DHCP and DNS Protocols

DHCP (Dynamic Host Configuration Protocol) is an industry standard protocol that lets a DHCP server (Unix/Window/As400 system) allocate temporary IP addresses and other network parameters to terminals and PCs when they are powered on. This can greatly simplify managing large networks.

DNS (Domain Name Services) is an extension to this concept where the DNS server (Unix/Window/As400 system) associates 'English' names to the IP addresses of terminals and PCs. This further simplifies management as the DNS server effectively handles all use of IP addresses and users only need to be aware of the 'English' names of their computers. (i.e. a given terminal or PC could always be referred to as FRODO, regardless of its IP address). It may well be given a different IP address by the DHCP server every time it boots up.

The DHCP server and the DNS server are independent services and may or may not both run on the same server or on different servers

Note: the DNS protocol is only available with certain AX3000 models.

This documentation describes Axel's implementation of DNS and DHCP.

1 - SETTING-UP THE AX3000

This section deals with the following topics:
- AX3000 interface (DHCP, IP address, net mask, etc.),
- the DNS parameters,
- the host table,
- the router table.

1.1 - AX3000 Interface Box

The AX30000 interface characteristics are:
- the IP address,
- the netmask,
- the name.

To set the AX3000 interface select the **[Configuration]→[TCP/IP]→[Interface]** menu. A dialog box as shown in Figure 1.1 is displayed:

Figure 1.1: AX3000 Interface Box

Usage of this AX3000 Interface Box depends on whether or not the DHCP protocol is enabled.

a) "Enable DHCP" is set to "No"

Only the **'AX3000 IP Address**' and **'AX3000 Netmask'** parameters are available. These two parameters MUST be entered.

b) "Enable DHCP" is set to "Yes"

The **'AX3000 IP Address'** field is inaccessible and the following DHCP Option List allows certain parameters to be automatically assigned by DHCP:
- AX3000 Netmask,
- Default router: see Chapter 1.4,
- DNS Servers: see Chapter 1.2,
- 1st DNS Search Domain: see Chapter 1.2.

The "**AX3000 Name (FQDN)**" (Fully Qualified Domain Name) is an optional parameter allowing a Platine to be identified by this name if both a DHCP server and a Dynamic DNS server are available. At the boot time the AX3000 broadcasts a DHCP request to obtain its IP address. Within this DHCP request the AX3000 specifies its name. If the DHCP server is correctly set, it will both give an IP address to the AX3000 and inform the DNS server a new device is available. Refer to Figure 1.1, the AX3000 name is "ax3001.terminals.axel.com" and its IP address is 192.168.1.245.

When <Space> is pressed on "**Enhanced Parameters**" a dialog box as shown in Figure 1.2 is displayed:

Figure 1.2: DHCP Enhanced Parameters

The parameters of the DHCP Enhanced Box are:
- **Lease Time (minutes)**: lease time value requested by the AX3000 from the DHCP server. Depending on the DHCP server settings this parameter may be ignored. The AX3000 automatically renews the lease when it expires.
- **Client Identifier**: when a static IP address is needed (i.e. for the AX3000's print server), the AX3000 Ethernet address is generally used to identify the AX3000. Some DHCP servers allow this character string as an alternative identifier.
- **Trace Mode**: in the event of problems this mode allows the data exchanged between the AX3000 and the DHCP server to be visualised. The trace data is displayed directly on the AX3000 screen without any consideration of current use (i.e. messages may 'pollute' the AX3000 display at any time).
- **Check IP Address**: when the offered IP address is received, the AX3000 can check that it's not already in use.

1.2 - DNS Protocol Box

To set the DNS protocol, select the **[Configuration]→[TCP/IP]→[DNS]** menu. A dialog box as shown in Figure 1.3 is displayed:

```
                          DNS Parameters
  DNS Servers
    1st DNS Server IP address    192.168.1.180
    2nd DNS Server IP address    192.168.1.162
  Default DNS Domains
    1st Domain        servers.axel.com
    2nd Domain        terminals.axel.com
    3rd Domain        ............................
  Enhanced Parameters
    Trace Mode        No

  VALID                                        CANCEL
```
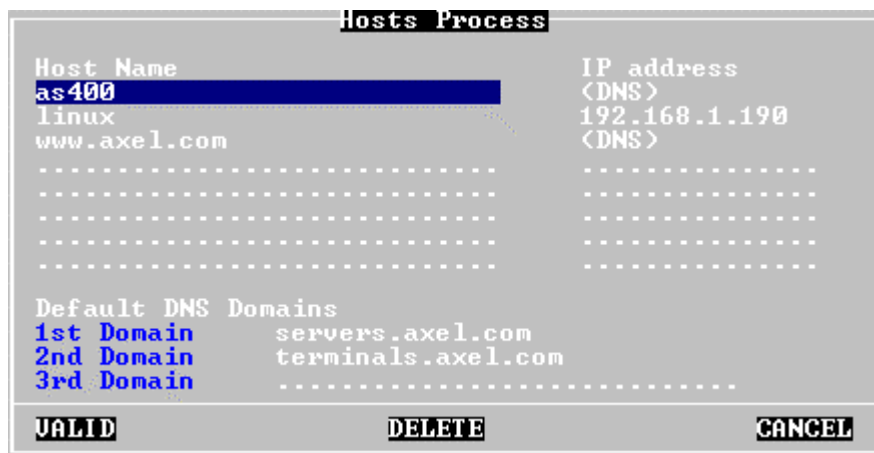
Figure 1.3: DNS Box

The parameters of the DNS box are:
- **DNS Servers**: to resolve a name, the AX3000 sends DNS requests to a DNS server. The IP address of this DNS server must be known. The AX3000 set-up procedure allows two DNS servers to be set.
  Note: if **'DNS Servers'** is enabled in the AX3000 Interface box (see Figure 1.1) these two parameters are supplied by DHCP and cannot be accessed here.
- **Default DNS Domains**: theses domains can be used during the resolving operation (see Chapters 3).
  Note: if the '1st DNS Search Domain' is enabled in the AX3000 Interface box (see Figure 1.1) the '1st Domain' parameter is automatically set and cannot be accessed here.

1.3 - Host Management Box

A host is a TCP/IP machine (UNIX, AS/400, etc) to which the AX3000 can open connections (telnet, tty and VNC).

To configure the host table, select the **[Configuration]→[TCP/IP]→[Hosts]** menu. A dialog box as shown in Figure 1.4 is displayed:

```
                        Hosts Process
  Host Name                        IP address
  as400                            <DNS>
  linux                            192.168.1.190
  www.axel.com                     <DNS>
  ..........................       ...............
  ..........................       ...............
  ..........................       ...............
  ..........................       ...............
  ..........................       ...............

  Default DNS Domains
    1st Domain        servers.axel.com
    2nd Domain        terminals.axel.com
    3rd Domain        ............................
  VALID                 DELETE                  CANCEL
```

Figure 1.4: Host Table Box

The host server definition depends on whether or not DNS is enabled (see Chapter 1.2):
- **No DNS**: a host is identified by both an alphanumeric character string beginning with a letter AND an IP address.

- **With DNS**: a host is defined only by its name. This name can be either a full name (www.axel.com) or an incomplete name (as400). Its IP address is resolved later. (See Chapter 3).

Add a Host: move the highlight cursor to a vacant line and enter the name and either its IP address or set DNS.

Delete a Host: select the host and press [DELETE].

Change a Host: move the highlight cursor over the name or IP address of the host and enter the new value.

Note: the Default DNS domains, previously defined through the DNS box (Figure 1.3), are displayed for information (they can not be modified).

1.4 - Router Management Box

A router is either a special electronic unit, or a suitably configured host computer which enables data to be sent across two or more distinct physical networks.

One router can be nominated as the 'default router' and then used to access any network. Use of a default router simplifies site network administration. The default router is only identified by its IP address.

However additional routers can also be declared, to reach specific destination hosts or networks. Any such router must be identified with 3 parameters:
- the router's IP address,
- the destination IP address,
- the destination type (a simple host or an entire network).

To configure the router table, select the **[Configuration]→[TCP/IP]→[Routers]** menu. A dialog box as shown in Figure 1.5 is displayed:

Figure 1.5: Router Table Box

Default Router: to specify a default router enter its IP address. If a default router is not required, leave this field blank. If **'**Default Router' is enabled in the AX3000 Interface box (see Figure 1.1), this parameter is automatically supplied by DHCP and cannot be accessed.

To Add a Router: move the highlight bar to a vacant line and enter the router parameters.

To Delete a Router: select the router to be deleted from the menu and press [DELETE].

To Change a Router: move the highlight cursor over a router parameter and enter the new value.

2 - THE DHCP PROTOCOL

The DHCP protocol allows certain parameters (IP address, netmask, etc.) to be automatically assigned.

2.1 – Overview

Here is a brief description of Axel's implementation DHCP:
- At boot time the AX3000 broadcasts DHCP requests to find the DHCP server.
- If a DHCP server is found and correctly set-up, an IP address, and subsequently other parameters are given to the AX3000.
- Before accepting the IP address the AX3000 can be set to check that the IP address given really is free (ARP protocol).
- The IP address offered is given temporarily. This duration is called the 'Lease Time'.
- If a lease time has been entered through the AX3000 Set-Up, this lease time is offered to the DHCP server, which may or may not accept this value.
- The AX3000 is expected to renew its lease before the lease expires. Once the lease has expired the AX3000 is no longer permitted to use the assigned IP address.
- Generally an IP address is dynamically assigned out of a pool of IP addresses. However static IP addresses can be associated to AX3000s (for instance when the AX3000's print server is used). This association is performed either by using the AX3000 Ethernet address or by using a 'Client Identifier' (which is a character string entered through the AX3000 Set-Up) .
- The DHCP protocol can be considered as a superset of the BOOTP protocol. IP addresses can also be offered to AX3000s by a BOOTP server (in this case the 'lease time' is infinite).
- The AX3000 DHCP client protocol is compliant with RFCs 1533 and 1541.

This document deals only with the AX3000 DHCP protocol use. To set-up and enable a DHCP server please read your operating system's manual.

2.2 - Setting-Up the AX3000

See Chapter 1.

2.3 - Using the AX3000

If the DHCP protocol is enabled the AX3000 automatically requests an IP address on boot and the following dialog box is displayed:

```
DHCP: searching, please wait
```

Note: the search can be aborted by entering the set-up.

If a DHCP (or BOOTP) server is available an IP address is given after a few seconds. This dialog box is then cleared and the AX3000 follows its normal behaviour: either the set-up idle is displayed (no automatic session is set) or an automatic connection is opened.

Further 'lease time' re-negotiations are totally invisible to the AX3000 user. Only error messages are displayed (see next chapter).

Note: enter the set-up to find out the AX3000 IP address or other parameters offered by the DHCP server.

2.4 - Errors

a - Boot Time Failure

The AX3000 automatically searches for a DHCP server on booting. If after 30 seconds no DHCP (or BOOTP) server answers the following dialog box is displayed:

```
                    DHCP NEGOTIATION FAILED

          Please contact your network administrator

                  Press <F11> to reboot
```

At this stage two options are available:
- <F11>: rebooting the AX3000 to run the DHCP search again.
- <Ctrl><Alt><Esc>: entering the set-up to modify AX3000 settings.

b - Re-negotiation Failure

The lease time must be regularly re-negotiated (except if the IP address has been offered by a BOOTP server).

If a re-negotiation fails the following dialog box is displayed:

```
             WARNING: DHCP REBINDING TOO LONG

     The AX3000 could be disconnected in 2 minutes
        Please log-off before automatic shutdown

            Press <F11> to clear this message
```

This indicates that in two minutes the AX3000 will be no longer be permitted to use the leased IP address and the session will be terminated

If after these two minutes, the re-negotiation has still failed, the following dialog box is displayed:

```
                    DHCP REBINDING FAILED

          Please contact your network administrator

                  Press <F11> to reboot
```

All current sessions (telnet, tty, lpd, etc.) will have been closed (i.e. lost).

Note: the AX3000 Trace Mode allows a trace of data exchanged between the AX3000 and the DHCP server (see Figure 1.2). This is useful to diagnose problems.

3 - THE DNS PROTOCOL

The DNS protocol (Domain Name System) allows names to be 'resolved' by the AX3000. Resolving is retrieving an IP address associated with a name.

3.1 - Overview

A domain (computer network) can be considered as a tree, with branches (nodes) such as hubs, switches, routers, print servers etc, and leafs, for example PCs, terminals and printers.

The domain system makes no distinction between the use of interior nodes and the leafs, and this documentation uses the term "nodes" to refer to both. (i.e. any network resource).

Each node has a name (**Label**) which must be unique to other nodes at the same level, but not necessarily unique within the whole network.

Label syntax:
- Permissible characters are letters (a..z to A..Z), numbers (0..9) and the hyphen (-).
- A Label must begin by a letter and be ended by a letter or a number.
- The resolution is not case-sensitive.

The domain name of a node is the list of the labels on the path from the node to the root of the tree. A dot is used to separate each label. Two types of host names can be distinguished within the AX3000:
- **A full name**: one or more dots are included in the name.
  Example: "www.axel.com"
- **An incomplete name**: no dots are used. The resolution procedure concatenates, another character string to this name (the default DNS domain name). For more information see Chapter 1.2.
  Example: "as400" is concatenated with "servers.axel.com" to create a full name of "as400.servers.axel.com"

A host name is only resolved if the IP address is needed. (i.e. to open a session or to ping).

Note: a name is resolved for each connection attempt, even if its IP address has been obtained by a previous resolution.

3.2 - Resolution Strategy

To resolve a name, a DNS request is sent by the AX3000. A DNS request contains the destination DNS server IP address and the name to be resolved.

To resolve a name possibly more than one DNS request is needed (if one or more default DNS domains are defined). The resolution process is stopped either when the AX3000 receives a positive response from a DNS server (success: an IP address is associate to this name) or when all the DNS requests has been sent and no positive response has been received (failure: the name is not resolved).

The order of the requests sent to resolve a hostname is called the resolution strategy.

The resolution strategy depends on both:
- whether or not a domain name is declared,
- whether the name to resolve is complete.

If no default DNS domain is defined in the AX3000 Set-Up, the resolution is done with the name itself regardless of whether the name is full or not.

If one or more default DNS domains are defined, the resolution strategy depends on the name:
- Full name: the resolution is first done with this name. If unsuccessful new resolutions are performed by concatenating the full name with the defined DNS domains.
- Incomplete Name: the resolutions are first done with the defined default DNS domains. If unsuccessful a new resolution is performed with this incomplete name.

Example of name resolutions: looking at the example on the Figure 1.4 the name resolution attempts are:
- **as400**: this is not a full name, the resolution is first made with the first DNS domain (as400.servers.axel.com). Then, in event of failure, with the second DNS domain (as400.terminals.axel.com). Then, in event of failure, the resolution is made with the name itself (as400).
- **linux**: an IP address is associated. No DNS resolution.
- **www.axel.com**: this is a full name. The resolution is first made with the name itself (www.axel.com). Then, in event of failure, the resolution is made with the first DNS domain (www.axel.com.servers.axel.com). Then, in event of failure, with the second DNS domain (www.axel.com.terminals.axel.com).

3.3 - Resolution Method

To resolve a name, the AX3000 sends DNS requests to the DNS server(s).

If a DNS server sends back a positive response, then the IP address is found and the resolution operation is completed. If not two cases of failure are possible:
- **Receiving a negative response**: the name is not known by this DNS server. The AX3000 will retry with a new DNS request or with the second DNS server.
- **No response (time-out)**: after a few seconds the DNS server has not sent back a response. The AX3000 resends the same request to the DNS server.
  Note: after 4 time-out errors on the same DNS server, this server is "removed" from the resolution operation.

Note: if a response previously considered as a time-out error is received, this response is treated as a valid response (positive or negative).

The AX3000 requests a **recursive search** to the DNS servers (and not iterative search). This means that the DNS server must search itself for a DNS server which is able to resolve the required name.

The resolution operation depends on the number of DNS servers. These are the steps for a one-server resolution and a two-server resolution.

One DNS Server:
1 - A DNS request is sent to the server.
2 - In event of no response, this request is sent again (4 times max.).
3 - In event of negative answer, the resolution is aborted.
4 - If other requests can be sent (default DNS domains are defined), go back to step 1.

Two DNS Servers:
1 - A DNS request is sent to the server 1.
2 - In event of no response from server 1, this request is sent to the server 2.
3 - In event of no response from server 2, go back to step 1 (4 times max.).
4 - In event of negative answer from any server, the resolution is aborted.
5 - If other requests can be sent (using default DNS domains are defined), go back to step 1.

Example: looking at the example on the Figures 1.3 and 1.4, these are the DNS requests sent to resolve "as400" with 2 DNS servers and 2 default DNS domains (of course this process is stopped if one DNS server sends back a positive response):
- "as400.servers.axel.com" to DNS server 1
- "as400.servers.axel.com" to DNS server 2
- "as400.terminals.axel.com" to DNS server 1
- "as400.terminals.axel.com" to DNS server 2
- "as400" to DNS server 1
- "as400" to DNS server 2

3.4 - Messages Displayed on the AX3000 Screen

To open a session the AX3000 must resolve the host name (if no IP address has been associated through the set-up).

This is a screen-shot example when the resolution successes:

```
Connecting to as400.servers.axel.com:23 (Telnet)...
Session number 1
Resolving...
Resolved: 192.168.1.180
Connected
```

Explanation: the AX3000 attempts to resolve "as400.servers.axel.com". The resolution process returns the IP address which is 192.168.1.180.

In the event of a problem, the "Resolved: xxx.xxx.xxx.xxx" message is replaced by an error message. For example:

```
Connecting to as400.servers.axel.com:23 (Telnet)...
Session number 1
Resolving...
Srv: domain not found
Press <Ctrl><Alt><Shift><D> to close this session
```

Error messages: Error messages reported by the DNS server begins with Srv. Error messages from the terminal begin with "Loc". The main error messages are:
- **Srv: domain not found**: the name doesn't exist within this domain.
- **Srv: refused query**: the DNS servers refuses to respond to the request. This could be due to a DNS server security function.
- **Loc: no DNS server defined**: no DNS server has been defined through the AX3000 Set-Up.
- **Loc: name syntax error**: the syntax of the name to resolve is not correct (for example two consecutive dots: as400..servers).
- **Loc: timeout**: no DNS server responds
- **Loc: no memory**: due to a temporary memory overload, the AX3000 can not process the name resolution. Retry later.

When the resolution fails, the session must be manually closed. This is done by pressing <Ctrl><Alt><Shift><D>.