an engineering Client called Mojo. Additionally, the MCON publishes tag data out through a variety of standardized interfaces for 3rd party integration. These interfaces include Microsoft Biztalk Provider, Web Service Definition Language (WSDL), IBM Websphere, and ALE.

### 6.1. Network Setup

#### 6.1.1. Connecting to the MCON

The MCON by default uses DHCP for IP assignment. If a DHCP server is not found within 5 minutes of the power up, the MCON uses the following default IP address.

- Default Static IP: 169.254.1.1
- Default Netmask: 255.255.0.0
- Default Gateway: 169.254.1.1
- Recommended to connect MCON using loopback/crossover cable directly to a windows PC – for first time setup. This will ensure that MCON defaults to the IP address above after 5 minutes. If the MCON is instead connected to a LAN with DHCP server, it may acquire a different IP address, making it difficult to locate on the network for first time setup.

The STAR Receiver strictly uses a static IP address with the following default settings.

- Default Static IP: 169.254.1.2
- Default Netmask: 255.255.0.0
- Default Gateway: 169.254.1.1

#### 6.1.2. Changing Network Settings

**Changing the IP of the MCON:** The simplest way to change network settings on the of the MCON is to simply navigate a web client to <http://<IP-address-of-mcon>/network> and changing settings from this screen. This web interface is the preferred way to configure network and operational system parameters. The following figure shows the network configuration screen:

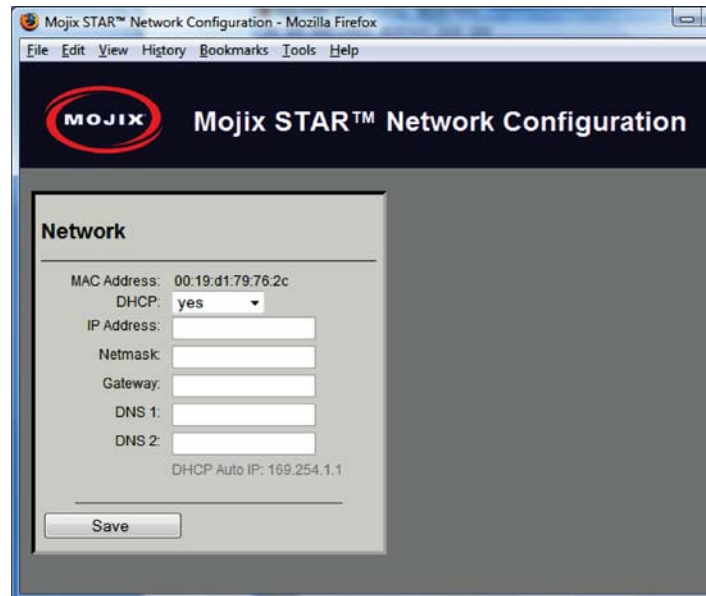


Figure 20: Network Configuration

**Changing the IP of the STAR:** To change the STAR IP requires a telnet session. The following examples assume the availability of a telnet Client, such as PuTTY (<http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html>). The same PuTTY Client can be used to establish a Telnet connection. Likewise, a telnet session from the MCON command prompt or a Windows XP command prompt may be used as well.

First establish a Telnet session with the STAR as follows.

```
$ telnet 169.254.1.2
```

Once connected, there will be no prompt presented and the characters will not be echoed either. To change the network settings the user must be connected to the STAR from the same LAN segment and not over a WAN connection. Enter the following commands in this order.

1. gateway <Gateway ip address (Ex. 192.168.1.1)>
2. netmask <Netmask (Ex. 255.255.255.0)>
3. ip <ip address (Ex. 192.168.1.2)>

All setting changes are immediate. Once the IP is changed, the user must re-establish a telnet session to the new address. The last step in this process is to save the settings in flash memory. To do this, establish a new telnet session with the STAR at its new address. Using the example IP from above of 192.168.1.2, enter the following commands.

```
$ telnet 192.168.1.2
sys commit
```

This will commit the new settings to flash memory, making the new network settings permanent. The system will return a message indicating that the Kernel commit to flash has been verified, as indicated in the Figure that follows.

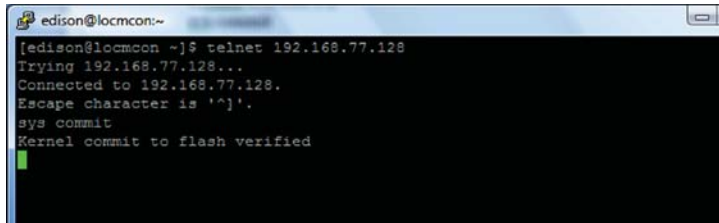


Figure 21: Committing Network Settings

To exit from a telnet session, the user must enter 'ctrl-]' and then type "quit" (ctrl = control key).

## 6.2. Graphical User Interface

The Web Graphical User Interface (Web GUI) provides the user a simplified HTTP based interface to configure and run the system. Currently, the only supported browsers are Mozilla Firefox and Microsoft Internet Explorer. To launch the Web GUI, enter the MCON IP address in the URL field of the browser. Not all screens are described in this version of documentation. The following screen is the landing page for the system.



Figure 22: Main Web Control Landing Page

From this interface, the user has access to various utilities for configuration and execution of the system. When presented with a Username and password, enter the default credentials as follows:

Username: edison

Password: m0j1xInc



This interface is divided into 2 sections: Master Controller Options and Utilities. The Master Controller Options area allows the user to configure and run the system. The Utilities area allows the user to run diagnostic utilities.

### 6.2.1. Hardware Button

The Hardware Button launches the configuration interface for the STAR.

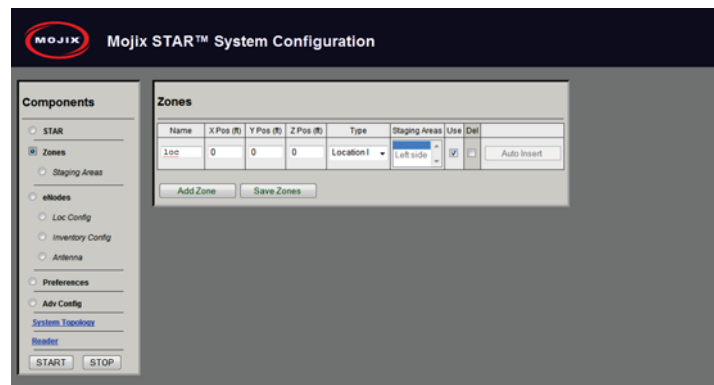


Figure 23: STAR Receiver Setup and Configuration

This interface shows a configuration menu frame on the left and configuration input fields on the right. Beginning with the STAR configuration, the user must first enter the IP address of the STAR under the “Name” input field.

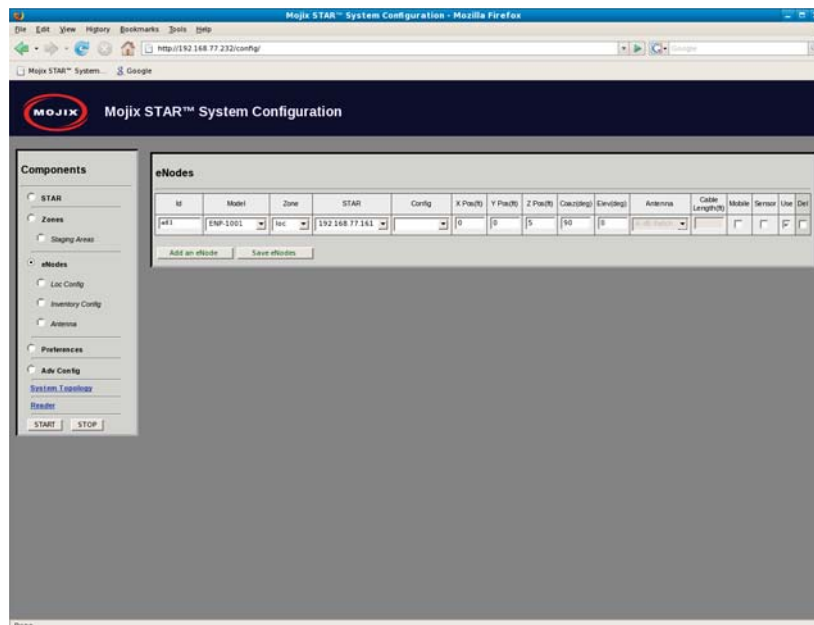


Figure 24: eNode Setup and Configuration

For information about setting up zones and location information, see Appendix A.

### 6.2.2. Reader Button

The Reader Button launches an interface that gives the user controls to run the system.



Figure 25: Reader Interface – showing tag reads

### 6.2.3. Network Button

The Network Button launches an interface to configure network settings for the STAR and MCON, and was discussed early in Section 6.1.2 and shown in Figure 19.

### 6.2.4. Status Button

The Status Button launches an interface used to view diagnostic messages.

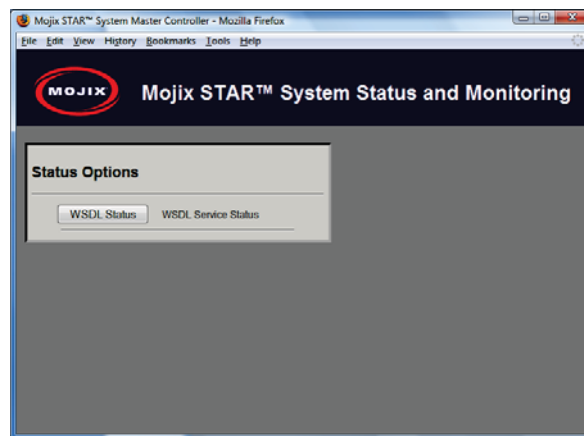


Figure 26: System Status, and Diagnostics

### 6.2.5. Phpmyadmin Button

This Button launches password protected MySQL browser utility and should only be used by advanced users.

### 6.2.6. dbPlot Button

The dbPlot Button launches a Java application that provides various graphical diagnostic functions.

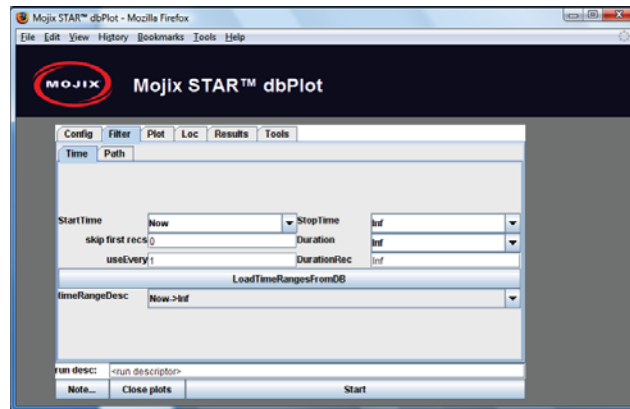


Figure 27: dbPlot, graphical diagnostics

### 6.2.7. Topology Button

The Topology Button launches a diagram of the system topology as configured by the user.

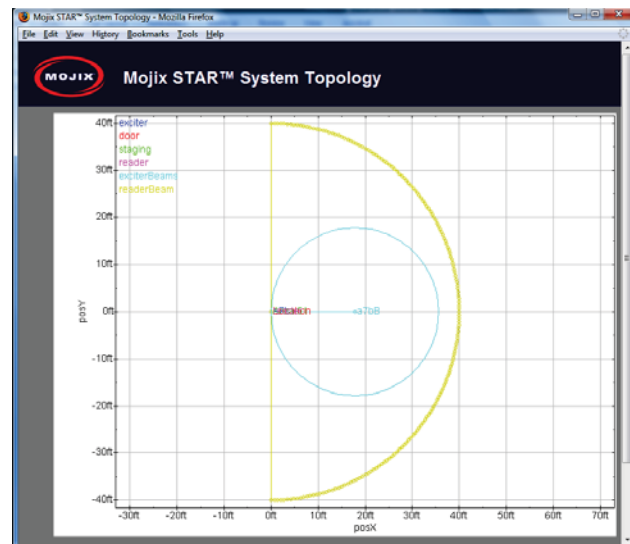


Figure 28: System Topology graphical display

### 6.3. eMux Calibration

eMux's must be calibrated to ensure that they amplify the STAR's signal correctly. Improperly calibrated systems will either exhibit mis-calibrating eNodes which can be seen from the eNode calibration (middle) LED blinking slowly or not illuminating at all when directed to excite tags. In newer systems, an eMux Button on the Web GUI allows for remote calibration by simply pressing the Calibration Button once all hardware has been connected and powered on. This process should be done after changing any cable lengths or eNodes prior to collecting data.

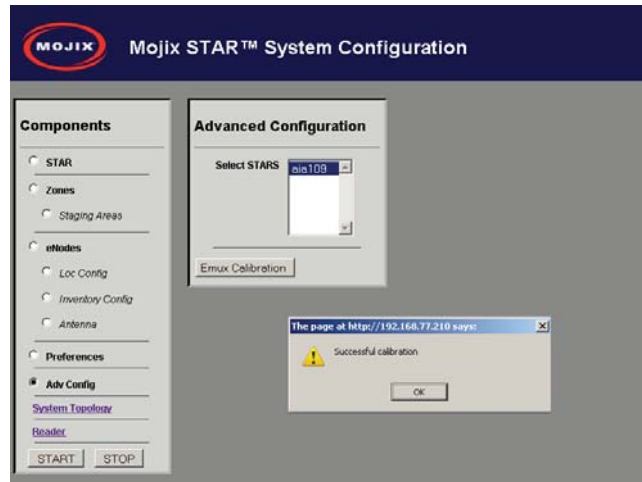


Figure 29: eMux Calibration

- Step 1: Click the Adv Config Button
- Step 2: Select the STAR Receiver whose emuxes you are calibrating
- Step 3: Click the "Emux Calibration" Button
- Step 4: Receive Confirmation and Click OK

## Appendix A: Location Configuration Guidelines

This section describes the setup and installation notes to estimate location. For most algorithm variations, the location and orientation of the receiver and eNodes is essential for determining tag location. What follows is the description of the coordinate system and the system components in it as well as how to enter this information so that it is accessible by the software applications.

The location and orientation of both reader and eNodes will be made with respect to a coordinate system that must be defined. The relationship between vectors x, y and z must follow the right hand rule, that is :  $\hat{z} = \hat{x} \times \hat{y}$  where  $\times$  denotes the vector product. The figure below shows an example of the relation between x, y and z.

The two angles that describe the beam boresight of both reader and eNodes must also be entered. These angles can be seen in Fig. 1 and are defined as follows:

coazDeg: coazimuth angle, in degrees. It is an angle that starts at zero in the +x-direction, and increases moving toward +y-direction.

elevDev: elevation angle, in degrees. Zero at the horizon, increases to +90 when pointing up.

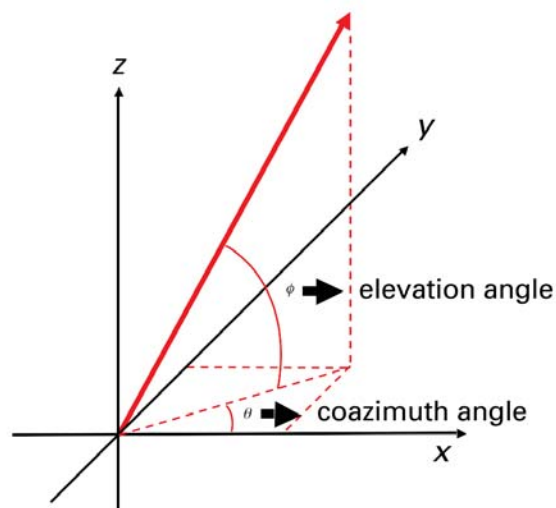


Figure 30: Coordinate system

The last entry that must be configured is the reader roll angle. It indicates the rotation of the reader on its own axis (the axis that corresponds to the beam boresight). The rotation values are as follows:

with power cord down, boresightRollDeg = 180

with power cord up, boresightRollDeg = 0

As a check on reader orientation, the 3rd element is at the end with the Ethernet connection. Look at dbPlot location plot for the 4 antenna elements to make sure the boresightRollDeg field was entered correctly. The following table illustrates a partial description of the fields.

Property	Comment	Example
aiaDottedIP, aiaName	Network address and reader name	192.168.77.100, 'aia109'
posXFt	The X position (ft) of the STAR reader	0.0
posYFt	The Y position (ft) of STAR reader	0.0
posZFt	The Z position (ft) of STAR reader. The ground is usually chosen to have a z coordinate of 0, so this represents the height of the reader.	5.0
boresightCoazDeg	Coazimuth, in degrees, of the direction the reader is pointing. This is the usual math convention on angle, where +x is 0deg, +y is 90deg, -x is 180deg, -y is 270deg	0 (reader pointed along x-axis)
boresightElevDeg	Elevation, in degrees, of the direction the reader is pointing. If eNode points horizontally, will be zero	0 (horizontally pointed star)
boresightRollDeg	Roll angle, in degrees, of the reader. If the power cord is down, the roll is 180deg. If up, 0 deg	180.0

Table 10: STAR Receiver Location Configuration Parameters

Property	Comment	Example
txID	ENode ID in hex	0xa01
posXFt	The X position (ft) of the eNode	0.0
posYFt	The Y position (ft) of STAR reader	0.0
posZFt	The Z position (ft) of eNode. The ground is usually chosen to have a z coordinate of 0, so this represents the height of the reader.	5.0
boresightCoazDeg	Coazimuth, in degrees, of the direction the eNode is pointing. This is the usual math convention on angle, where +x is 0deg, +y is 90deg, -x is 180deg, -y is 270deg	0 (eNode pointed along x-axis)
boresightElevDeg	Elevation, in degrees, of the direction the eNode is pointing. If eNode points horizontally, will be zero	0 (horizontally pointed eNode)

Table 11: eNode Location Configuration Parameters

Here are some examples of the coordinate systems that can be chosen (Always use x and y as the horizontal coordinates.)

- 1) Pick reader as origin, the direction it points as the x-axis  
STAR Receiver parameters (posXFt, posYFt, posZFt, boresightCoazDeg, boresightElevDeg) are all zero.
- 2) Use walls as axes
  - best for using laser rangefinder
  - only valid if there are two walls at right angles and nice and flat
- 3) Choose a corner eNode as the origin
  - good if eNodes are in a grid
  - reader is then offset from corner/reference eNode

# Appendix B: Deployment Example

## B.1 STAR Topology Examples & Deployment

This appendix illustrates an example topology and deployment following figure illustrates interrogation spaces and targeted locations for installing eNodes (i.e. labeled one through seven). The figure below shows the eNodes and their associated pointing angles, as well as the position and pointing of the STAR receiver.

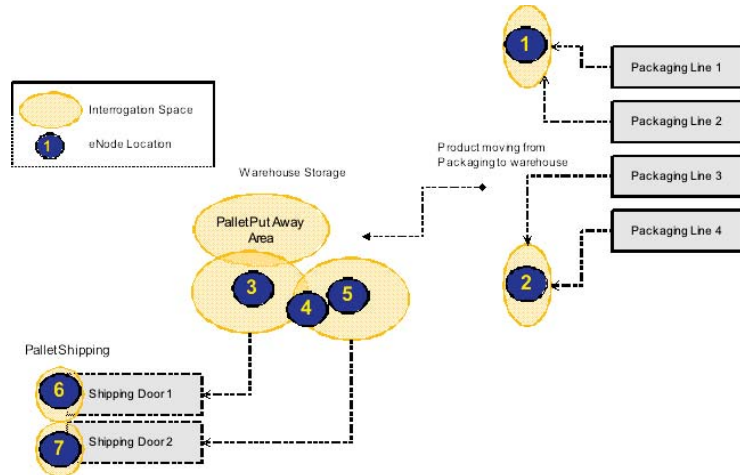


Figure 31: eNode Zones Example

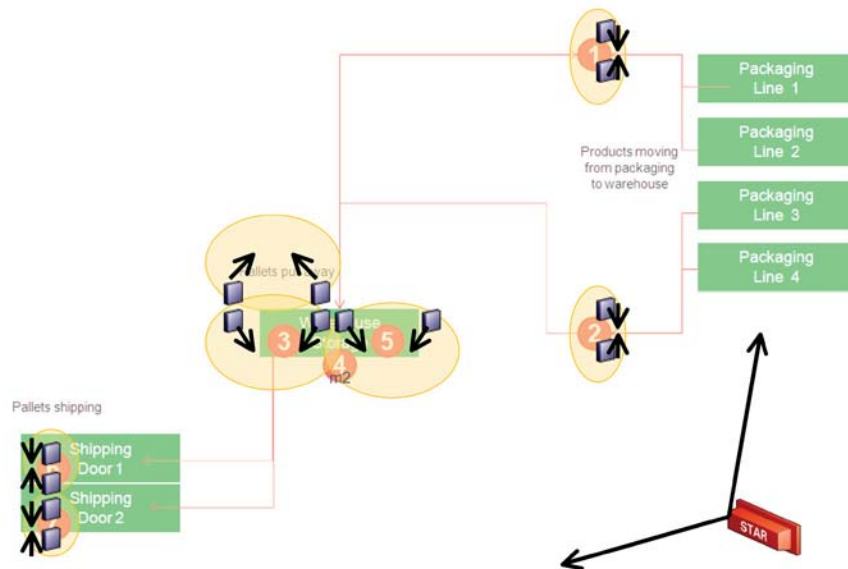


Figure 31: Deployment Example Showing eNode Zones



## B.2 STAR System Cabling Example

The following figure illustrates an example, showing the cable lengths between each segment of an example deployment. From the drawing, a measurement the insertion loss of each segment is computed, as shown in the figure below. This information is used for placing the eMuxes, to maximize power distribution across all eNodes. Keep in mind that cable runs need to run from eNode to eNode, but may also have to run up and down from the ceiling to the eNode itself. In many cases, cabling may not run in a straight diagonal line as shown, but instead may need to run along beams vertical or horizontal.

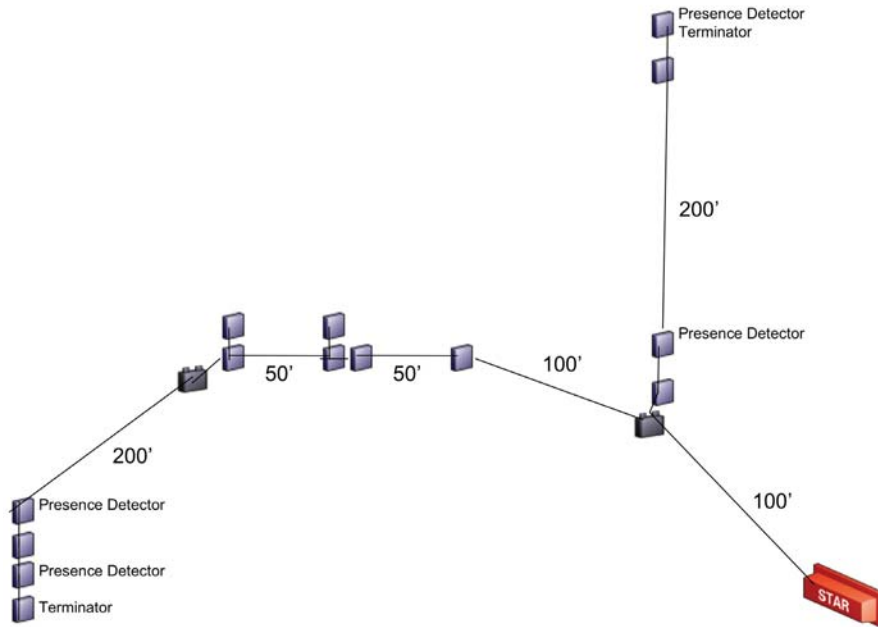


Figure 33: Example – Showing eNode, eMux and STAR cabling

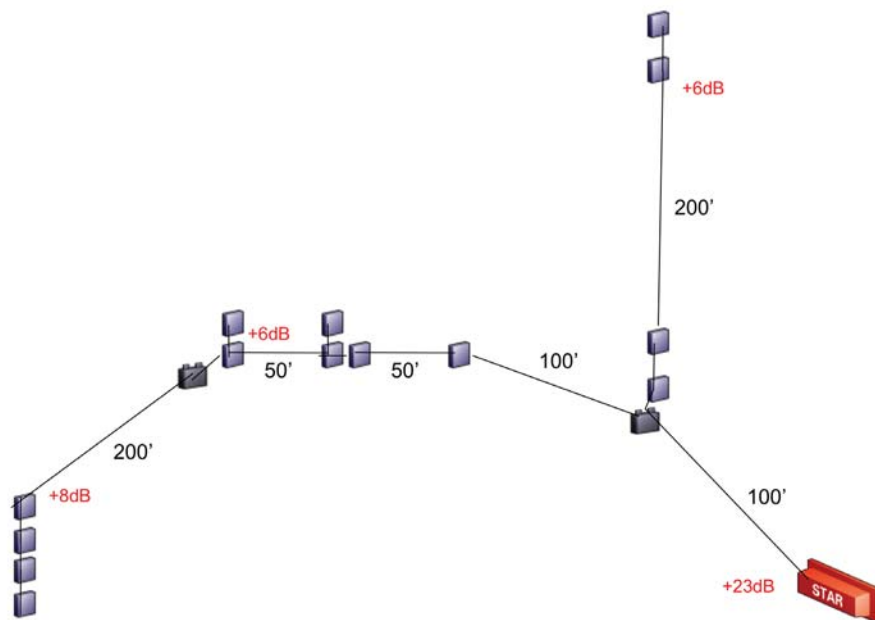


Figure 34: Example Showing Cable Losses

## Appendix C: Advanced Troubleshooting

### C.1 Accessing the Command Line

For advanced configuration working beyond the web interface of the MCON, users will need an SSH Client, a VNC Client and an FTP Client capable of using the SFTP protocol. The following list provides 3 suggested utilities and corresponding links.

1. SSH Client – PuTTY: <http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html>
2. VNC Client – RealVNC: <http://www.realvnc.com/>
3. FTP Client – Filezilla: <http://filezilla-project.org/>

### C.2 Additional Ways to Change MCON Network Settings

To change the IP of the MCON, the user will need to establish an SSH connection (TCP port 22) with the MCON. The first time a user connects with the MCON, the user will be asked to agree to accept a host key for the connection that will be cached in the registry from that point further. When asked, click on “Yes” or simply agree, depending on which type or Client is being used. The figure below shows an example of this confirmation dialog window.



Figure 35: SSH Host Key Confirmation

To connect to the MCON, use the following credentials.

Username: edison

Password: m0j1xInc

Once connected, the user is presented with a command prompt. At the prompt, enter the following command:

```
$ sudo setup
```

The user will be presented with an interface that allows for the configuration of several parameters as shown in the following figures.

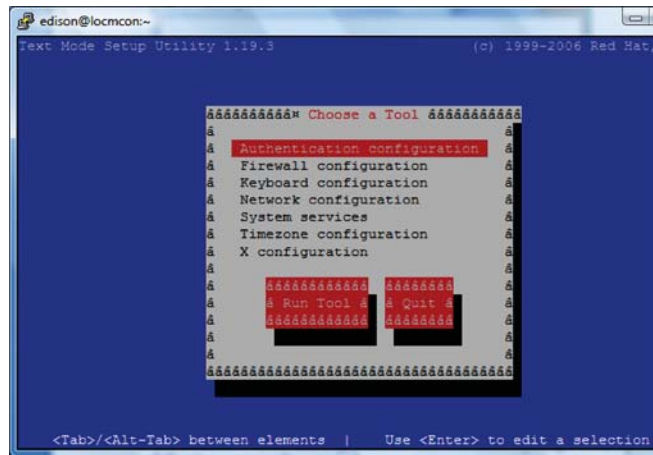


Figure 36: Setup Screen

Scroll down to the Network configuration and hit “enter”. From here, select the eth0 interface, which will present the following screen.

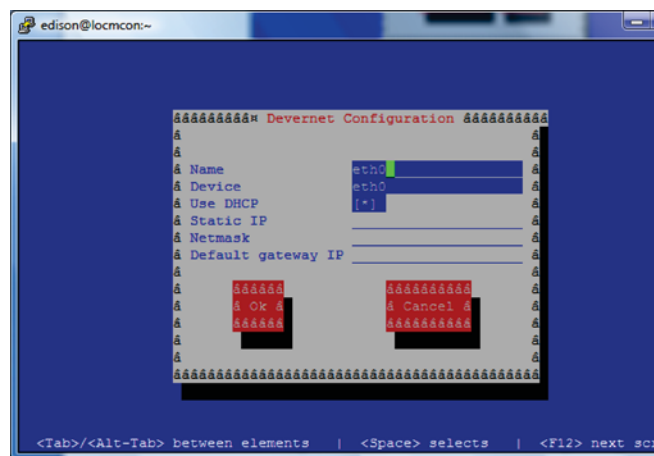


Figure 37: Eth0 Configuration

From here the user can enter any fixed IP address or select DHCP. Once the changes are made, select “Ok” and Quit out of the setup utility. The user will once again be presented with a command prompt (\$). For the new network changes to take place the user must enter the following command.

```
$ sudo service network restart
```

The user should note that once this command is issued the new network settings will take place immediately, requiring the user to re-establish the SSH connection using the new IP address.

### C.3 Connecting to the MCON

A VNC Client is used to establish a remote desktop connection with the MCON and is required to run a Mojix configuration and diagnostic utility called Mojo. To establish a VNC connection, enter the following command at the command prompt.

```
$ sudo service vncserver start
```

Now the user can run a VNC Client and connect to the MCON using the following connection address and session number format.

```
<ip of MCON>:9
```

This indicates that session 9 is used to establish the VNC session with the MCON. The following illustrates an example connection through the RealVNC Client interface.

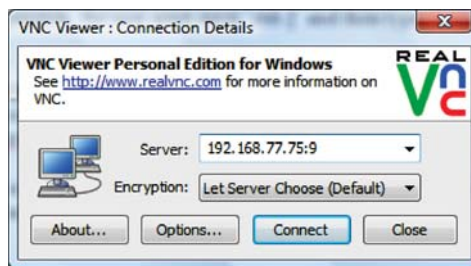


Figure 38: VNC Client Connection Window

The password to establish the VNC connection is: m0j1xInc

## Appendix D: Engineering Interface — Mojo

Mojo provides users with an integrated interface for both configuration and execution of the system. The functions of this interface are summarized as follows:

- STAR Parameter Configuration
- eNode Configuration
- Inventory Program Generation
- System Operation

To run Mojo, the user must connect to the MCON using VNC and bring up a terminal window by clicking on the Terminal icon on the desktop. With the terminal window open, enter the following command to launch Mojo:

```
$ Mojo <STAR ip>
```

This will launch the Mojo application and the user will be presented with the following screen.

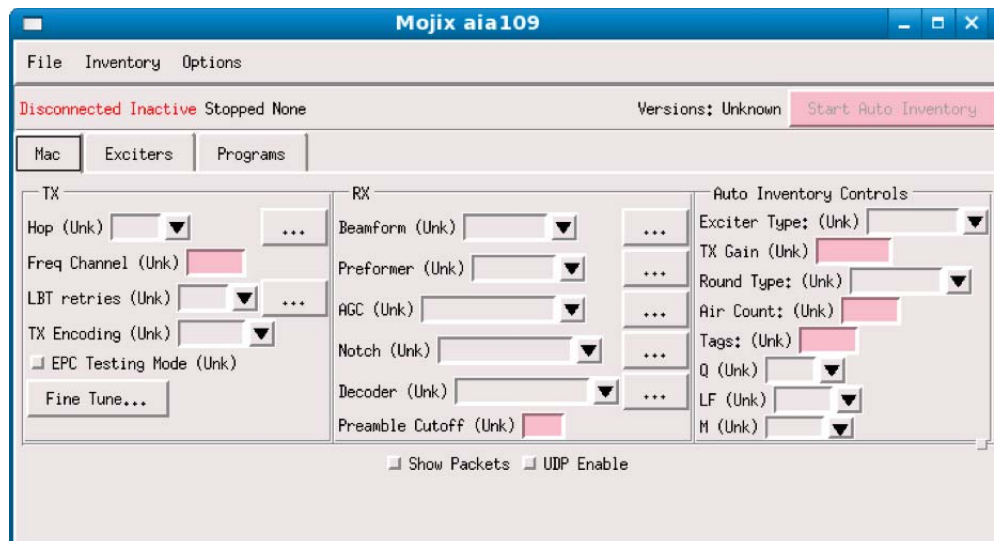


Figure 39: Mojo Main Screen

From here the user must click on the “File” menu and select “Connect”. This will establish a connection between the Mojo Client application and the STAR. At this point, the user can make real-time configuration changes. The most basic configuration to begin reading tags would be to enter one or more eNode addresses in the “Exciters” tab as shown in the following figure.

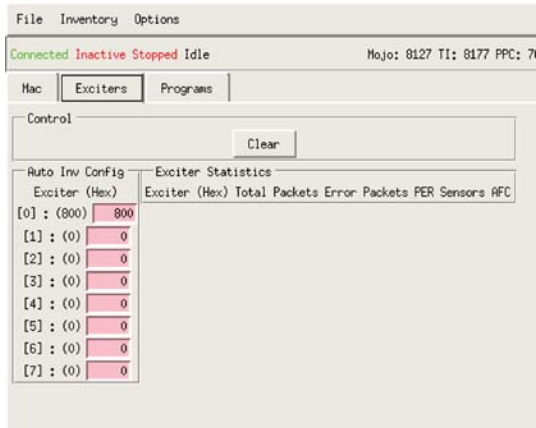


Figure 40: eNode Configuration (eNode Tab)

The address of an eNode is written on the eNode itself as the last three digits of the serial number. The number is presented as three hexadecimal digits, for example, B89. The user must use the Enter key when entering the eNode addresses in this window for the values to be accepted. Note, when the value is accepted it will appear in parenthesis to the left of the text entry box.

Once the eNodes are entered, the user can return to the “Mac” tab and click on the “Start Auto Inventory” Button in the top right corner. The Button will turn green when the system is running and the Button text will change to “Stop Inventory”. This is how to start and stop tag reads. To view tag reads, the user must select the “Show Packets” check box as shown in the following figure.

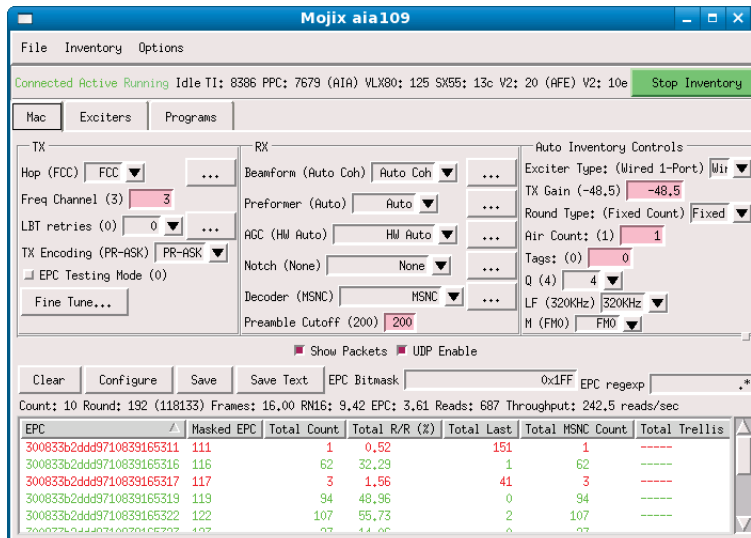


Figure 41: Tag Reads

Note that selecting the “Show Packets” box will redirect tag reads away from the MySQL database and to the Mojo interface for display. Unselecting the box will return tag reads to the database. The EPC display area at the bottom of the Mojo screen shows active tag reads.

TX

Hop (FCC) FCC ▼ ...

Freq Channel (1) 1

LBT retries (0) 0 ▼ ...

TX Encoding (PR-ASK) PR-ASK ▼

EPC Testing Mode (0)

Fine Tune...

Figure 42: Transmit Parameters

Auto Inventory Controls

Exciter Type: (Wired 1-Port) Wired 1-Port ▼

TX Gain (-48,5) -48,5

Round Type: (Fixed Count) Fixed Count ▼

Air Count: (1) 1

Tags: (0) 0

Q (4) 4 ▼

LF (320KHz) 320KHz ▼

M (FM0) FM0 ▼

Tari (6.25 uSec) 6.25 uSec ▼

Session (S1) S1 ▼

Send Select (1)

Toggle Target (0)

RN16 Packet Enable (0)

Decoder error check (1)

Figure 43: Auto Inventory Controls

RX

Beamform (Auto Coh) Auto Coh ▼ ...

Preformer (Max Chan) Max Chan ▼ ...

AGC (HW Auto) HW Auto ▼ ...

Notch (None) None ▼ ...

Decoder (MSNC) MSNC ▼ ...

Preamble Cutoff (200) 200

Filter Type (Minimal) Minimal ▼

Analog Filter (1MHz) 1MHz ▼

Digital Filter (HBF+IDF) HBF+IDF ▼

Figure 44: Receive Parameters

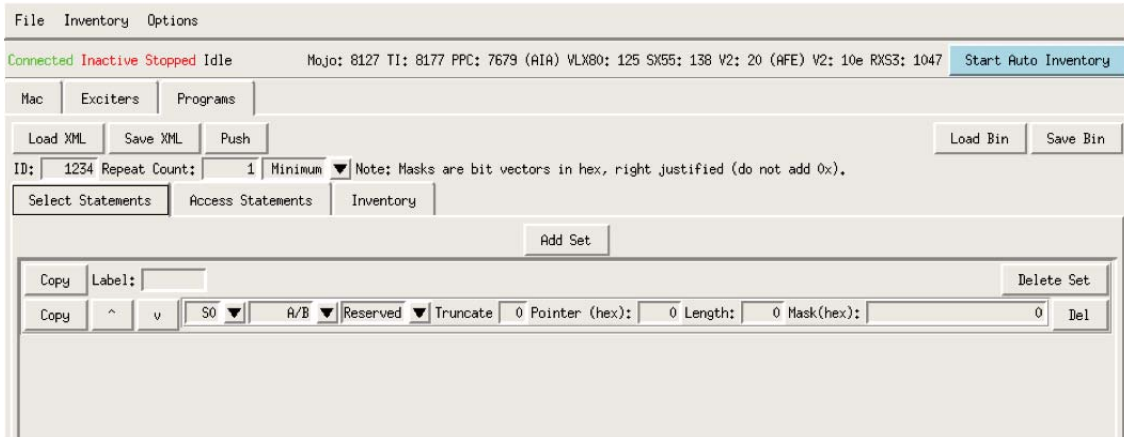


Figure 45: Select Statements

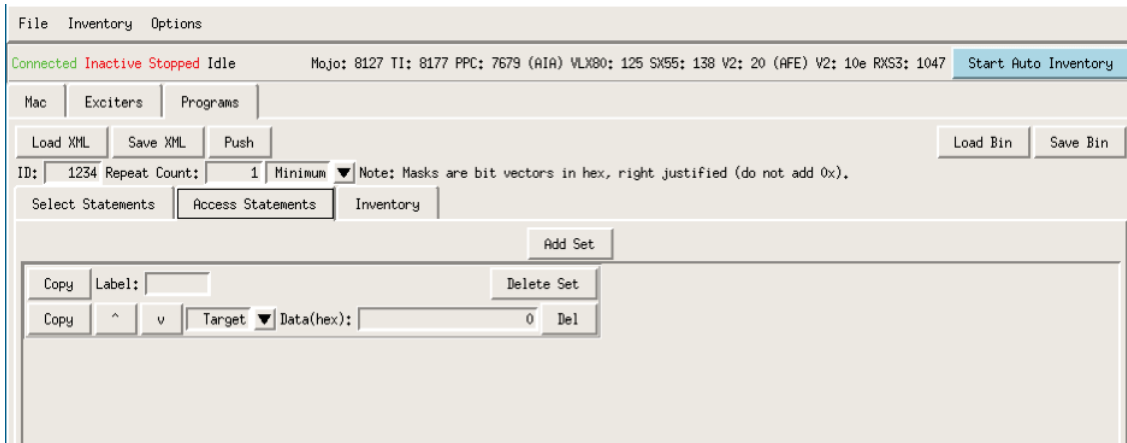


Figure 46: Access Statements

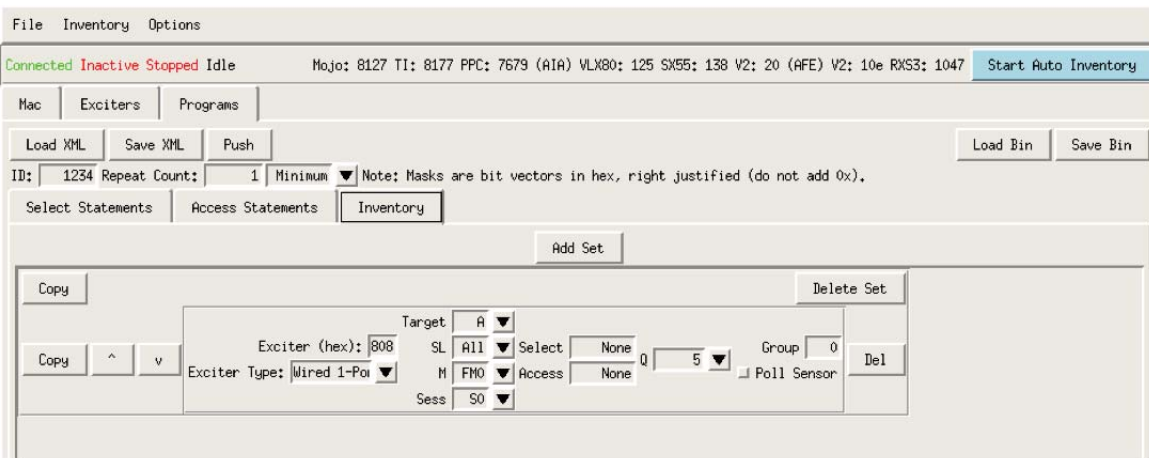


Figure 47: Inventory Programs



## Appendix E: Manual eMux Calibration

eMux's are generally manually calibrated as they are being installed as they may be in hard to reach areas. To manually calibrate an older revision eMux, you will need:

- (1) A connected system with all devices prior to the needed eMux including:
  - a. A networked STAR receiver
  - b. A networked master controller
  - c. All planned eNodes between eMux and STAR connected
- (2) A spectrum analyzer (with DC Block and TNC male connection)
- (3) A small flat head screw driver with at least a 2" neck
- (4) A power source where the eMux is to be implemented
- (5) An eMux with power brick
- (6) A terminated LMR240 cable with known loss (recommend 1 dB.)

### Step 1: Set the STAR to Transmit a single channel tone

1. From Mojo application, select single channel by turning frequency hopping off.
2. On diagnostics tab, type startcwtx

### Step 2: Plug the power cable into the eMux and connect the coax cable planned as the input to the eMux to a spectrum analyzer

1. Be sure to connect the spectrum analyzer through a DC Block. **Warning: failure to use a DC Block could significantly damage the spectrum analyzer.**
2. You may need an adapter to connect your spectrum analyzer to the DC Block, or to the coaxial cable. LMR240 coaxial cable is straight TNC for Mojix systems.

### Step 3: Measure the power level of the signal from the coaxial cable (planned to go into the input port on the eMux) and record this level. This level must be above -10 dBm.

1. If the signal planned to come into the input port is below -10 dBm, you must put the eMux into the system earlier in the chain where there is less insertion loss.
2. After measuring the power level, connect the coaxial cable directly into the input of the eMux.
3. Record the serial number of the eMux.

### Step 4: Determine which output port will have the most gain.

1. With the input connected on the eMux, connect a cable to the first output port of the eMux (the output port closest to the power supply connection.)
2. Attach the other end of the cable to an available eNode.

**Step 5: Set the gain to the maximum output level.**

1. Using a small slotted edge screwdriver, adjust the gain control by turning in a clockwise direction until the green light turns on, but the red light is off.
2. Continue turning the adjustment clockwise until the red light turns on.
3. Once the red light is on, turn the adjustment counter-clockwise by a single click.

**Step 6: Connect all needed coaxial cables planned to branch from the eMux.**

1. Connect coaxial cables intended as outputs to the eMux output ports. The most challenging branch from an insertion loss perspective should be attached to the port with the most gain. The difference in gain from the first port and the 4th port is 2 dB. The maximum output setting based on this calibration method will be +23 dBm
2. Label the output cables and record to which port each coaxial cable is connected

**Step 7: Restore STAR to normal operation**

1. On diagnostics tab, type stoptx
2. From Mojo application, turn frequency hopping back to the appropriate setting for your geography.

## Appendix F: Glossary

**AIDC:** Automatic identification and data collection.

**Active Tag:** RFID tags with their own internal power source, which is used to power the integrated circuits and to broadcast the response signal to the reader. Active tags typically beacon their identifier at fixed intervals and can feature sensor information and extended memory. (See also “passive tag” and “semi-passive tag.”)

**Air Interface:** The means used to wirelessly enable tag-reader communications.

**Antenna Polarization:** The orientation of the antenna’s electromagnetic (EM) field. Polarization often implies a preferred tag-antenna orientation which optimizes the antenna’s ability to acquire tag signal and data. Technically, polarization relates to the orientation of EM fields at specific antenna components. In user-level discussions, however, polarization is typically referenced to the ground and assumes the antenna is in its normal mounting position. If, for example, a horizontally polarized (parallel to the ground) antenna that is normally mounted upright on a beam or wall were mounted on its side instead, it would then be thought of as being vertically polarized (perpendicular to the ground) from the user’s perspective, though the antenna’s inherent polarization never changes.

**Anti-collision:** The ability of a reader to read multiple tags in the field (read window) virtually simultaneously. (See “discrimination.”)

**Attenuate:** To decrease the broadcasting range of an antenna’s signal.

**Backscatter (backscatter modulation):** A method of tag-reader communication that uses radio frequency (RF) energy broadcast from a reader/antenna to essentially bounce the RF signal off the tag and back to the reader. The tag encodes its own identification data on the original signal and reflects (backscatters) the modified (modulated) signal back to the reader’s receiver. The alternative to backscatter technology is transmitter technology (see “active tag 1”). Backscatter tags may be powered solely by the reader’s signal or may include a battery for increased read range or to power an onboard processor.

**Beam-Powered Tag:** A tag whose internal circuitry is energized by converting a portion of the reader’s RF signal (“beam”) to power that enables it to modulate and reflect (backscatter) that signal to the reader. (See “passive tag 2.”)

**Beamforming:** A signal processing technique used in sensor arrays for directional signal transmission or reception. This spatial selectivity is achieved by using adaptive or fixed receive/transmit beampattern. Beamforming takes advantage of interference to change the directionality of the array. When receiving, information from different sensors is combined in such a way that the expected pattern of radiation is preferentially observed.

**Beam steering:** Changing the direction of the main lobe of a radiation pattern. In radio systems, beam steering may be accomplished by switching antenna elements or by changing the relative phases of the rf signals driving the elements.

**Chip:** (See “integrated circuit.”)

**Coax:** Coaxial Cable.

**DepCon:** (See “Master Controller.”)

**Deployment Controller:** (“See Master Controller.”)

**Discrimination:** The ability of a reader to read individual tags in a field containing multiple tags, or the ability of the system to determine efficiently what to report. Discrimination with regards to tags uses anti-collision algorithms (See “anti-collision.”) Discrimination with respect to interrogation zones uses information to determine how best to report in which interrogation zone a tag is located (See “interrogation zone.”)

**Electronic Product Code (EPC):** An ultra-low-cost RFID tag containing a 64-bit or 96-bit unique ID codes—the equivalent of the bar-coded UPC (Universal Product Code) plus additional data not accommodated by UPCs. The EPC tag falls under AIDC Class 1.

**eGroup™:** Electronic manifest of a targeted population of tags that enable true electronic proof of delivery and heightened levels of anti-counterfeiting, security and authentication.

**EM:** Electromagnetic.

**eMux:** eNodes frequently are deployed with multiplexers (eMux’s) that can connect up to ten eNodes to a STAR or to another (upstream) eMux. The eMux amplifies and conditions RF signals from the STAR and provides DC power to eNodes.

**eNode:** Each Mojix eNode excites all passive RFID tags within its designated interrogation space to a range of up to 30 feet. eNodes can be fixed, wireless or handheld, and can be deployed as needed to shape discrete, overlapping or contiguous interrogation spaces, as well as to create virtual fences for securing tagged items.

**EPC:** Electronic product code.

**EPCglobal:** A member-driven organization developing global standards for EPC use.

**eTag:** (see "eGroup.")

**Excision:** Removal or strong suppression of interfering radio signals. The STAR uses excision, among other tools, to operate reliably in very challenging and noisy environments. (See "Interference.")

**Excite:** To transmit a radio signal with enough power and the right communication to "wake up" a passive tag or group of tags.

**ENode:** (See "eNode".)

**FCC:** Federal Communications Commission (U.S. regulatory body).

**FileZilla:** A freeware file transfer protocol (FTP) Client which allows SSH security.

**Firmware:** Basic programming built into the STAR receiver. Firmware consists of various sets of commands the STAR is designed to understand and obey. Firmware runs on the STAR's microprocessor.

**Frequency Band:** A range of frequencies on the EM spectrum, typically defined by their applications or authorized uses as designated by organizations such as the FCC in the U.S. Frequency bands are often referred to by their center frequencies. For example, the "915 MHz band" covers frequencies ranging from 902 MHz to 928 MHz.

**Frequency Hopping:** A method of transmitting RF energy that minimizes interference among devices operating in the same band. The reader frequency hops from one specific point on the EM spectrum (within the frequency band) to another and another (according to a "hopping table" defined by the FCC and programmed into the reader's ROM) at precise 400 mS intervals.

**IC:** Integrated circuit.

**Integrated Circuit (IC):** Connected to a tag antenna, an RFID IC is the brain of the RF tag. It rectifies (converts) reader RF energy to power itself (in beam-powered and hybrid beam/battery-powered tags), maintains tag memory and has the intelligence to execute anti-collision functions so a reader can read many tags in its field virtually at once. Also referred to as "chip," "die" or "device."

**Interference:** Any emissions in the electromagnetic spectrum that have the capacity to disrupt, distort, weaken or cancel the effective transmission of an EM signal. In RFID, interference may come from other RFID devices operating in the same frequency band, communication devices operating in the same band, or spurious noise emissions from mechanical sources that contain frequencies in the RFID operating band. Interference is minimized through the use of RF filtering and frequency hopping.

**Interrogation Zone:** Fixed or mobile, STAR interrogation spaces are business process-specific and can be optimized for tag density or coverage. Each individually controlled interrogation space is created by the deployment of single or multiple eNodes and is dynamically sized by the STAR system, which controls each node's power output.

**Interrogator:** (See "eNode".)

**Line of Sight:** Optical (barcode) systems of automatic identification require that the laser scanner have an unobstructed path (line-of-sight) to the barcode for reading the UPC. Any objects between barcode and scanner will prevent proper reading. Mojix STAR systems are not limited to line-of-sight in that RF tags can be read through or around most materials.

**Master Controller:** The STAR Master Controller is a dedicated Linux server, a Mojix software program called Deployment Controller, and a MySQL relational database that is used to store STAR System information and tag data. Master Controller provides a single point in STAR for data collection, communication with corporate business processes, and command and control of the STAR System. When more than one STAR 1000 receiver is deployed in a STAR System due to the size or layout of the area of coverage, a single Master Controller will control the entire system.

**Multipath:** Multiple versions of the same signal (often reflected by objects or materials in the RF operating environment) that arrive at the reader at various times (like an echo). Those that arrive in phase with the original signal will enhance that signal. Those that arrive out of phase will cancel the original signal.

**Mux:** ("See eMux.")

**Open Protocol** (also “open system” or “open specification”): A specification that is made publicly available for all to use without payment of license or other fees. The AIDC is developing a fully open specification for adoption by its members.

**Passive Tag:** (communications context) A tag that relies solely on backscatter modulation of a reader’s signal for communication with the reader. A passive tag in this context is one that has no transmitter. (power context) A tag that derives its power exclusively from the energy contained in the reader’s incident signal (i.e., RF “beam”-powered). (See “semi-active tag” and “semi-passive tag.”) (See also “active tag.”)

**Phased Array:** A group of antennas in which the relative phases of the respective signals feeding the antennas are varied in such a way that the effective radiation pattern of the array is reinforced in a desired direction and suppressed in undesired directions. (See also “beamforming” and “beam-steering.”)

**Protocol:** (See “specification.”)

**Putty:** A freeware telnet application which is capable of SSH telnet.

**Reader:** A transmitter/receiver (“transceiver”) that sends out RF signals into an environment where tags are expected and acquires RF signals (either transmitted or backscattered) from the tags. This architecture is used by conventional RFID systems.

**Read Range:** Distance from a reader antenna at which tags may be successfully read. May refer to the optimal or ideal range at which tags can be read reliably under all reasonable circumstances by a system of a specific design. Read range may also refer to the maximum range at which tags can be read.

**Receiver:** (See “STAR Receiver.”)

**RFID:** Radio frequency identification.

**Semi-Active Tag:** (See “Semi-Passive Tag.”)

**Semi-Passive Tag:** A battery-assisted passive tag. Semi-passive tags need an external system to initiate their transmission, but the internal battery allows for that signal to be weaker than its transmission signal. (See also “passive tag” and “active tag.”)

**Smart Label:** An RFID tag in the flat, flexible form of a paper or plastic label.

**Source Tagging:** The integration of tags into product packaging at the source or point of manufacture.

**Specification:** An RFID specification describes all the operating parameters of a system, including frequency, air interface, communication timing, anti-collision logic, etc.

**SSH:** Secure shell, a common network protocol for remote administration of Unix computers

**STAR:** Space Time Array Reader. See (“STAR Receiver.”)

**STAR-1000:** Space Time Array Reader, series 1000. See (“STAR Receiver.”)

**STAR Receiver:** The STAR receiver functions as a single point of STAR system data collection, STAR system provisioning, eNode command and control, and integration with enterprise systems for a STAR System. With the ability to detect extremely faint signals and free from conventional RFID’s line-of-sight restrictions, the STAR receiver works in concert with its satellite eNodes to support one or many business processes across the entire coverage area.

**Tag:** An RFID device capable of receiving reader signal and returning data to the reader. Sometimes called a “transponder,” though not all tags are true transponders.

**Tag Orientation:** The presentation of the tag to a reader antenna. May indicate a preferred position that optimizes tag readability. The meaningful relationship of tag to reader antenna is fairly complex and internal to both devices. However, for the purposes of user discussions referencing optimal positioning, tag orientation is usually stated as relative to the ground. Thus horizontal tag orientation would indicate the longer axis of the tag is parallel with the ground. Vertical orientation would indicate the tag’s long side is perpendicular to the ground.

**Transceiver:** Transmitter/receiver. (See “reader.”)

**UltraVNC:** A freeware version of VNC Client and server software. (See “VNC.”)

**VNC:** A graphical desktop sharing system which uses the RFB protocol to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates back in the other direction, over a network.

**Web Service Definition Language (WSDL):** An XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.

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**INSTRUCTION TO THE USER (if device DOES NOT contain a digital device)**

The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

**INSTRUCTION TO THE USER (if device contains a digital device)**

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

CAUTION: To comply with FCC RF exposure compliance requirements, a separation distance of 20 cm must be maintained between the antenna of this device and all persons.

**Need More Help?** Our product support team is comprised of individuals highly experienced in RFID deployments across a broad spectrum of application and use cases. If you are an existing customer of Mojix, please login to the secure area and submit a service request if you have additional questions. If you are unable to login, then please send us an email at: [service@mojix.com](mailto:service@mojix.com)



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