iDigi Platform for Embedded Linux User Manual

90002000_B

© 2012 Digi International Inc.
All Rights Reserved.

Digi, Digi International, the Digi logo, the Digi website, Digi ESP, iDigi, the iDigi logo, the iDigi website, iDigi Device Cloud, iDigi Developer Cloud, iDigi Manager Pro, iDigi Web Services API, ConnectCore 9C, ConnectCore Wi-9C, ConnectCore 9P, ConnectCore Wi-9M 2443, ConnectCore Wi-MX51, ConnectCore Wi-MX53, ConnectCard for i.MX28, and Digi Connect ME are trademarks or registered trademarks of Digi International, Inc.

All other trademarks mentioned in this document are the property of their respective owners.

Information in this document is subject to change without notice and does not represent a commitment on the part of Digi International.

Digi provides this document “as is,” without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of fitness or merchantability for a particular purpose. Digi may make improvements and/or changes in this manual or in the product(s) and/or the program(s) described in this manual at any time.

This product could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes may be incorporated in new editions of the publication.

Digi International Inc.
11001 Bren Road East
Minnetonka, MN 55343 (USA)
☎ +1 877 912-3444 or +1 952 912-3444
http://www.digiembedded.com

Contents

Contents 3

1. Introduction 5

1.1. What is the iDigi Device Cloud? 5
1.2. What are the applications of the iDigi platform? 5
1.3. iDigi concepts 5
1.3.1. Cloud computing 5
1.3.2. Protocols 6
1.3.3. Applications 6
1.3.4. iDigi Web Services API 6
1.3.5. iDigi Manager Pro 6
1.4. Conventions 7
1.5. Abbreviations 8
1.6. Supported Platforms 8
1.7. Requirements 8

2. First steps in iDigi 9

2.1. Creating a new iDigi account 9
2.2. Adding iDigi to your platform 9
2.2.1. Adding the device sample applications 9
2.2.2. Including wireless tools 10
2.2.3. Build the project 11
2.2.4. Configuration file 11
2.3. Start the embedded device 11
2.3.1. Configuring the network interface 11
2.3.2. ADDP daemon 12
2.4. Register your device to your iDigi account 13
2.4.1. Manual registration 14
2.4.2. Device ID 15
2.4.3. Check that your device is registered 15
2.5. Registration of a Vendor ID 15
2.5.1. Device type 16
2.5.2. Firmware version 16
2.5.3. Cached data in iDigi 16
2.5.4. Register a new Vendor ID 17
2.5.5. Instructing devices to supply the Vendor ID 17

3. iDigi applications 18

3.1. Methods of communication 18
3.1.1. Remote Control 18
3.1.2. Data storage 18
3.2. Sample applications 18

4. Remote control examples 19

4.1. Device application (idigimanager) 19
4.1.1. Device properties 20
4.1.2. File system management 21
4.1.3. Firmware update 21
4.1.4. Securing the connection 24
4.1.5. Validation of server SSL certificate 25
4.2. Device application (idigibuttonled) 26
4.2.1. Testing the buttons and LEDs thread 27
4.3. Client application (iDigiLedDemo.jar) 27

5. Data storage example 30

5.1. Device application (idigistorage) 30
5.1.1. Retrieving data from iDigi 31

5.2. Client application (iDigiTankDemo.jar) 32

6. Application development 35

6.1. iDigi API functions 35
6.1.1. Functions for remote control 35
6.2. The idigibuttonled sample application in detail 36
6.2.1. Source tree 36
6.2.2. RCI requests and replies 37
6.2.3. Defining custom commands 38
6.2.4. Implementing the custom commands callbacks 38
6.2.5. Custom commands descriptors and registration 41
6.2.6. Rest of code 42
6.3. The client application iDigiLedDemo 43
6.4. The idigistorage sample application in detail 44
6.5. The client application iDigiTankDemo 44

7. Configuration file 45

7.1. Section DEVICE_CONFIG_GROUP 45
7.2. Rest of sections 45

8. Known issues and limitations 46

8.1. Network connection and interfaces 46
8.1.1. Gateway IP 46
8.1.2. DNS addresses 46
8.2. Buttons and LEDs on hardware platforms 46
8.2.1. Digi Connect ME 9210 46
8.2.2. ConnectCore Wi-9M 2443 46
8.2.3. ConnectCard for i.MX28 46
8.3. Limitations on file uploads/download 47

9. Reference documentation 48

1. Introduction

1.1. What is the iDigi Device Cloud?

The iDigi® Device Cloud™ is a platform that allows for application-to-device data interaction (messaging), application and device data storage, and remote management of devices. Devices are associated with iDigi® through the Internet or other wide area network connections, which allow for communication between the device, the iDigi server, and customer applications. An important part of this communication is the transfer of data from a device to iDigi. Users can write applications that run on devices which pass data (messages) as well as send data to a temporary data cache on the iDigi platform, to be available for retrieval by iDigi Web Services clients.

The iDigi platform solves some difficult problems for deployment of devices with a communications interface, and allows the application developer to concentrate on their field of interest without having to worry about network management, data storage and remote firmware updates.

All of this is available if there is an available connection to the Internet, at least part of the time but preferably with permanent access. It works behind firewalls, or with direct Internet connections.

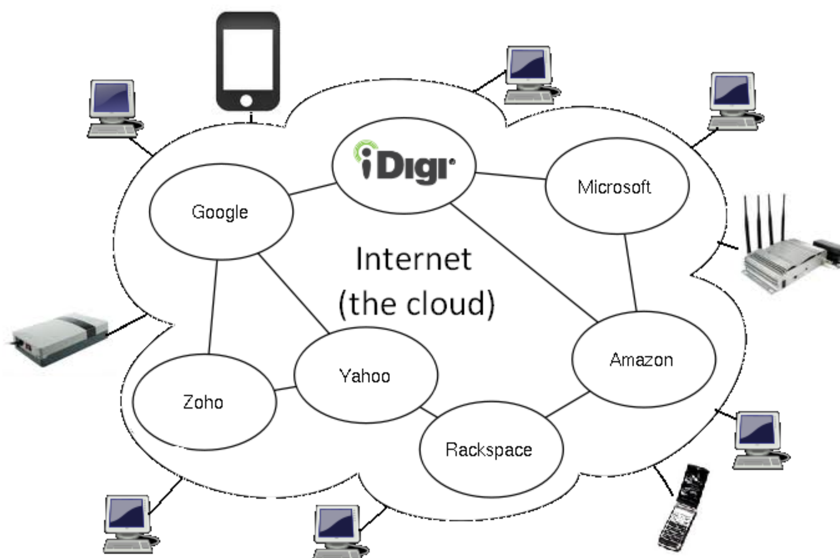
1.2. What are the applications of the iDigi platform?

There are many real world applications where iDigi can be very beneficial. One such application is in energy management, where power utilities can provide remote access and management to appliances in homes or businesses that put a heavy load on the energy grid. Other applications are fleet management, where a fleet of vehicles can be monitored from a remote location or building automation, where lighting can be controlled to save energy. Also, the monitoring and data collection of a sensor network can be made easier with iDigi. In addition to handling data from your devices, iDigi supports device management such as upgrading firmware and making configuration changes.

1.3. iDigi concepts

1.3.1. Cloud computing

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, similar to the electricity grid.



The *cloud* is a metaphor for the Internet in cloud computing, based on how it is depicted in computer network diagrams and as an abstraction for the complex infrastructure it conceals.

You can consider iDigi as a platform that lives in this *cloud* and allows your computers and embedded devices to communicate with each other even when they are at different locations.

1.3.2. Protocols

iDigi works in combination with different communication protocols:

- **ADDP**: (*Advanced Device Discovery Protocol*) is a Digi proprietary network protocol that allows for discovery of devices connected to an Ethernet LAN. The protocol also allows basic network configuration of the device.
- **EDP**: (*Easy Device Protocol*) is a Digi proprietary network protocol for communicating with iDigi.
- **RCI**: (*Remote Command Interface*) is a high level communication protocol written in XML. This XML protocol is the one used for communications in the *cloud* between user-end applications, iDigi to remotely command and communicate with the embedded device, and with the iDigi server or with any client application that resides on the *cloud*.

1.3.3. Applications

When working on the *cloud* there are two distinct types of applications:

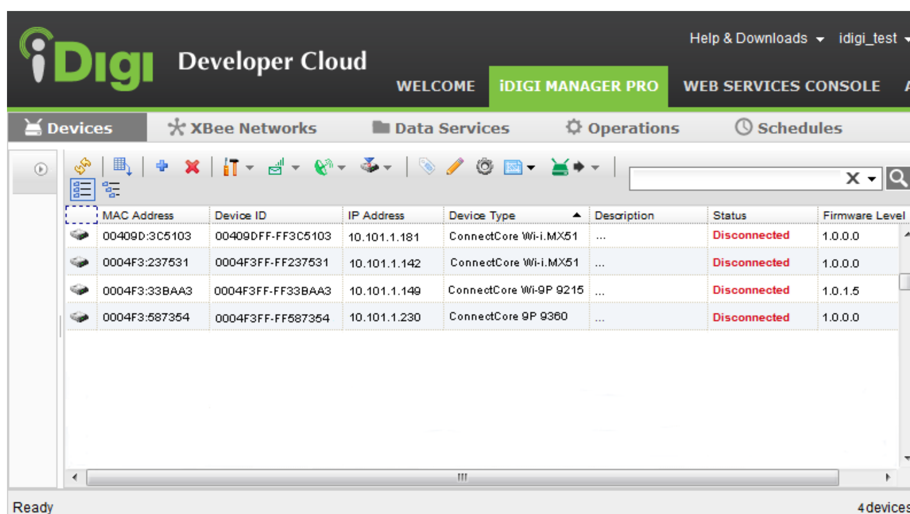
- **Device applications**: applications running on the embedded device, that send data to and receive data from iDigi.
- **Client applications**: applications that may run on any PC, or other device in the *cloud,* and use iDigi Web Services to communicate with the device application running on the embedded device.

1.3.4. iDigi Web Services API

The iDigi Web Services API™ is a set of protocols and standards for data interchange between applications. Different applications written in different programming languages and running in different hardware architectures can use web services to interchange data over networks, such as the Internet.

1.3.5. iDigi Manager Pro

The iDigi Manager Pro™ service is a Digi web portal where users can register their devices for remote management and firmware updates.



1.4. Conventions

This document uses these conventions, frames, and symbols to display information:

Convention	Use
`Style` (italic)	New terms and variables in commands, code, and other input.
`Style`	In examples, to show the contents of files, the output from commands. In text, the C code.
	Variables to be replaced with actual values are shown in italics.
Style	For menu items, dialogs, tabs, buttons, and other controls.
	In examples, to show the text that should be entered literally.
$	A prompt that indicates the action is performed in the host computer.
#	A prompt that indicates the action is performed in the embedded device.
Menu name > option	A menu followed by one or more options; for example, **File > New**.

This manual also uses these frames and symbols:

A warning that helps to solve or to avoid common mistakes or problems.

A hint that contains useful information about a topic.

```
$   A host computer session.
$   Bold text indicates what must be input.
```

```
# A embedded device session.
# Bold text indicates what must be input.
```

```
An excerpt of a file
Bold text indicates what must be input.
```

1.5. Abbreviations

ADDP	Advanced Device Discovery Protocol
EDP	Easy Device Protocol
GPIO	General Purpose Input Output
HAL	Hardware Abstraction Layer
HTTP	Hypertext Transport Protocol
LAN	Local Area Network
LED	Light-Emitting Diode
MAC	Media Access Control
OEM	Original Equipment Manufacturer
RCI	Remote Command Interface
SCI	Server Command Interface
SSL	Secure Sockets Layer
UI	User Interface
XML	eXtensible Mark-up Language

1.6. Supported Platforms

iDigi for Digi Embedded Linux is currently supported on the following platforms:

- ConnectCore™ 9P 9360
- ConnectCore™ 9C/Wi-9C
- ConnectCore™ 9P/Wi-9P 9215
- Digi Connect ME® 9210
- ConnectCore™ 9M/Wi-9M 2443
- ConnectCore™ Wi-i.MX51
- ConnectCore™ Wi-i.MX53
- ConnectCard™ for i.MX28

Depending on which platform is being used, the information displayed in dialogs and output messages may vary from that shown in this manual.

1.7. Requirements

- A Linux distribution with Digi Embedded Linux version 5.2 or later is required.
- To run iDigi Manager Pro one of the following web browsers is required: Firefox 3+, Safari 4+, Chrome 3+ or Internet Explorer 7+. It is required that the web browser has the latest JAVA virtual machine and JAVA is enabled. To check that you have the latest version of JAVA enabled please visit: *http://www.java.com/en/download/help/testvm.xml*
- JAVA Runtime Environment is also needed for running sample client applications.

If you do not have JAVA installed, install it with the following command (on a Kubuntu distribution):

```
# sudo apt-get install sun-java6-jre sun-java6-plugin sun-java6-fonts
```

2. First steps in iDigi

This section helps you get familiar with the iDigi Device Cloud platform, and guides you through the process of creating your iDigi account as well as discovering and registering embedded devices to your iDigi account.

2.1. Creating a new iDigi account

To create a new iDigi account:

1. Navigate to *http://developer.idigi.com* in a web browser.
2. Click on "**Are you a new user?**" and fill in the form to create a new iDigi account.

2.2. Adding iDigi to your platform

Support for iDigi is included in Digi Embedded Linux distribution, it also includes:

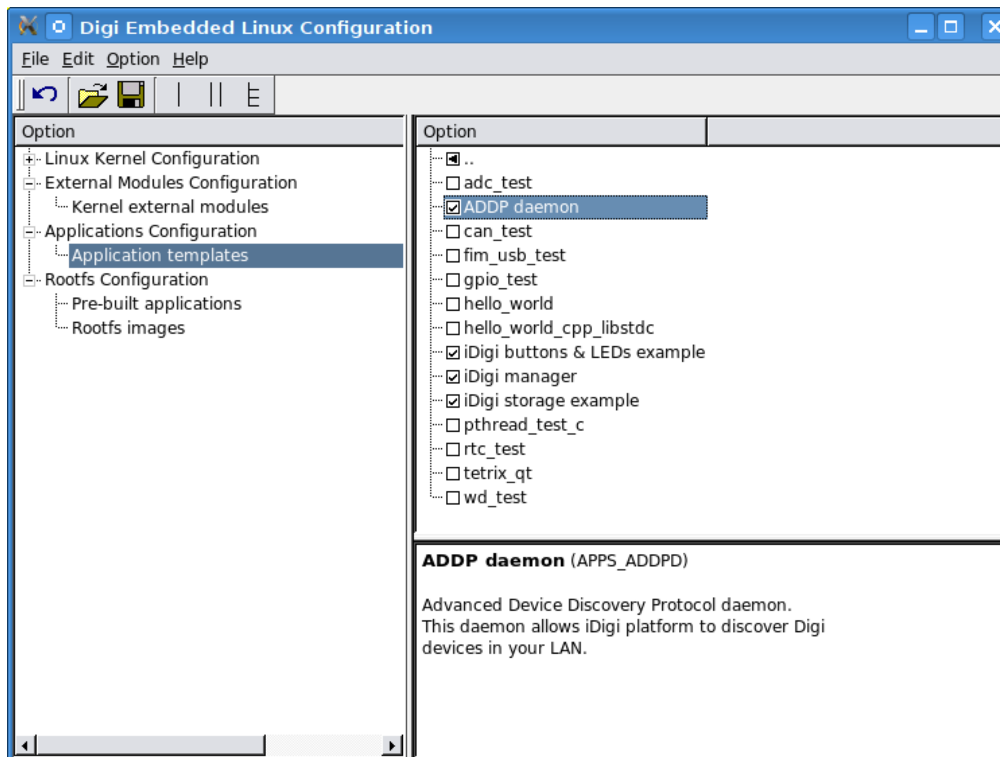
- **Sample Applications** that run on the embedded device side.
- **Libraries** to support iDigi.
- **Client Sample Applications** that run on a host PC and communicate with the application running on the device.
- **Documentation** (this manual).
- **Header files** for iDigi application development.
- **Configuration file** for iDigi applications.
- **Source code** for the device sample applications and for the client sample applications.

The following instructions assume you have created a Digi Embedded Linux project with support for applications and root file system. If you have not done so, please refer to Digi ESP™ for Embedded Linux documentation (accessible via an icon in your desktop after installing Digi Embedded Linux) for instructions.

2.2.1. Adding the device sample applications

Open the configuration tool on your project (by pressing the **Configure Project** button in Digi ESP or running *make xconfig* if using the command line) and in the **Applications** section select the following elements:

- **ADDP daemon**
- **iDigi buttons & LEDs example**
- **iDigi manager**
- **iDigi storage example**



The necessary iDigi libraries will be automatically added to your root file system.

The iDigi Buttons and LEDs application makes use of the two user buttons and user LEDs on the development board. For the application to work it is necessary that their associated GPIOs are not being used by any other driver or application.

If using platform *ccw9m2443js*, the wireless interface uses LED1 of the development board for showing the wireless status. You must disable this feature in the kernel configuration under *Device Drivers > Network device support > Wireless LAN > Digi Piper Wifi support > Enable GPIO for Wifi status LED.*

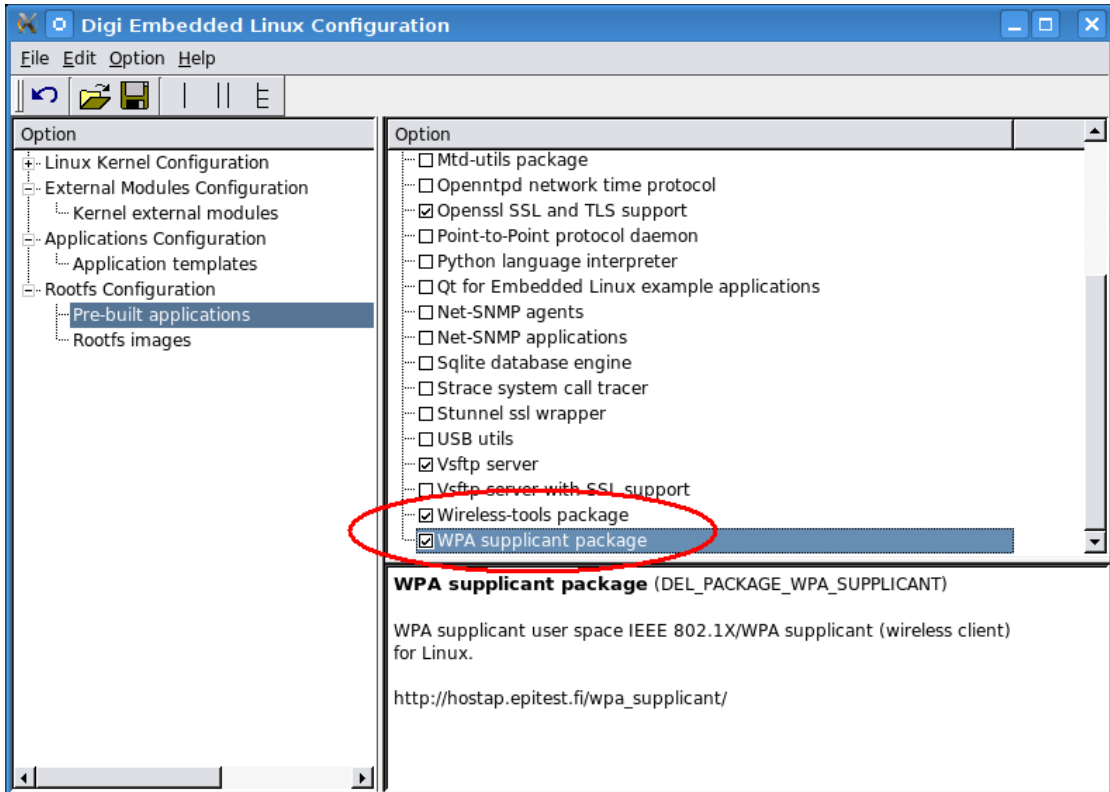
If you are using the ConnectCard for i.MX28 platform, AUART1 and AUART2 conflict with the user buttons and LEDs. Please refer to your OS documentation to disable them to be able to run the user and button led demo. Please refer to the Hardware Reference manual of the platform for specific instructions about needed configuration jumpers.

2.2.2. Including wireless tools

If you own a wireless capable platform, you must add the following wireless applications to your root file system since iDigi makes use of them when configuring the wireless adapters.

Go to **Rootfs Configuration > Pre-built applications** and enable:

- **Wireless-tools package**
- **WPA supplicant package**



Save the changes and exit the configuration tool.

2.2.3. Build the project

Build and install your Digi Embedded Linux project.

2.2.4. Configuration file

When adding support for iDigi sample applications, the iDigi configuration file is copied to your root file system at **/etc/idigi.conf**.

Initially, you do not need to modify this file. Section *7 Configuration file* explains the configuration file in detail.

2.3. Start the embedded device

Update the flash of your device with the new system and start it. Please refer to the Digi ESP for Embedded Linux documentation for instructions on updating your embedded device firmware.

2.3.1. Configuring the network interface

To be able to remotely manage your device through iDigi and use the iDigi Web Services API, you need to configure the device so that it establishes a connection to iDigi. For this, you may need to configure the IP address, subnet mask and gateway of your embedded device's network interface, as well as the DNS addresses, so that it can route packets to the Internet and resolve Internet names. All these network settings can be permanently configured in the U-Boot console. Please refer to the U-Boot Reference Manual for instructions on configuring the network parameters of your embedded device.

To see if your device has access to the Internet, you can perform a ping to the Digi website:

```
# ping www.digi.com
PING www.digi.com (172.16.1.69): 56 data bytes
64 bytes from 172.16.1.69: seq=0 ttl=250 time=339.719 ms
64 bytes from 172.16.1.69: seq=1 ttl=250 time=349.424 ms
64 bytes from 172.16.1.69: seq=2 ttl=250 time=363.303 ms
64 bytes from 172.16.1.69: seq=3 ttl=250 time=343.482 ms
```

Note, the first time this is done it may take some seconds for the embedded device to resolve the name before the ping packets can be transmitted.

If you cannot ping an Internet address, check that you have a default route in your system:

```
# route
Kernel IP routing table
Destination   Gateway        Genmask        Flags Metric Ref    Use Iface
10.101.0.0    *              255.255.0.0    U     0      0      0   eth0
default       mygateway      0.0.0.0        UG    0      0      0   eth0
```

and that your system has registered your DNS addresses set in U-Boot:

```
# cat /etc/resolv.conf
# Automatically generated
nameserver 2.2.2.2
nameserver 8.8.8.8
```

2.3.2. ADDP daemon

The ADDP daemon (addpd) will launch automatically at start, allowing the device to be discovered by iDigi. You can see it start in the boot messages:

```
...
Starting addpd: OK
...
```

You can also check that the *addpd* daemon is running with:

```
# ps | grep addpd
254 root        708 S     /usr/sbin/addpd
275 root       1120 S     grep addp
```

If the daemon is not running, you can launch it manually with:

```
# /etc/init.d/S81addpd.sh start
Starting addp daemon: OK
```

ADDP daemon listens to multicast Digi device discovery packets on your LAN.

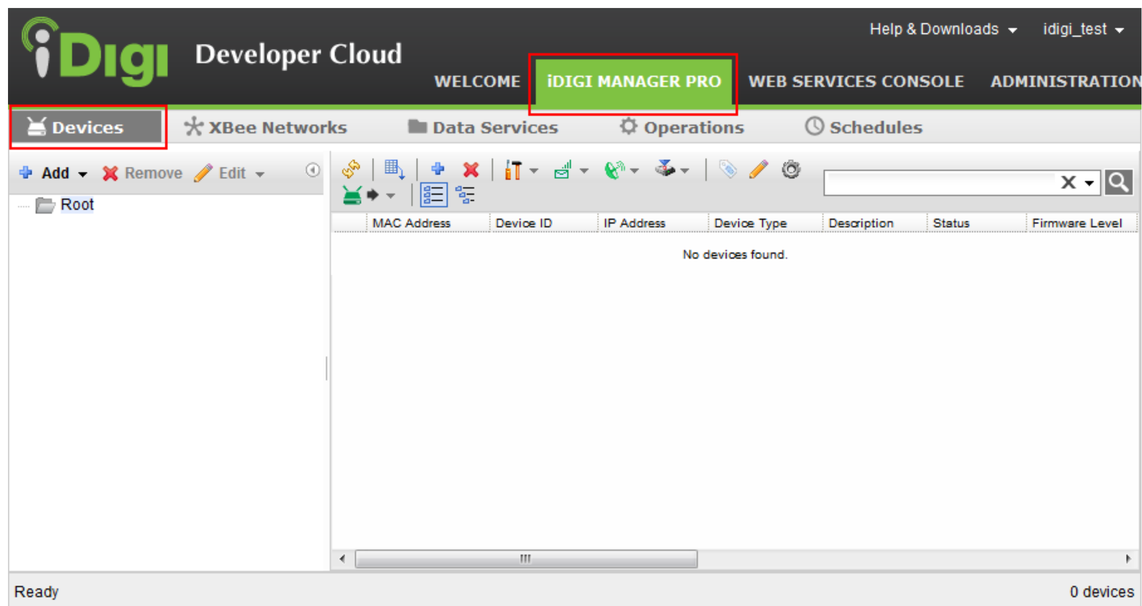
2.4. Register your device to your iDigi account

To manage your device remotely via iDigi, you must first register it within your iDigi account.

iDigi Manager Pro uses JAVA language. It is important that your PC has the latest version of JAVA runtime environment installed and that the Internet browser has JAVA enabled. Refer to section 1.7.Requirements for more information

To register your device:

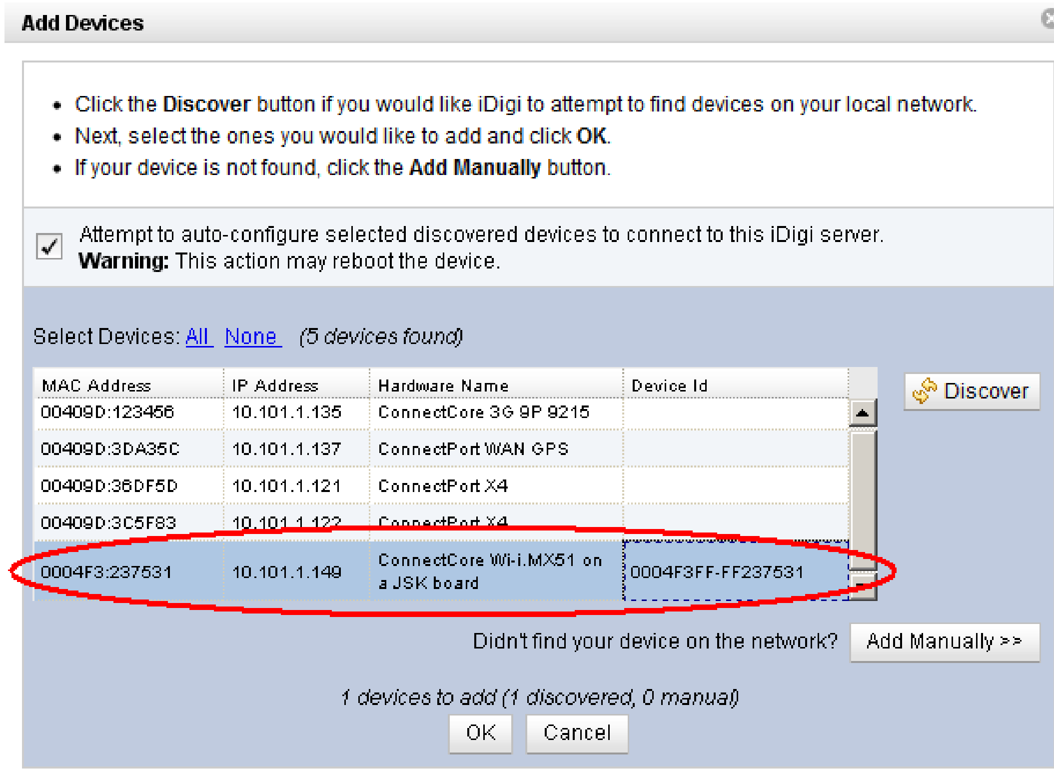
1. Navigate to *http://developer.idigi.com* in a web browser.
2. Login with the username and password you created in section *2.1 Creating a new iDigi account.*
3. Open the Devices page by selecting the **Devices** menu within the **iDigi Manager Pro** tab.



Initially, your account will not have any registered devices.

4. To add a device, click the Add Devices button (➕) within the Devices page's toolbar. The *Add Devices* applet will be displayed.

5. Click the Discover button to display all the Digi devices discovered in your LAN through the ADDP protocol.



6. Locate your Linux Embedded Device by its Hardware Name and MAC or IP address. Select your device from the list and click **OK** to add the device to your account. If the checkbox on top is enabled, the device will be configured to connect to that iDigi server and the device will reboot.

2.4.1. Manual registration

If your device does not appear in the list, you can add it manually if you know the MAC address of the primary wired Ethernet interface:

1. Click the **Add Manually >>** button within the *Add Devices* applet.

2. Select the **MAC Address** option from the drop-down box, then type in the MAC address of your device's primary wired network interface.

Add Devices

Enter a device's MAC address and click **Add** for each device you want to add. If the device doesn't have a MAC address then add it by IMEI number or device ID. (Click here for details.)
To find devices on the local network click the **Launch discover** button. When you are done click **OK**.

MAC Address: | 01:02:03:04:05:06 | Add

MAC Address	Device ID

Remove

<< Discover Find your device on the network.

No devices to add

OK Cancel

3. Click **Add** to add it to the list.
4. You will be redirected to the previous Add Devices applet page. Your device will now appear in the list. Select your device entry from the list and click **OK**.

2.4.2. Device ID

The Device ID is a 16 octet number that uniquely identifies a device within iDigi. For embedded devices, the Device ID is built using the MAC address of the primary wired Ethernet interface of the device (typically 'eth0'). In the example above, for a MAC: 01:02:03:04:05:06, the Device ID is 00000000-00000000-010203FF-FF040506 (for clarity, initial zeros on the left part will be hidden).

2.4.3. Check that your device is registered

If your device was successfully registered, it should now appear in your Devices list. Initially it will appear as *Disconnected*.

2.5. Registration of a Vendor ID

A Vendor ID is a unique identifier assigned by Digi to an OEM. To understand the need to request a Vendor ID, the concepts of *Device Type* and *Firmware Version* must be introduced and some background about how iDigi stores information must be given.

2.5.1. Device type

The *Device type* (shown as *deviceType*) is a string representing a particular kind of device. Devices with the same *deviceType* should share a reasonably similar set of features.

This string can be supplied in the configuration file */etc/idigi.conf* in your device's rootfs, in section DEVICE_CONFIG_GROUP:

```
[DEVICE_CONFIG_GROUP
vendorId=
firmwareVersion=1.0.0.0
deviceType=My Device Type I
companyName=Digi International Inc.
deviceModel=
certificateStore=
]
```

If no value is given to *deviceType* the hardware platform name will be used by default.

2.5.2. Firmware version

The F*irmware Version* (shown as *firmwareVersion*) is a 32 bit value given as four decimals separated by periods, which represents the version of the firmware running in your embedded device. The value must be defined by the user in the configuration file:

```
[DEVICE_CONFIG_GROUP
vendorId=
firmwareVersion=1.0.0.0
deviceType=
companyName=Digi International Inc.
deviceModel=
certificateStore=
]
```

2.5.3. Cached data in iDigi

For certain devices, connection to the Internet may be intermittent and/or expensive. For this reason, data and descriptors (meta-data) are cached on iDigi instead of being constantly polled and refreshed.

Data presented to you about your device in iDigi Manager Pro is normally data that was cached sometime in the past and may not be the most up to date real data. iDigi Manager Pro contains a **Refresh** button which can be pressed in order to force the query of current data.

A combination of device type and firmware version is used as a key to cache information such as RCI descriptors, default values, and other information.

Currently, there is no process for acquiring a device type beyond simply choosing one and hoping that it is available and does not collide. If a collision does occur, there is the possibility of odd behavior. For instance, if someone connects a device to the iDigi platform with the device type “VendingMachine” iDigi will attempt to acquire information from this device. This information can be used for multiple purposes such as generating the management UI for the device or determining if the device can support file uploads. This information is expensive to acquire, so it is cached in the platform making it available for any other device that connects using the device type and firmware version. Additionally, some devices may not support being queried for this information directly, so it can be loaded into the platform out of band and available for later use.

There is nothing stopping someone else from choosing a device that also has the device type “VendingMachine”. This device may be significantly different, but the platform will still think it can apply its cached data to the device type. As a result, the device will have a broken UI, as it will show management options and other features that may not be applicable to the device.

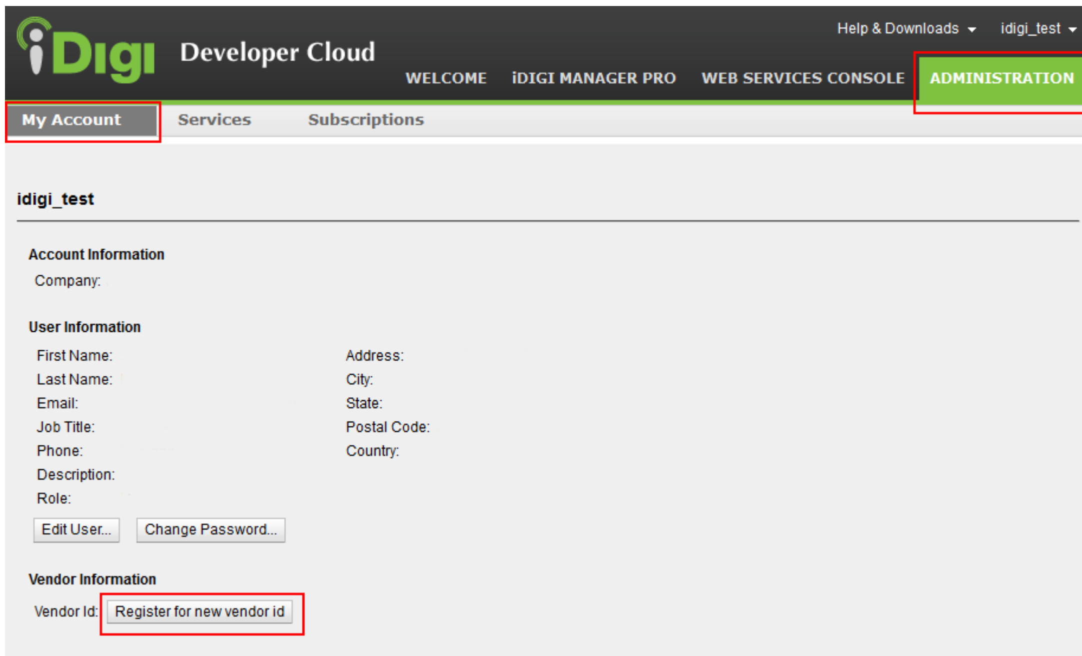
Vendor ID registration is a process that allows third parties to create their own device types without having to worry about the type already existing, or someone coming in later and overwriting the cached data for their type.

2.5.4. Register a new Vendor ID

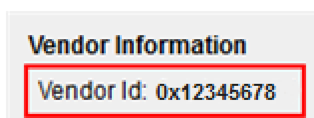
Registering a Vendor ID (shown as *vendorId*) is optional. If you do not register a Vendor ID, a common Vendor ID will be assigned allowing you to work normally. The only risk of not registering a Vendor ID is that another iDigi user chooses the same device type and firmware version as your device and the collision explained above could occur.

To avoid this from happening, request a new Vendor ID as explained:

1. Select the **My Account** menu within the **Administration** tab, then click the **Register for new vendor id** button:



2. A unique Vendor ID number will be assigned to your iDigi account.



2.5.5. Instructing devices to supply the Vendor ID

Once a Vendor ID is assigned to your iDigi account, all registered devices must supply the Vendor ID number when they connect to iDigi.

This can be done by filling the *vendorId* field in the configuration file with the Vendor ID that was assigned to your account.

```
[DEVICE_CONFIG_GROUP
vendorId=0x12345678
firmwareVersion=1.0.0.0
deviceType=
companyName=Digi International Inc.
deviceModel=
certificateStore=
]
```

If you do not supply one, the default Vendor ID will be used, but you will not be able to manage the descriptors (meta-data) of your device.

3. iDigi applications

3.1. Methods of communication

iDigi's Data Service facilitates the sending of commands and data requests from client applications to remote devices. Devices can also push data up to iDigi in the form of XML files that are saved in the iDigi database. The uploaded files are kept in collections, which are similar to folders. The organization of the collections reflects the hierarchical nature of a user's groups within iDigi. Clients can access the data within these collections and then work with it; for example, by displaying it in a graph on a webpage. Files and collections can also be accessed through the iDigi User Portal as well as via iDigi Web Services.

By their methodology two communication methods can be distinguished:

- Remote control
- Data storage

3.1.1. Remote Control

iDigi supports web services that allows requests to be sent to devices. This can be done using the *Server Command Interface* (SCI). Among other things, an SCI request can be used to wrap an RCI (*Remote Command Interface*) request. RCI provides a way for users to send a request to a single device. RCI can be used to get and set information about a device's settings/state, reboot a device, update its firmware, etc. It can also be used to send custom requests to a device.

An SCI request allows an RCI request to be sent to multiple devices at once.

3.1.2. Data storage

Applications on a device can easily send any data to iDigi with a simple function call, and the device and iDigi take care of the details. With this feature, a user can decide which data to send to iDigi and how often to send it. The data that is sent by the device will usually be in the form of an XML file that will be stored in iDigi.

3.2. Sample applications

Some sample applications are distributed with iDigi support, each representing one of the methods described above. In the following chapters, applications will be presented and ran in order to demonstrate how they work. Then, in another chapter, the source code used to understand the iDigi API will be explained.

The device applications are stored in subfolder *apps/* on your Digi Embedded Linux installation folder, typically */usr/local/DigiEL-X.Y*.

4. Remote control examples

There are two applications that run on the embedded device for showing how to remotely control an embedded device using iDigi: **idigimanager** and **idigibuttonled**.

idigimanager is a very tiny application that controls the agent on the device that is responsible for establishing the connection to iDigi Manager Pro, and allows for remote management of the device.

idigibuttonled is an application based in **idigimanager** that adds custom user commands, to demonstrate how to add custom functionality for remote management via Web Services. The purpose of this application is to allow remote control and monitoring of the device's hardware (user LEDs on the development board) through the Internet.

This last example combines the device application itself (*idigibuttonled*) written in C that runs on the embedded device, and a client application (*iDigiLedDemo*) written in JAVA that runs on a desktop PC.

Both applications (idigimanager and idigibuttonled) launch the client that establishes the connection to iDigi; therefore, they should not be running at the same time.

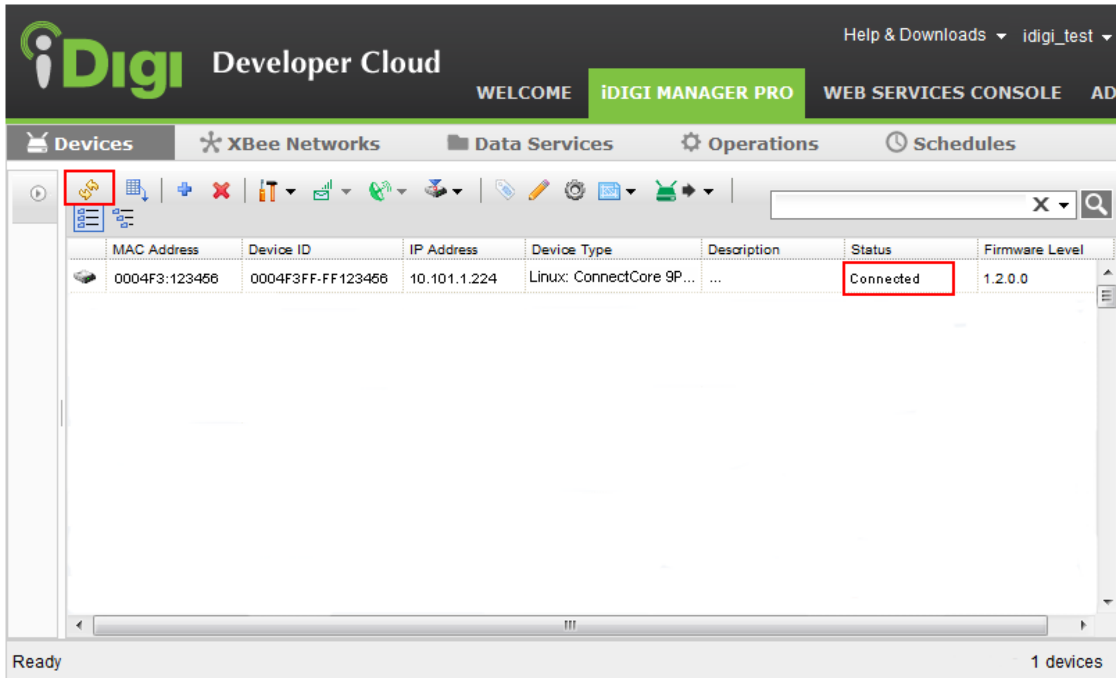
4.1. Device application (idigimanager)

This application runs on the embedded device and calls the iDigi start function that allows remote control of the device from within iDigi.

If you included this application in your project (as explained in section *2.2.1 Adding the device sample applications*) you can run the application with:

```
# idigimanager
Application: iDigi Manager
Network support in firmware:
                Ethernet
Device ID: 00000000-00000000-0004F3FF-FF690045
Vendor ID: 0xFE080003
Device Type: ConnectCore 9P 9360 on a JumpStart board
Acquired Ethernet MAC address=00:04:f3:69:00:45
IP information:
                IP address=10.101.1.143
                Netmask=255.255.255.0
                Gateway=10.101.1.1
                Primary DNS=10.49.2.2
                Secondary DNS=10.10.8.62
Initiating client-initiated connection
Finding Service, URL=en://developer.idigi.com
Trying to connect via TCP...
Version OK
Verifying ID
ID Verify Passed
Connected Using TCP to en://developer.idigi.com
```

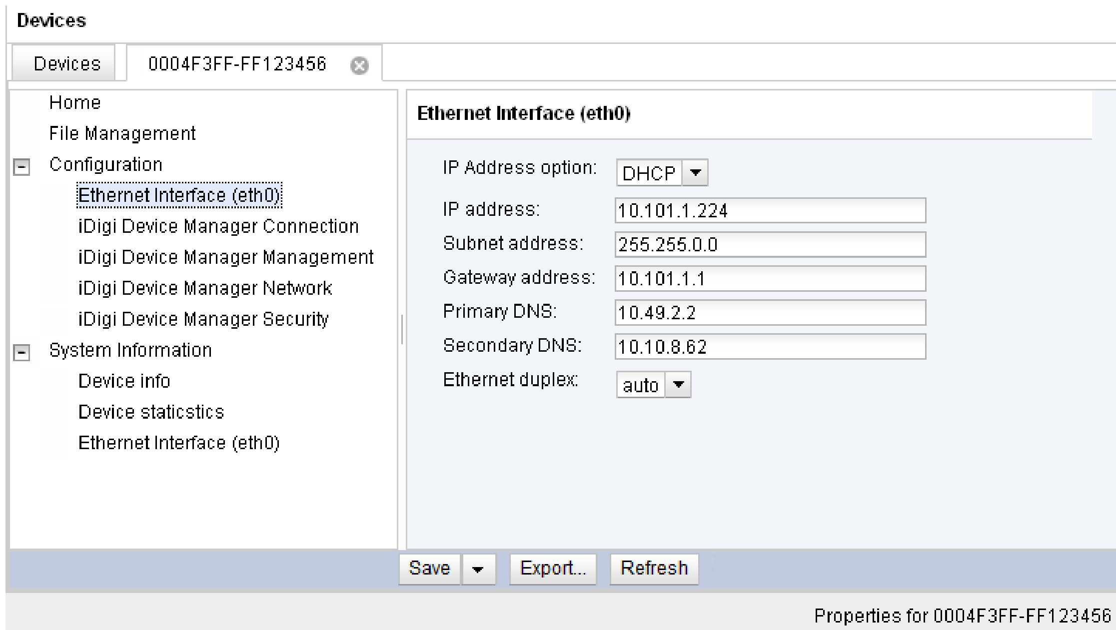
The application should now be able to connect to iDigi. Click the **Refresh** button within the Device page's toolbar to ensure that your device was successfully connected. Once refreshed, your device's status should appear as *Connected.*



4.1.1. Device properties

You are now able to double-click the device and explore the device's properties and settings.

Once the *Properties* Page is opened for a device, various options can be displayed and configured. The example below shows the Ethernet Interface settings for a device. The System Information section displays items including System Uptime, Firmware Version, Used Memory, and CPU Utilization.



Some of the settings are read only, while others can be modified.

Be careful when modifying network settings, as a bad configuration might prevent your embedded device from connecting to the Internet, thus losing the connection to iDigi.

4.1.2. File system management

The **File Management** section allows a user to browse through the embedded device's file system.

This tool also allows some manipulation of the file system such as uploading, downloading, and deleting files.

Devices

Devices | 0004F3FF-FF123456

Home
File Management
Configuration
Ethernet Interface (eth0)
iDigi Device Manager Connection
iDigi Device Manager Management
iDigi Device Manager Network
iDigi Device Manager Security
System Information
Device info
Device staticstics
Ethernet Interface (eth0)

File Management

/ Go

File Name	Size (bytes)
bin	0
dev	0
etc	0
home	0
lib	0
media	0
mnt	0
nfs	0

Save | Export... | Refresh

Properties for 0004F3FF-FF123456

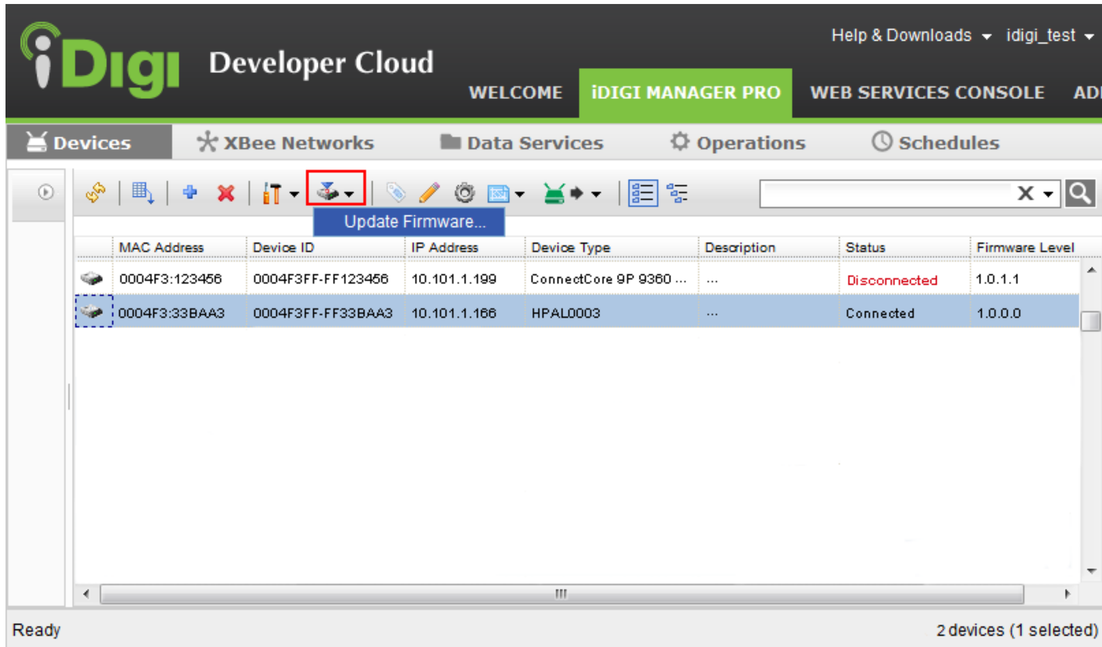
Files are transferred via HTTP with base64 encoding which adds an overhead of around a 33% in the size being transferred.

Transfer of big files is subject to the available free RAM memory in the embedded system.

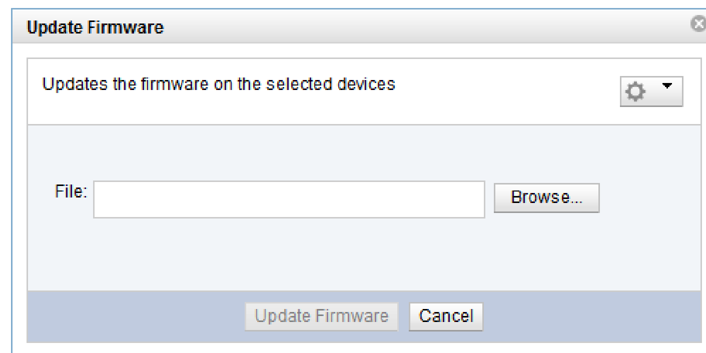
4.1.3. Firmware update

iDigi allows a user to remotely update the firmware of their embedded device (to do so you must be logged in to iDigi). To remotely update a device's embedded firmware:

1. Open the Devices page by selecting the **Devices** menu within the **iDigi Manager Pro** tab.
2. From the devices list, select the device or devices (more than one can be updated at the same time) that you want to update.
3. Click the **Firmware** button within the toolbar, then select **Update Firmware...**.



An update firmware dialog will then be displayed allowing you to select a firmware file on your host PC to be sent to the device for updating the Flash memory.



4.1.3.1. Firmware files and partitions

A device running Digi Embedded Linux has its Flash memory segmented in different partitions. The partition table can be defined using the U-Boot monitor and the **flpart** command. Please refer to the U-Boot Reference Manual for instructions about modifying the Flash partition table.

iDigi Manager Pro's firmware update utility allows the user to update only <u>one</u> Flash partition at a time. The user, however, does not need to select which partition he/she wants to update. The partition that will be updated is selected automatically based on the filename of the file being sent to the embedded device.

There is a table in the iDigi configuration file */etc/idigi.conf* that links each Flash partition to a filename pattern defined by a regular expression. This table can be found within the *FLASH_UPDATE_GROUP* section, and by default has the following entries:

```
[FLASH_UPDATE_GROUP
U-Boot=u-boot.*\.bin
NVRAM=nvram-.*
Splash=splash\.bmp
Kernel=uImage-.*
RootFS=rootfs-.*
UserFS=
]
```

Each entry is formed by a pair:
`partition_name=filename_pattern`

where *partition_name* is the name of the Flash partition as given in U-Boot, and *filename_pattern* is a regular expression that a filename must match in order to be used to update the referred partition.

For example, the first entry `U-Boot=u-boot.*\.bin` tells the device to update the U-Boot partition if the received filename begins with the string **u-boot**, then it has zero or more characters, and finishes with the extension **.bin** (note the dot is escaped with the backslash to have it taken as a literal character). This regular expression will accept filenames like *u-boot.bin*, *u-boot-cc9p9360js.bin, u-boot123.bin...* but will reject filenames like *uboot.bin, u-boot.img, U-Boot.bin*.

The third entry `Splash=splash\.bmp` tells the device to update the Splash partition only if the received filename matches the string **splash.bmp** exactly and no other strings.

The default values in the configuration file are already set up to match the standard binary image names produced by the Digi Embedded Linux development environment. Normally you will not want to change the table in the configuration file unless you have decided to modify the standard names of the images produced by Digi EL.

If a filename matches two or more patterns in the table, the file will be written to the first partition whose pattern matches the filename. The rest of partitions will be ignored.

If a partition's name does not appear in the configuration file, or if it appears but has no defined pattern (as it occurs with entry `UserFS=`) the device will accept, by default, a filename in the form **partitionX** where **X** is the index of the partition in the U-Boot partition table (starting at index 0). So, if a *UserFS* partition has an index of 6 in the U-Boot partition table, a file named **partition6** (without extension) will be written to the *UserFS* partition.

For example, if a user goes to U-Boot and creates a new partition called *myTest,* which is given index 7, two things can be done to update this partition using iDigi Manager Pro's firmware update tool:

- Leave the configuration file as it is and create your images for this partition with the name **partition7** (without extension).
- Edit the configuration file and add an entry for the new partition with a new pattern. For example *myTest=mytest\.img* which would only accept filename **mytest.img** (note the *idigimanager* application must be stopped and launched again in order to accept any changes in the configuration file).

Users are encouraged to extend the table in the configuration file to match their specific Flash partition table.

Firmware updates may take some time as the image files are transferred over the Internet to your embedded device. The time depends on the size of the file, and the speed of the connection.

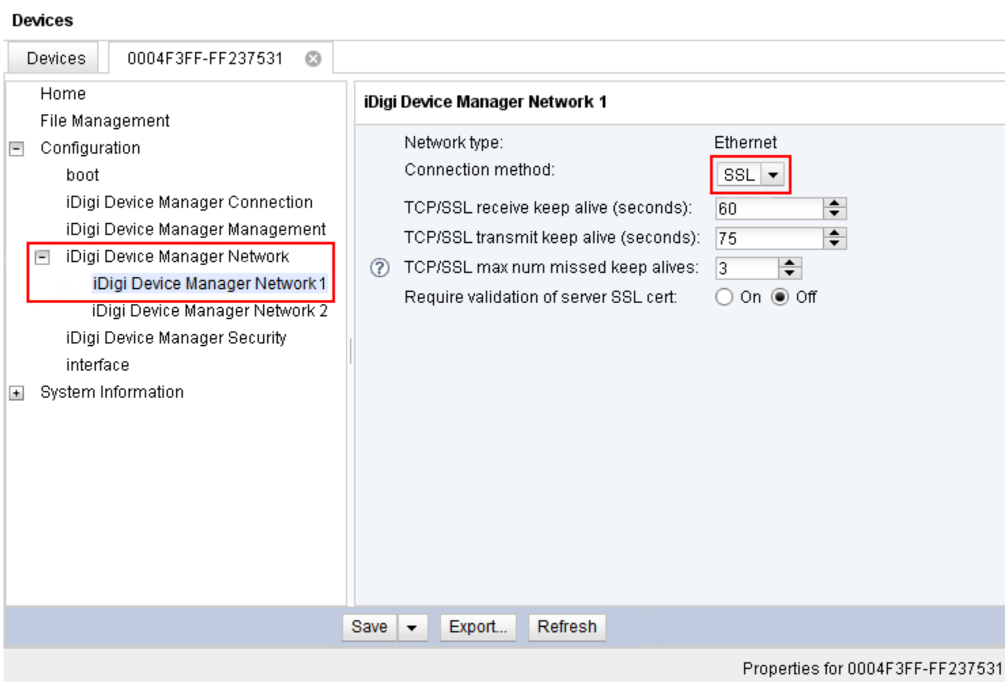
After each partition update, the embedded device will disconnect from iDigi. The application will automatically reconnect after a number of seconds defined in the configuration file under the key *clientConnectionReconnectTimeout*.

Since the root file system partition is a critical partition, if it is being updated the device will reboot when the update process is complete (after reboot you will need to start the *idigimanager* application again because it does not start automatically).

4.1.4. Securing the connection

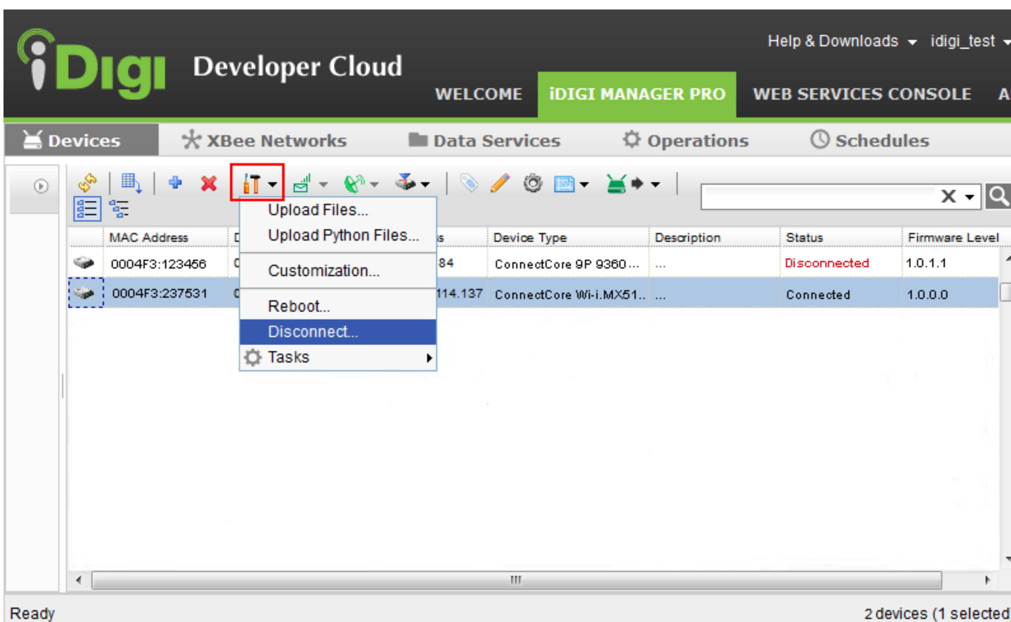
Security within iDigi is provided via SSL. By default, connections are not secured. To activate SSL, open the Devices page by selecting the **Devices** menu within the **iDigi Manager Pro** tab. From the devices list select the device that you want to update, then double-click on the device to open its Properties page.

From the menu displayed, click on **Configuration** and then select the **iDigi Device Manager Network** option from the list. If you have more than one network interface you must select the one that is used for connecting the device to the Internet.



If the device's *Connection method* setting is set to TCP, change it to SSL then click the **Save** button to save your changes. The new connection method will not be applied until the device is disconnected and reconnected again.

To disconnect the device from iDigi, return to the Devices page and select your device from the list. Then, click on the **Administration** button within the toolbar and select **Disconnect…**.



The application will automatically reconnect again after a number of seconds defined in the configuration file under the key *clientConnectionReconnectTimeout*. The reconnect timeout value can be changed (or even disabled) within iDigi under the *iDigi Device Manager Connection* section.

Verify that the new connection is encrypted via SSL by looking at the messages printed on the console:

```
...
Trying to connect via TCP...
Wrapping the connection through SSL
Connected with EDH-RSA-DES-CBC3-SHA encryption
Version OK
...
```

4.1.5. Validation of server SSL certificate

By default, validation of SSL certificates sent by the iDigi server are disabled. To enable validation of SSL certificates, open the Devices page by selecting the **Devices** menu within the **iDigi Manager Pro** tab. From the devices list select the device that you want to update, then double-click on the device to open its Properties page. From the menu displayed, click on **Configuration > iDigi Device Manager Network**, then select **iDigi Device Manager Network 1**. You can turn required validation ON and OFF by selecting the radio buttons within the **Require validation of server SSL cert** option.

Devices
Devices | 0004F3FF-FF237531
Home
File Management
Configuration
Ethernet Interface (eth0)
iDigi Device Manager Connection
iDigi Device Manager Management
iDigi Device Manager Network
iDigi Device Manager Network 1
iDigi Device Manager Network 2
iDigi Device Manager Security
Wireless Interface (wlan0)
System Information

iDigi Device Manager Network 1
Network type: Ethernet
Connection method: SSL
TCP/SSL receive keep alive (seconds): 60
TCP/SSL transmit keep alive (seconds): 75
TCP/SSL max num missed keep alives: 3
Require validation of server SSL cert: On Off

Save | Export... | Refresh
Properties for 0004F3FF-FF237531

This action will tell the embedded device to reject the connection if the certificate sent by the server could not be authenticated.

Authentication of the server certificate happens in two ways:

- If the certificate sent by the server is a self-signed certificate, the embedded device must have the same certificate (PEM format) in the trusted certificates store within the root file system.
- If the certificate sent by the server is a CA signed certificate, the embedded device must have the CA's root certificate (PEM format) in the trusted certificates store within the root file system.

In order to use peer validation you will need to obtain the self-signed or root CA certificate for the iDigi server you are connecting to.

If peer validation is enabled without the correct CA certificate loaded, the device will not be able to connect to iDigi.

4.1.5.1. Instructions for configuring Linux for peer certificate validation

1. **Download the iDigi Device Cloud CA certificate**

   Navigate to (*http://developer.idigi.com*) and login to your account. From the **Help & Downloads menu** (in the upper-right corner of the page's banner) select the **Downloads** option. The iDigi Help & Downloads resources page will be displayed. Within the General Downloads section of the page, locate the *iDigi Device Cloud CA Certificate* link and download it. Extract it to your development computer at the place where the rest of your certificates are stored (for example at */etc/ssl/certs/*).

2. **Create a symbolic link to the certificate with the name of the certificate's hash**

   Use the **openssl** application to obtain the certificate's hash:

```
# cd /etc/ssl/certs
# openssl x509 -hash -noout -in idigi-ca-cert-public.crt
789761b3
```

   Then create the symbolic link with the hash:

```
# ln -s idigi-ca-cert-public.crt 789761b3
```

3. **Set the path to the certificate in the configuration file (/etc/idigi.conf)**

   Edit the iDigi configuration file on your device rootfs (/etc/idigi.conf) and add set the field **certificateStore** to the path where the CA certificate is:

```
[DEVICE_CONFIG_GROUP
vendorId=
firmwareVersion=1.0.0.0
deviceType=
companyName=Digi International Inc.
deviceModel=
certificateStore=/etc/ssl/certs/
]
```

Given that targets sometimes haven't configured the system time (because the RTC is disabled or not powered) a common problem when activating SSL certificate validation, is the connection denial due to causes like "Certificate is not yet valid" or "Certificate expired".

Please check that the system time and date are properly setup in your target to avoid these connection problems.

4.2. Device application (idigibuttonled)

This application is based on **idigimanager** application. It runs on the embedded device and does the following:

- Registers custom user command functions that will be called when certain custom RCI requests arrive at to the embedded device (for controlling the LEDs).

- Launches a thread that polls the pressing of user buttons and toggles the associated user LEDs. When a user presses BUTTON1, the associated LED1 will toggle its status. When a user presses BUTTON2, the associated LED2 will toggle its status.
- Calls the iDigi **start** function that allows remote control of the device within iDigi.

If using platform *cme9210js*, BUTTON1 is associated with LED2 and BUTTON2 is associated with LED3. Refer to section *8.2 LEDs on hardware platform*.

As explained in section *2.2.1 Adding the device sample applications*, no other interface or application should be using the user GPIOs or LEDs for the example to work properly.

If you included this application in your project as explained in section *2.2.1 Adding the device sample applications* you can run the application with:

```
# idigibuttonled
Application: iDigi LEDs & Buttons demo
Network support in firmware:
                Ethernet
Device ID: 00000000-00000000-0004F3FF-FF690045
Vendor ID: 0xFE080003
Device Type: ConnectCore 9P 9360 on a JumpStart board
Acquired Ethernet MAC address=00:04:f3:69:00:45
IP information:
                IP address=10.101.1.143
                Netmask=255.255.255.0
                Gateway=10.101.1.1
                Primary DNS=10.49.2.2
                Secondary DNS=10.10.8.62
Initiating client-initiated connection
Finding Service, URL=en://developer.idigi.com
Trying to connect via TCP...
Version OK
Verifying ID
ID Verify Passed
Connected Using TCP to en://developer.idigi.com
```

The device will connect to the iDigi server specified in the */etc/idigi.conf* configuration file (by default *http://developer.idigi.com*).

4.2.1. Testing the buttons and LEDs thread

As introduced previously, the sample application also launches a thread which toggles the user LEDs upon button presses.

Press the user buttons on the development board and check that their associated LEDs toggle on each button press.

4.3. Client application (iDigiLedDemo.jar)

The Client application *iDigiLedDemo.jar* is a JAVA executable that can be found in the DigiEL installation folder under */usr/local/DigiEL-X.Y/idigi/client_apps/iDigiLedDemo/bin*. To execute it in a Linux PC, Java Runtime Environment must be installed and you must have access to the Internet.

To run it:

```
$ cd /usr/local/DigiEL-X.Y/idigi/client_apps/iDigiLedDemo/bin/
$ java -jar iDigiLedDemo.jar
```

A dialog box will appear. Follow these steps to configure and run the application:

1. Double-click the executable.
2. In the iDigi Account window enter your iDigi username and password, and use **developer.idigi.com** for the iDigi Server name. Then click the **Connect to iDigi** button.

3. The application will connect to your iDigi account and the Device ID combo box will be filled in with all the devices registered in your iDigi account. Select your Device ID from the combo box and click **Start the application with the selected device**.

4. The main window of the application displays the status of the two LEDs (representing the LEDs on the development board) and the two user buttons (representing the buttons on the development board). A text box is also available to establish the refresh time (the number of seconds after which a request will be sent to the device, to check the status of the LEDs). This refresh time can be modified by the user. The time remaining until the next refresh is showed at the bottom of the window.

5. The JAVA client application performs the same functions as the device application that is already running on the embedded device. When a user clicks on BUTTON1, the associated LED1 will toggle its status. When a user clicks on BUTTON2, the associated LED2 will toggle its status. This has immediate effect on the development board and demonstrates how a embedded device can be remotely controlled through the Internet.

6. If a user physically presses a button on the development board, the associated LED will toggle. The JAVA application will not update its status until the refresh period is over.

5. Data storage example

The purpose of this example is to allow the device to upload data to the iDigi data storage service (Data Services). This communication method is typical of devices that do not need to be remotely controlled, but instead, need to report or log some form of data, to be retrieved asynchronously.

This example is formed using a device application (*idigistorage*) written in C that runs on the embedded device plus a JAVA application (*iDigiTankDemo*) that grabs the data from iDigi and represents it graphically.

5.1. Device application (idigistorage)

This application simulates an embedded device, controlling different sensors and actuators on a tank which is filled with a certain liquid:

- Temperature sensor
- Level sensor
- 5 valves that control the input/output of liquid

The embedded device should periodically report the measurements of the sensors and the status of the valves, to keep track of the tank status. Since the application is just an example that runs on the development board, instead of having sensors and actuators random values will be generated and they will be limited to a certain range.

The device will periodically push data (including the date and time of the measurements) as an XML file. The method of formatting data being pushed to iDigi is up to the user. For this example the following format for the tank data has been designed:

```
<tank>
     <date>2010/03/21</date>
     <time>21:55:38</time>
     <level>68%</level>
     <temperature scale="Celsius">17</temperature>
     <valve id="0">closed</valve>
     <valve id="1">open</valve>
     <valve id="2">open</valve>
     <valve id="3">closed</valve>
     <valve id="4">open</valve>
</tank>
```

The file will be saved into the iDigi data storage service (Data Services) to the path */<device-id>/examples/tank.xml*. Again, the path can be anything the user wants (the root folder is always the Device ID and is added automatically).

Every X seconds the application will generate new data and will send the new file to the same path (thus overwriting the old file). The period can be set by the user through the command line (with a minimum of 5 seconds). Default period is 10 seconds.

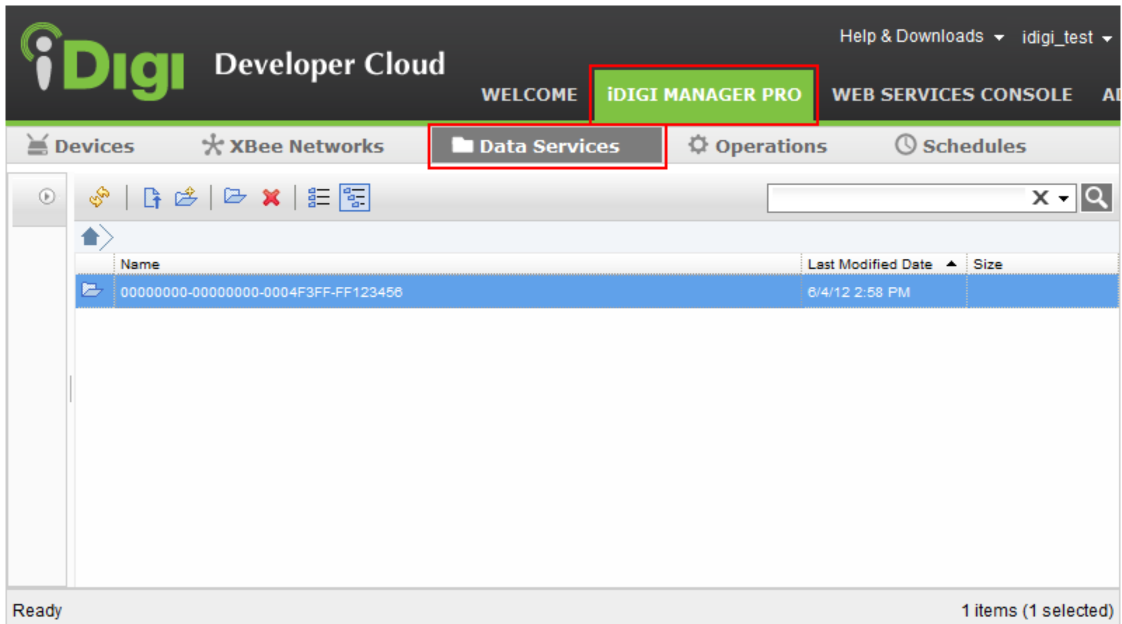
If you included this application in your project as explained in section *2.2.1 Adding the device sample applications,* you can run the application with:

```
# idigistorage -t 10
Application: iDigi Storage demo (tank simulation)
File transferred OK
 Sleeping for 10 seconds
```

where -t sets the number of seconds to wait before sending updated data.

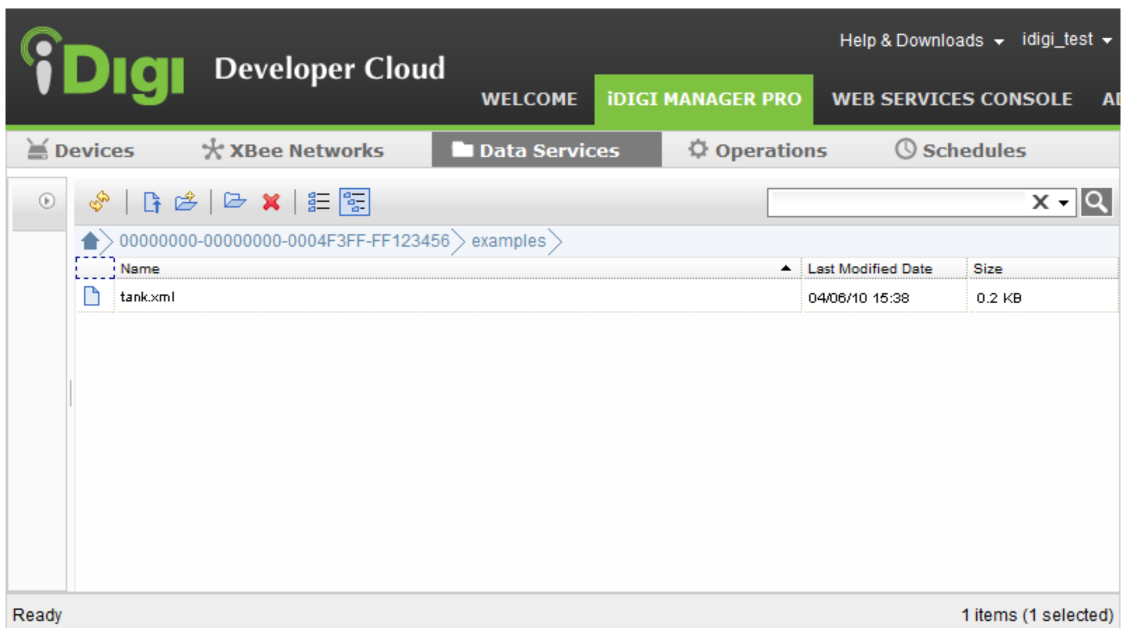
5.1.1. Retrieving data from iDigi

The data file pushed by the embedded device to iDigi can be manually retrieved from the Data Services page. To open this page, select the **Data Services** menu within the **iDigi Manager Pro** tab.



Double-click on the folder that matches your Device ID, and then on the subfolder titled *examples.*

The top bar shows the complete file path within iDigi Storage service.



Finally, double-click the *tank.xml* file to access its contents.

5.2. Client application (iDigiTankDemo.jar)

Data files can be retrieved using a PC client application by means of Web Services. All that the client application needs to do is to send an HTTP GET request to the address **developer.idigi.com/ws/data/<*file_path*>** and it will receive the XML file.

In the example above, the <*file_path*> would be:

00000000-00000000-00004F3FF-FF123456/examples/tank.xml

The client application *iDigiTankDemo.jar* is a JAVA executable that can be found in the Digi EL installation folder under */usr/local/DigiEL-X.Y/idigi/client_apps/iDigiTankDemo/bin*.

This client application receives the *tank.xml* file via Web Services as explained above, then parses and interprets the data within and represent it in a graphic with the tank.

To execute this application in a Linux PC, you must have the Java Runtime Environment installed and have access to the Internet. To run it:

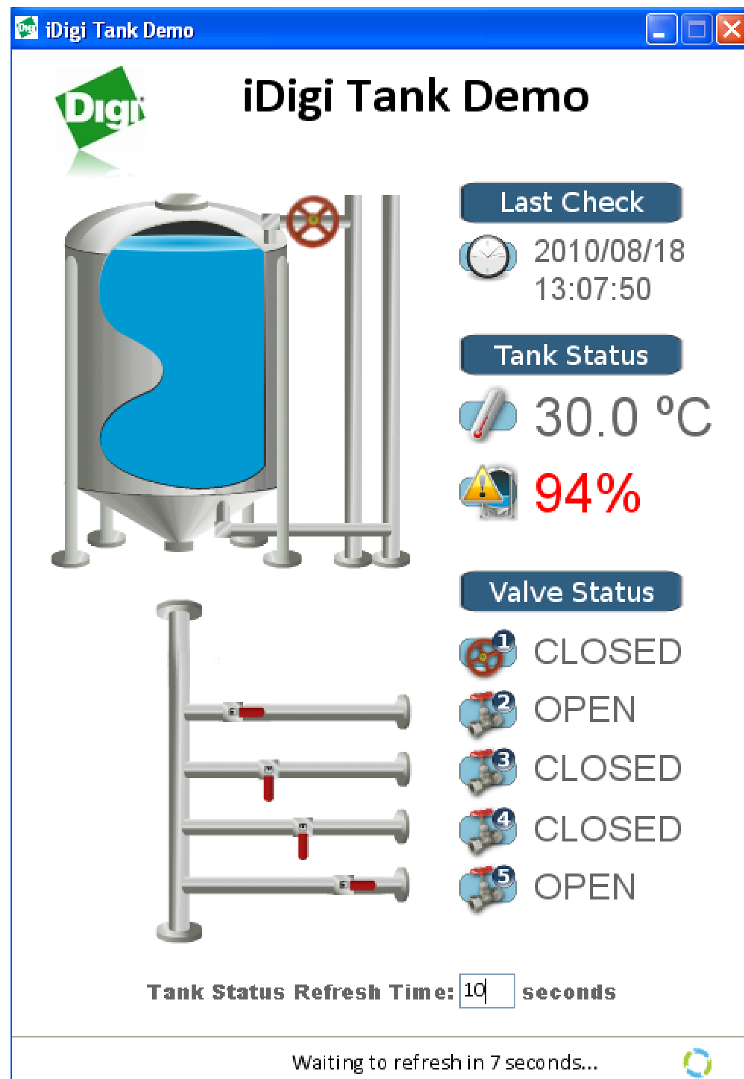
```
$ cd /usr/local/DigiEL-X.Y/idigi/client_apps/iDigiTankDemo/bin/
$ java -jar iDigiTankDemo.jar
```

A dialog box will appear. Follow these steps to configure and run the application:

1. Double-click the executable.
2. In the iDigi Account window enter your iDigi username and password, and use **developer.idigi.com** for the iDigi Server name. Then click the **Connect to iDigi** button.

3. The application will connect to your iDigi account and the Device ID combo box will be filled with all the devices registered in your iDigi account. Select your Device ID from the combo box and click **Start the application with the selected device**.

4. The main window of the application shows the status of a tank, representing the data reported by the ***idigistorage*** application. This data is the tank status (temperature and level), the status of the five valves, and the date and time when the data was last reported. A text box is also available to establish the refresh time (the number of seconds after which a request will be sent to the iDigi server to read the file stored). This refresh time can be modified by the user. The time remaining to the next refresh is showed at the bottom of the window.



5. The JAVA client application reads the file from within iDigi data storage, and displays the data in a graphic interface. This application demonstrates how a device can be remotely monitored using the Internet.

6. Application development

The following chapter discusses sample device applications and the iDigi API functions used for communication between the client application and iDigi.

6.1. iDigi API functions

To use iDigi functionality you must know the following functions:

- Functions for Remote Control
  - idigi_start()
  - idigi_register_usercmd()
  - idigi_query_attribute()
- Functions for data storage
  - idigi_putfile()

6.1.1. Functions for remote control

6.1.1.1. idigi_start

This function establishes the connection to iDigi Manager Pro in an endless loop.

```
int idigi_start(void)
```

It takes no parameters and only returns upon a critical error. This function opens the connection to iDigi and waits for something to do.

6.1.1.2. idigi_register_usercmd

This function allows the user to register custom callback functions (hooks) that will be called whenever the embedded device receives a certain RCI request via Web Services.

```
int idigi_register_usercmd (const rci_desc_cmd_t *descriptor,
                            rci_desc_error_t *error_descriptor_list)
```

The function requires two parameters:

- A descriptor, which is a struct that defines the command name, description, the process callback, the response callback, and the context.
- An array of error codes and their description text.

The function returns 0 if the registration was successful or -1 on error.

6.1.1.3. idigi_query_attribute

This function is usually called from within the custom callback functions and allows the user to retrieve the value of attributes from the XML string received in the RCI request.

```
char * idigi_query_attribute(void *descriptor_handle, char *name)
```

The function requires two parameters:

- A pointer to the descriptor handle, which is accessible from within the callback functions previously registered.
- The name of the attribute whose value we want to retrieve.

The function returns the string with the attribute's value, or NULL if the attribute was not found in the XML string of the RCI request.

6.1.1.4. Functions for data storage

Only one function is needed in order to upload XML files into the iDigi Data Services.

6.1.1.5. idigi_putfile

This function uploads a data buffer to the specified path within the Device ID's folder.

```
int idigi_putfile(char *filename, void *file_data, size_t length)
```

The function requires three parameters:

- The filename, including any internal path and where to store the data (for example: "examples/tank.xml". If the path does not exist it will be created as you go.
- A pointer to the data buffer.
- The length of the buffer (in bytes).

The function returns 0 if the upload was successful or -1 on error.

6.2. The idigibuttonled sample application in detail

See section *4.2.Device application (idigibuttonled)* for more information on the idigibuttonled application.

6.2.1. Source tree

The following table shows the different files that form the application, and their functionality:

File	Description
buttonled.c	Contains the callback functions that process and respond to a custom RCI request that arrives to the embedded device via Web Services.
platform.c	Contains functions to guess the hardware platform and operate the LEDs
main.c	Contains the descriptors for the custom commands and the calls to the API functions that register the callback functions and establish the connection to iDigi.

6.2.2. RCI requests and replies

As introduced in section *1.3.2.Protocols*, the Remote Command Interface (RCI) is the high level communication protocol that the embedded device will use to communicate with iDigi. RCI is just plain text in XML format.

An RCI request specifies the XML element “rci_request” optionally with a version number.

```
<rci_request version="1.1">
</rci_request>
```

An RCI reply specifies the XML element “rci_reply” in a similar way.

```
<rci_reply version="1.1">
</rci_reply>
```

6.2.2.1. Commands

The command section describes the action requested (or action performed in replies).

Supported commands are:

Command	Request description	Reply description
query_setting	Request for device settings. May contain setting group elements to subset query (only setting group subset supported. Subsetting below this level not supported).	Returns requested config settings. Requests specifying no settings groups (eg. <query_setting/>) return all settings.
set_setting	Set settings specified in setting element. Settings data required.	Empty setting groups in reply indicate success.
query_state	Request current device state such as statistics and status. Sub-element may be supplied to subset results.	Returns requested state. Requests specifying no groups (eg.<query_state/> return all state.
set_factory_default	Sets device settings to factory defaults. Same semantics as set_setting.	Same semantics as set_setting.
reboot	Reboots the device immediately	Empty reboot node indicates success (the reply is actually sent before the reboot is performed).
do_command	If the ‘target’ attribute is ‘file_system’ it allows to run file system related operations. If the ‘target’ attribute is ‘user_defined’ it allows any custom callback function to execute.	For file system related operation, it returns the result of the operation. For user defined commands, the reply is defined by the user in a response callback function.

iDigi uses these commands to communicate with the embedded device and represent its information on the web. For example, when you click on **System Information > Device statistics** and press the **Refresh** button, the following RCI request is sent by iDigi to your device:

```
<rci_request version="1.1">
    <query_state>
      <device_stats/>
    </query_state>
</rci_request>
```

And the device answers, for example, with:

```
<rci_request version="1.1">
    <query_state>
          <cpu>17</cpu>
          <uptime>27754.09</uptime>
          <totalmem>126764</totalmem>
          <freemem>119380</freemem>
    </query_state>
</rci_request>
```

The syntax for each command element and response is predefined and it is not the purpose of this document to explain all the commands in detail.

The power of RCI resides in the **do_command** command, which allows you to create your own custom commands, assign them custom callback functions to process them, and build response messages.

```
<rci_request version="1.1">
    <do_command target="user_defined">
          <my_command my_attribute="my_value"/>
    </do_command>
</rci_request>
```

6.2.3. Defining custom commands

A client application, for example, should be able to:

- Operate the embedded device's LEDs
- Show the status of the embedded device's LEDs (which may change if operated manually on the development board)

In other words, the goal is to be able to set an LED (write) and get back its status (read).

In order to define a custom command for these two operations a user must know how to write a LED, know the LED they want to operate, and know whether they want to turn the LED ON or OFF. As an example, the following syntax can be used:

```
<led_write number="1" control="on"/>
```

where:

- **led_write** is the command
- **number** is an attribute that indicates the LED to be operated
- **control** is the action to do on the LED

To read an LED, a user only needs to know the LED they want to read.

As an example, the following syntax can be used:

```
<led_read number="1"/>
```

A complete RCI request to turn both LEDs on would then look like this:

```
<rci_request version="1.1">
    <do_command target="user_defined">
          <led_write number="1" control="on"/>
          <led_write number="2" control="on"/>
    </do_command>
</rci_request>
```

6.2.4. Implementing the custom commands callbacks

Now that the syntax that will be used for your custom commands has been defined, callback functions can be implemented to process commands and respond to them. In the previously mentioned sample application, the callbacks are implemented in *buttonled.c*.

For each command, two callbacks need to be implemented:

- A *process* callback function which processes the command and performs whatever functionality needs to be done. The *process* callback is called once for each instance of a custom command received through RCI (in the previously mentioned example, once for each <led_write> or <led_read> instance).
- A *response* callback which will create the RCI reply to be sent back to the requestor. The *response* callback is called repeatedly until it sets a response complete flag. The response buffer written by this function will be inserted between the start and end tags of the custom command. For example, if this function writes "MY REPLY TEXT", the final RCI reply would look like this:

```
<rci_reply version="1.1">
    <do_command target="user_defined">
         <led_write number="1" control="on">MY REPLY TEXT</led_write>
    </do_command>
</rci_reply>
```

Process and response callbacks are explained in detail in sections 6.2.4.1.Process callback and 6.2.4.2.Response callback.

If the response is not needed, the response callback can be set to NULL or have it respond with no text.

Instead of implementing these two callbacks for each command (led_write/led_read), a user could implement one *process* callback and one *response* callback for both commands, and use the **context** parameter (explained later on in this manual) to distinguish which command triggered the callback.

6.2.4.1. Process callback

The prototype for the *process* callback is:

```
int process(void *handle, char *data, unsigned length, unsigned long
context)
```

where:

- **handle** is a pointer to the descriptor handle.
- **data** is a buffer containing the text portion of the received custom command XML. For example, if the received command is <mycmd myattr="myval">MYTEXT</mycmd>, **data** would contain the text: MYTEXT.
- **length** is the length of the **data** buffer (in the example, the length of MYTEXT = 6).
- **context** is a number that is passed to the callback and is defined upon registration of the command descriptor.

Open the *buttonled.c* source file and check the implementation of this callback (called **led_process** in the source code). The process function does the following:

- Initially, depending on the platform used, configures the needed GPIOs (buttons and LEDs).
- Then it calls the API function idigi_query_attribute() to retrieve the **number** attribute from the RCI request. This attribute must always exist, no matter if the callback was triggered by a *led_read* or by a *led_write* command. There is some additional code to check that the received number is either 1 or 2 (which are the only allowed numbers) and to get the GPIO number associated to the corresponding LED in the current hardware platform.

- Next, the callback enters a *switch* control. This operates differently depending on whether the callback was triggered by a *led_read* or a *led_write*. This is determined by the **context** argument.
- If the command was a *led_read*:
    - A function is called to retrieve the current status of that LED.
- If the command was a *led_write*:
    - The API function idigi_query_attribute () is called to retrieve the **control** attribute from the RCI request. This attribute indicates whether the LED must be turned ON or OFF. The string value is converted to the needed GPIO setting value and finally a function is called to set the LED.

Throughout the code, there are different points in which the callback may encounter an error. In such cases, error codes are returned. Topic *6.2.5.2 Descriptor errors* explains how to define custom error codes.

If the execution was successful, this function must return a zero.

6.2.4.2. Response callback

The prototype for the *response* callback is:

```
int response(void *handle, char *data, unsigned *length, int
*rsp_complete, unsigned long context)
```

where:

- **handle** is a pointer to the descriptor handle.
- **data** is the buffer where to write the response text.
- **length** is a pointer where to store the length of the response buffer.
- **rsp_complete** is a flag to denote whether the response is complete.
- **context** is a number that is passed to the callback and is defined upon registration of the descriptor.

Open the *buttonled.c* source file and check the implementation of this callback (called **led_response** in the source code). The response function does the following:

- Initially sets the *rsp_complete* flag to 0 (not complete)
- Next it enters a *switch* control. This operates differently depending on whether the callback was triggered by a *led_read* or not. For a led_write a response does not need to be written so its response callback will be set to NULL). This is determined by the **context** argument.
- If the command was a *led_read*:
    - According to the LED status read previously on the *process* callback it will write a response of "on" or "off" text. As explained in section *6.2.2 RCI requests and* replies, this text is inserted between the start and end tags of the custom command.
    - The *rsp_complete* flag is set.
- If not:
    - The response length is set to zero (outputting any text as a response is not needed
    - The *rsp_complete* flag is set.

6.2.5. Custom commands descriptors and registration

Once the *process* and *response* callbacks four our two custom commands (led_read and led_write) have been implemented, their descriptors must be defined and registered to the iDigi library in order to establish the link between the RCI message handler and our callback functions.

6.2.5.1. Descriptor

As described in section *6.1.1.2 idigi_register_usercmd*, a descriptor is a struct that defines the command name, description, the process callback, the response callback, and the context.

For our example, two descriptors need to be defined, one for *led_read* and another for *led_write*. This is done in file *main.c*:

```
/* Descriptor for led_read */
rci_desc_cmd_t led_read_command = {
        "led_read",
        "Read user LED on JumpStart board",
        led_process,
        led_response,
        E_READ_LED
};

/* Descriptor for led_write */
rci_desc_cmd_t led_write_command = {
        "led_write",
        "Write user LED on JumpStart board",
        led_process,
        NULL,
        E_LED_WRITE
};
```

The name of the descriptor is the string that links the callbacks to the XML RCI request.

The context, is an unsigned long that will be passed as parameter to the callback functions. This allows the callback functions for different descriptors to be reused, similar to that within the example above.

Instead, separate callbacks for each descriptor could have been written. For example, a *led_read_process()* and *led_read_response()* for the *led_read* descriptor and *led_write_process()* and *led_write_response()* for the *led_write* descriptors; using a zero for the context (which would then not be used within the callbacks). The results would be the same, only the code would be bigger.

When the *led_read* command contains a response callback (which will respond with "on" or "off" depending on the status of the LED), the *led_write* does not need to respond with anything, so its response_callback can be set to NULL. This means no function will be called for building a response for this command.

6.2.5.2. Descriptor errors

As described in section *6.1.1.2 idigi_register_usercmd*, in order to register a custom command, the *idigi_register_usercmd()* function must be called with the descriptor and its errors. The descriptor errors is an array of structs that define a code and a description string about the possible errors the process callback can return. An error code of 0 means success.

In the previously described example, the error codes are defined at *buttonled.h*:

```
/* Error codes for LED processing */
enum {
      LED_SUCCESS,
      LED_UNKNOWN_PLATFORM,
      LED_GPIO_REQCONFIG,
      LED_MISSING_PARAMS,
```

```
        LED_INVALID_NUMBER,
        LED_INVALID_VALUE,
        LED_UNABLE_DRIVER,
        LED_UNABLE_VALUE
};
```

Descriptor errors are defined at *main.c*:

```
/* Descriptor errors */
rci_desc_error_t led_errors[] = {
        { LED_UNKNOWN_PLATFORM,    "Unknown platform" },
        { LED_GPIO_REQCONFIG,      "Failed requesting/configuring GPIOs"
},
        { LED_MISSING_PARAMS,      "Missing parameters" },
        { LED_INVALID_NUMBER,      "Invalid LED number" },
        { LED_INVALID_VALUE,       "Invalid LED control value" },
        { LED_UNABLE_DRIVER,       "Unable to open GPIO driver" },
        { LED_UNABLE_VALUE,        "Unable to write GPIO value" },
        { 0, NULL },
};
```

The last item in the array must be {0, NULL} to mark the end point.

6.2.5.3. Registration

Once the descriptors and their error codes have been defined, the API function can be called in order to register them. This is done in the file *main.c*:

```
      /* Register User defined iDigi commands */
      /* Register led_read callback */
      if (rci_register_usercmd(&led_read_command, led_errors) != 0)
      {
           printf("Couldn't register user command '%s' (%s)\n",
                 led_read_command.name, led_read_command.desc);
      }
      /* Register led_write callback */
      if (rci_register_usercmd(&led_write_command, led_errors) != 0)
      {
           printf("Couldn't register user command '%s' (%s)\n",
                 led_write_command.name, led_write_command.desc);
      }
```

6.2.6. Rest of code

The rest of the code in *main.c* pertains to launching a thread to poll for button pressing in the board, and other platform functionality specific to this example:

```
      /* launch thread that polls buttons and toggles LEDs */
      status = pthread_create(&poll_button_thread,
                              NULL,
                              read_button,
                              NULL);
      if (status != 0) {
           printf("Error creating poll button thread\n");
      }
```

and launching the connection to iDigi:

```
      /* Start iDigi endless loop */
      if (idigi_start() < 0) {
            printf("Error starting iDigi\n");
            return -1;
      }
```

6.3. The client application iDigiLedDemo

See section *4.3 Client application (iDigiLedDemo.jar)* for more information on the iDigiLedDemo application. The application does two things:

- When a button is pressed an *led_write* request, similar to the one shown below, is sent (with the appropriate LED number and control):

```
<rci_request version="1.1">
    <do_command target="user_defined">
          <led_write number="1" control="on"/>
    </do_command>
</rci_request>
```

- When the refresh period is over, the following *led_read* request is sent:

```
<rci_request version="1.1">
    <do_command target="user_defined">
          <led_read number="1"/>
          <led_read number="2"/>
    </do_command>
</rci_request>
```

The above RCI requests are wrapped around SCI requests to the DeviceID number selected at the startup dialog, so the actual transmitted buffer looks like this:

```
<sci_request>
    <send_message cache=\"false\">
       <targets>
          <device id="00000000-00000000-00034FFF-FF123456"/>
       </targets>
       <rci_request version="1.1">
          <do_command target="user_defined">
             <led_read number="1"/>
             <led_read number="2"/>
          </do_command>
       </rci_request>
    </send_message>
</sci_request>
```

This message is sent as an HTTP POST to the following URL: <u>*http://developer.idigi.com/ws/sci*</u>. iDigi then transfers the message to the specified embedded device.

Full source code to this application can be found within your Digi EL installation folder, typically: */usr/local/DigiEL-X.Y/idigi/client_apps/iDigiLedDemo/source*

6.4. The idigistorage sample application in detail

This is a command line application that has a parameter entered by the user which defines the period in seconds to send data to iDigi. During every given period the application collects information of different sensors and sends them to iDigi. Since the example is designed to run on any development platform, the data of the sensors are simulated with random generated values.

The source code is very simple and is formed using one file:
idigistorage.c.

The application generates random values for the sensors and writes a buffer with the user defined XML format, using the simulated values. The buffer contains no spaces or line breaks. When the buffer has been built, the API function *idigi_putfile()* is called to upload the data to a given path (*examples/tank.xml*). Then it sleeps for the given period.

```
/* endless loop */
while (1) {
        /* Generate random data */
        get_random_data(&tank);
        /* Build output buffer */
        build_buffer(buffer, &tank);
        /* Put buffer as a file into iDigi server */
        if (!idigi_putfile(IDIGI_FILENAME,
                          (void *)buffer,
                          strlen(buffer)))
             printf("File transferred OK\n");
        else
             printf ("File transfer FAILED\n");
        /* Sleep interval seconds */
        printf("Sleeping for %d seconds\n", interval);
        sleep(interval);
}
```

6.5. The client application iDigiTankDemo

This is a JAVA client application whose interface was explained in section *5.2 Client application (iDigiTankDemo*.jar). The application does two things:

- When the when refresh period is over, an HTTP GET request is sent to the address **developer.idigi.com/ws/data/<*file_path*>** where <file_path> is a string formed by the Device ID (as selected in the startup dialog of the application) plus the path */examples/tank.xml* where the file with the information resides.
- Parses the data in the received XML file and represents them graphically.

Full source code to this application can be found within your Digi EL installation folder, typically: */usr/local/DigiEL-X.Y/idigi/client_apps/iDigiTankDemo/source.*

7. Configuration file

iDigi device applications rely on the configuration file */etc/idigi.conf* in order to determine certain values necessary for connecting to iDigi.

In Digi Embedded Linux, this configuration file is stored in the subfolder *rootfs/idigi/etc/* of the installation path, typically */usr/local/DigiEL-X.Y/*.

Initially, you can run with the default values.

7.1. Section DEVICE_CONFIG_GROUP

This section stores generic information about the embedded device such as:

- **vendorId**: a unique hex number for OEMs that you can request in iDigi (explained in section *2.5 Registration of a Vendor ID*).
- **firmwareVersion**: a custom X.Y.Z.N version number (explained in section *2.5.2 Firmware version*).
- **deviceType**: a string that describes the type of device (explained in section *2.5.1 Device type*).
- **companyName**: the name of the manufacturer (up to the user to define).
- **deviceModel**: the device's model (up to the user to define).
- **certificateStore**: a path to either of the following:
    - a self signed certificate file (PEM format) for doing the peer validation of iDigi server's certificate (if the server sends a self-signed certificate).
    - the directory where trusted CA root certificates reside as hash symlinks to PEM format certificates (if the server sends a CA signed certificate). Refer to openssl *c_rehash* script to see how hash symlinks are generated.

None of these values are strictly needed. However, if you requested a VendorID number, you must configure this value to be able to manage your embedded device’s descriptors. Also, you must keep in mind that information may be cached by iDigi upon the combination of vendorId, firmwareVersion, and deviceType (as explained in section *2.5.3 Cached data in iDigi).*

7.2. Rest of sections

The rest of the sections described in this manual pertain to iDigi connection, network, security, and global settings. All these settings are described within this guide and can be changed within iDigi.

8. Known issues and limitations

8.1. Network connection and interfaces

If you own a wireless capable module, a connection to iDigi can be established either through the wired network interface or through the wireless interface. In any case, you should only have one default route on the interface that has access to the Internet.

8.1.1. Gateway IP

If you own a device with two or more network interfaces (either wired or wireless), setting the gateway IP address of any of them through the user interface in iDigi will overwrite the U-Boot variable **gatewayip**, which the Linux system uses to create the default route.

This happens because only one gateway IP is stored in NVRAM, regardless of the number of network interfaces. It is recommended to set this IP in U-Boot and not change it using iDigi unless absolutely necessary.

8.1.2. DNS addresses

Similar to gateway IP, Digi EL only stores two DNS addresses in the NVRAM (U-Boot variables **dnsip** and **dnsip2**) which are not linked to a specific network interface. Changing the DNS address of any interface in iDigi will overwrite the U-Boot variables which the Linux system uses to register DNS addresses.

8.2. Buttons and LEDs on hardware platforms

8.2.1. Digi Connect ME 9210

Platform *cme9210js* uses the same GPIO for BUTTON1 and LED1. For the *idigibuttonled* example application to work properly, the example for this platform works with the following association:

BUTTON1 switches LED2

BUTTON2 switches LED3

8.2.2. ConnectCore Wi-9M 2443

If you are using the *ccw9m2443js* platform, the wireless interface uses LED1 of the development board for showing the wireless status. You must disable this feature in the kernel configuration under **Device Drivers > Network device support > Wireless LAN > Digi Piper Wifi support > Enable GPIO for Wifi status LED**.

8.2.3. ConnectCard for i.MX28

User buttons and LEDs on the ConnectCard for i.MX28 platform conflict with AUART1 and AUART2 serial ports. Please refer to your OS documentation to disable them to be able to run the user and button led demo. Please refer to the Hardware Reference manual of the platform for specific instructions about needed configuration jumpers.

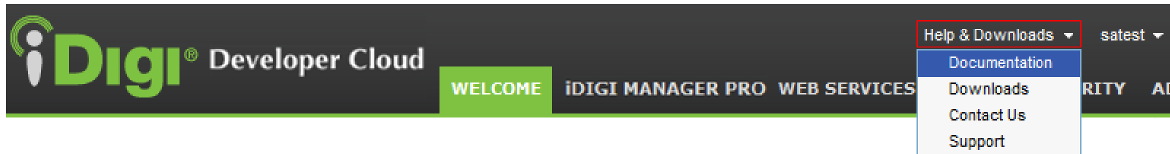
8.3. Limitations on file uploads/download

The File Management utility (within a device's properties page) allows you to upload/download files to the embedded device. The system however is not thought of as an FTP system because files are transferred with base64 encoding through HTTP. The file size that can be transmitted without errors varies between platforms, as it depends on the available RAM memory. For large file transfers FTP is recommended.

The iDigi server imposes a limit on the size of files being transferred which as of the date of this manual's creation is 48Mb to upload a file to the device, and 5Mb to download a file from the device.

9. Reference documentation

Within iDigi, additional resources and documentation, including the iDigi Web Services Programming Guide, are available. To locate this information, you must be logged in to your iDigi user account. Once logged in, navigate to **Help & Downloads > Documentation** from the Help & Downloads menu in the upper-right corner of the page's banner. This will open the iDigi Resources page.



The **iDigi Resources page** contains several links to additional iDigi-related resources. The documents within the iDigi Platform Documentation section provide an in-depth description of the iDigi Device Cloud Portal and its uses.

DOCUMENTATION

IDIGI PLATFORM DOCUMENTATION

iDigi User's Guide
iDigi Web Services and Programming Guide
iDigi Platform Release Notes

GENERAL DOCUMENTATION

Device Partners Developers Guide: Digi X-Grid
Application Partners Developers Guide: Digi X-Grid
iDigi Connector User Guide

DOWNLOADS

DIGI ESP FOR PYTHON AND IDIGI DIA

How to install Digi ESP for Python
Digi ESP for Python - Windows XP/Vista/Windows 7 installer ver. 1.4.0
Digi ESP for Python - Mac OS X (10.6) installer ver. 1.4.0
Digi ESP for Python ver. 1.4.0 release notes

GENERAL DOWNLOADS

Factory Python Load for ConnectPort X2 for Smart Energy
iDigi Connector for Embedded (formerly iDigi Integration Kit)
iDigi Device Cloud CA Certificate

SUPPORT AND DEVELOPMENT LINKS

FORUMS

Support Forums

DEVELOPER COMMUNITIES

iDigi Platform Wiki
iDigi Dia Wiki
iDigi Python Wiki

TERMS OF SERVICE

iDigi Development Cloud Terms of Service
Digi International Authorized Use Policy
Digi International Privacy Policy
Digi International DMCA statement