
The SpeedTouch™ and Ethernet Connectivity

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Abstract: This application note provides technical Ethernet information and how this relates to the various DSL SpeedTouch™ products. In the introduction, a brief background on Ethernet is presented. The subsequent sections give detailed information on Ethernet's features and capabilities within the context of twisted pair networks.

The last section describes the Managed Ethernet Switch feature. This feature is available (from R4.2 onwards) on SpeedTouch™ devices equipped with a four port 10/100Base-T auto-sensing MDI/MDI-X Ethernet switching hub.

Applicability: This application note applies to all SpeedTouch™ products equipped with Ethernet ports.

Updates: Due to the continuous evolution of SpeedTouch™ technology, existing products are regularly upgraded. For more information on the latest technological innovations, software upgrades, and documents, please visit the SpeedTouch™ web site at:

www.speedtouch.com

1 INTRODUCTION

Experimental Ethernet was developed in the seventies by the Xerox Palo Alto Research Center. It has become the most widely used Local Area Network (LAN) technology, not only in the corporate environment, but also in the residential space.

Since its introduction, Ethernet has constantly evolved. It is now supported on various media, like coax, twisted pairs, optical fiber and wireless, and features a broad range of communication speeds, i.e. from 1Mb/s up to 100Mb/s and more.

Initially, Ethernet was standardized by Xerox, Intel and Digital. This responsibility was taken over by the Institute of Electrical and Electronic Engineers (IEEE) and resulted in the IEEE802.x range of standards. The most recent version can be obtained from the following website:

<http://standards.ieee.org/getieee802/>.

2 BASIC CONCEPTS

At present, Ethernet Ports always feature a same set of capabilities; irrespective whether these are present on broadband modems, or advanced enterprise switches:

- Communication speed (10Mb/s and/or 100Mb/s)
- Duplex mode (half and/or full duplex)
- Auto-Negotiation capabilities (10/100Mb/s and/or half/full duplex)
- Ethernet connector type and signal-to-pin mapping
- Repeating hubs and switching hubs
- Ethernet limitations, restrictions and considerations.

These items and their applicability to the SpeedTouch™ family are explained below.

As current SpeedTouch™ products feature either 10Mb/s or 10/100Mb/s Ethernet for twisted pair cabling, this application note will further concentrate on these implementations of the standard.

2.1 Communication Speed

For end-users the most essential parameter of a communication system is the maximum supported bandwidth. Bandwidth is expressed in Mb/s (Megabits per second).

10Base-T

10Base-T Ethernet provides a bandwidth of up to 10Mb/s.

It operates over two wire pairs: one pair for transmission, another pair for reception. To improve signal characteristics, the two wires in each pair are twisted together (the T in 10Base-T stands for “twisted” in reference to this fact).

100Base-T

100Base-T Ethernet provides a bandwidth of up to 100Mb/s. As for 10Base-T, 100Base-T uses twisted pair cabling. 100 Base-T is considered to be one of the most popular implementations of the IEEE802.3 standard.

2.2 Duplex Modes

The duplex mode of a communications system refers to its simultaneous transmission and reception capabilities. For Ethernet, two distinct modes of operation exist:

- **Full duplex:**
In full duplex, a node can simultaneously transmit and receive data.
- **Half duplex:**
In half duplex, a node cannot simultaneously transmit and receive data, although the communication medium might be perfectly suited for this purpose.

Half duplex mechanism

All Ethernet systems support at least half duplex communication because of the technological history of Ethernet. The first Ethernet systems used coaxial cable and applied baseband modulation techniques.

In order to create a shared communication environment, only a single station is allowed to transmit at any one time. All other stations should be in listening mode. If more than one station is transmitting at the same time, a collision condition occurs. The involved transmitting nodes revert to back-off state and wait for a random period of time before retransmitting their data.

Hub types

The duplex mode depends on the hub type used in the network:

- Twisted pair systems connected via repeating hubs inherit identical properties and behavior from coaxial Ethernet systems. Thus all the Ethernet nodes operate in half duplex and not more than one is allowed to transmit data at any one time.
- If the shared environment is constructed with switching hubs, it is possible for the nodes to operate in full duplex mode.

Note For more information on the different hub types, see [2.5 "Repeating Hubs and Switching Hubs"](#) on [page 8](#).

Aggregate bandwidth

An important consequence for the end-user is that the half or full duplex mode of an Ethernet segment influences the aggregate bandwidth of the communication environment. E.g., a 10Mb/s full duplex system exhibits an aggregate bandwidth of 20Mb/s, whereas a 10Mb/s half duplex system exhibits an aggregate bandwidth of only 10Mb/s.

2.3 Auto-Negotiation

Function

The Auto-Negotiation mechanism permits two ports sharing an Ethernet segment, to exchange performance information such as operating speed and duplex mode. Auto-Negotiation subsequently determines and configures the common capabilities.

Note Auto-Negotiation is described in Clause 28 and Annex 28D of IEEE standard 802.3, 2000 Edition.

Performance level

If two Auto-Negotiation devices with multiple capabilities are connected, Auto-Negotiation assures that the highest common denominator capability is selected to achieve the highest possible performance level.

If one device is not Auto-Negotiation capable, the Auto-Negotiation capable device will select the same speed but will always select half duplex mode. The duplex mode can only be passed via the Auto-Negotiation mechanism.

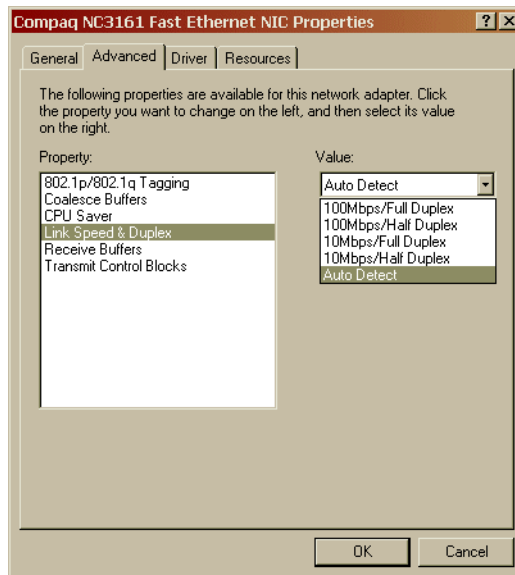
Manual override

In principle no user intervention is required if Auto-Negotiation is active at one or both ends of an Ethernet segment. If Auto-Negotiation fails to converge to a common operational mode, most Ethernet ports allow overriding Auto-Negotiation by setting the operating speed and duplex mode manually.

The ability to override auto-negotiation is also supported by the 10/100Base-T Ethernet variants of the SpeedTouch™ products. Via the SpeedTouch™ Command Line Interface (CLI) it is possible to configure a default operating speed and duplex mode and whether auto-negotiation is allowed or not.

See 3.3 "Advanced SpeedTouch™ Configuration" on page 14.

Example: The figure below shows the configuration panel of a typical Ethernet PC-NIC:



2.4 Ethernet Connector Type and Signal-to-Pin Mapping

Ethernet connector type

Most of the time end-users are confronted with Ethernet when connecting cables to Ethernet ports in order to setup a local network. Both the 10Base-T and 100Base-T standard use the same type of miniature 8-pin connector, commonly referred to as RJ45.



Both the 10Base-T and 100Base-T standard use only 4 pins of the connector: 2 pins for transmission and 2 for reception. As the transmit pair must be connected to the receive pair of the link partner and vice versa, it is important to know the signal to pin mappings of both ports.

Signal-to-pin mapping

The IEEE standard allows for two mappings:

- MDI (Medium Dependent Interface)
- MDI-X (MDI-Crossed).

The table below lists the signal-to-pin mappings for both types of Ethernet port and the cable pairs:

Pin	MDI Ethernet port	MDI-X Ethernet port	Cable pair
1	Send (pos. signal)	Receive (pos. signal)	1
2	Send (neg. signal)	Receive (neg. signal)	1
3	Receive (pos. signal)	Send (pos. signal)	2
4	Not used	Not used	3
5	Not used	Not used	3
6	Receive (neg. signal)	Send (neg. signal)	2
7	Not used	Not used	4
8	Not used	Not used	4

Irrespective of the signal-to-pin mapping of Ethernet ports, the transmitter output pins must always be connected to the partner's receiver input pins and vice versa. This can be accomplished in various ways depending on the MDI type of the Ethernet port and the use of straight-through or crossover Ethernet cables.

MDI ports are mostly found on "terminal equipment" (PC, workstation, Ethernet ports on LAN printers, etc.). MDI-X ports are found on "network equipment" (repeating hubs, switches, routers, etc.).

On most SpeedTouch™ products the Ethernet ports have fixed MDI-X interfaces. From R4.0 on, all SpeedTouch™ devices are equipped with Ethernet ports capable of auto-sensing whether they should operate as MDI or MDI-X port.

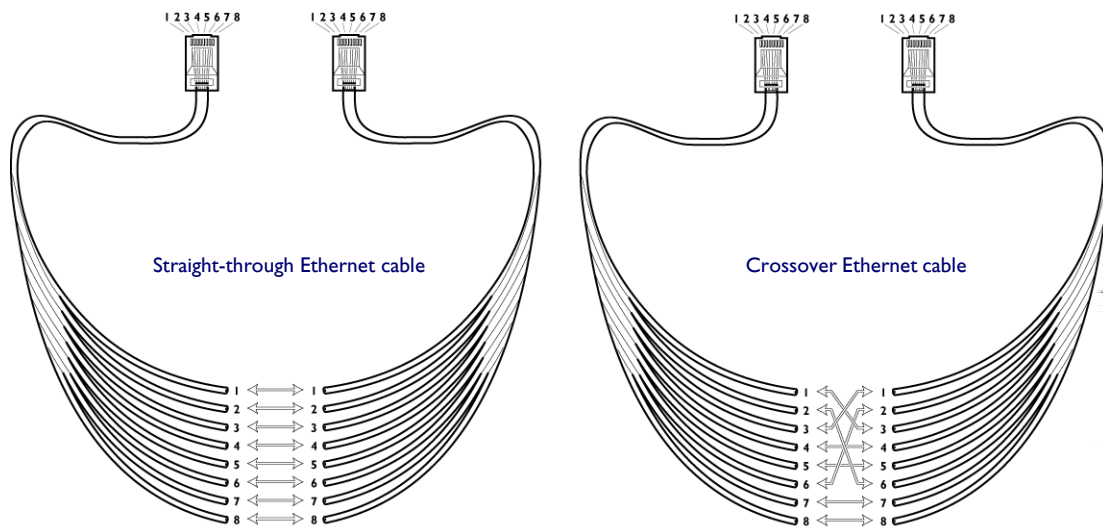
UTP cables

10/100Base-T Ethernet uses Unshielded Twisted Pair (UTP) cable assemblies. This type of cable is made of four twisted pairs of copper wire, terminated by RJ45 connectors.

UTP cables are available in different qualities. Nowadays the so-called Cat-5 cable type is the most common. Cat-5 UTP cables support frequencies up to 100 MHz and speeds up to 1000Mb/s, allowing for future cost-effective upgrades.

Ethernet cable types

To cope with the MDI/MDI-X issues, two types of UTP cable assemblies exist: straight-through and crossover. The picture below shows the layout for both types of cable assembly.



The relationship between the logical layouts of the termination jacks and the cable assembly to use, is depicted in the table below:

Ethernet port of device A	Ethernet port of device B	Cable type
MDI-X	MDI	Straight-through
	MDI-X	Crossover
MDI	MDI	Crossover
	MDI-X	Straight-through

2.5 Repeating Hubs and Switching Hubs

Hub types

Each 10/100Base-T Ethernet segment is actually a point-to-point link. If multiple segments need to be interconnected, an Ethernet hub is required. Two types of Ethernet hub exist:

- **Repeating hubs**
A repeating hub simply acts as a conduit for data between different Ethernet segments. Data arriving at one hub port is copied to all other hub ports, i.e. forwarded to all connected segments.
Repeating hubs are an ideal solution for small (Home) Ethernet networks: they are inexpensive, and simple to install and use.
- **Switching hubs (also called an Ethernet switch)**
A switching hub has the same purpose as repeating hubs, that is, connecting different Ethernet segments. However, switching hubs are more advanced: they are capable of directing traffic to the appropriate ports instead of all ports.
In addition, switching hubs allow for Ethernet segments with dissimilar speeds and duplex modes to form a shared network.
The use of switching hubs is recommended, or even required in case of larger networks, or mixed 10 and 100Base-T Ethernet segments.

Note The Ethernet ports of a hub are always of type MDI-X. On some hubs, a (sometimes switchable) “uplink”, “cascade” or “extension” port may be present. This MDI type port allows to enlarge the network by cascading hubs.

2.6 Ethernet Limitations and Considerations

When creating an Ethernet LAN, take note of the following limitations and considerations to preserve network integrity and overall data quality:

Cable length

The maximum length of a Cat-5 UTP cable in an Ethernet segment should never exceed 100 meters (328 feet).

Operation mode

Some Ethernet ports can only operate in half duplex mode. In this case, the counterpart Ethernet port may never be configured for full duplex. Always follow the instructions and advisories of the manufacturer.

Cascading repeating hubs

The following considerations apply when cascading repeating hubs:

- Do not cascade more than four 10Base-T repeating hubs.
- Do not cascade more than three 100Base-T or 10/100Base-T repeating hubs.

Note This consideration does not apply to switching hubs.

3 USING THE SPEEDTOUCH™ IN AN ETHERNET ENVIRONMENT

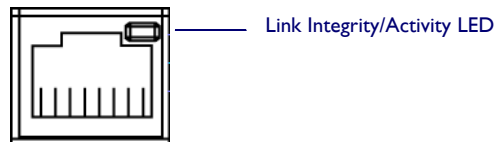
Introduction

Depending on the network setup, and the Ethernet variant of the SpeedTouch™ product, several ways exist to connect the SpeedTouch™ to your network.

Ethernet port LED indicators

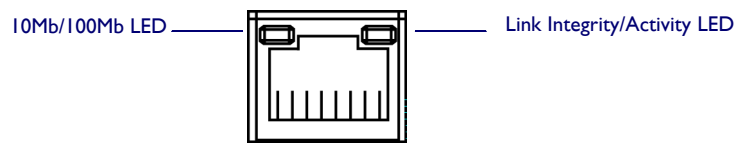
Each Ethernet port on the back panel of the SpeedTouch™ has one or two LEDs:

- **Link Integrity/Activity LED:**
This LED shows the link integrity and if traffic is present on the port



If this LED is:

- **on:** both ports are properly connected.
 - **off:** no or bad connection.
 - **flashing:** traffic is present on the port.
- **10Mb/100Mb LED**
If applicable, a second LED may show whether the port is operating at 10Mb/s or 100Mb/s.

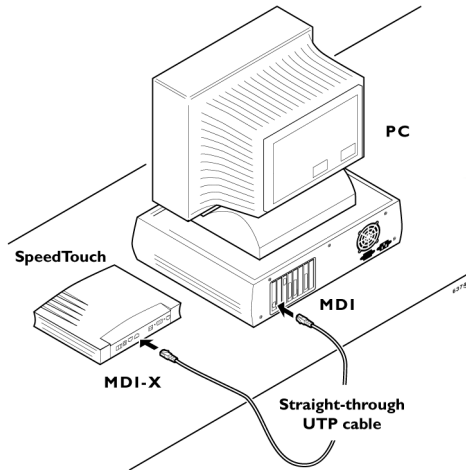


If this LED is

- **off:** the communication speed of the port is 10Mb/s.
- **on:** the communication speed of the port is 100Mb/s.

3.1 Single Computer Ethernet Wiring

In this network setup, the SpeedTouch™ is connected to a single computer. The LAN segment consists of one computer and the SpeedTouch™:



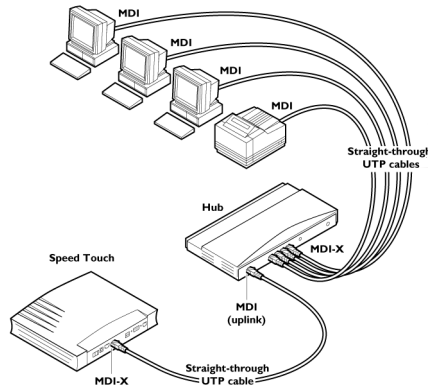
As the computer's Ethernet port will always be of type MDI, and the SpeedTouch™ Ethernet port of type MDI-X, a straight-through UTP cable must be used.

Note If the SpeedTouch™ features an auto-sensing MDI/MDI-X Ethernet port, it does not matter which cable is used.

3.2 Multiple Computer Ethernet Wiring

3.2.1 Single Ethernet SpeedTouch™ Variant

In case of a single Ethernet port SpeedTouch™ variant, a repeating or switching hub is needed to build the network. A possible setup is shown below:

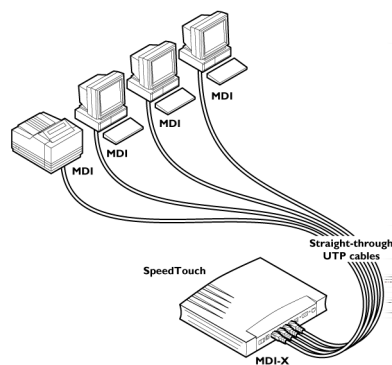


In the example the hub's "uplink" (or "cascade") Ethernet port is used to connect the SpeedTouch™. Therefore a straight-through cable is used.

3.2.2 Ethernet hub SpeedTouch™ Variant

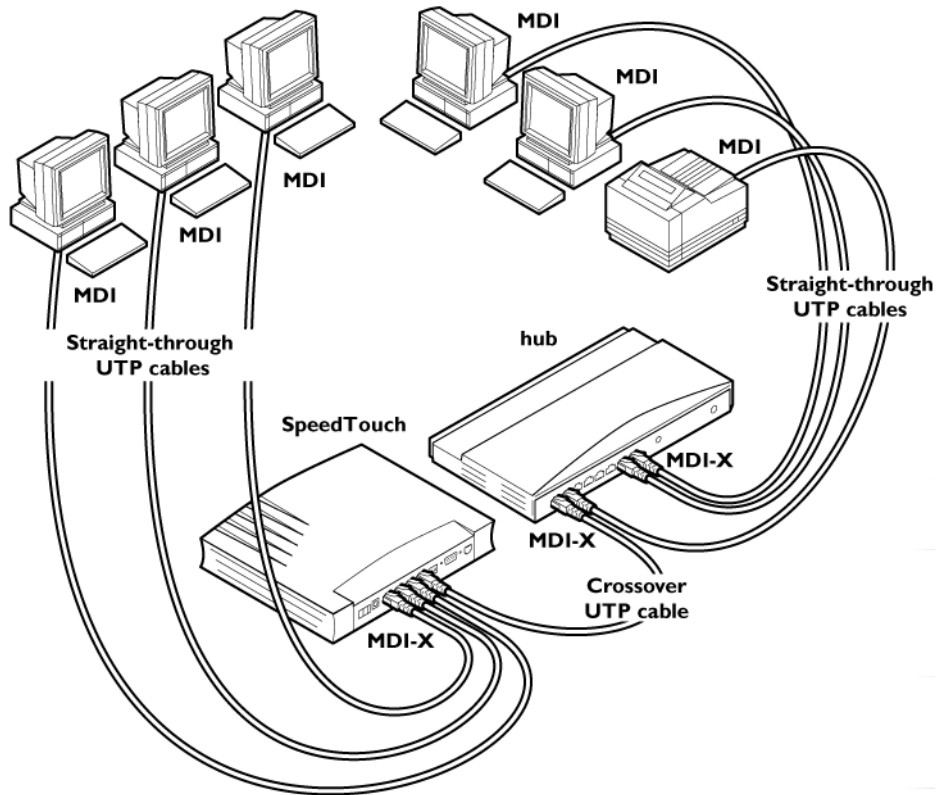
Network of up to four devices

No additional devices are needed to build the network when an Ethernet hub SpeedTouch™ variant is used, whether it's a repeating hub or a switching hub.



Network of more than four devices

In this network, an additional hub will have to be cascaded with the SpeedTouch™ hub to increase the number of available Ethernet ports:



In the example, the additional hub is not equipped with an “uplink” MDI Ethernet port to connect the SpeedTouch™. As one of the MDI-X Ethernet ports of the SpeedTouch™ hub must connect to one of the MDI-X Ethernet ports of the hub, a crossover cable is required.

Note If the SpeedTouch™ device is equipped with an auto-sensing MDI/MDI-X Ethernet port, it does not matter which cable is used.

3.3 Advanced SpeedTouch™ Configuration

CLI commands

The SpeedTouch™ Ethernet ports can be configured manually via the CLI commands. You can:

- enable or disable Ethernet ports.
- change the communication speed and duplex mode of an Ethernet port.

Enable/disable ports

This procedure gives an example of how to disable an Ethernet port (here port 3).

- 1 Display the current configuration:

```
=>eth config
ETH Intf 1 port state = UP [forwarding]
ETH Intf 2 port state = UP [forwarding]
ETH Intf 3 port state = UP [forwarding]
ETH Intf 4 port state = UP [forwarding]
=>
```

- 2 Disable port 3:

```
=>eth config intf=3 state=disabled
=>
```

- 3 Display the new configuration:

```
=>eth config
ETH Intf 1 port state = UP [forwarding]
ETH Intf 2 port state = UP [forwarding]
ETH Intf 3 port state = DOWN [disabled]
ETH Intf 4 port state = UP [forwarding]
=>
```

Port 3 is now disabled.

Communication speed and duplex mode

In principle no user intervention is required if Auto-Negotiation is active at one or both ends of an Ethernet segment. If Auto-Negotiation fails to converge to a common operational mode, most Ethernet ports allow to override Auto-Negotiation by configuring the operating speed and duplex mode manually.

Example:

Suppose port 3 of the SpeedTouch™ is connected to an older 10Base-T half duplex PC-NIC card that does not support Auto-Negotiation and Auto-Negotiation fails to converge to a common operational mode.

Follow this procedure to change the communication speed and duplex mode of port 3:

- 1 Display the current configuration:

```
=>eth iflist
Intf  Type          Result Type
1     auto         100BaseTFD
2     auto         100BaseTFD
3     auto         100BaseTFD
4     auto         100BaseTFD
=>
```

- 2 Configure port 3 for 10Base-T half duplex

```
=>eth ifconfig intf=3 type=10BaseTHD
=>
```

- 3 Display the new configuration:

```
=>eth iflist
Intf  Type          Result Type
1     auto         100BaseTFD
2     auto         100BaseTFD
3     10BaseTHD    10BaseTHD
4     auto         100BaseTFD
=>
```

Port 3 is now configured as a 10Base-T half duplex Ethernet Port

Note For more detailed information on the CLI commands, see the CLI Reference Guide

4 MANAGED ETHERNET SWITCH

Introduction

The Managed Ethernet Switch gives LAN administrators the ability to control how traffic is forwarded. This can be done via:

- Port isolation.
- Port mirroring.

Configuration

The Managed Ethernet Switch feature can only be configured via CLI commands.

Applicability

The Managed Ethernet Switch feature is only available on SpeedTouch™ devices equipped with a four port 10/100Base-T auto-sensing MDI/MDI-X Ethernet switching hub.

From R4.2 on, all SpeedTouch™ devices with 4 Ethernet ports are equipped with this feature.

4.1 Port Isolation

Introduction

Port Isolation works on base of grouping. Grouping prevents ports from two different groups from communicating with each other, but ports in the same group can communicate with each other.

The only traffic that is blocked are the frames generated from a port belonging to a specific group and destined for a port belonging to a different group than the source group.

Up to 4 different groups can be configured. By default, all the ports are in the same group (Group 0).

Isolated port

An isolated port is a port that has been removed from Group 0 and put in a different Group *i* (*i* can be 1, 2 or 3). That particular port can then only communicate with:

- port(s) of the same Group *i*.
- port(s) of Group 0.

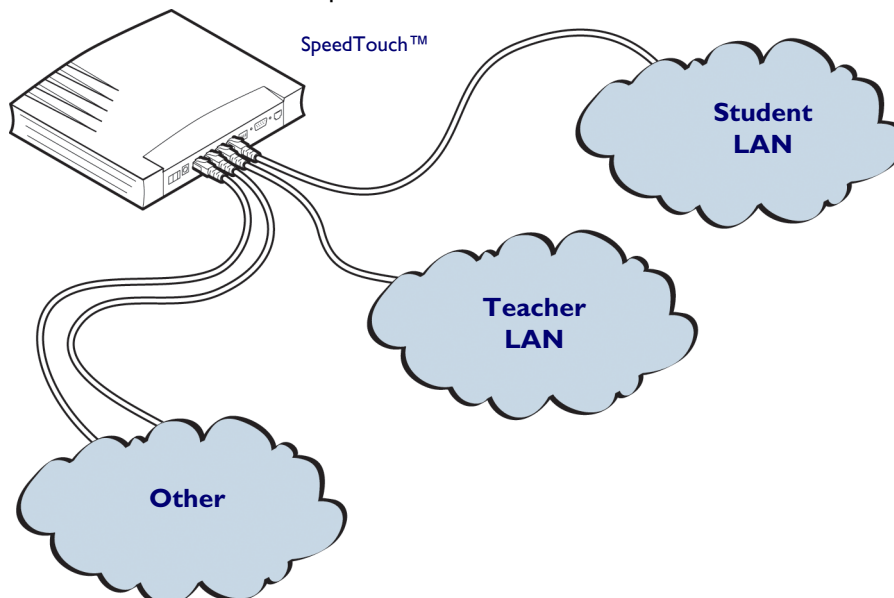
Non-isolated port

A non-isolated port is a port belonging to Group 0. A port in Group 0 can communicate with any port, no matter to which group they belong.

Example: decoupled LANs

The following example shows a possible application of port isolation in a school.

The LAN of the teachers is connected to port 3 and the LAN of the students is connected to port 4.



The teachers want to prevent the students from sniffing the traffic on the LAN of the teachers.

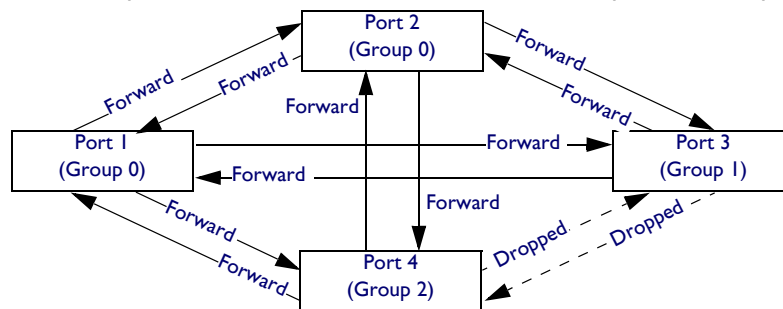
This can be achieved by isolating both ports from each other.
The following configuration could be used:

- Put port 3 in Group 1
- Put port 4 in Group 2
- The other ports can stay in Group 0

So, in terms of groups:

- Group 0 (non-isolated) contains Port 1 and Port 2
- Group 1 (isolated) contains Port 3
- Group 2 (isolated) contains Port 4

The figure below shows the possible flow of traffic between the different ports of the SpeedTouch™:



The procedure below shows how to configure the example above via CLI commands:

- 1 Display the current configuration (here still the default configuration):

```

=>switch group list
Group 0 Ports: 1 2 3 4
=>
  
```

- 2 Move the ports to the different groups:

```

=>switch group move group=1 port=2
=>switch group move group=2 port=3
=>
  
```

- 3 The configuration is now:

```

=>switch group list
Group 0 Ports: 1 4
Group 1 Ports: 2
Group 2 Ports: 3
=>
  
```

Note For more detailed information on the CLI commands, see the CLI Reference Guide.

4.2 Port Mirroring

Introduction

Port monitoring allows to monitor the traffic from one port (called Mirrored Port) to another predefined port (called Mirror Capture Port).

Note Any switch port can be configured as the Mirror Capture Port, but only one port can be the Mirror Capture port at any one time.

Scenarios

The following scenarios are possible for Port Mirroring:

- **Mirrored Egress Port**
The outgoing traffic on one port is mirrored to the Mirror Capture Port.
- **Mirrored Ingress Port**
The incoming traffic on one port is mirrored to the Mirror Capture Port.
- **Mirrored Egress and Ingress Port**
Both the outgoing and the incoming traffic on one port are mirrored to the Mirror Capture Port.

Restrictions

- The mirror capture port cannot be the same port as the mirror ingress or mirror egress port.
- Only 1 port can be configured as mirrored ingress port at any one time.
- Only 1 port can be configured as mirrored egress port at any one time.
- A port can be configured as mirrored ingress port and mirrored egress port at the same time.
- Multi-port mirroring is not allowed to prevent congestion.

Example

In this example, port 2 will be configured as the Mirrored Capture Port and port 3 will be configured as the Mirrored Egress and Ingress Port.

- 1 Configure port 2 to be the Mirror Capture Port:

```
=>switch mirror capture port=2  
=>
```

- 2 Configure port 3 to be the Mirrored Egress Port:

```
=>switch mirror ingress port=3 state=enabled  
=>
```

- 3 Configure port 3 to be the Mirrored Ingress Port:

```
=>switch mirror egress port=3 state=enabled  
=>
```

The configuration can be verified as follows:

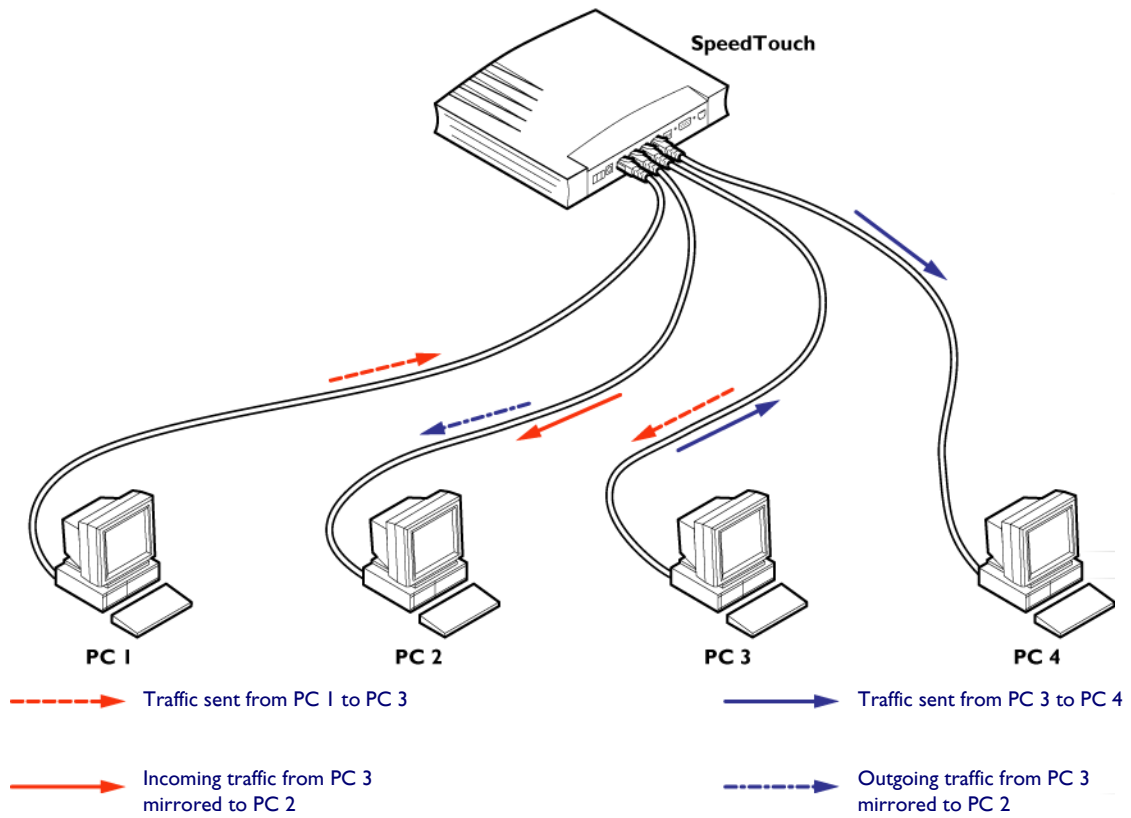
```

=>switch mirror capture
Mirror capture port = 2
=>switch mirror ingress
Ingress mirror port = 3
=>switch mirror egress
Egress mirror port = 3
=>
    
```

Note For more detailed information on the CLI commands, see the CLI Reference Guide.

In this configuration:

- Traffic sent from port 3 will be mirrored to port 2.
- Traffic sent to port 3 will be mirrored to port 2.



Visit us at:

www.speedtouch.com

Acknowledgements

All Colleagues for sharing their knowledge.

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