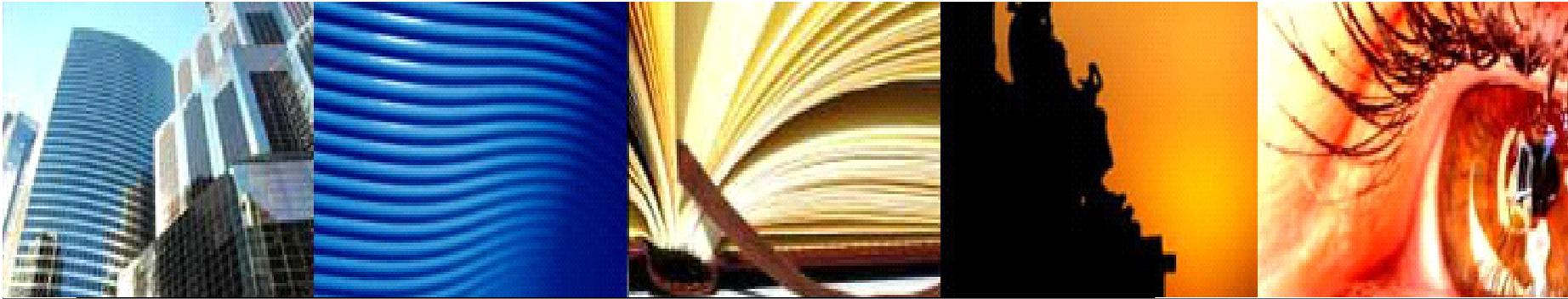
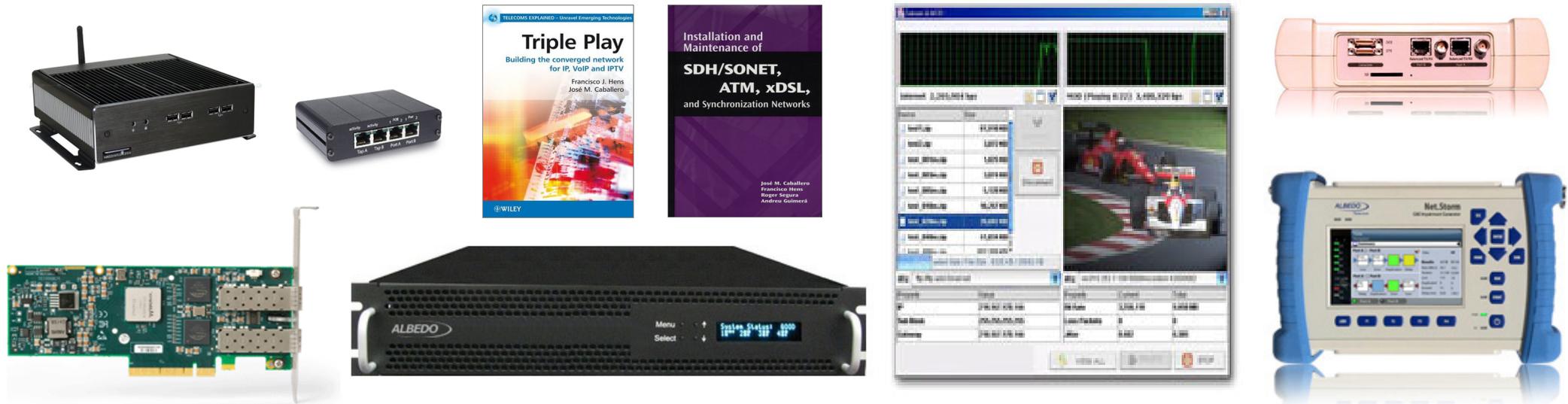


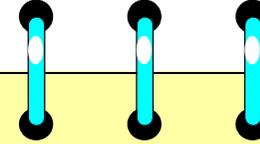
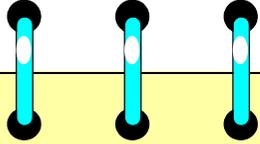
Carrier Ethernet Testing





ALBEDO Telecom offers a full range of telecommunication products and services that help your organization make the most of your investment in telecoms

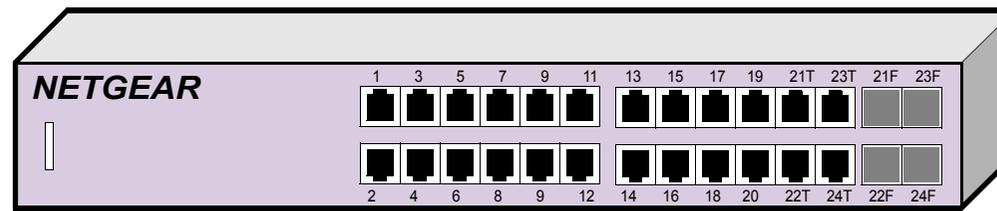
- **Hand-held testers:** E1, SDH, GbE, SyncE, IP, IPTV, VoIP, Datacom, Jitter, Wander
- **Impairment Generator:** Carrier Ethernet and IP
- **Acceptance Labs:** IPTV, VoIP, ISDN, POTS
- **Distributed Test System:** SLA, QoS, Bandwidth profile
- **Professional Training:** xDSL, PON, Carrier Ethernet, MPLS, SDH, Synchronization, IPTV, VoIP
- **Consultancy / Integration:** IPTV, VoIP



Good Cabling Practices

Section

Our Switch: Netgear ProSafe GSM7224R



24 x Ports 10/100/1000BASE-T

4 x Ports 1000BASE-X

Wirespeed Gigabit performance fiber connectivity enabled through four combination interfaces

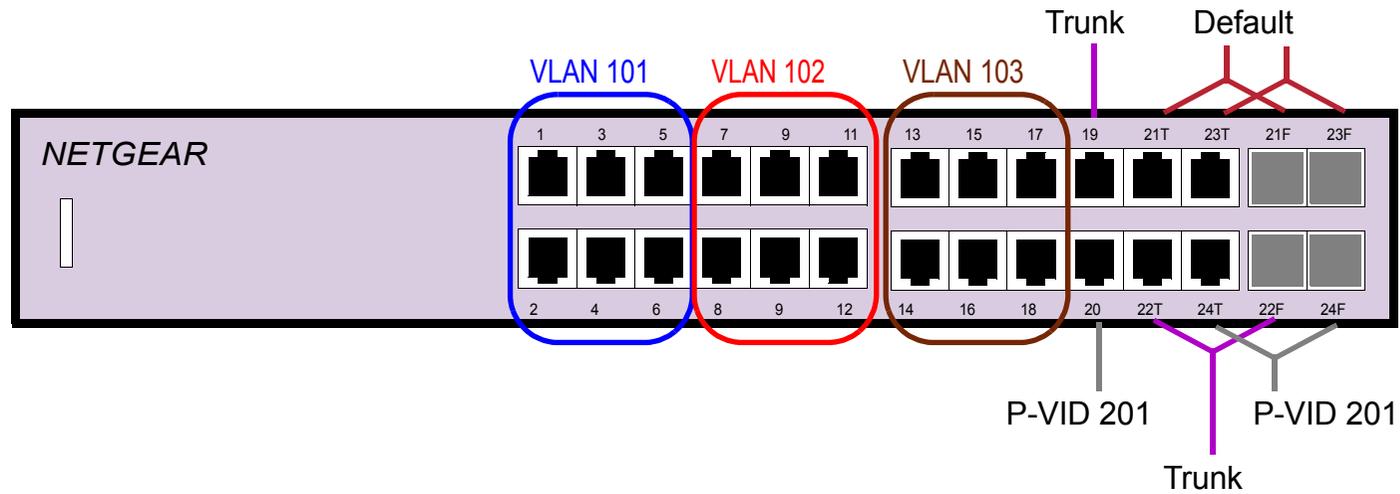
Layer 2 Services

- IEEE 802.1Q static VLAN (512)
- IEEE 802.1p Class of Service (CoS)
- IEEE 802.1 Q-in-Q
- IGMP v1, v2 snooping support
- Ingress rate limit in 1 Kbit/s increments (CIR)
- Weighted round robin (WRR) queue technology (QoS)

Layer 3 Services

- IGMP Querier
- Diffserv QoS
- Static routing
- ARP

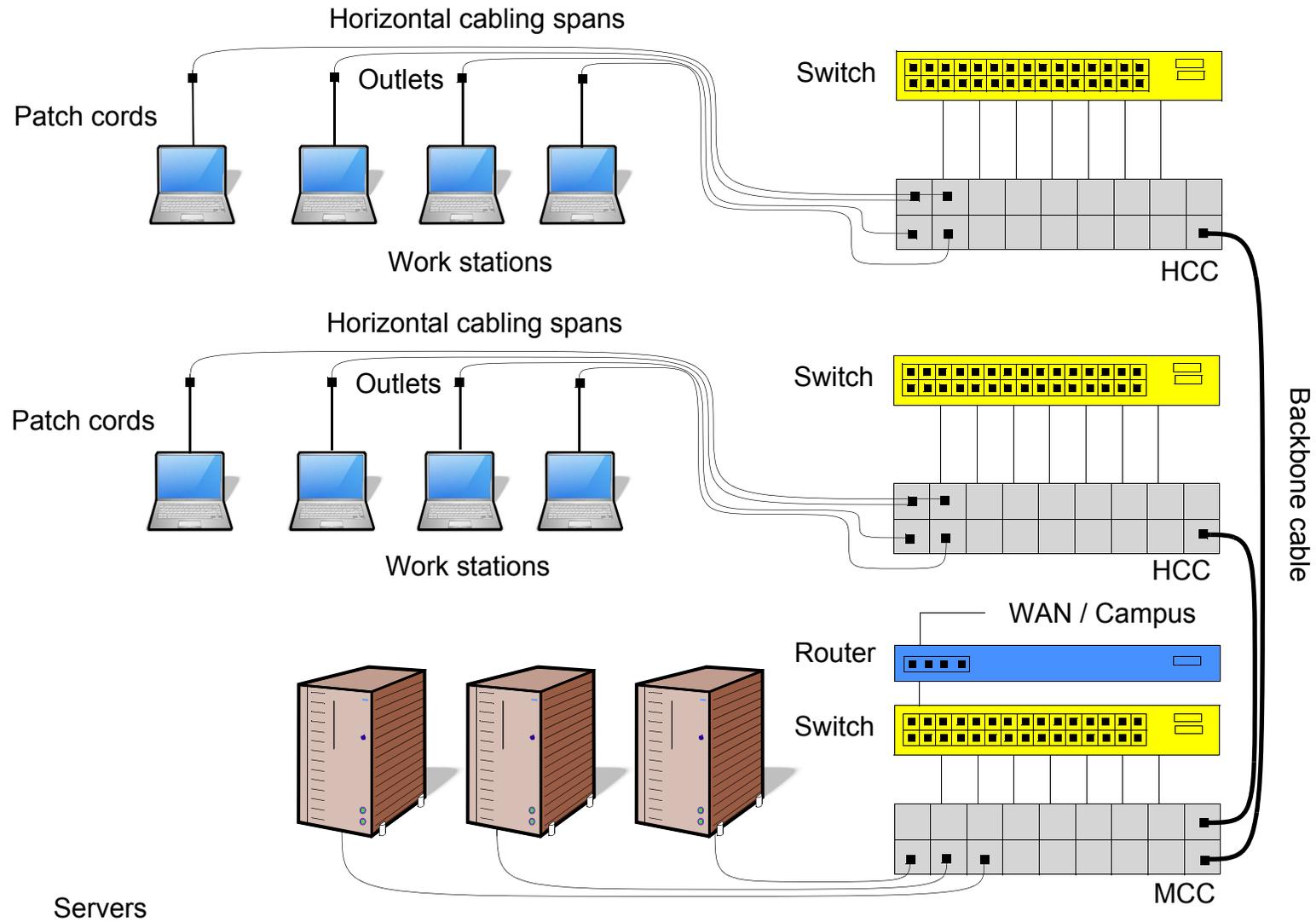
Configuration



- Switch MAC address: 00:01:22:BC:08:73

Port	Autoconfiguration	MTU	VLAN	VLAN ID	IP	QoS
1 to 6	Auto	1518 bytes	1	101	192.168.101.1 / 24	CIR (global) = 2 %
7 to 12	100BASE-T / HDX	1518 bytes	2	102	192.168.102.1 / 24	n.a.
13 to 17		9000 bytes	3	103	192.168.103.1 / 24	if DSCP=46 then CIR=10 Mbit/s CBS=100 kB, strict priority
19 & 22	Auto	1522 bytes		Q-tag trunk		
20 & 24		1526 bytes	n.a.	Q-in-Q, P-VID 201	trunk	n.a.
21 & 23				Default (Admin.1)	n.a.	

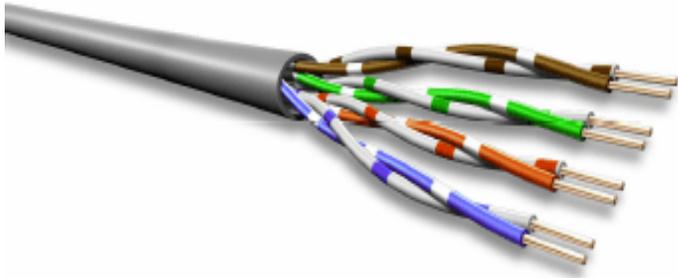
The Structure of LAN Cabling



Cable type

Comments

Unshielded Twisted Pair (UTP)



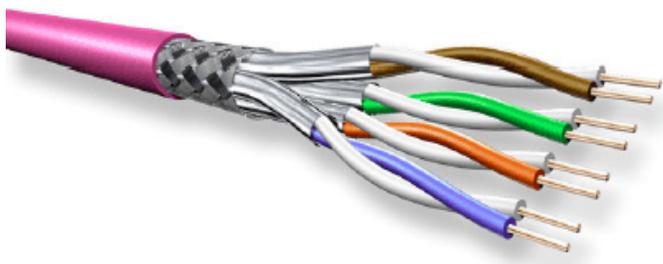
- The most common (and lowest cost) twisted pair. A UTP cable usually contains four different copper pairs. However it is also manufactured in bundles of 25 pairs and even larger sizes.

Foil Twisted Pair (FTP)



- The foil screened version of the twisted pair is known as FTP. In the FTP, a metallic shield is wrapped around all pairs. FTP is thicker, more expensive and more difficult to handle than UTP. The shield must be grounded, otherwise, performance might be even worse than with UTP. However, if used with care it offers better performance than UTP.

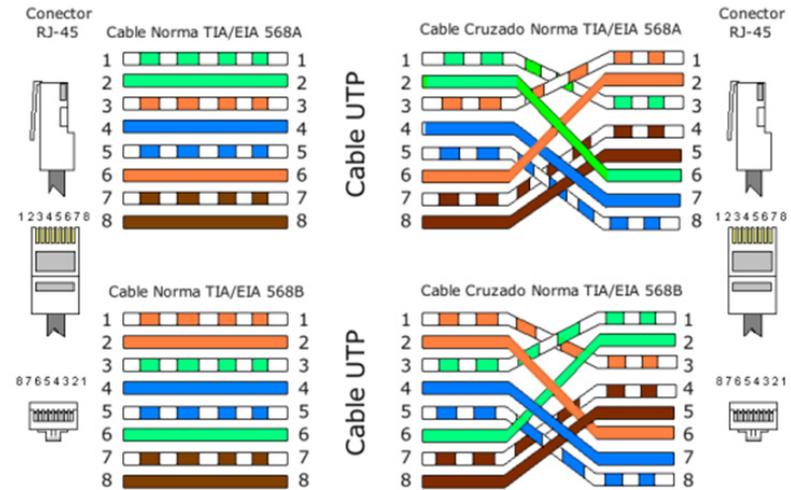
Shielded Twisted Pair (STP)



- If individual pairs are shielded from each other, the cable is known as STP. The shield protects signals transported in the pairs from being damaged from crosstalk and external interferences. STP has the same disadvantages than FTP but, on the other hand, it offers increased performance.

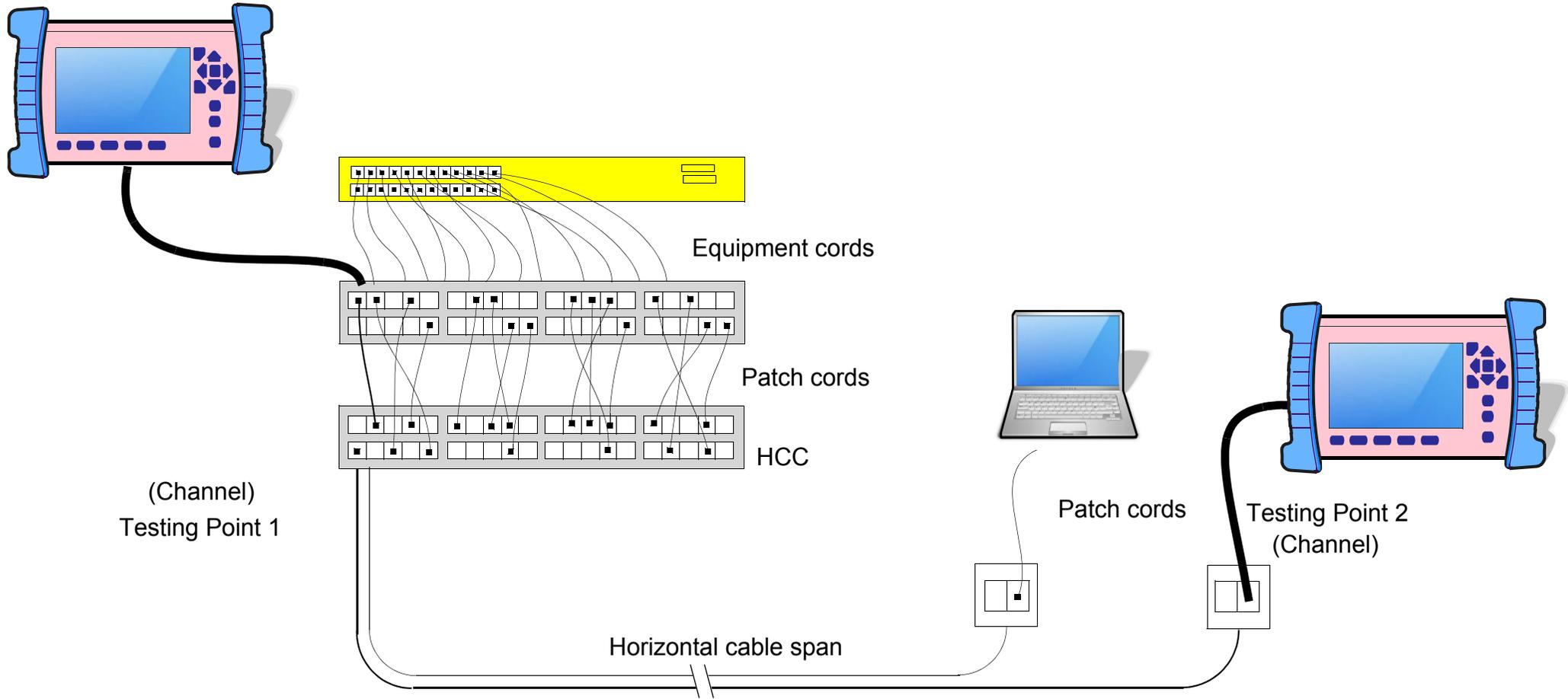
EIA/TIA Cable Categories

Cat	Bandwidth	Common Application
1	-	Telephony, ISDN BRI
2	4 MHz	4 Mbit/s Token Ring
3	16 MHz	Telephony, 10BASE-T, 100BASE-T4 (four wires)
4	20 MHz	16 Mbit/s Token Ring
5	100 MHz	100BASE-T, 1000BASE-T (four wires)
5e	100 MHz	100BASE-T, 1000BASE-T (four wires)
6	250 MHz	1000BASE-T (four wires)

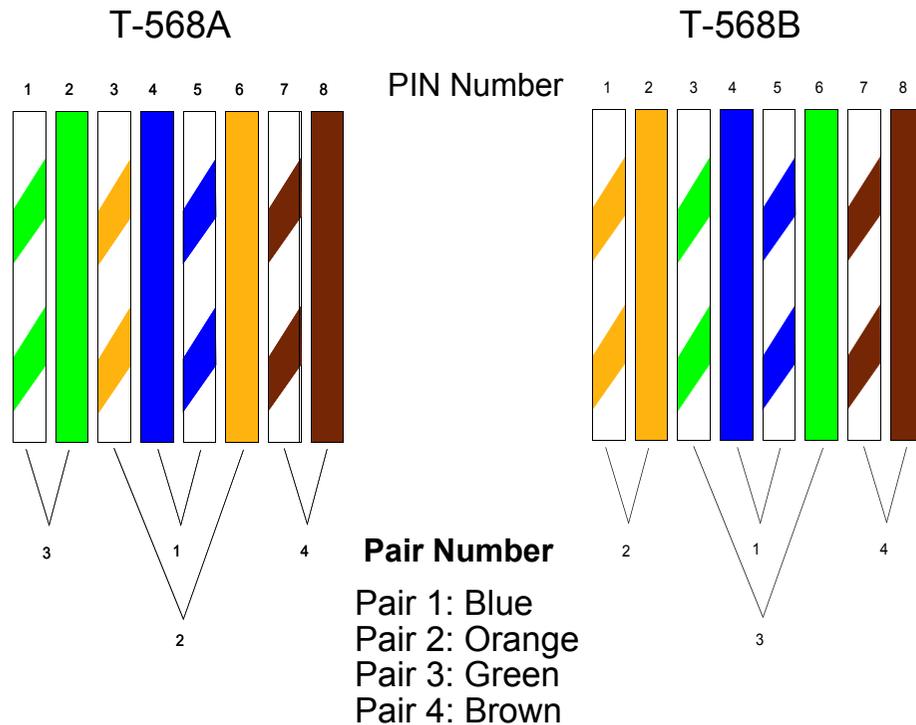


Category	Cat 6	Cat 5e	Cat 5
DC resistance (20°C, 100 m)(max)	9.5 Ω	9.5 Ω	9.5 Ω
DC resistance unbalance (max)	2 %	2 %	5 %
Mutual capacitance (100 m)(max)	5.6 nF	5.6 nF	5.6 nF
Worst case cable skew (100 m)	25 ns	22 ns	45 ns
Nominal velocity of propagation	73%	75%	70%
Loss (20/100/250 MHz)(100m)(max)	8/18/30 dB	9/20/33 dB	9/21/- dB
PSNEXT (20/100/250 MHz)(100m)(min)	65/57/48 dB	58/47/41 dB	50/39/- dB

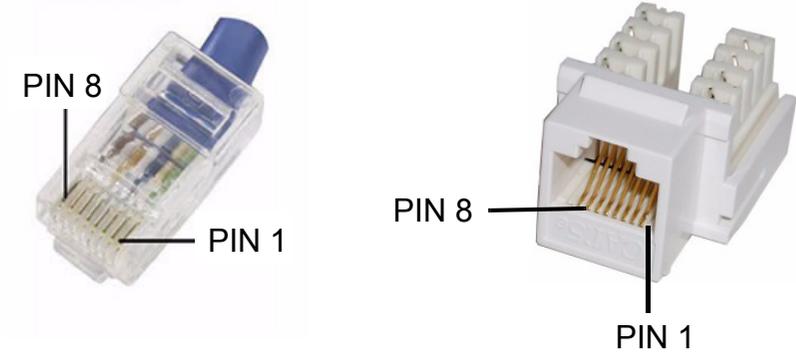
Testing Cabling in LANs



Pin/Pair Assignment Standards



Where is the pin #1?

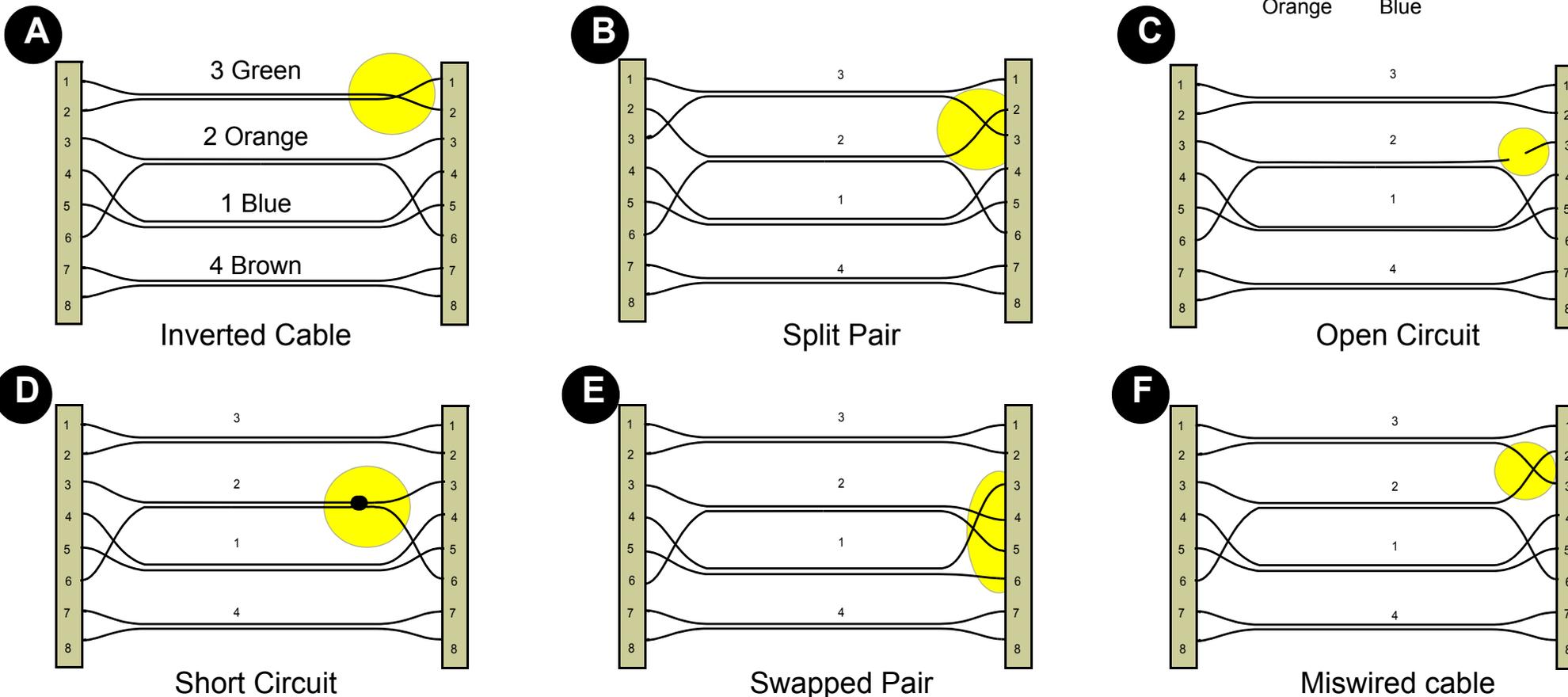
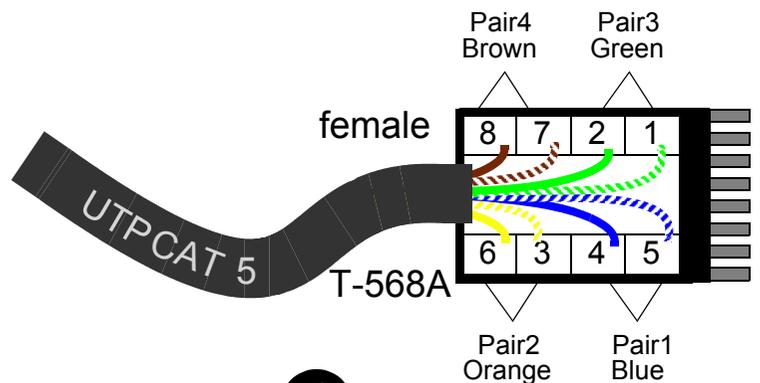
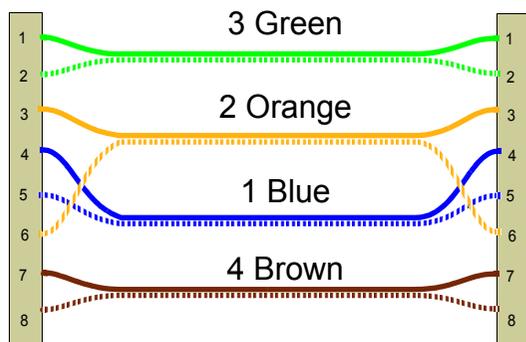


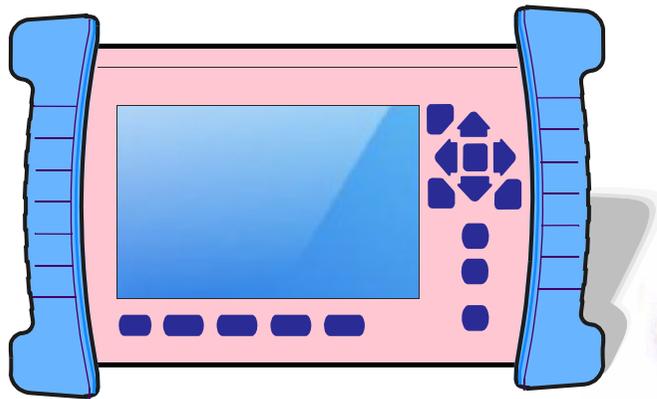
There are two wiring standards, T-568A and T-568B. So far this conference, the difference is the color used by pair 2 and pair 3. In our model we are using the **T-568A**

The two standards should no be used in the same cable.

Common Cabling Faults

T-568A
Correct cable:





ALBEDO tester



Miswired cable



Open Circuit



Short Circuit



Swapped Pair

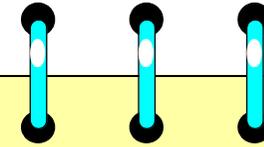
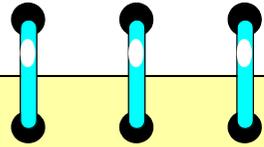


Split Pair



Reversed Cable

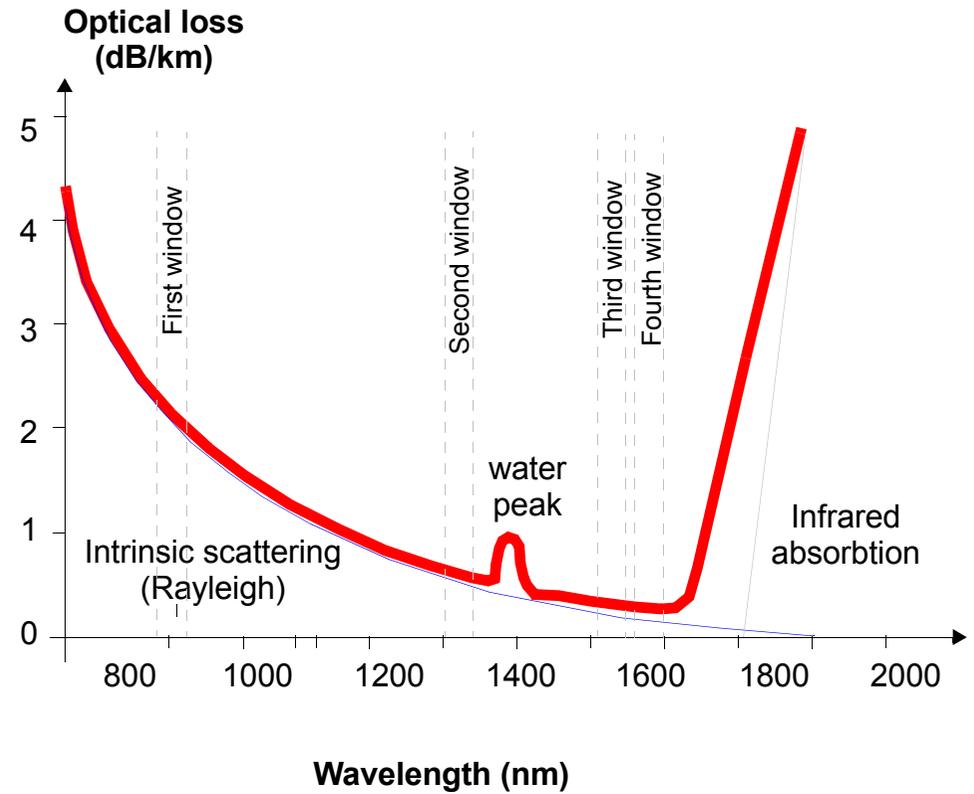
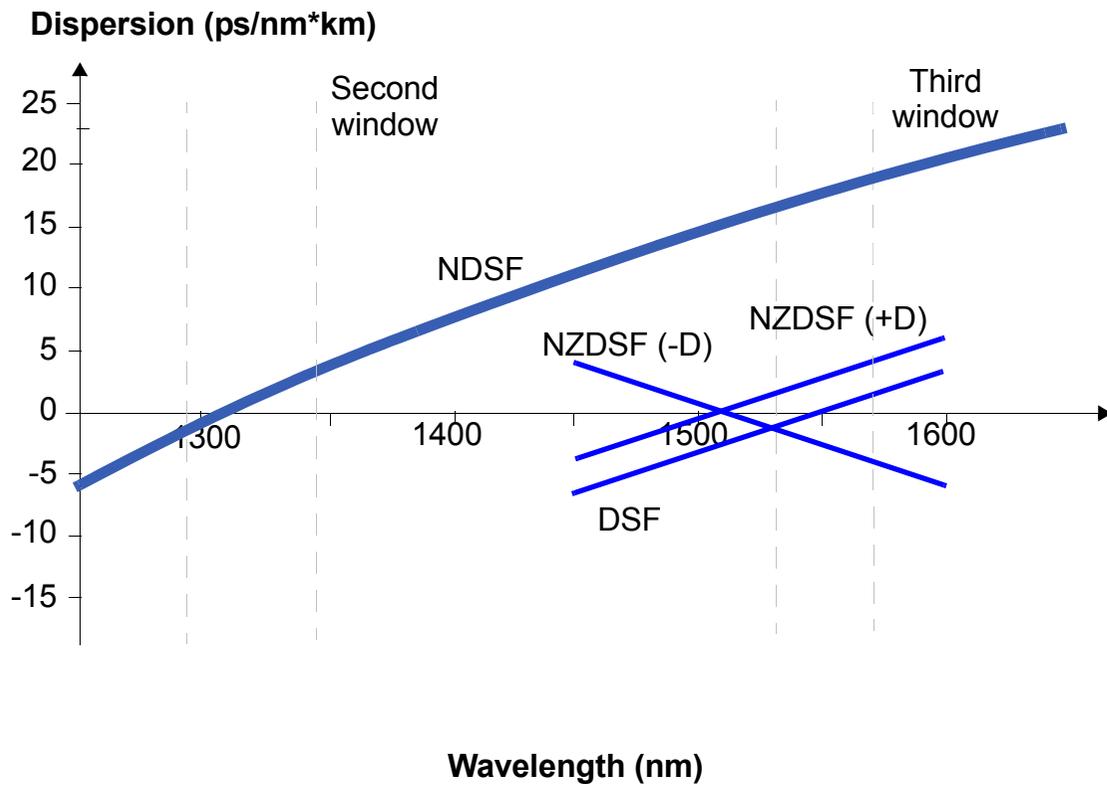
- Connecting to a Line using the RJ45 Connector Ports C only
- *General Config*: Select Endpoint Mode
- *Set Up*: Test Sel cable
- (Num Port, in General Config, changes automatically to P1 - C)
- *Start* the Cable test
- *Results*: select Cable
- Choose the pair (Pair 1, Pair 2, Pair 3 or Pair 4) you want to display the results.



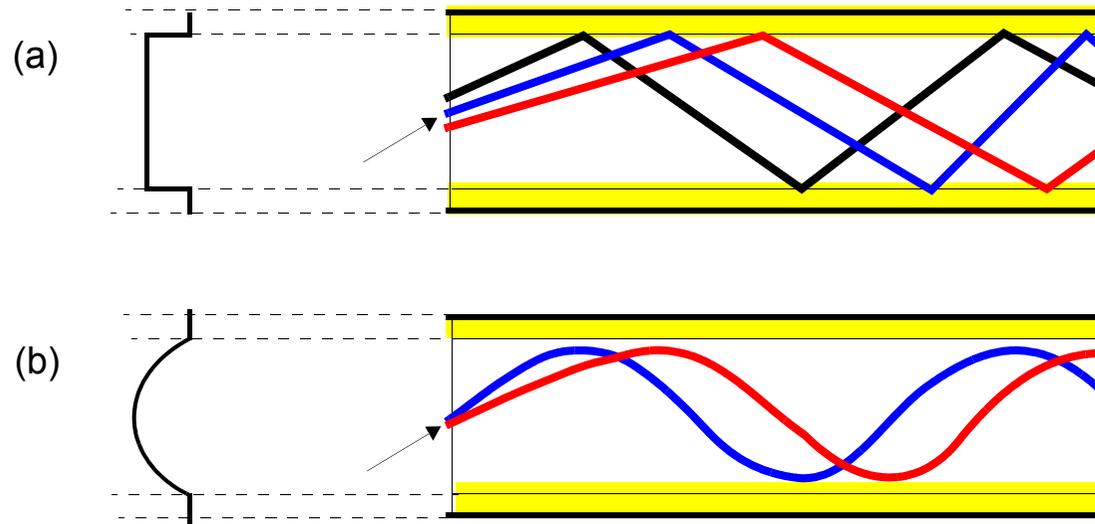
Installation and Qualification of Optical Fiber Cabling

Section

Light Propagation in Optical Fibers

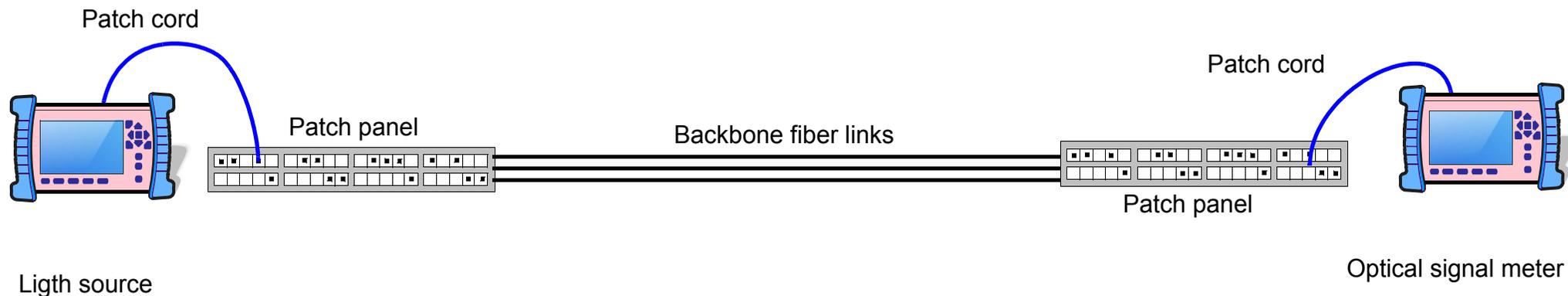


Modal Dispersion

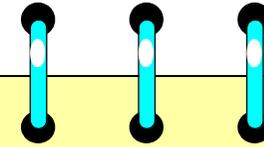
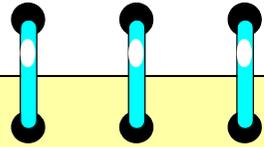


Fiber type	Modal Bandwidth	1000BASE-SX	10GBASE-S
62.5 μ s MMF	160 MHz*km	2 ~220 m	2 ~ 26 m
62.5 μ s MMF	200 MHz*km	2 ~275 m	2 ~ 33 m
50 μ s MMF	400 MHz*km	2 ~500 m	2 ~ 66 m
50 μ s MMF	500 MHz*km	2 ~550 m	2 ~ 82 m

Loss and Reach Limitations of Optical Fibers



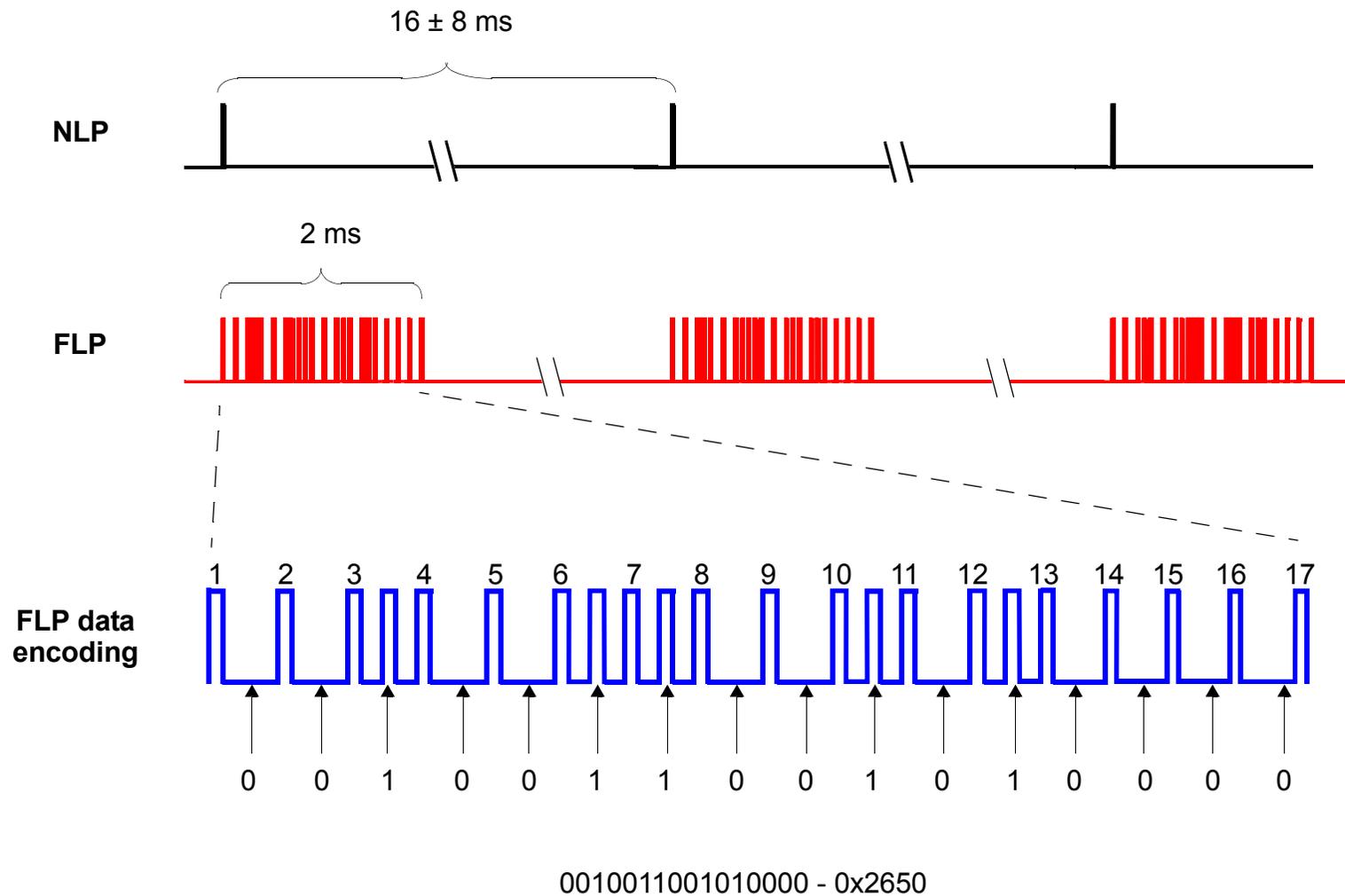
Rate	Fiber type / wavelength	Insertion Loss	Reach
1000 Mb/s	62.5 μ s MMF, 160 MHz*km / 850 nm	2.33 dB	220 m
	62.5 μ s MMF, 200 MHz*km / 850 nm,	2.53 dB	275 m
	62.5 μ s MMF, 500 MHz*km / 1300 nm,	2.32 dB	550 m
	50 μ s MMF, 400 MHz*km / 850 nm	3.25 dB	500 m
	50 μ s MMF, 500 MHz*km / 850 nm	3.43 dB	550 m
	50 μ s MMF, 400 MHz*km / 1300 nm	2.32 dB	550 m
10000 Mb/s	10 μ s SMF / 1310 nm	4.5 dB	5000 m
	62.5 μ s MMF, 160 MHz*km / 850 nm	2.6 dB	26 m
	62.5 μ s MMF, 200 MHz*km / 850 nm,	2.5 dB	33 m
	50 μ s MMF, 400 MHz*km / 850 nm	2.2 dB	66 m
	50 μ s MMF, 500 MHz*km / 850 nm	2.3 dB	82 m
	50 μ s MMF, 2000 MHz*km / 850 nm	2.6 dB	300 m
	10 μ s SMF / 1310 nm	6.0 dB	10 km
10 μ s SMF / 1550 nm	11.0 dB	40 km	



Verification of the Ethernet Auto-Negotiation

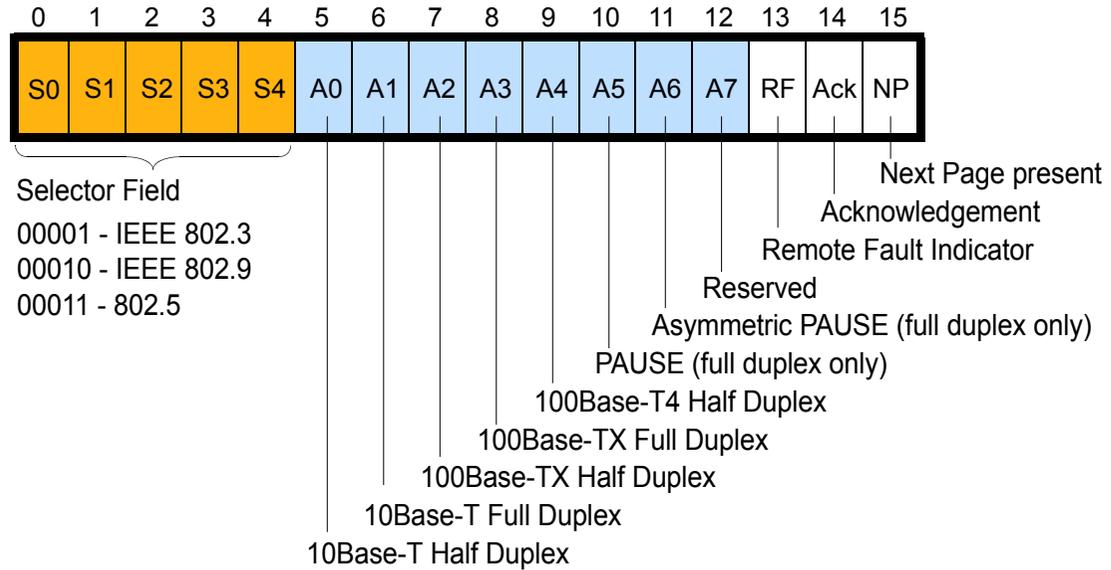
Section

NLP Auto-negotiation Pulses

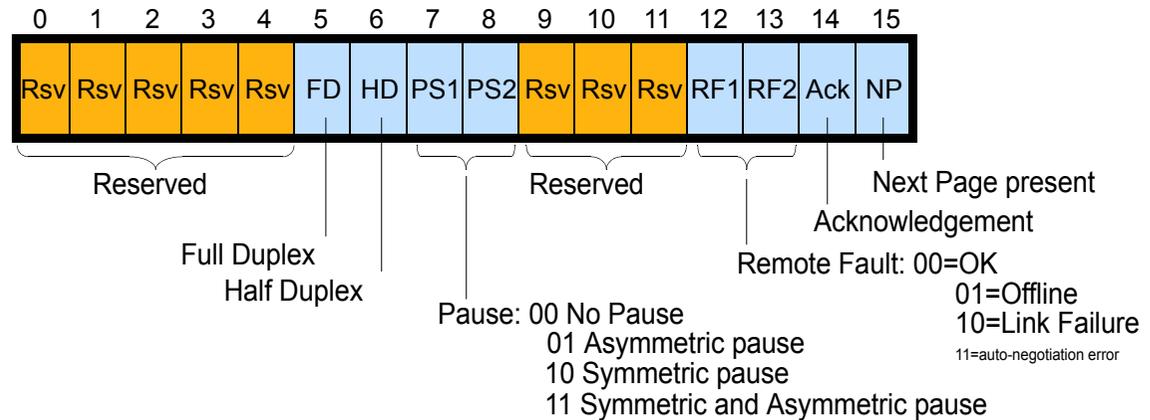


Electrical and Optical Autonegotiation

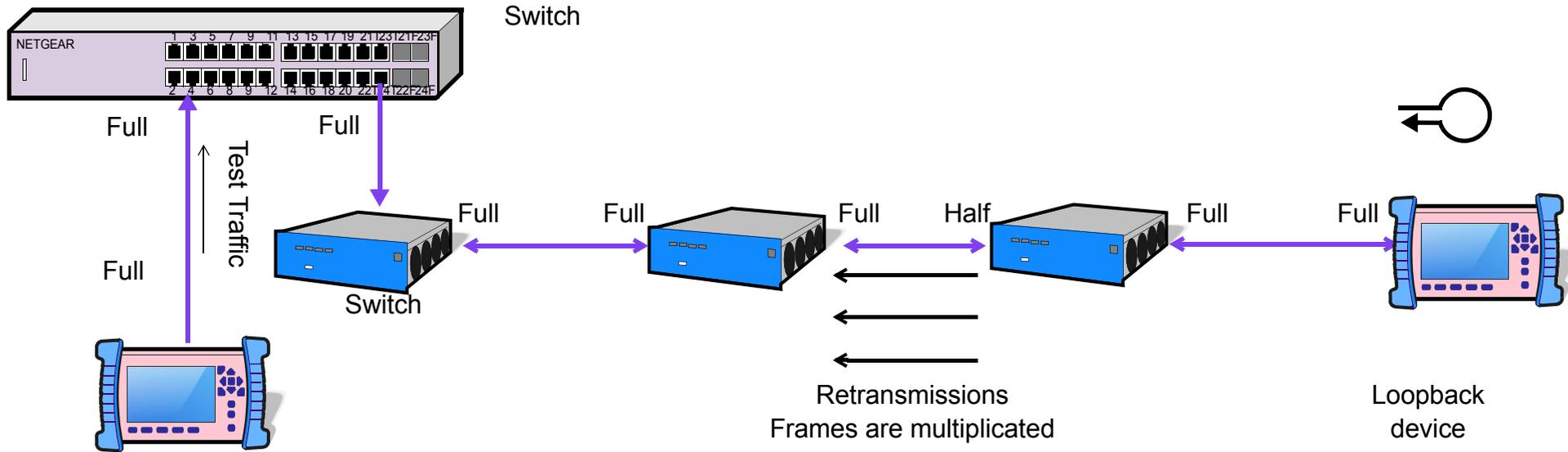
Auto-negotiation Base Page 10/100/1000BaseT



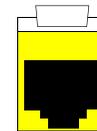
Auto-Negotiation Base Page 1000BASE-X



Testing Auto-negotiation



	Preferred features	Actual features
Interface	10BASE-TX	10BASE-TX
Duplex mode	Full Duplex	Half Duplex



RJ-45 Network interface

Mind that:

- 1000BASE-T must always interchange Autonegotiation page
- If an interface does not have Autonegotiation then it can't have 1000BASE-T

Test 1

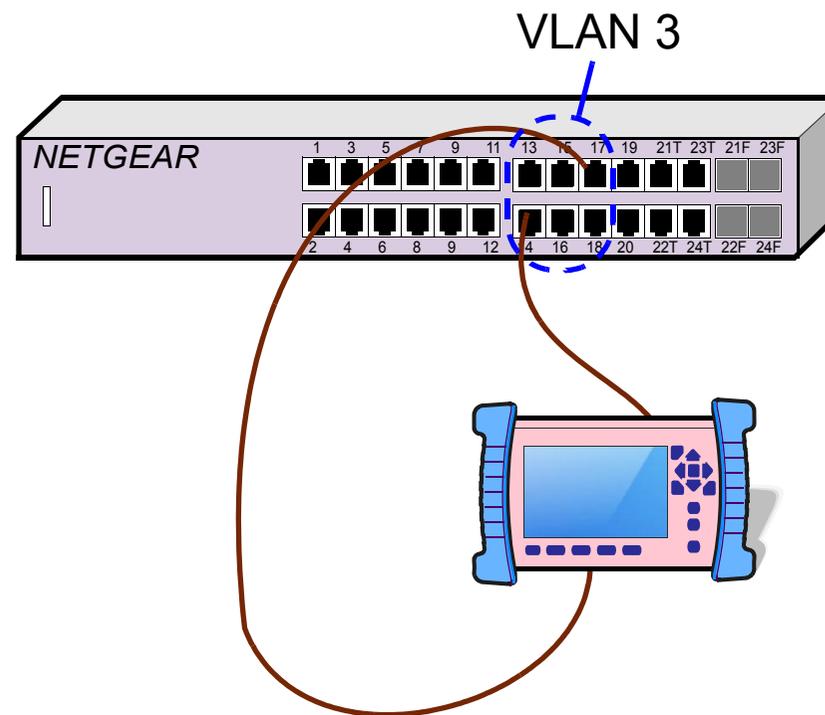
1. *Gen Config menu*: Set Port C, Autonegociation On
2. *Gen Config menu*: Set Port D Autonegociation On, Loop back On
3. Connect Port C and Port D to VLAN 3
4. *Setup menu*: Taffic test, *Setup P1*: Constant, *Percent*: 100%
5. Start traffic test

Results: *Results menu*: Both ports are connected at 1000 Mbit/s and Traffic goes OK. No errors

Test 2

1. *Gen Config menu*: Set Port C, Autonegociation **Off** (Max rate is 100 Mbit/s)
2. *Gen Config menu*: Set Port D Autonegociation On, Loop back On
3. Connect Port C and Port D to VLAN 3
4. *Setup menu*: Taffic test, *Setup P1*: Constant, *Percent*: 10%
5. Start traffic test

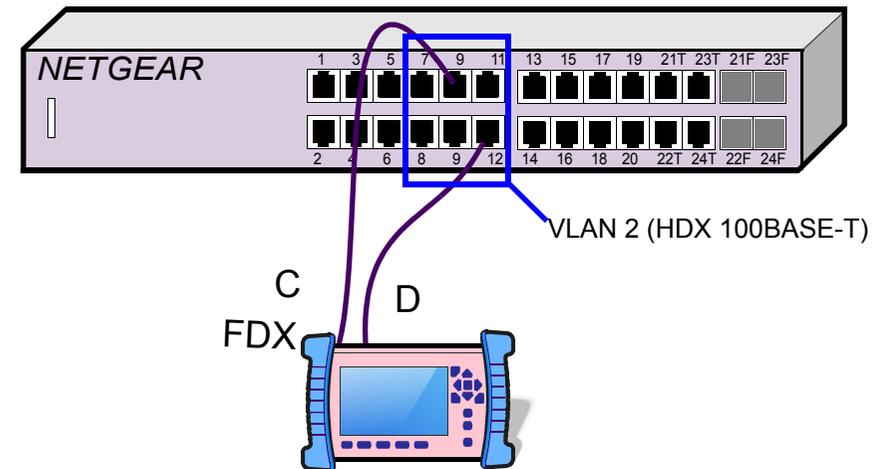
Results: Port 1: connected HDX 100Mbit/s Port 2 C: Line rate 1000 Mbit/s / Bandwidth only 1%



Test 3

1. *Gen Config menu*: Set Port C, Auto Off, FDX
2. *Gen Config menu*: Set Port D Autonegotiation On, Loop back On
3. Connect to VLAN 2 which is HDX
4. *Setup menu*: Traffic test, *Setup P1*: Constant, *Percent*: 10%

Results: *Results menu*: Both ports are connected at 1000 Mbit/s and Traffic goes OK. No errors

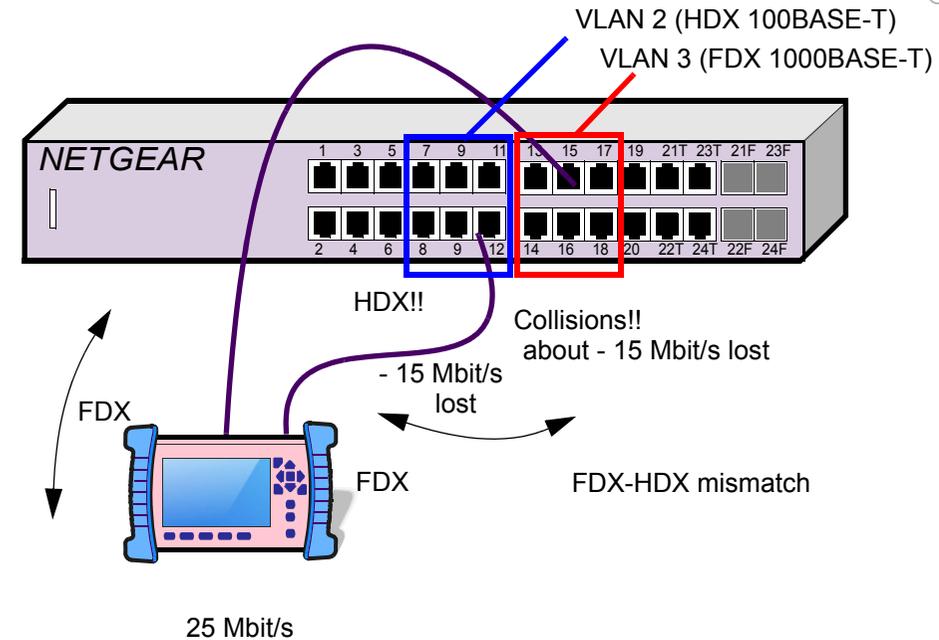


Test 4 / Use two VLAN

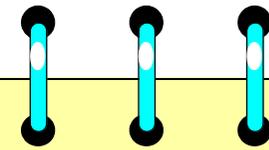
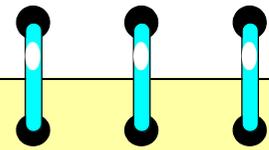
1. *Gen Config menu*: Set Port C, Auto Off, FDX
2. *Gen Config menu*: Set Port D Autonegotiation On, Loop back On
3. Connect C to VLAN2-HDX & D to VLAN3-FDX
4. *Setup menu*: Traffic test, *Setup P1*: Constant, *Rate*: 41,6 Mbit/s

Results: Collisions in port D, when transmitting (15Mbit/s lost) and receiving (15Mbit/s lost) then only Rx = 10 Mbit/s are received

No collisions in Port D: Rx = 25 Mbit/s



C : Tx = 41,6 Mbit/s Rx = 10.1 Mbit/s
D : Loop back Rx = Tx = 25 Mbit/s

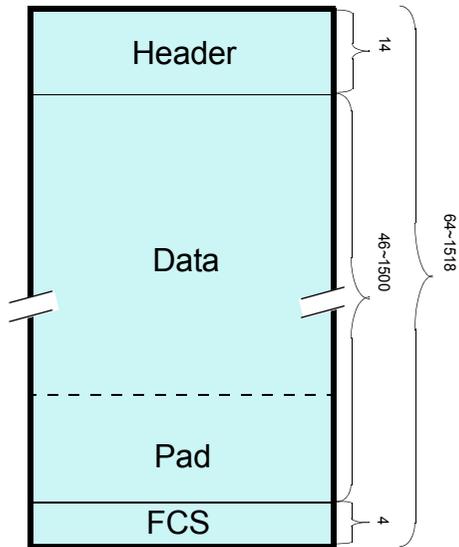


Determining Support of Jumbo Frames in a Switch Chain

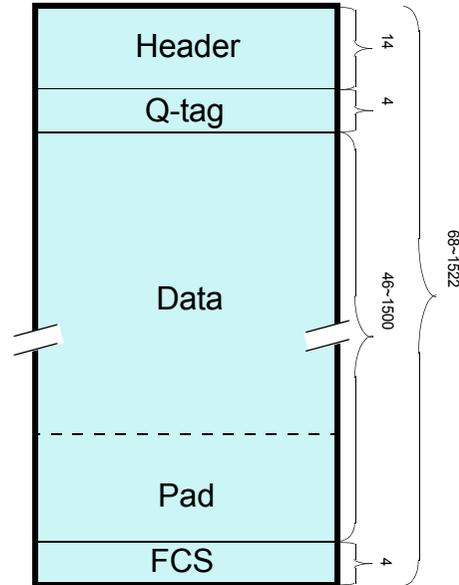
Section

Baby Giant Frames

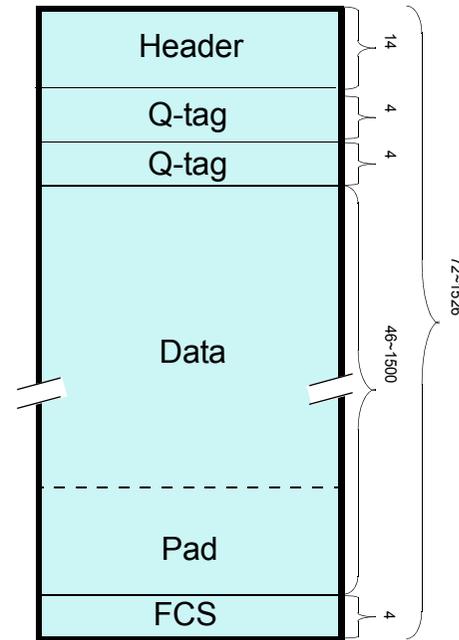
IEEE 802.3 frame



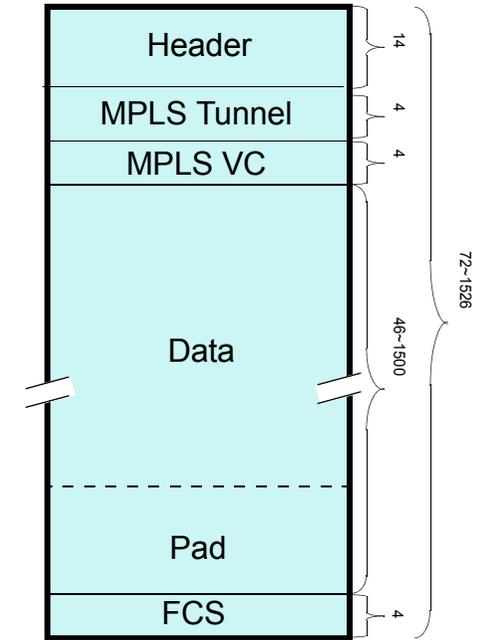
IEEE 802.1Q frame



IEEE 802.1ad



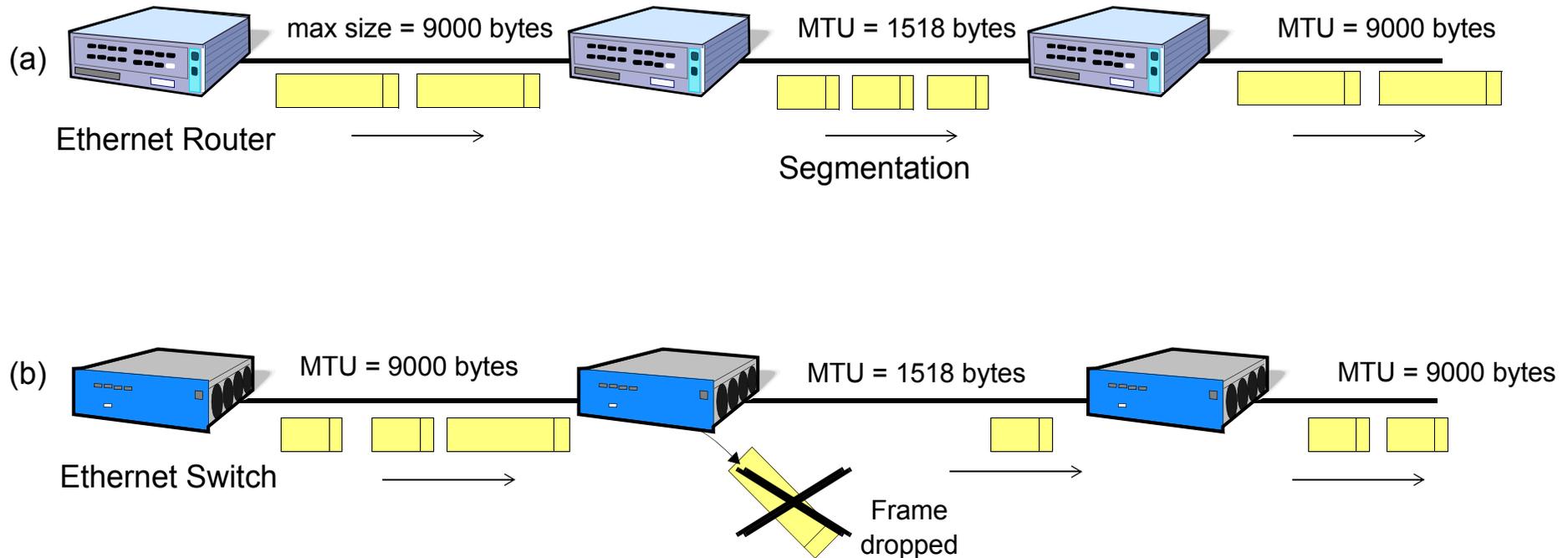
Pseudowire



Ethernet standard max. size is 1518 bytes, 1500 payload, 14 header 4 FCS. But longer frames do exist:

- Frames carrying *Virtual LAN*. Single Q-tagged is 1522 bytes double Q-tagged 1526 bytes.
- Frames carrying MPLS can be up to 1526 bytes.

Frames slightly larger than 1518 bytes are known as **Baby Giant** frames which generally are **standard**

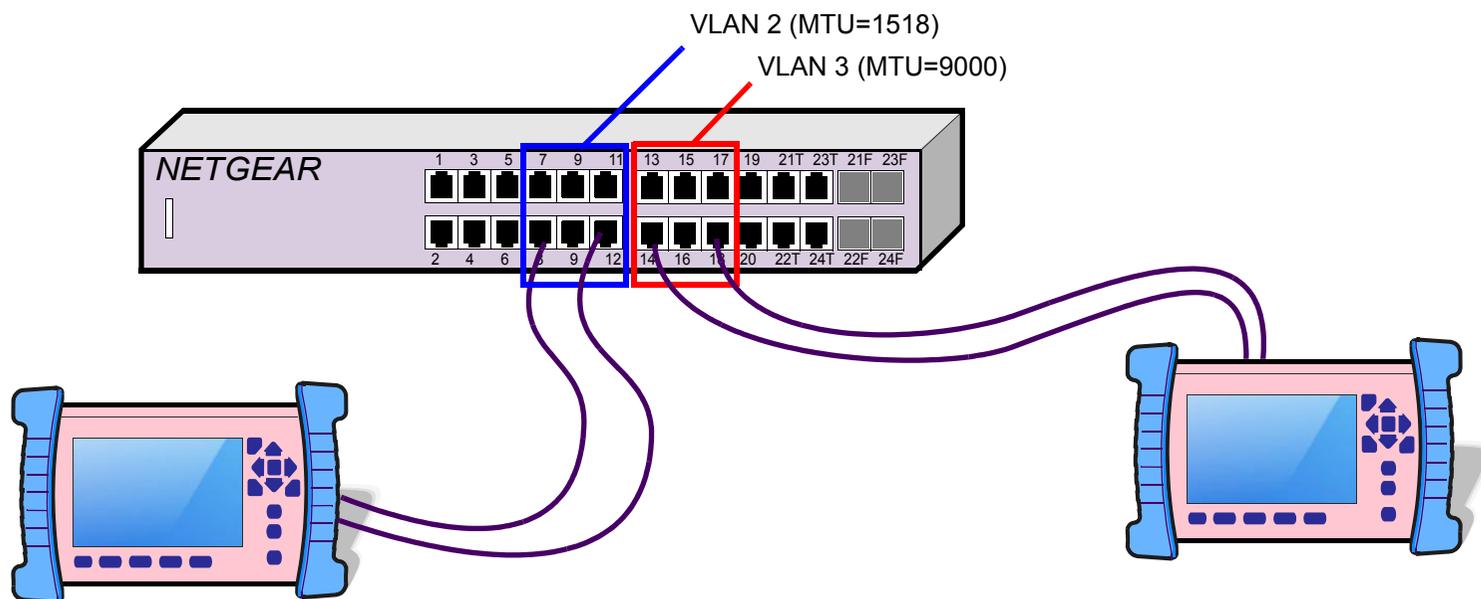


Jumbo Frames are often much longer than regular Ethernet frame size of 1518 bytes. Typical sizes are 4470, 9216, 9192, 9180, or 9176 bytes, they are **not standard but proprietaries**.

Many switches and routers allow the configuration of Maximum Transport Unit (MTU) from the console but there are others that do not support them.

Routers, that operate at layer 3, allow the segmentation (see figure a) however Ethernet networks do not have segmentation/assembly feature and drop frames if they are larger than MTU

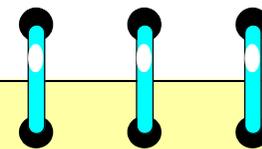
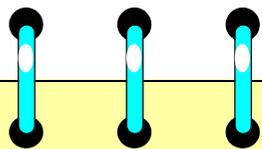
Therefore it is necessary to determine the MTU allowed in Ethernet networks and devices.



Test 5

1. Load Basic Traffic configuration (1000BASE-T / FDX / Port D=Loopback)
2. Gen Config: Port C & D, set max size > 9000
3. Set up P1 - Profile Constant - Frame size: User - Size = 9500
4. Run test. Go to Results P1 / P2 and verify that there is not traffic
5. Set up P1 - Profile Constant - Frame size: User - Size = 8500 and run the test again

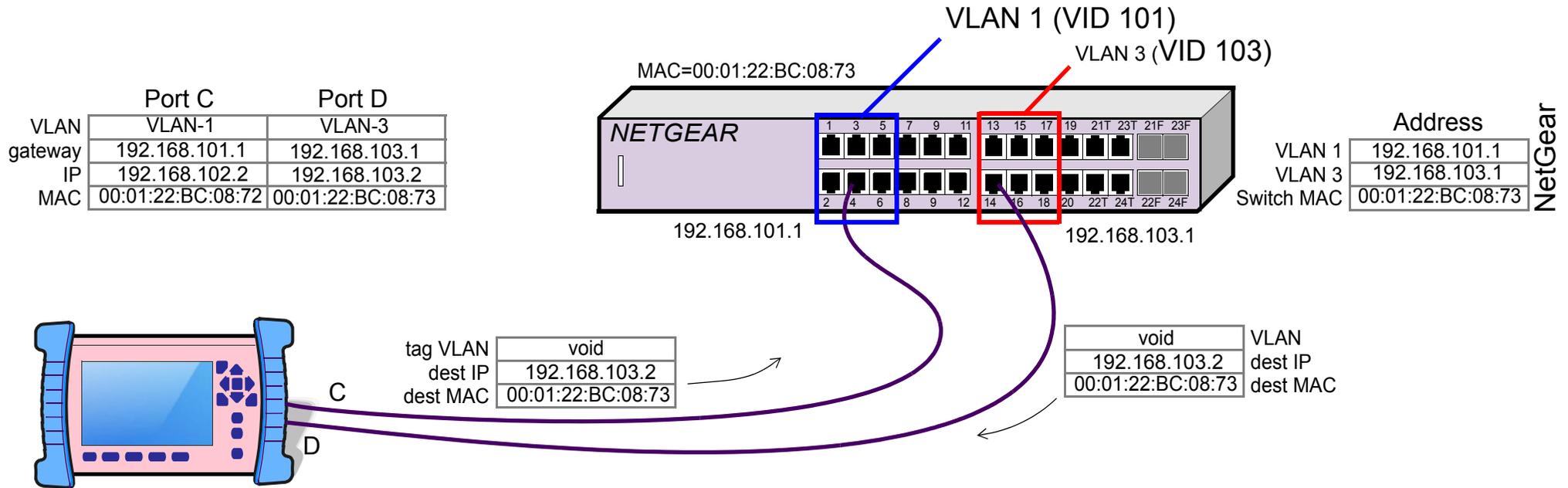
Repeat the test in VLAN 1 or VLAN 2 where the MTU = 1518 bytes



Checking Isolation and Routing between VLANs

Section

Routing between VLANs



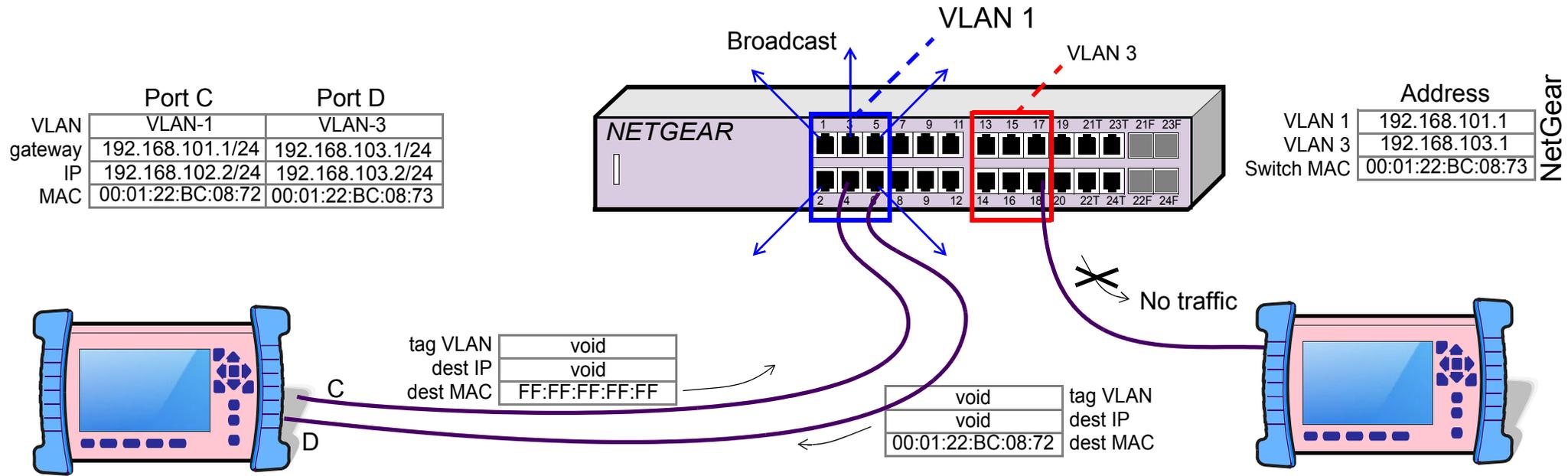
Test 6

1. Load VLAN routing configuration (1000BASE-T / FDX / Port D=Loopback)
2. VLAN, IP and MAC addresses according figure
3. Connect C to VLAN 1 and D to Port D
4. Run the test

Attention! Note that send data from C to D we are using the IP address (rather than MAC). However it is necessary to use the switch MAC address

Conclusion: VLANs allow the use of permanent IP addresses independently of the Physical Port

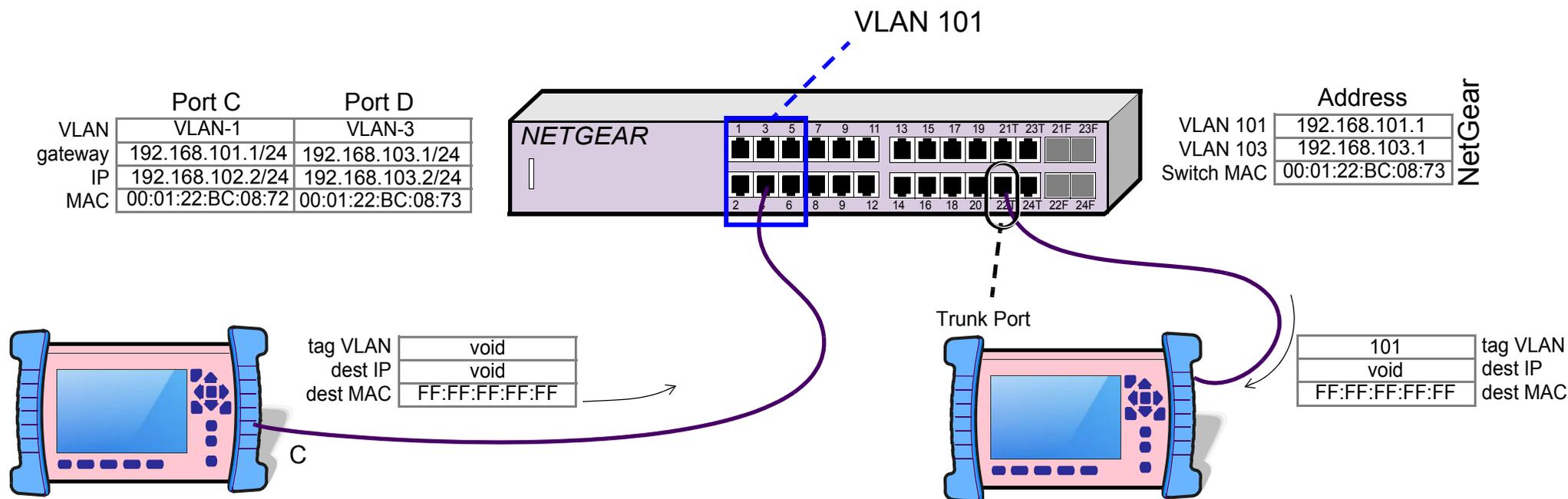
Ports Testing Isolation Between VLANs



Test 6

1. Load VLAN broadcast configuration (1000BASE-T / FDX / Port D=Loopback)
2. Port C is sending broadcast traffic using destination MAC = FFFFFFFF
3. The switch flood the broadcast to all the ports of the same VLAN
4. No traffic in other ports external to the VLAN1

Testing Isolation Between VLANs in Trunk



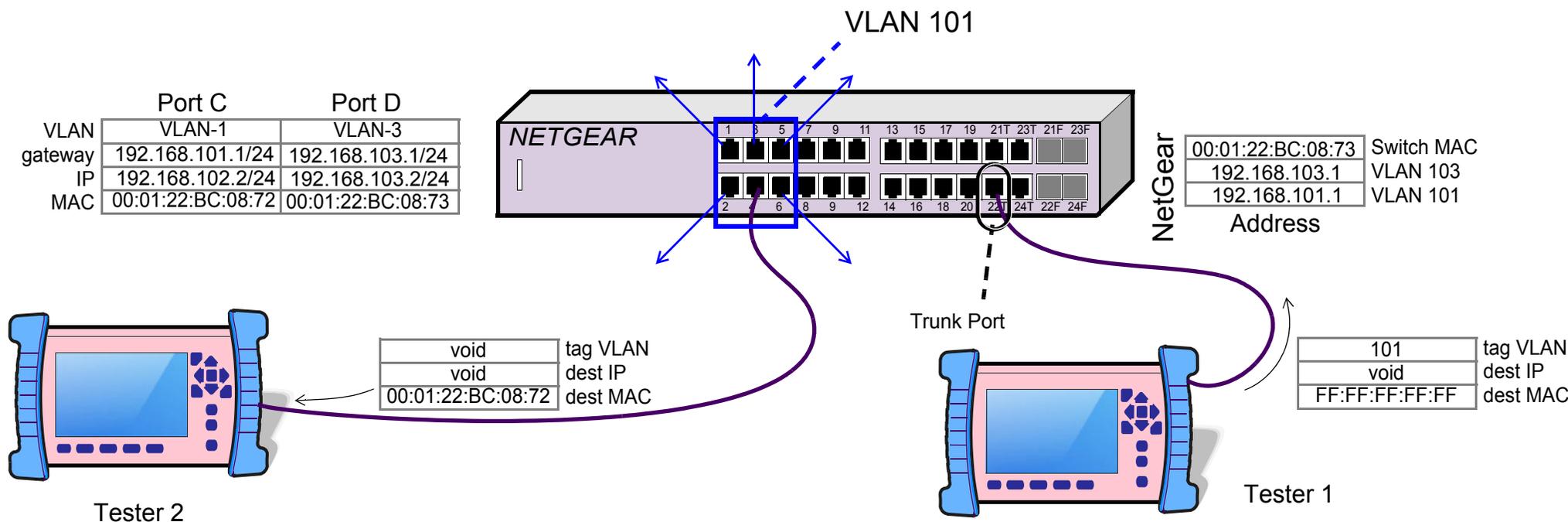
Test 7

In this test we are going to use of Trunk ports therefore tags VLAN are required.

1. Load VLAN Trunk configuration
2. Port C is sending broadcast traffic through VLAN 101
3. Since it is broadcast it is received at the trunk port with the VLAN tag 101

Note that in generation there were not tags but the switch inserts it before forwarding it to the Trunk. This is a remarkable difference with other ports that may be part of a VLAN but do not have to fill up the tag

Testing Isolation Between VLANs in Trunk

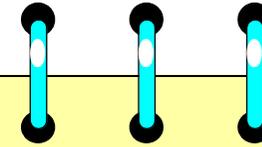
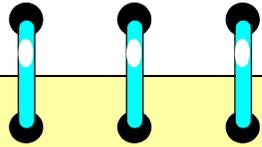


Test 8

In this test we are going to use of Trunk ports therefore tags VLAN are required.

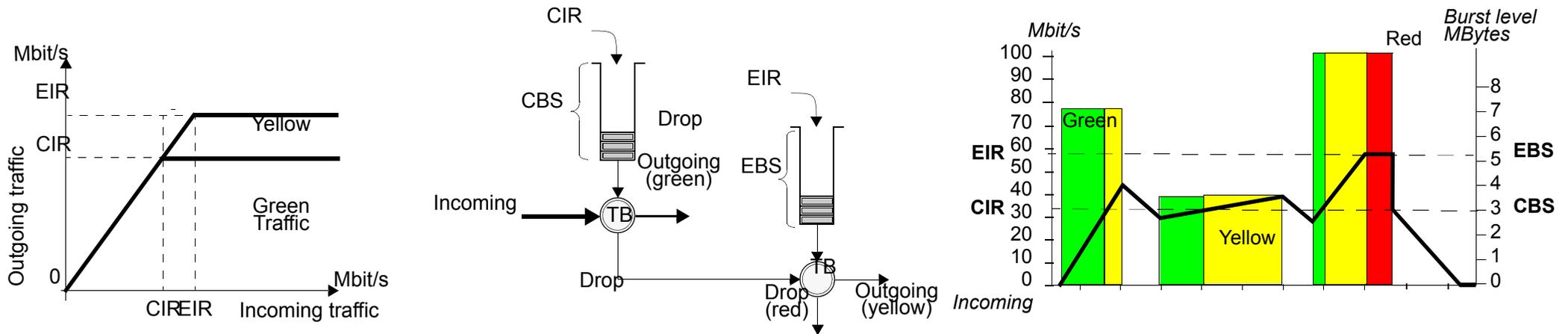
1. Load VLAN Trunk configuration
2. Tester 1 is sending broadcast traffic to using VLAN tag=101 and destination MAC = FFFFFFFF
3. The switch flood the broadcast to all the ports of the same VLAN1
4. Tester 2 receives the message without VLAN tag

Note that in generation there were not tags but the switch inserts it before forwarding it to the Trunk.



Checking Ethernet Admission Control Mechanisms

Section

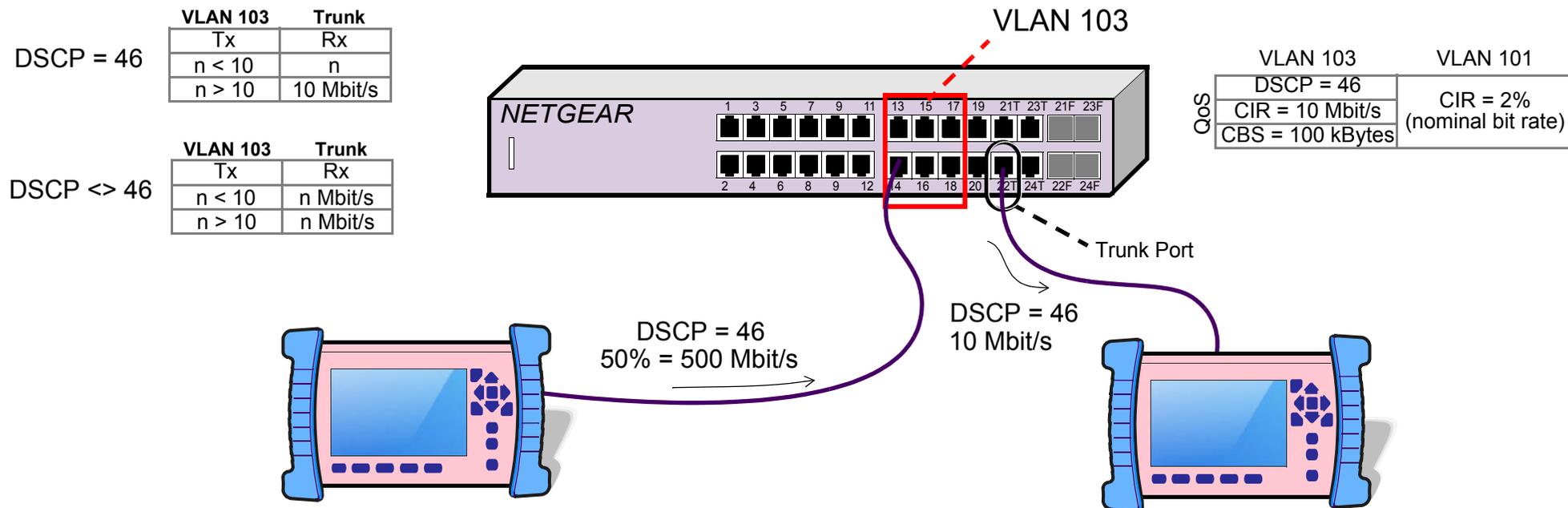


Admission control for Ethernet uses bandwidth profiles based on parameters defined by the MEF

- **Committed Information Rate (CIR)** — average rate up to which service frames are delivered as per the service performance objectives.
- **Committed Burst Size (CBS)** — maximum number of bytes up to which service frames may be sent as per the service performance objectives without considering the CIR.
- **Excess Information Rate (EIR)** — average rate, greater than or equal to the CIR, up to which service frames do not have any performance objectives.
- **Excess Burst Size (EBS)** — the number of bytes up to which service frames are sent (without performance objectives), even if they are out of the EIR threshold.

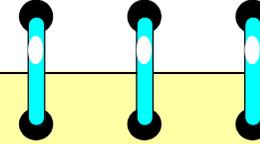
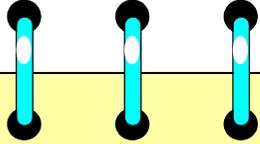
The basic tool to verify the Admission control are provided by the IETF RFC 2544

- **Throughput test**, is the maximum rate at which the Device Under Test (DUT) drops no frames
- **Back-to-back tests**, measure the length of the longest maximum-rate frame burst



Test 10, Admission Control managed by DSCP

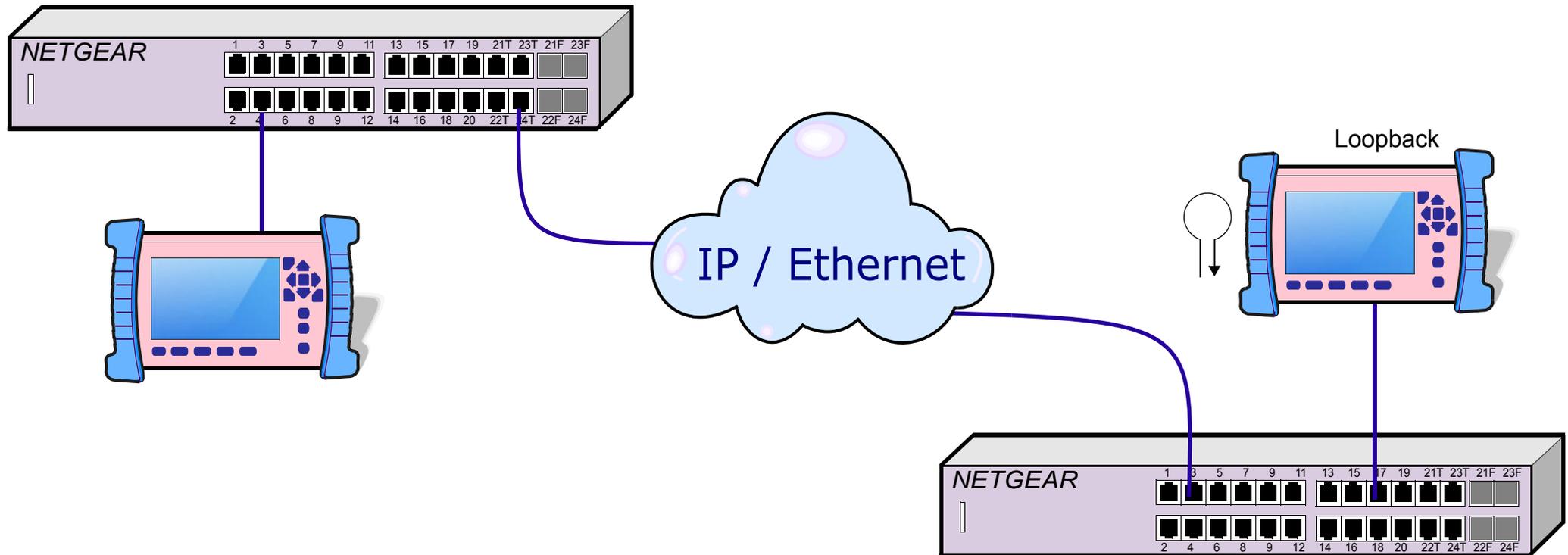
1. Load basic traffic configuration
2. Set up, we may start testing any DSCP different to 46
3. Run the test and at D, connected at the trunk port, we should get the same bit rate
4. Set up, we may start testing any DSCP equals to 46
5. Run the test then Rx at the trunk should receive up to 10 Mbit/s which is the max admission control



Checking End-to-End Performance Parameters

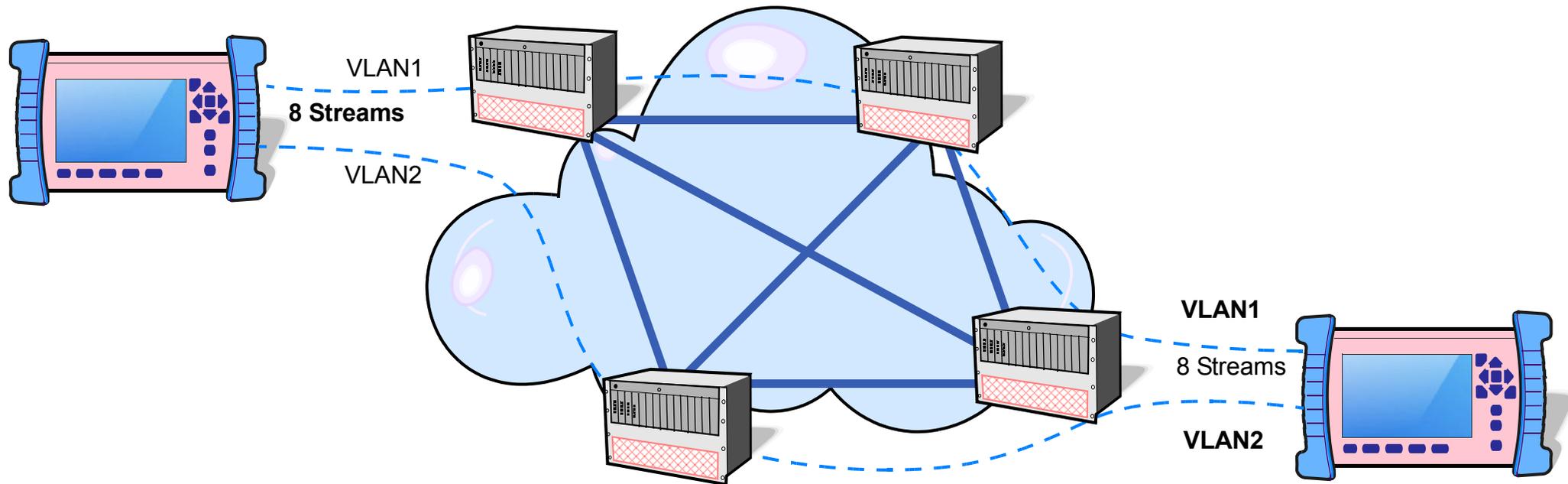
Section

BERT Test



BERT (BER Test) is an analysis of network transmission efficiency that computes the percentage of bits received in error from the total number sent. The BERT transmits traffic with a test pattern in the payload over an Ethernet network under test, and checks the transmission quality of Ethernet network between the local and the remote devices.

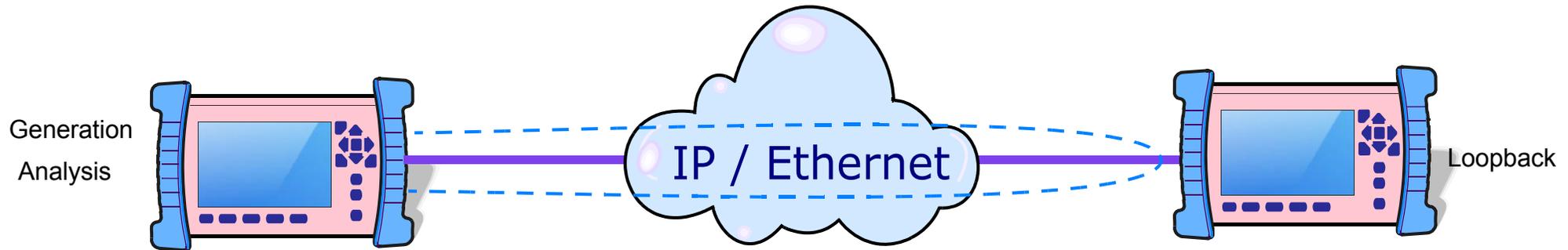
When running a BER test, your system expects to receive the pattern according to the configured condition to ascertain the BER SYNC or Loss of SYNC. If BER is not allowed in point-to-point operation, then create a loop back function on the far end CSA or in the network, send out a predictable stream to ensure that you receive the same data that was transmitted.



Multi-Streams in Uniform Traffic profile is used to simulate a large number of user traffic to verify the provisioning and routing of network or devices under test. This allows users to configure up to 8 MAC and/or IP address to simulate 8 users, a range of VLAN is also available to emulate different user traffic carried in different VLAN which is more realistically in the real world.

For example, users configure 8 MAC and IP address on the tester to generate 8 user traffics and 2 VLANs for different cities in the same country. Run the test to verify if the network provisioning and routing configuration is proper and efficient, users can get the BER SYNC if the network and devices under test running accurately.

QoS Test Setup



The trend of network services is toward supporting a variety of Timing or Loss sensitive applications on the Metro Ethernet Network (MEN). And service providers are required to assign different service quality level for those modern network applications.

Traffic Statistics	<ul style="list-style-type: none"> • Top 16 talkers: Sour/Dest MAC / IPv4 / IPv6 addresses, VID (VLAN), C-VID (Q_in_Q), S-VID (MPLS) • Ethernet Frame Counts (RFC 2819): VLAN, Q-in-Q, Priority, Control, Pause, BPDU • Tx/Rx Uni-Multi-Broadcast, Errors, Undersized, Oversized, Fragments, Jabbers, Runts, (Late) Collisions, Sizes, MPLS stack length • Bandwidth Statistics: (in bit/s, frame/s, %) Rate, Max, Min, Aver, Occupancy, Unicast, Multicast, Broadcast • IPv4 & IPv6 counts: (in bit/s, frame/s, %) Unicast, Multicast, Broadcast, Errors, TCP, UDP, ICMP
Results	<ul style="list-style-type: none"> • Twisted Cable: MDI/MDI-X status, Open, Cable Length Test, Short, Polarities, Pair Skew. PoE: voltage and current • SFP: Presence current interface, Vendor, Part number, Optical power (over compatible SFP) • Frame Delay (FTD) Y.1563: Min/Max/Med/Mean; Delay Variation (FDV) RFC1889: Peak; Jitter Curr/Max/Min/Mean • Frame Loss (FLR) Y.1563, Duplicated: Out-of-Order packets (RFC 5236) • Availability: SES and Y.1563 PEU; BER: Count, seconds with errors, Pattern losses, pattern loss seconds
RFC-2544 & Y.1564	<ul style="list-style-type: none"> • RFC 2544: Throughput, Latency, Frame Loss, Back-to-back, Recovery • eSAM: test up to 8 non-color or 4 color aware services. Configuration: CIR, EIR, max. throughput for each service • Tests (CIR, EIR and policing) with FTD, FDV, FLR and availability • Performance test with FTD, FDV, FLR and availability results for all services
ICMP	<ul style="list-style-type: none"> • RFC 792: IP ping / Traceroute, Generation of ICMP echo request: Dest. IP address, Packet length, Generation interval • Analysis of ICMP echo reply: Round trip time, Lost packets, Time-To-Live Exceeded, Port unreachable

Many things might happen to packets as they travel from source to destination. For example, we know voice quality is affected by two major factors: Packet loss and Packet delay. Packet loss causes voice skips, while Packet delay can cause voice quality degradation. If the delay is variable, there is a risk of jitter buffer overruns at the receiving end. Before we start to run QoS test, the following is a summary for main factors of QoS measurement.

Jitter, Packets from source will reach the destination with different delays. This variation in delay is known as jitter. Jitter can seriously affect the quality of streaming audio and video.

Out of Sequence, When a group of related packets is routed through the Internet, different packets may take different routes. The packets arrive in a different order, and these out-of-order packets need to rearrange to be isochronous. The lack of isochronicity dramatically affects VoIP and video streams quality.

Packet Loss, The main observable reason of Packet Loss is poor data throughput performance. The network might fail to deliver some packets when the packets arrive and their buffers are already full. Some of the packets might be dropped because of QoS ToS policy on the device. Packet loss may also be caused by other factors such as signal degradation and faulty networking hardware.

BERT Error, Sometimes packets are corrupted or misdirected, and BERT Error may occur during transmission.

Network Delay, Packets take time to reach their destination. IP network delay is primarily determined by the buffering, queuing, and switching or routing delay.

Inter-Arriving Time, The Inter-Arriving Time measurement is an integral part of traffic management and monitoring tasks in QoS networks. It shows the time differences between two consecutive timestamps of packet arrival

That's all



ALBEDO

Telecom

the Path to Excellence