DESIGN OF SYSTEMS ON SILICON

DH-10E and DU-100 Installation Guide for Spirit v1.0.25

Corporate Headquarters

Design of Systems on Silicon
Charles Robert Darwin, 2
46980 Paterna – Valencia
Spain

Tel: +34.96.136.6004
Fax: +34.96.136.6250
WWW: http://www.ds2.es
Email: info@ds2.es

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Table of Contents

1 Introduction

This document describes the basic configuration of the in-home modems for evaluation purposes. The manual presents the two HW platforms, DU-100 and DH-10E, and the two chip options, DSS9001 and DSS9010. In addition, it explains the configuration of the Spirit software for various in-home scenarios.

2 In-Home Modem Family

The in-home modem family comprises two platforms: the DU-100 and the DH-10E. The second type is available with two chip options: DSS9001 and DSS9010. All three models run Spirit, a firmware specifically designed for highly demanding in-home applications requiring audio, video and data sharing the same PLC network.

DU-100 characteristics:

- DSS9001 chip
- Master, repeater and slave capability
- 10/100 Ethernet and USB 1.1 interfaces
- VoIP support (RJ-11 analog telephone connector)
- Advanced traffic classifying capability
- Desktop format
- High PLC power (-54 dB_m/Hz)

DH-10E with DSS9001 characteristics:

- DSS9001 chip
- Master, repeater and slave capability
- 10/100 Ethernet interface
- Advanced traffic classifying capability
- Wall plug or desktop format
- Reduced PLC power (-66 dB_m/Hz)

DH-10E with DSS9010 characteristics:

- DSS9010 chip
- Slave only
- 10/100 Ethernet interface
- Wall plug or desktop format
- Reduced PLC power (-66 dB_m/Hz)

Spirit firmware features:

- Simple configuration through HTTP
- Multimedia-oriented QoS
- Static or dynamic IP
- Master–slave or peer-to-peer MAC

3 Home Scenarios

Two possible home scenarios were taken as a framework to demonstrate the capabilities of in-home modems. The two topologies are presented in Figure 1 and Figure 2, and explained below.

Figure 1: Data-Only PLC Network

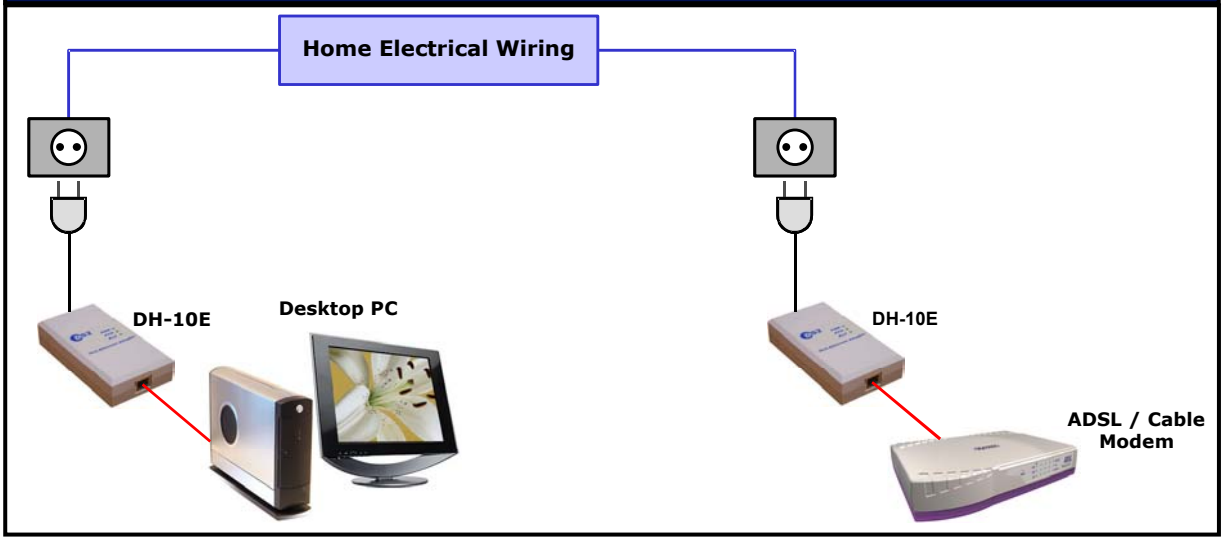


Figure 2: Mixed Data-Video PLC Network

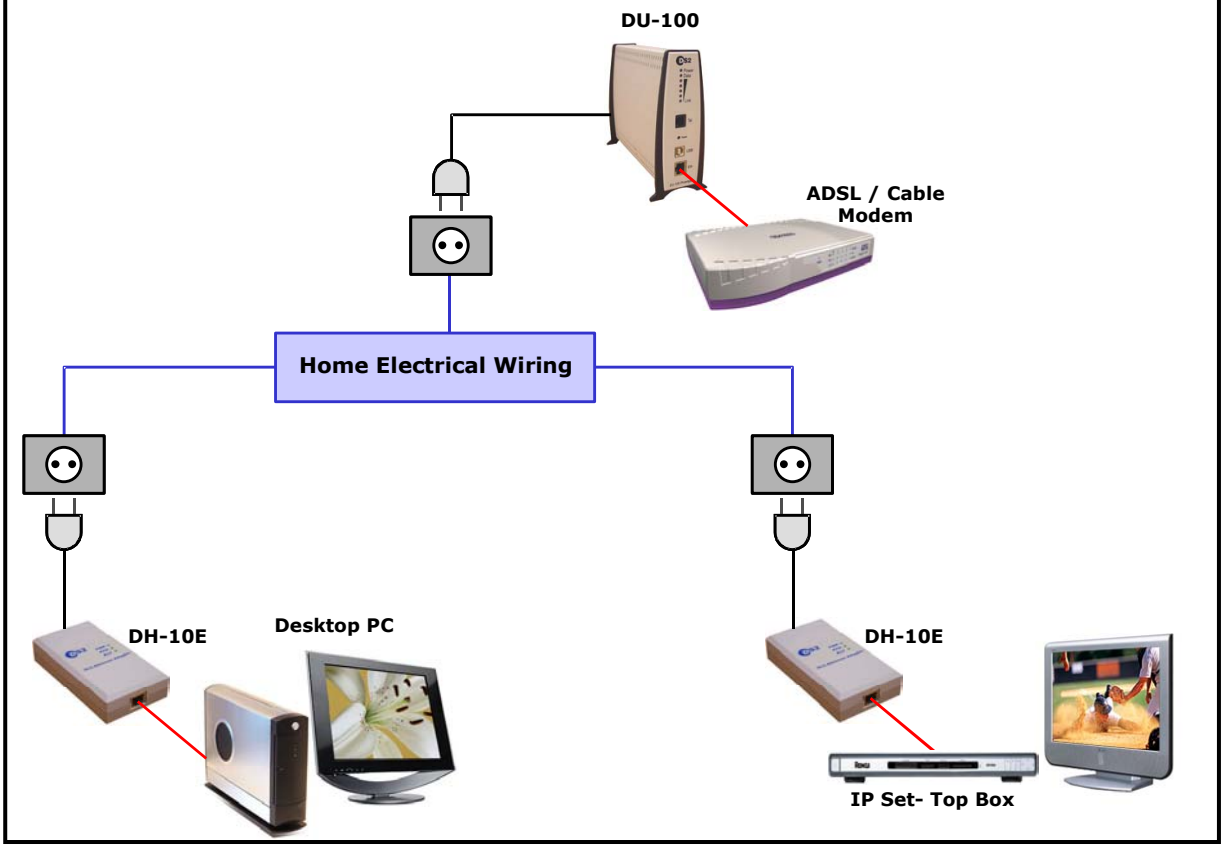


Figure 1 exhibits a simple PLC solution where two modems are used to make the Internet access connection available in all outlets of the house. This is the simplest case, where no QoS configuration is required.

Figure 2 shows a more advanced PLC network with three modems. This is a frequent situation where Internet access and digital video are delivered through the ADSL line. This configuration requires some QoS settings to guarantee video quality when the network is congested with data.

Any of these two basic scenarios can be enlarged adding more modems, computers and set-top boxes.

4 Getting Started with the Modem

The following items are needed to start using the modems:

- Straight Ethernet cables (provided with the modems)
- Any operating system supporting TCP/IP (Windows, Linux, MacOS, Unix…)
- Web browser (Netscape, Internet Explorer, Opera…)

Also the following items might be needed at some point in time:

- PLC filter (to isolate networks or to filter out a noisy appliance)
- TFTP server (to perform a firmware upgrade)

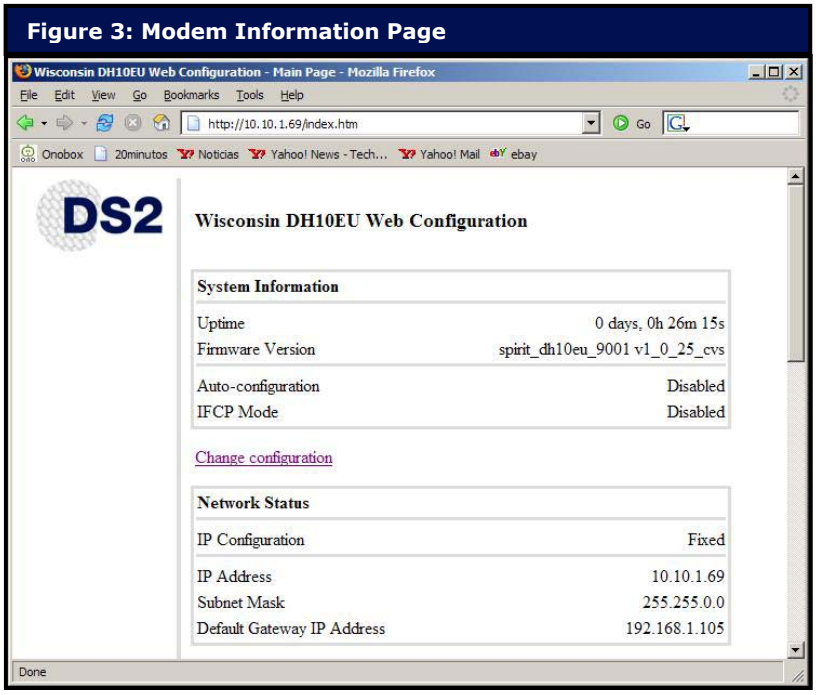
All of the modems are delivered with a static default IP address: **10.10.1.69**. Changing the default IP is required to allow access to the modem when two or more units are active in the same network. Follow the steps below to configure a new IP address in the modems:

1. Assign the PC an address in the range 10.10.X.X and the netmask 255.255.0.0. This is needed in order to be compatible with the modem's default settings.

2. Plug in one of the PLC modems and connect it to the PC using an Ethernet cable.

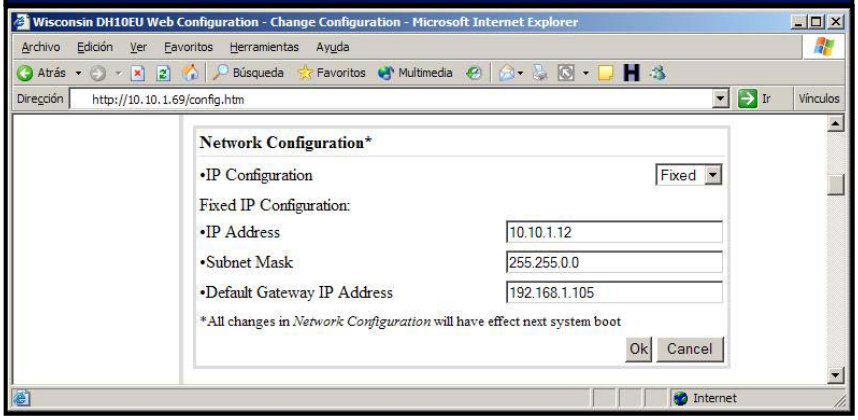
3. Open the Web browser and type the following URL: http://10.10.1.69. A web page like the one below will appear:

Figure 3: Modem Information Page



4. Click on "Change configuration" and a new page will be presented (Figure 4). This page allows changing the IP address of the modem.

Figure 4: Modem Configuration Page



5. In the Network Configuration section, enter the desired IP address, netmask and gateway for the modem. (See notes below.)

6. Click on the *change* button to store the values in the memory. Wait for the page to refresh.

7. Unplug the modem, take another one and go back to Step 2.

NOTES:

- A different IP must be set for each of the modems that will work on the same network. The IP of the modems does not need to be in the same range as the devices communicating through the modems. Only the PC accessing the configuration page of the modems must have the same address range as the modems.

- The netmask can also be changed, for example to a type C (255.255.255.0) if needed.

- If the modem is going to be accessed through a router (for example in a large office network) the gateway IP needs to be configured. Otherwise, it can be ignored.

- The IP change in the modems will be effective only after a reboot or a power cycle. DS2 recommends placing a label on each modem with the IP assigned to it.

WARNING: If you change the IP and forget it, there is no way to reset it to the default value. You will have to rewrite the FLASH memory using a JTAG writer tool. This may imply sending the unit back to DS2 for reprogramming.

5 Selecting the MAC Mode

The Spirit software has two running modes: in-home AV (master–slave) and peer-to-peer (P2P).

In in-home AV mode, nodes can be an access point (AP) or end point (EP). Only one AP is allowed per network. There can be up to 32 EPs using a DSS9001-based device as AP.

In P2P mode, all of the nodes are peers. Automatic repeating is performed to allow communication between nodes that do not have direct visibility. Configuration is simpler, because all of the nodes have the same settings (except the IP).

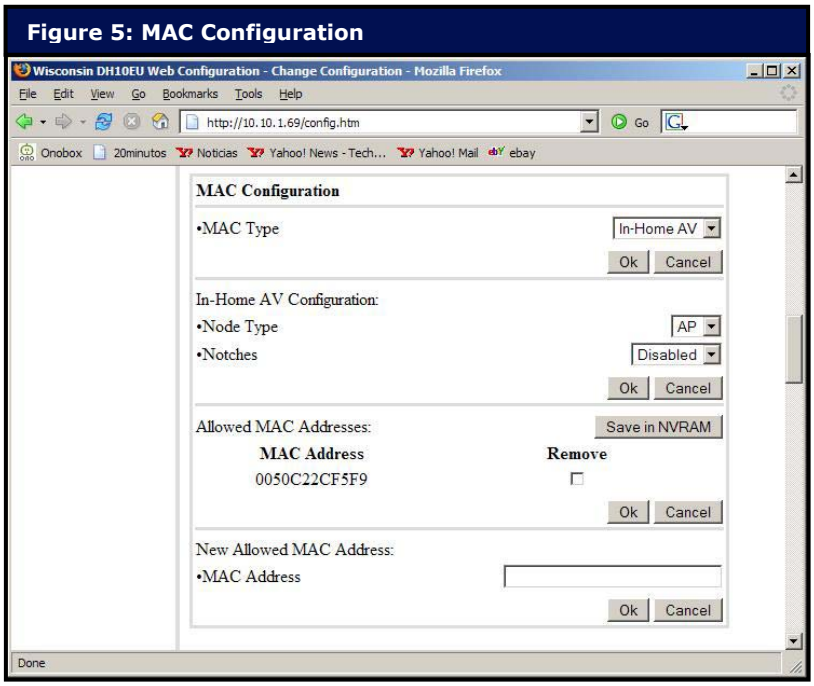
If working with only two modems, there is the option of having an in-home AV solution with one AP and one EP, or a P2P network. Performance is slightly higher with an in-home AV configuration.

To change the MAC mode, go to the MAC Configuration window. In the *MAC Type* field, select "In-Home AV" or "P2P".

In the case of in-home AV, further configuration is possible. A node can be defined (*Node Type* field) as an Access Point (*AP*) or End Point (*EP*).

In the case of an access point, there is also a list of the allowed end point MAC addresses that can be registered in the access point, as can be seen in Figure 5. The list can be saved in the modem (*Save in NVRAM*). Moreover, the user can remove MAC addresses by ticking them in the list and clicking *Ok*. A new MAC address can be added to the list by entering it, in hexadecimal format, in the appropriate field and clicking *Ok*.

Figure 5: MAC Configuration



If the modem is running in an environment where it can cause interference to a radio amateur receiver, the option of spectral masking can be enabled. This option, called "notching", will remove the entire PLC signal from the frequency bands used by the radio amateurs when enabled.

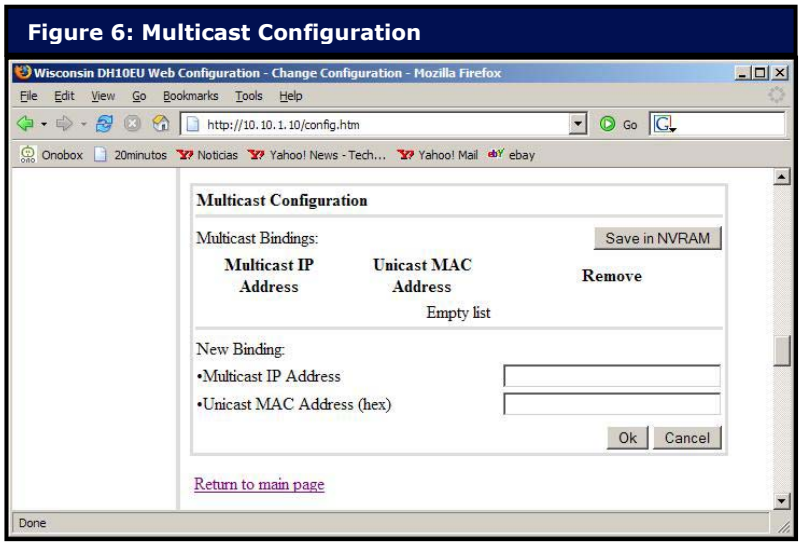
For the configuration to become effective, click *change* and wait for the page to refresh. The modem does not need to be rebooted.

6 Multicast Traffic Optimization

In this window, the number of modems (identified by their MAC addresses) that are going to receive a multicast stream (identified by its IP address) can be restricted. By default, if no bindings are specified, multicast traffic is sent to all devices in the PLC network. The list of bindings can be saved in the modem (*Save in NVRAM*). Moreover, the user can remove bindings by ticking them in the list and clicking *Ok*. A new binding can be added to the list by entering the multicast IP address, in

decimal format (*ddd.ddd.ddd.ddd*), and the unicast MAC address, in hexadecimal format (*XXXXXXXXXXXX*), in the suitable fields and clicking *Ok*.

Figure 6: Multicast Configuration



7 Configuring Security

Three different actions can be performed using the Security Configuration window:

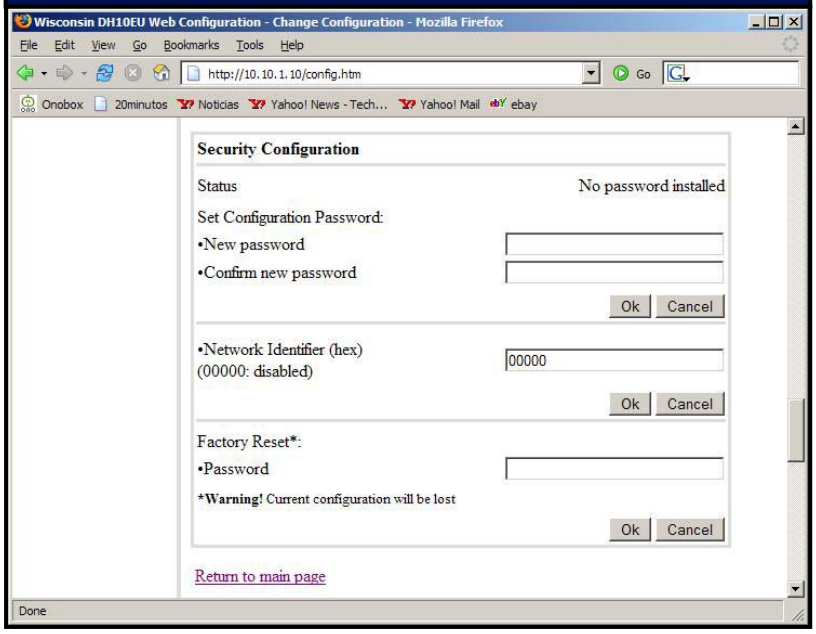
- Set a password for access to the web application.
- Configure a *Network Identifier* shared by all modems in the same PLC network.
- Reset the modem to factory default.

A password for the Web application can be configured by typing it twice in the two specified fields. If both fields are left empty and the OK button is pressed, the configuration password will be disabled and the message "No password installed" will be shown in the security configuration form. The authentication can be enabled anytime by setting a non-empty string as the configuration password.

A *Network Identifier* can also be configured. The *Network Identifier* is a hexadecimal value and should be the same value in each modem of the same network. This number (between 1 and 2^{20}-1) is used to cipher PLC transmissions. Entering 00000 disables the encryption. Modems with different *Network Identifiers* are not able to send data between them. The purpose of this basic encryption scheme is to provide an isolation method between different in-home networks.

Finally, a factory reset can be executed. In order to do that, a specific password is required. If the password is valid, the configuration will be set to the default values. The password is specified in the DS2's *Firmware Release Notes* document.

Figure 7: Multicast Configuration

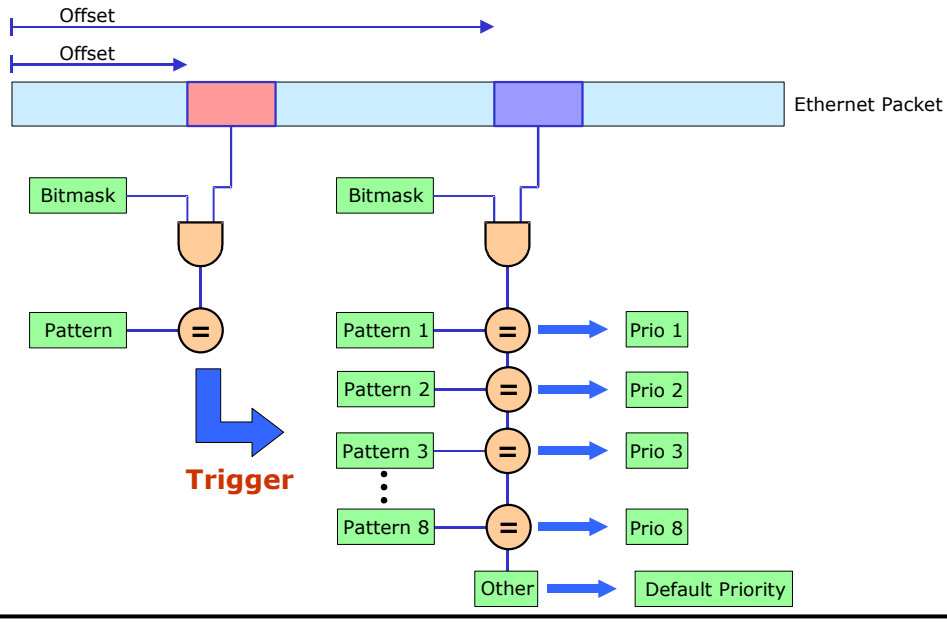


8 The Traffic Classifier

When several traffic flows are sharing the same network, there is sometimes the need to establish several levels of priority to guarantee that bandwidth-sensitive applications such as video or telephony continue to work smoothly even under network congestion.

The traffic classifier is a packet inspector that is able to recognize several patterns inside an Ethernet frame and assign a different priority to each of them. To ensure that the classification is done to the right type of packet, there is a trigger mechanism preceding the actual classification. The trigger mechanism is also based on pattern recognition in a given location of the Ethernet packet. Figure 8 depicts the packet classification mechanism.

Figure 8: Traffic Classification Mechanism



There is one offset, one bitmask and pattern for the trigger condition. The trigger condition is useful to make sure that the Ethernet frame contains, for example, an IP frame. To check this condition, the offset would need to be set to 16 and the bitmask to 0xFFFF. If the resulting pattern is 0x0800, then the Ethernet frame contains an IP packet and the classification can be done to a known field.

There is another offset and bitmask for the classification condition. The resulting value is compared with a set of patterns. If the value matches a given pattern, the packet will be classified with the specified priority. If the value does not match any of the patterns, it will get a default priority.

This classification mechanism is only available in the DU-100 and the DH-10E equipped with the DSS9001 chip.

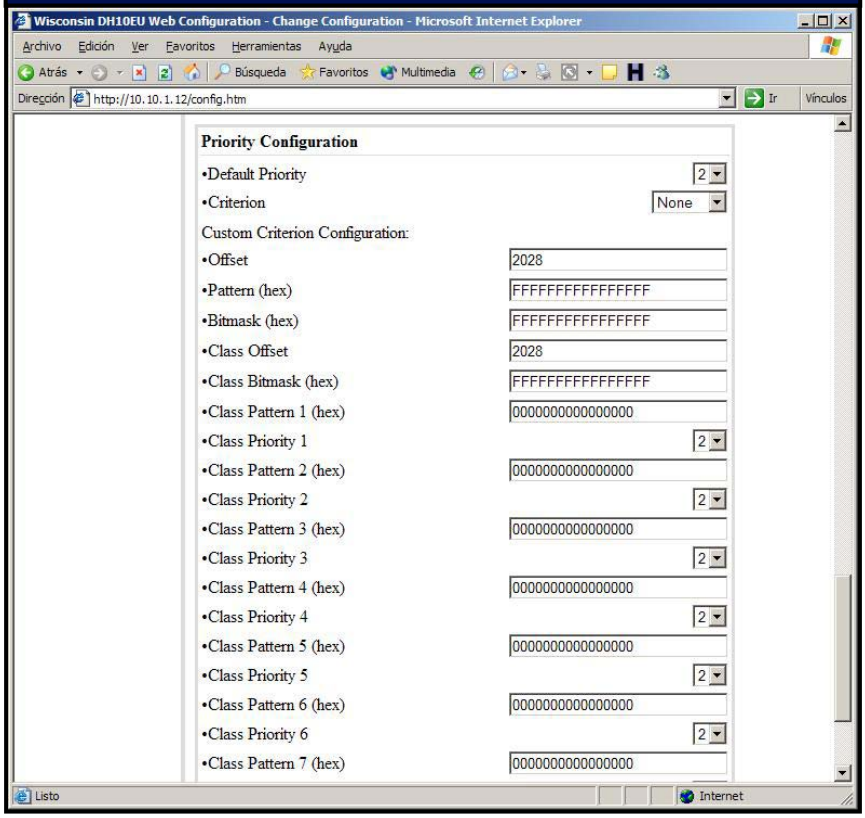
There is a set of pre-defined criteria that allow classifying traffic based on the 802.1p field of the Ethernet packet or the TOS field of the IP packet.

9 Configuring Video Applications

In the case of a network where real-time traffic must coexist with massive data transfers, the service classifier must be used to prioritize the bandwidth-sensitive traffic above the other types of traffic.

As an example, consider the network shown in Figure 2. The node connected to the ADSL modem is the access point. Data and video are delivered through ADSL. The access point has to prioritize UDP video over data to avoid a jittery image when there is a heavy data download.

Figure 9: Traffic classifier configuration



First of all, the *Criterion* field must be set to *CUSTOM*, in order to create your own rules to classify the traffic.

To prioritize UDP traffic, first the Ethernet packets containing IP packets have to be detected. This requires detecting the pattern 0x0800 at offset 16. Because the field to inspect is two bytes, the bitmask must also cover the same space. Therefore, 0xFFFF is used as bitmask. These values are introduced in the fields *Custom Criterion Offset*, *Custom Criterion Pattern* and *Custom Criterion Bitmask*.

Once the trigger condition is entered, the classification rules must be specified. Only the fields that are actually changed will take effect. The rest will be ignored. IP packets have a one-byte field at offset 27 that indicates the *Protocol Type*. UDP protocol is pattern 0x11. Because the field to inspect is only one byte, the bitmask is also one byte. The values are entered in the first available rule (1) as *Class Pattern 1* and *Class Priority 1*.

The rest of the traffic (FTP, Web browsing, etc.) will receive default priority 2. On the other side of the network, the modem connected to the computer will also classify outgoing data traffic with default priority 2 because no rule has been programmed.

NOTES:

- While the offset value is assumed to be decimal, the patterns and the bitmasks are in hexadecimal format by default.

10 Firmware Upgrade

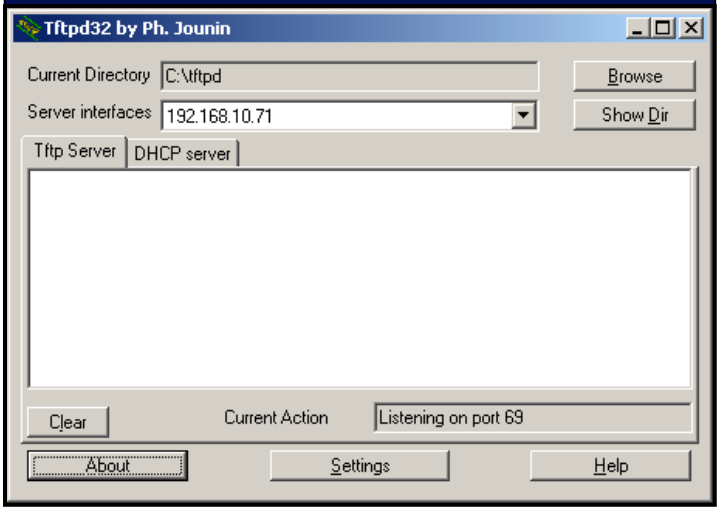
To upgrade the firmware of the modem, a TFTP server must be running in a computer. DS2 recommends a freeware tool called TFTPD32. This tool can be downloaded at the following address: http://tftpd32.jounin.net/.

The firmware image is provided by DS2. Check that the name of the image file matches the platform (du100, dh10) and type of chip (9001, 9010) that is being upgraded.

Follow the steps below to upgrade the firmware of a modem:

1. Execute TFTPD32. This application has the GUI shown in Figure 10.

Figure 10: TFTP32 User Interface



2. Place the image file in the directory specified in *Current Directory* or change it to point to the place where the image is stored.

3. Open the Web browser and enter the IP of the modem that to be upgraded.

4. When the page comes up, click on *Change configuration*.

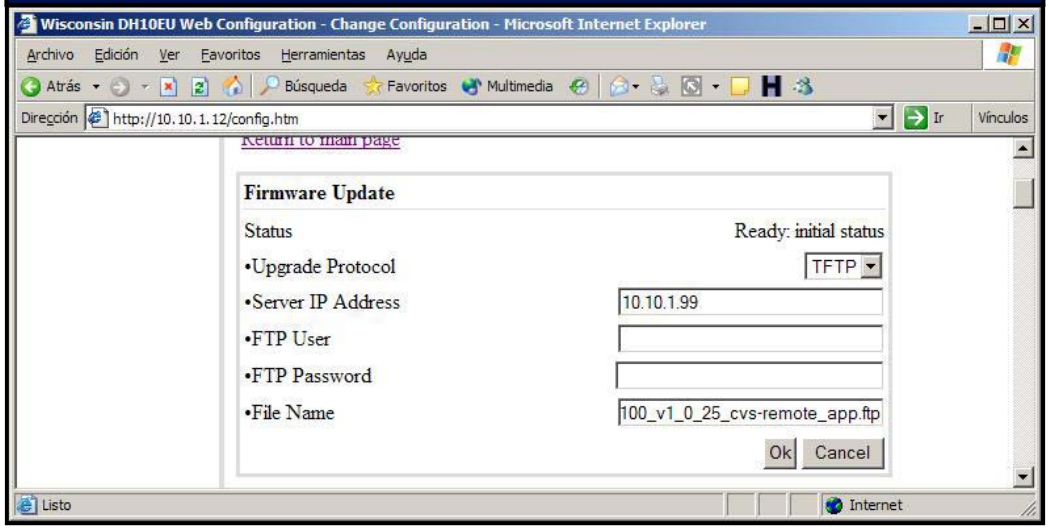
5. In the *Firmware Update* window, select TFTP and enter the IP of the TFTP server and the name of the image file, as shown in Figure 11.

6. Click *OK*to start the process. Progress information is shown on the Web page every 30 seconds.

7. The modem will first download the file and then calculate the CRC.

8. If the CRC is correct, the *Hardware Reset* button will be highlighted. The modem must be reset for the new firmware to start running.

Figure 11: Firmware Update Procedure



11 Improving FTP Performance

The latency of a PLC network is higher than that of an Ethernet network. Most operating systems have a default setting of the network latency based on Ethernet figures. To obtain the maximum performance using TCP traffic (FTP download, for example) the operating system has to be tuned to the new network conditions.

With a Windows PC, simply double-click on the file **tcpwin.reg**, provided with the modem. With a Linux PC, execute **tcpwin.sh** logged in as root. In both cases the PC has to be reset.

If you do not have these files, they can be created by copying the contents shown below:

tcpwin.reg

```
Windows Registry Editor Version 5.00

[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters]
"TcpWindowSize"=dword:00080000
"GlobalMaxTcpWindowSize"=dword:00080000
"Tcp1323Opts"=dword:00000003
```

tcpwin.sh

```
$wind = ($ARGV[0] * 1024);

`echo $wind > /proc/sys/net/core/rmem_default`;
`echo 8388608 > /proc/sys/net/core/rmem_max`;
`echo $wind > /proc/sys/net/core/wmem_default`;
`echo 8388608 > /proc/sys/net/core/wmem_max`;

`echo 4096 $wind 8388608 > /proc/sys/net/ipv4/tcp_rmem`;
`echo 4096 $wind 8388608 > /proc/sys/net/ipv4/tcp_wmem`;
`echo 8388608 8388608 8388608 > /proc/sys/net/ipv4/tcp_mem`;
```

To use this script in Linux, you must have kernel 2.4. Logged in as root, execute the following command:

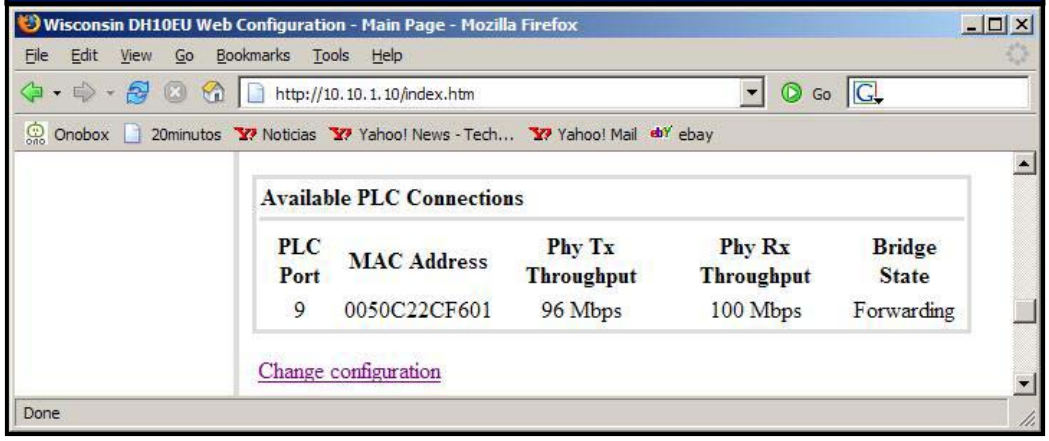
```
./tcpwin.sh 512
```

This will set the TCP window to a size of 512 Kilobytes.

12 Checking Physical Throughput

In the main page, under the heading *Available PLC Connections*, there is a list of the MAC addresses of all of the neighboring modems that have a connection with the device. This list also indicates the physical throughput in transmission and reception that the device is achieving with every neighbor.

Figure 12: Firmware Update Procedure



13 Using PLC Filters

A PLC filter is a low-pass filter that will only allow the 50/60 Hz mains voltage through it. This filter blocks the PLC signal.

When to use this filter:

- When you want to isolate a PLC test network from the rest of the electrical grid, either because you do not want the PLC signal to go out and disturb other modems, or because you want to prevent the noise from getting in your network. This situation is presented in Figure 13.

- When you want to filter the noise produced by some appliance, because this noise falls in the PLC band and disturbs the modems. This situation is presented in Figure 14.

Figure 13: Using the Filter to Isolate a Test Network

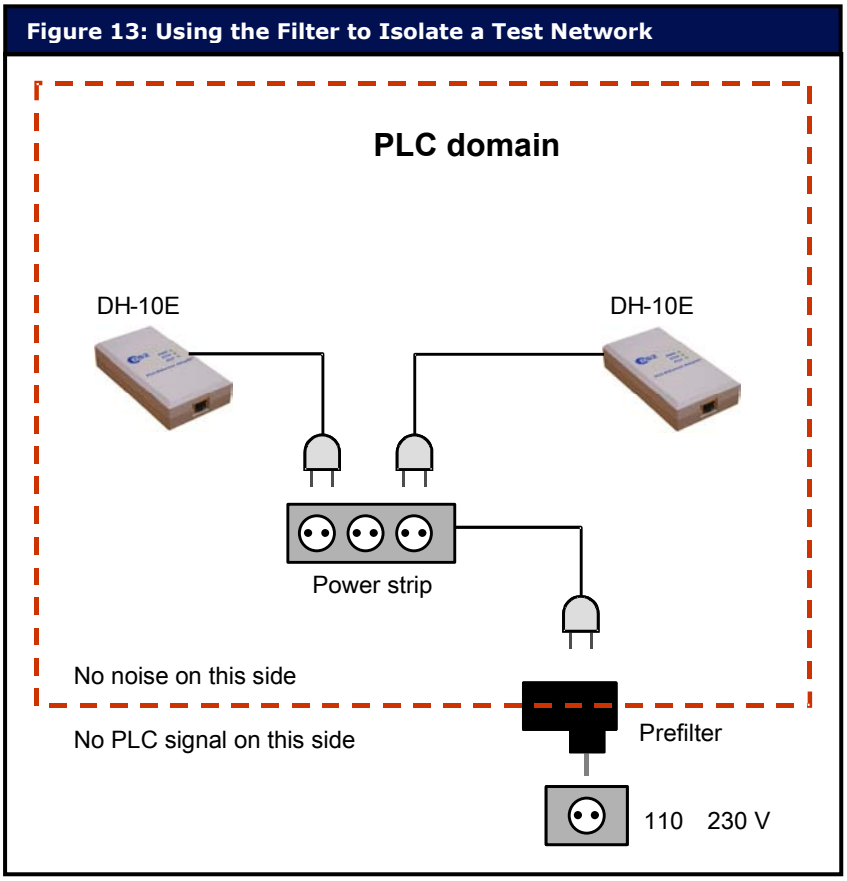


Figure 14: Using the Filter to Isolate a Noisy Device