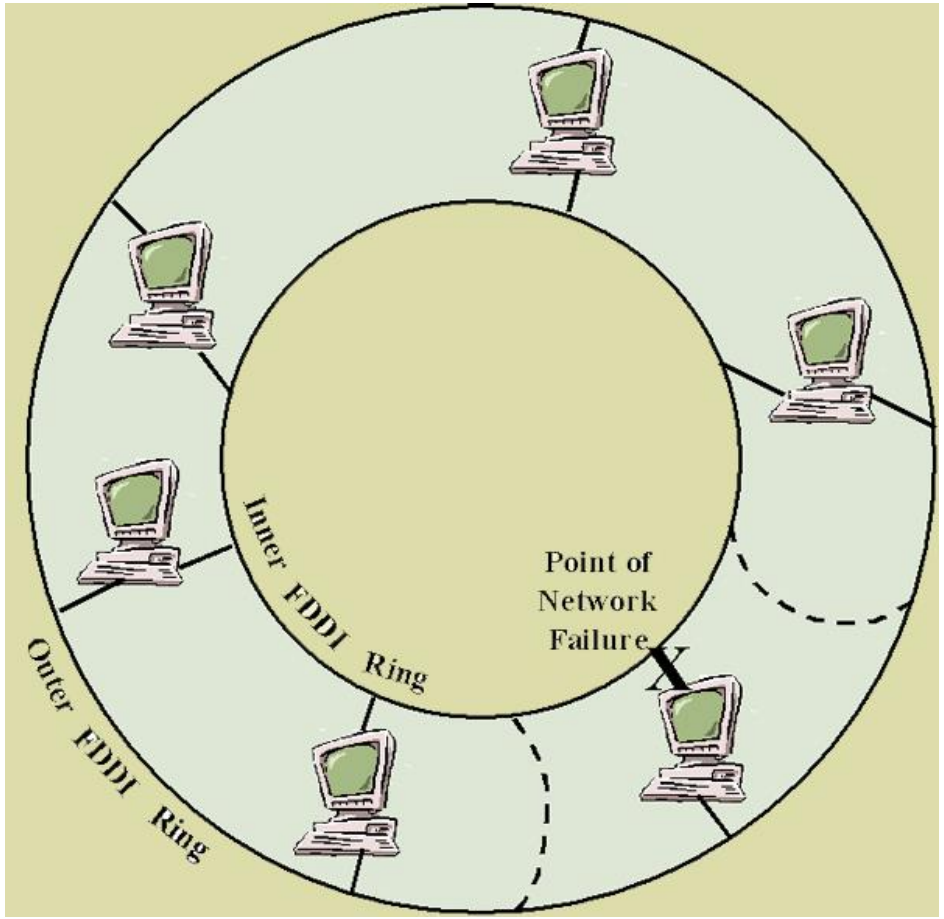
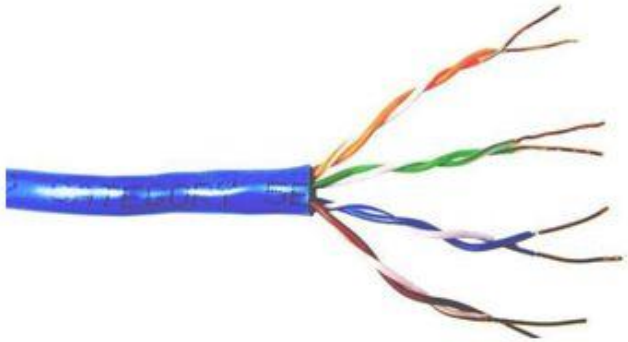
Fiber Distributed Data Interface (FDDI)



Common network cable types

- Unshielded twisted pair (UTP)

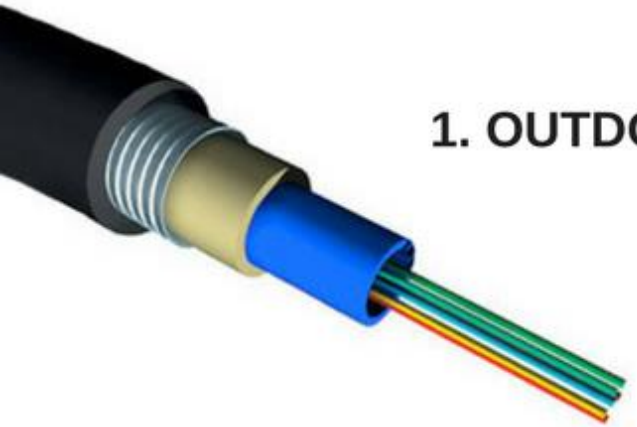


- Shielded twisted pair (STP)

- Coaxial cable

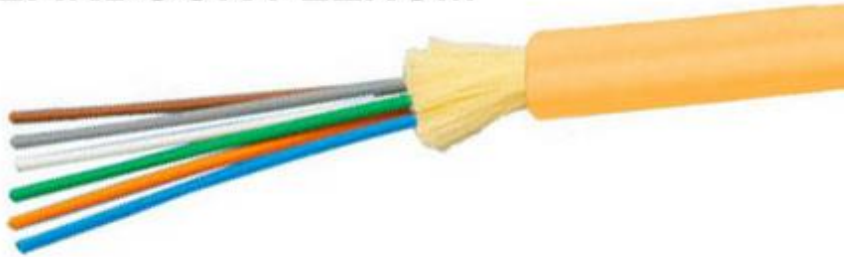
- Fiber optic

Types of Fiber Optic Cables



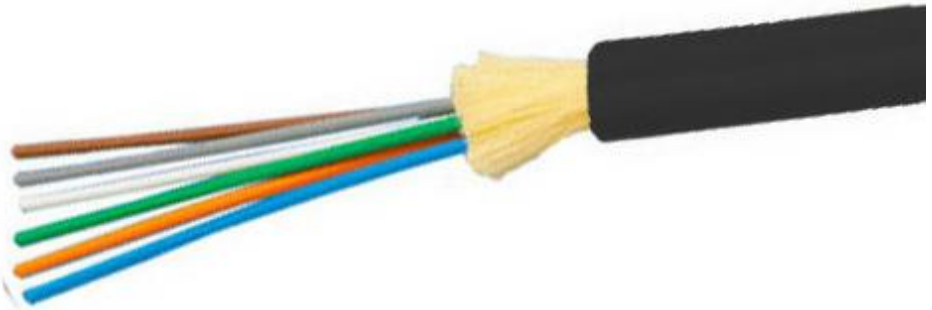
1. OUTDOOR CABLES

2. INDOOR PLENUM



3. OUTDOOR AERIAL CABLE WITH MESSENGER

4. INDOOR/OUTDOOR CABLES



Asymmetric Digital Subscriber line (ADSL)

Rate-Adaptive DSL (RADSL)

- The upstream transmission rate is automatically tuned based on the quality of the line and adjustments made on the modem.

Symmetric Digital Subscriber Line (SDSL)

- Uses the same rates for upstream and downstream transmissions.

Very High Bit Rate DSL (VDSL)

- Supports much higher transmission rates than other DSL technologies, such as 52Mbps downstream and 2Mbps upstream.

Common Types of DSL

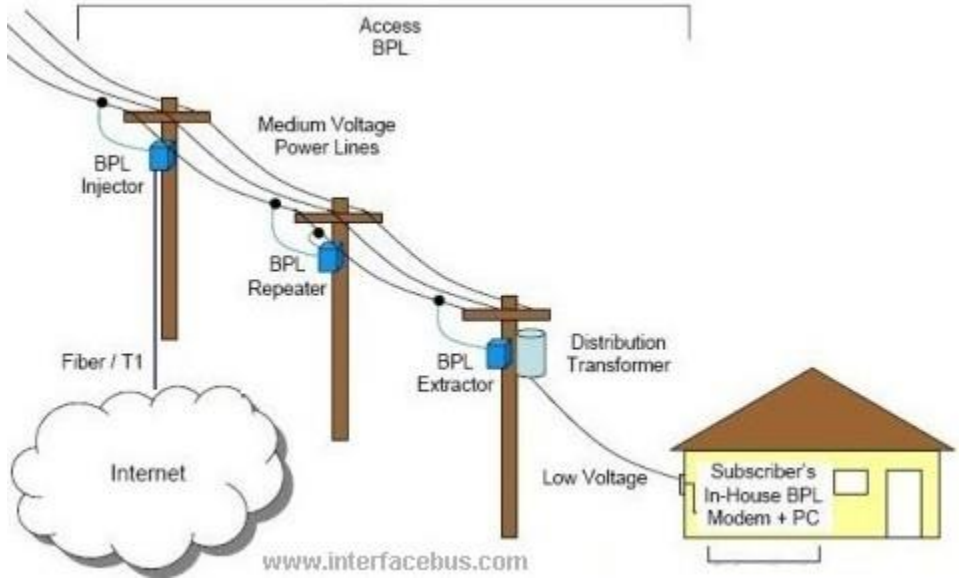
XDSL Series	Type	Down Speed	Up Speed	Distance
ADSL	Asymmetric	6-8Mbps	640Kbps	12000-18000ft.
ADSL2	Asymmetric	12 Mbps	1Mbps	6000ft.
ADSL2+	Asymmetric	27 Mbps	1Mbps	3000ft.
RADSL	Asymmetric	640-2200Kbps	27-1088Kbps	18000ft.
VDSL	Asymmetric/Symmetric	13-52 Mbps	1.5-2.3Mbps	4500ft.
HDSL	Symmetric	2.3 Mbps	2.3Mbps	12000ft.
IDSL	Symmetric	144 Kbps	144Kbps	Morethan 2000ft.

Cable Modem Data-Over-Cable Service Interface Specifications (DOCSIS)

DOCSIS Version	Maximum Download	Maximum Upload
DOCSIS 1	40Mbps	10Mbps
DOCSIS 1.1	40Mbps	10Mbps
DOCSIS 2	40Mbps	30Mbps
DOCSIS 3	1.2Gbps	200Mbps
DOCSIS 3.1	10Gbps	1Gbps
DOCSIS 3.1 Full Duplex	10Gbps	10Gbps

Broadband over Powerline (BPL)

- BPL is the delivery of broadband over the existing low- and medium voltage electric power distribution network. BPL speeds are comparable to DSL and cable modem speeds. BPL can be provided to homes using existing electrical connections and outlets.



Wi-Fi (Wireless LAN IEEE 802.11x)

Wireless LAN (Wi-Fi)

802.11x standards

	802.11a	802.11b	802.11g	802.11n
Frequency	5 GHz	2.4 GHz		2.5/5 GHz
Bandwidth	54 Mbps	11 Mbps	54 Mbps	up to 600 Mbps

Bluetooth (Wireless Personal Area Network IEEE 802.15)

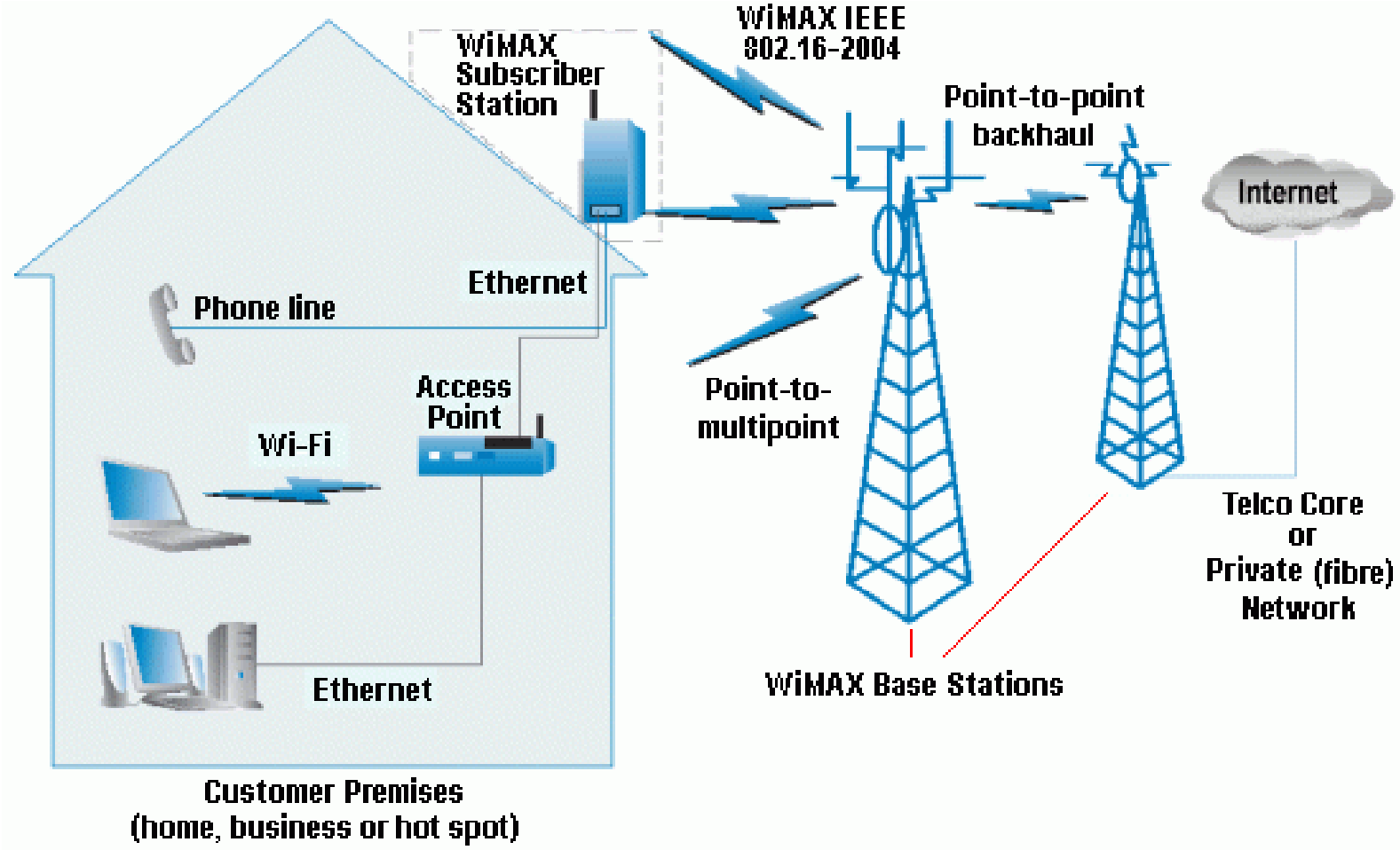
Wireless Personal Area Networks (WPAN)

- Communication within a person's operating space (~10m)
- Short range / Low power / Low cost / Small networks

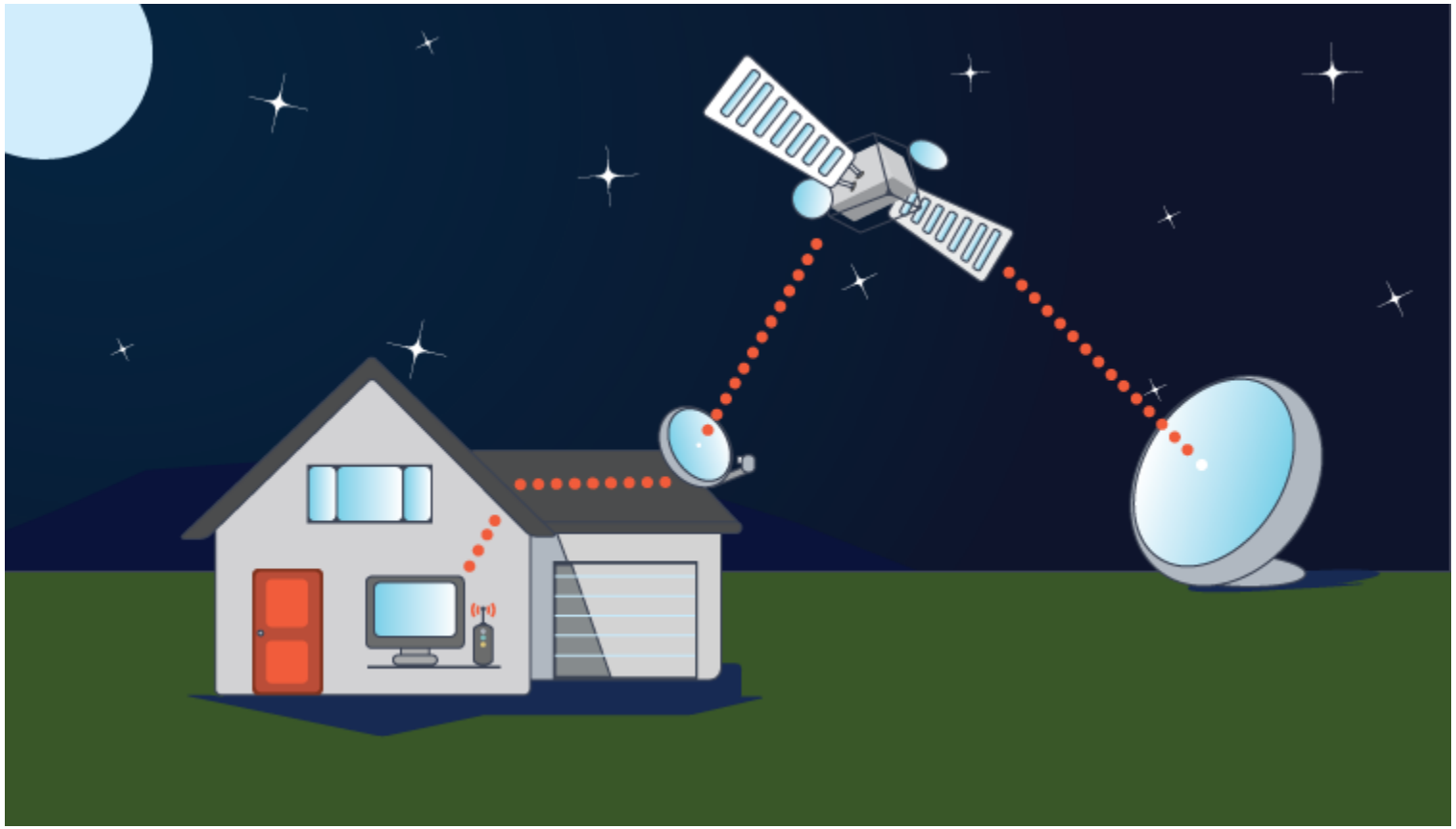
IEEE 802.15 family

- IEEE 802.15.1 (Bluetooth)
- IEEE 802.15.3 (**WiMedia**)
- IEEE 802.15.4 (ZigBee)
  - IEEE 802.15.2 defines the coexistence of WPAN with other wireless devices operating in unlicensed frequency bands

WiMAX (Broadband Wireless Access IEEE 802.16)

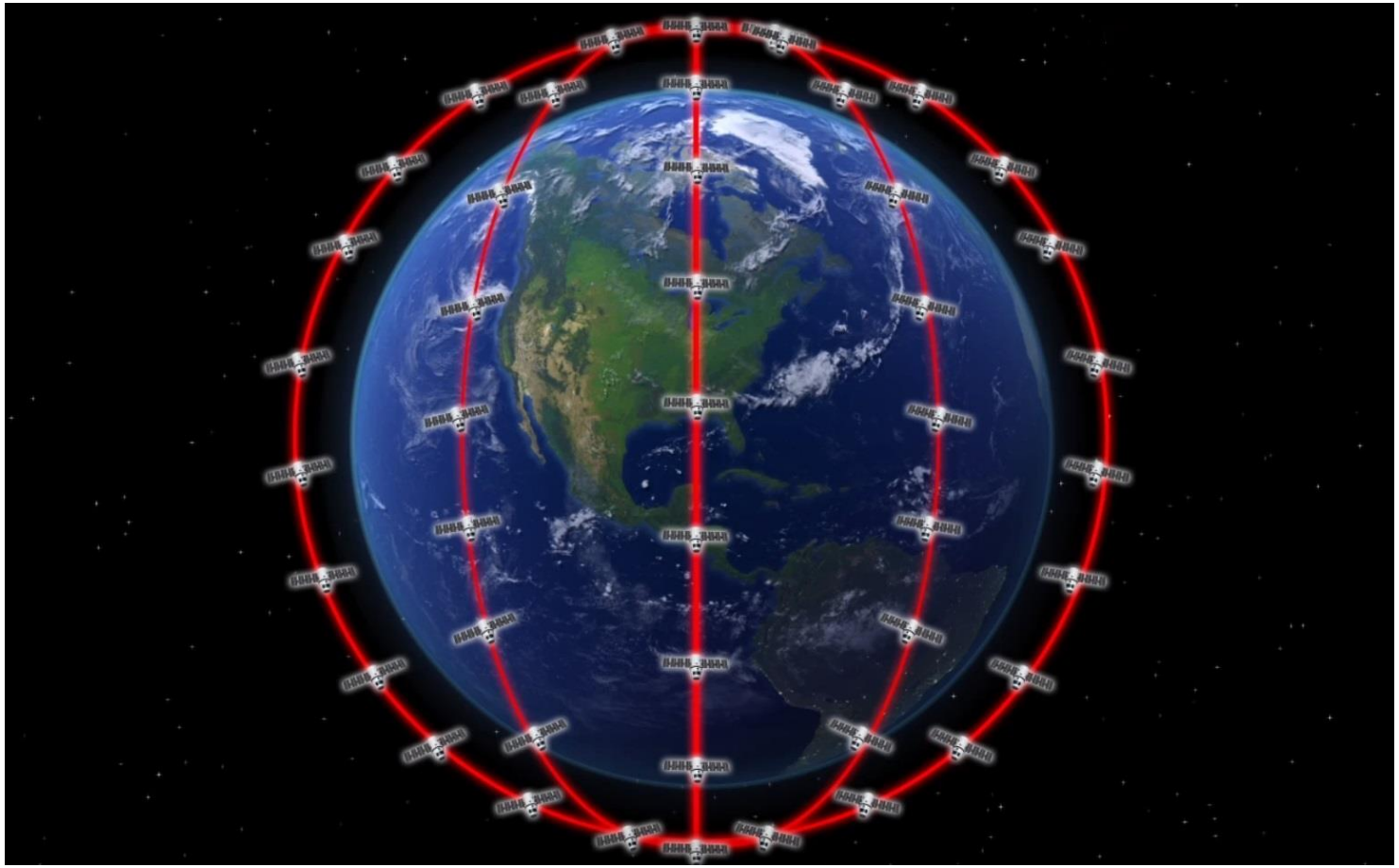


Satellite internet

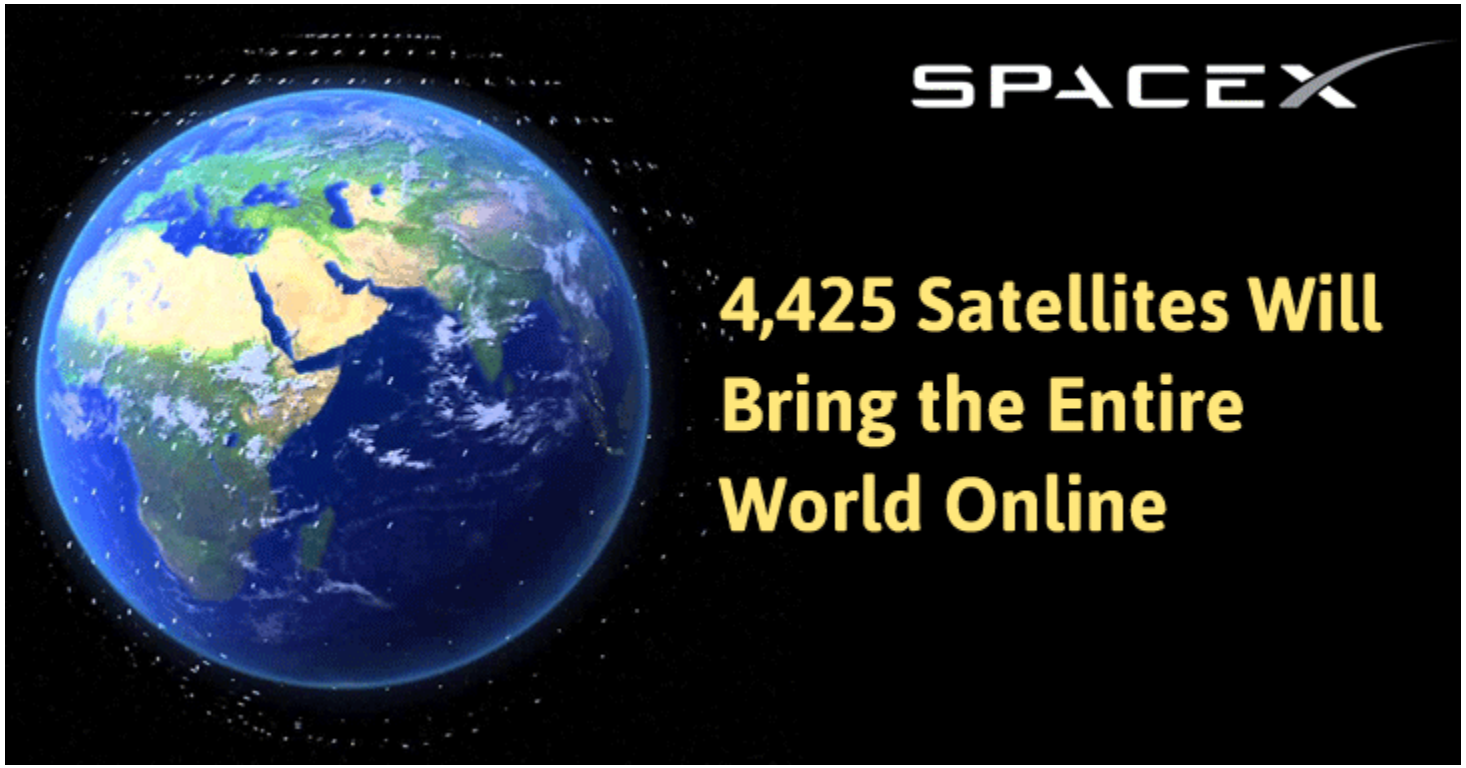


Satellite internet continued…

Satellite internet continued…



Space X satellite



Cellular Network

Generation	Advent	Transmission Speed	Technology Type	Purpose (each generation includes previous service)
1G	1980's	2.4Kbps	Analog	Phone calls
2G	1991	50Kbps to 1 Mbps	General Packet Radio Service (GPRS) with Enhanced Data Rates for GSM Evolution (EDGE)	Data services such as Short Message Service (SMS), pictures, and Multimedia Messaging Service (MMS)
3G	2001	Maximum of 52Mbps	HSDPA (High-Speed Downlink Packet Access)	Video calls and mobile internet
4G	2009	Maximum of 100Mbps	Long Term Evolution (LTE) or WiMax	HD mobile media and web conferencing
5G	Still in draft as of 2017	Maximum of 35Gbps	Software-defined networks (SDNs)	Internet of Things (IoT), self-driving cars, robot aided surgeries

Threats and countermeasures

Technology	Utilization	Threats	Countermeasures
Unshielded Twisted Pair (UTP)	Relative inexpensive network cable.	Easiest to tap and disclose data. Disrupt with electromagnetic interference (EMI) or radio frequency interference (RFI). Attenuation of signal begins at 100 meters or 328 feet.	Utilize STP or fiber optic cable to reduce EMI/RFI. Use repeaters and fiber optic cable to reduce issues with attenuation.
Shielded Twisted Pair (STP)	Provides greater protection against EMI/RFI.	Degradation or loss of a signal (attenuation) begins at 100 meters or 328 feet.	Use repeaters and fiber optic cable to reduce issues with attenuation.

Threats and countermeasures continued…

Technology	Utilization	Threats	Countermeasures
Coaxial Cable	Heavier gauge and shielding provides more protection than STP against EMI/RFI and greater bandwidth.	Cables can be difficult to manage.	Use fiber optic cable as alternative.
Fiber Optic Cable	Provides most protection against EMI/RFI and highest bandwidth.	Fiber optic taps can disclose data.	Use of end-to-end encryption when required.
Bus Topology	Easily add new node with negligible impact.	Bus failure leaves entire network inoperable. All nodes 'listen' to traffic along the bus.	Transition to star or mesh topology.

Threats and countermeasures continued…

Technology	Utilization	Threats	Countermeasures
Star Topology	Fewer cables than full or partial mesh. Nodes can be easily added.	Star device failure will leave connected nodes without access. All nodes connected to star device can potentially listen to traffic on the device.	Restrict traffic data disclosure by means of smart port management.
Ring Topology	Deterministic traffic management.	Single point of failure.	Use dual ring such as fiber distributed data interface (FDDI).
Mesh Topology	All nodes have a backup connection to every other node in the network. Designed for high availability.	Complex management of redundant cables and nodes may lead to loops of unintentional bypassing of access controls.	Use partially meshed.

Threats and countermeasures continued…

Technology	Utilization	Threats	Countermeasures
Bluetooth	Remote access and data sharing between devices.	Deprecated versions allow unauthenticated access. Blueborne, Bluejacking, and other attacks allow unauthorized access to data.	Keep up with patching and security updates. Do not use in insecure public settings. Use Bluetooth 4.x and above devices with Security Mode 4 Level 4 FIPS approved Advanced Encryption Standard (AES).
Cellular	Cell phones and other devices communicate globally.	Spoofed femtocells facilitate man-in-the-middle attack.	Require femtocell handset registration.