Testing Network Infrastructure

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Network Infrastructure

The infrastructure of a network can be summarised into two categories, passive cabling and active equipment.

The passive cabling systems consists of the cable permanently installed in the facility, the patch panels and outlets terminated at each end, optionally installed connection (consolidation) points installed in a horizontal link and the equipment/patch cords used to connect the cabling system to active equipment. This is true for nearly all systems including data, voice, CCTV, access control, A/V, alarm, access control, and more. The term “structured cabling” is used in various international standards to describe cabling systems, which are often referred to as generic cabling systems. Meaning the cabling is designed to support a number of systems and applications and is not proprietary to just one application allowing end-users great flexibility.

The active equipment in a network can be generic or proprietary depending on the application. Fortunately most of the information systems described above rely on Ethernet/IP as the foundation for data transmission and can be checked with field testers that can be used for virtually any application.

Testing network infrastructure can be accomplished with equipment that operates on one or more of the layers that define an Ethernet/IP network.

Network Layers

Ethernet/IP systems are divided into distinct layers defined by the OSI (Open Systems Interconnection) model. The OSI model separates the process of transmitting data across a network into functional blocks.

OSI Layers

Layer 1 – Physical Layer: The electrical/optical signaling and physical cabling components that connect devices on the network.

- Horizontal and backbone cabling, both copper and fibre optic.

- Wi-Fi and other wireless signals, which are considered physical even though they cannot be touched.
- Hubs and repeaters.
- Copper and fibre optic network interface ports (PHY) on network devices; e.g., PCs, switches, routers, IP cameras and wireless access points. Devices are referred to as nodes or hosts.
- The electrical or optical signaling between network devices; i.e., electrical current, light and radio waves.

Layer 1 testers are often called cabling Verifiers. The main purpose of a Verifier is to test electrical continuity of the cabling between two points, checking for shorts, opens, crossed and split pairs. Cable verifiers are inexpensive and should be carried by every cabling technician and used to test every link after it is terminated. More than 80% of all network problems can be traced back to a physical cabling fault.

In addition to testing continuity, many Verifiers have additional diagnostic and troubleshooting functions such as cable length, distance to fault, cable tracing with audible tone generation or visual port blinking, Ethernet service detection and PoE testing.

All of these parameters fall into layer 1 even when testing active electric signals. Layer 1 is not limited to only the passive cabling – it may also include electronic signaling and control messaging; it does not include the transmission of user generated data.

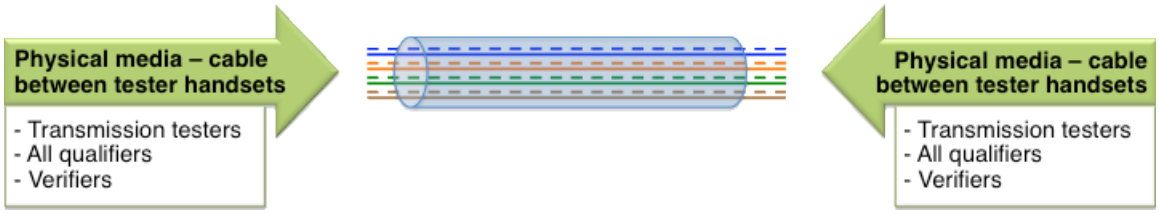

Figure 1 - Layer 1 tester checks only the cable

Figure 2 - Wiremap verifiers and cable certifiers are Layer 1 testers.

Layer 2- Data Link Layer: Provides data transfer between two directly connected nodes or two nodes on the same network.

- Detects and corrects physical layer problems, for example, automatic crossover switching between two Ethernet switches when a crossover cable is not used.
- Media Access Control (MAC) – controls the physical addressing of devices on the network; i.e., every Ethernet device in the world has a unique MAC address.
- Encodes and decodes data frames, adds a source and destination MAC address to each frame.
- Performs error checking and discards bad data frames transmitted on Layer 1.
- Synchronises devices with systems such as auto-negotiation between 10/100/1000 Mb/s devices.

Layer 2 testers generate Ethernet frames that simulate network data that traverses network cabling and can even be sent through Ethernet switches. This type of test is often called a data transmission test and is performed by field testers that generate Ethernet frames with a MAC address that can be read and directed by network switches. The result of a transmission test is a data loss ratio expressed as a percentage of total frame transmitted or the number of dropped frames. The allowable dropped frame count is a function of test time and when field testing a 1 Gb/s link, a total of 10 Gb of data is transmitted and zero frames are allowed to be dropped per the IEEE 802.2 gigabit Ethernet standard.

There is some confusion about Layer 2 testers because field-testing standards by the ISO and TIA standards bodies generally address Layer 1 testing only. People sometimes confuse “Qualifiers” as Layer 2 testers, which they are not. Qualifiers do not generate Ethernet frames with a MAC address that can be read by active network devices. A “Qualifier” is still a Layer 1 tester, a Layer 2 data transmission tester is not measuring electrical parameters of the cabling, it is measuring the successful transmission of data across a cable or through a network.

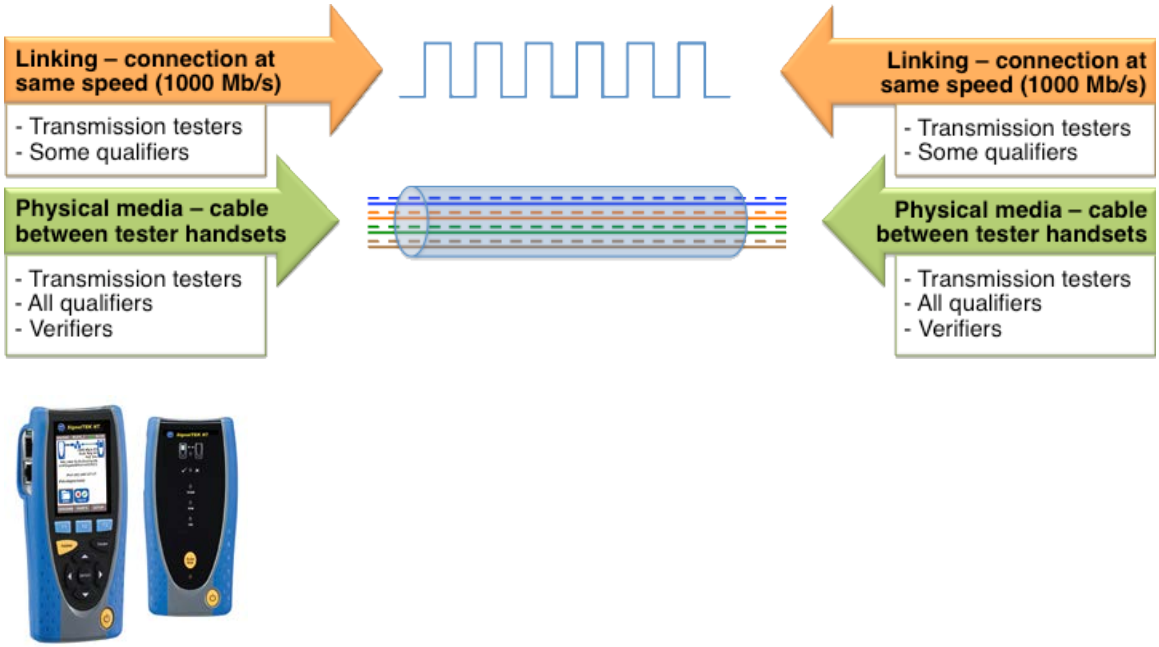

Figure 3 – A transmission tester generates Ethernet frames to measure data loss as a method on quantifying cable and network performance.

Layer 3- Network Layer: Provides data transfer between nodes on different networks.

- Encapsulates Layer 2 frames inside of a data packet.
- Adds source and destination IP address to each data packet.
- Assigns an IP address that is unique to each node on its own network.

Layer 3 testers are nearly identical to Layer 2 testers with the primary difference being that they generate an IP packet that encapsulates the Ethernet frame. The packet carries an IP address that can be read by Layer 3 switches and network routers. With this additional information a Layer 3 packet can traverse different *networks* or different *subnets* on a single network. For example, testing the data transmission between the wired and wireless portions of a LAN; or testing between different buildings of a large campus-sized network. While these may be the same *physical* network, they are different *logical* sub-networks (subnets) that allow a larger pool of IP addresses (more devices on the network) to prevent congestion by segmenting bandwidth across multiple switches/routers.

Users of Layer 3 testers need to be familiar with network addressing and subnets to properly configure the testers. For this reason Layer 3 testers are typically used by network owners/managers and system integrators rather than installers who are usually not involved in the details of network configurations.

Because a Layer 3 transmission tester generates complete packets with IP addresses, it can be used to test WANs (Wide Area Networks) to measure bandwidth between different locations across the Internet.

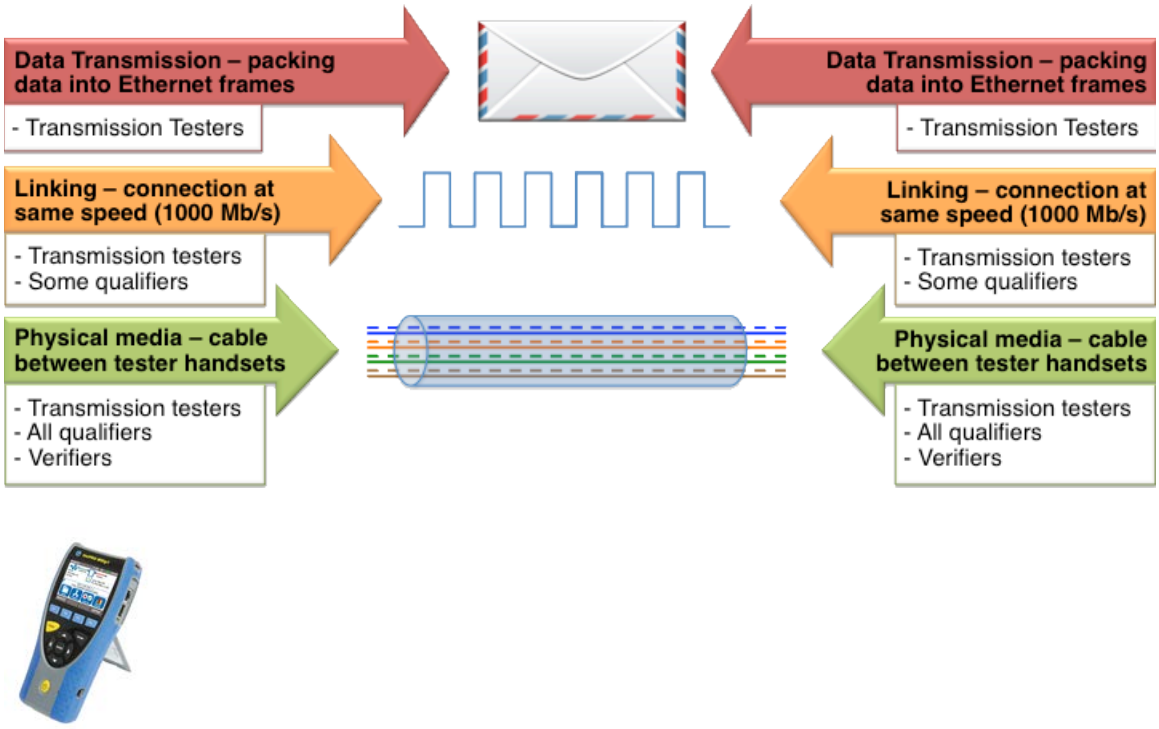

Figure 4 – Layer 3 transmission testers allow testing across different segments of a LAN or across WANs

Conclusion

When testing a network's infrastructure think of it as three basic components to choose the right equipment for the job.

1. Layer 1: Cabling – using a Verifier to test for correct installation of the cable and terminations and testing cable performance with a Certifier.
2. Layer 2: Ethernet frame transmission – using a transmission tester to check the performance of cabling and Ethernet switches by counting frame loss of actual network data.
3. Layer 3: Ethernet packet transmission – using a transmission tester to check the performance between different networks through routers and Layer 3 switches by counting packet loss of actual network data.