4.3.7.3 Network Performance

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About

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Network Performance captures the statistical metrics and the analytical review of a network. Collectively they reflect the network's Quality of Services.

It is a qualitative and quantitative process that measures and defines the performance level of a given network. It guides a network administrator in the review, measure and improvement of network services.

There are two main ways to connect devices together:

- Ethernet (i.e., wired using network cables.)
- Wireless Fidelity (Wi-Fi) (i.e., wireless using radio signals).

Although it is possible to connect computers directly together, generally the computers connect to a Network Device such as a Router. There are a number of variables that determine the actual speed of the connection between the computers. The wired connections are as a rule faster than the wireless connection but the number, length of the quality of the network connections and the kinds of network devices and the number of devices can impact wired connection speed. WiFi connections are more susceptible to interference from electrical devices, physical objects (i.e., metal walls or cages), or environmental conditions (i.e., weather and solar flares).

An Ethernet connection is consequently more reliable especially when Shielding Network Cabling (i.e., Category 6 (Cat-6),Category 7 (Cat-7), Category 8 (Cat-8)) are used. Ethernet is almost always faster than WiFi. The fastest Ethernet speeds today top out at 10Gbps or higher, while the fastest WiFi speeds theoretically max out at 6.9Gbps, though actual speeds are much slower – usually less than 1Gbps.[1)].

Speed

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Network speed is for the most part about acquiring the correctly sized physical Network Devices (i.e. Modem, Router, Switches, Network Cabling, etc.) to meet the demands of the system. However, there are restrictions that arise such as the need for wireless connections (i.e., WiFi, Bluetooth, ZigBee, Infrared Wireless Networking etc.), space and heat considerations (i.e., a big problems for planes, ships, labs, hospital rooms, etc.) or when the assets participating in the system are distributed and not under the control of a single source (i.e., blockchains, Distributed Ledger Technologies (DLT), supply chains, etc.).

Most Ethernet connections fall into the following categories: Wired Network and Wireless Network

The wired networks use hardware such a modems, routers, switches, cabling, etc. together.

Wireless cables connect to each and every one of the computers in the network. The cost of a wired network is lower compared to the wireless network since Ethernet, cables, and switches are not expensive. Wired LAN offers better performance compared to wireless networks.

Wired Connections

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Table 1: Summary of Difference between CAT-5 through CAT-8[2)]

Category	Standard	Data rate	Frequency[1)]	# of Conductors
Category 5 (Cat-5)	100BASE-TX	100Mbit	100 Mhz	4 or 8
Cat-5E	100BASE-TX	1Gbit	100 Mhz Duplex	8
Category 6 (Cat-6)	EIA 568B2.1	1-10 Gbit[2)]	250 Mhz	8
Cat-6A	10GBASE-T	10 Gbit	500 Mhz	8
Category 7 (Cat-7)	10GBASE-T	10 Gbit	600 Mhz	8
Cat-7A	10GBASE-T	10 Gbit	1000 Mhz	8
Category 8 (Cat-8)	40GBASE-T	40 Gbit	1600-200Mhz Mhz	8

[1)] **Note:** 1 hertz is roughly equivalent to 1000 milliseconds, 20 killohertz is roughly equivalent to 0.05 milliseconds. See Unit Juggler.
[2)] **Note:** Depends on the length and cable type

Wireless Connections

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Table 2: Side-by-side comparison of wireless routers[3)]

	Netgear Nighthawk X10 AD7200	Asus RT-AC86U AC2900	Linksys EA6350 AC1200+	TP-Link Archer C7 AC1750	Trendnet AC2600	TP-Link AC2300	Linksys WRT32X
Top Theoretical Speed	4600 Mbps on 60 GHz	2167 Mbps on 5GHz	867 Mbps on 5 GHz	1300 Mbps on 5 GHz	1733 Mbps on 5 GHz	1625 Mbps on 5 GHz	2600 Mbps on 5 GHz

Bandwidth

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Bandwidth is defined as the bandwidth data carrying capacity of a network channel or the entire network. Bandwidth is measured by the bit-rate of the network transmission capacity. This is sometimes thought of as the network channel's data transfer speed. Bandwidth can be used to describe wired, wireless or

even data buses.

A bit represents a single binary digit either '0' or '1'. The '0' or '1' generally represent yes/no, true/false, on/off, or up/down/ It does not necessarily equate a '0' with false and a '1' with true. When transmitted over a network, the data is sent as a stream of bits (not bytes). A byte is generally used to signify a unit of memory or storage (i.e., RAM or ROM) that usually is eights bits long (wide) and is the smallest number of bits used to represent a character in the original ASCII character set used by most most computers.

Bandwidth is measured as bits per second and is used as a denominator of bits (i.e., kilobits, megabits). When bandwidth is used to describe a network connection (i.e., switch, server or router), it is generally in megabits, however, when it is used to describe the data flowing into the connection then bandwidth referred to as traffic and could be measured in either megabits per second (Mb/s or Mbps) or megabytes per second (MB/s or MBps). Although the nomencalture is subtle, it is important to be aware of the difference. An inadvertent misunderstanding could result in a error of magnitude 8 (i.e., 1 byte = 8 bits).

Since the megabytes figure will be larger than the megabits figure (equation to follow shortly) most industry service providers like to give a total transfer based on this figure – however most bandwidth providers use megabits.

$$1 byte = 8 bits$$

Some examples:

Table 3: Some examples of converting MegaBits to MegaBytes

Mega Bytes per second	bits per Byte	MegaBits per second
8 MBps	*8	64 Mbps [1)]
9 MBps	*8	72 Mbps
10 MBps	*8	80 Mbps
20 MBps	*8	160 Mbps

[1)] **Note:** there are two kinds of units listed: Mbps (Mega BIT per second) and MBps (Mega BYTE per second)

> *Today, many cable ISPs are capable of delivering internet speeds over 1 Gigabit per second. That's 1 billion bits per second! Not everyone needs this much speed today (Netflix reports that a connection speed of 25 Megabits per second is all that's required to stream Ultra HD content), but cable ISPs see a future of virtual reality, telehealth, driverless cars, and an internet of things. In that environment, speed requirements are going to increase. Regardless of whether it's necessary today, ISPs are preparing their networks for the needs of the future. So, while we'll likely always measure speed in bits and data volume in bytes, the consistency and speed at which those bits are delivered over the internet will surely rise.*[4)]

In addition to the Internet Service Provider (ISP) bandwidth limitations, it is also important to remember that there are local hardware components to the network. For example, Network Quality of Service (QoS) Policies.

Network Quality of Service (QoS)

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Quality of service (QoS) captures the metrics used to measure the overall performance of a computer network as experienced by participants (i.e., computers, processes, devices, etc) in network.

Internet Protocol (IP) networks, QoS is particularly focused on setting priorities for packet traffic and reserving resources rather than the QoS of the Network Services (i.e, DNS). It helps establish overall priorities for applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, setting Voice over IP (VOIP) as a priority over texting.[5)] Some of the common metrics used to describe Network QoS are:

- Throughput
- Latency
- Packet Loss
- Jitter
- Bit Error
- Download Speed
- Upload Speed

DIDO Specifics

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To be added/expanded in future revisions of the DIDO RA

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2)
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3)
Connect at Speed with the Fastest Routers, Speedtest, PCMag, Accessed 21 July 2020, https://www.speedtest.net/about/knowledge/fastest-routers

4)
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5)

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