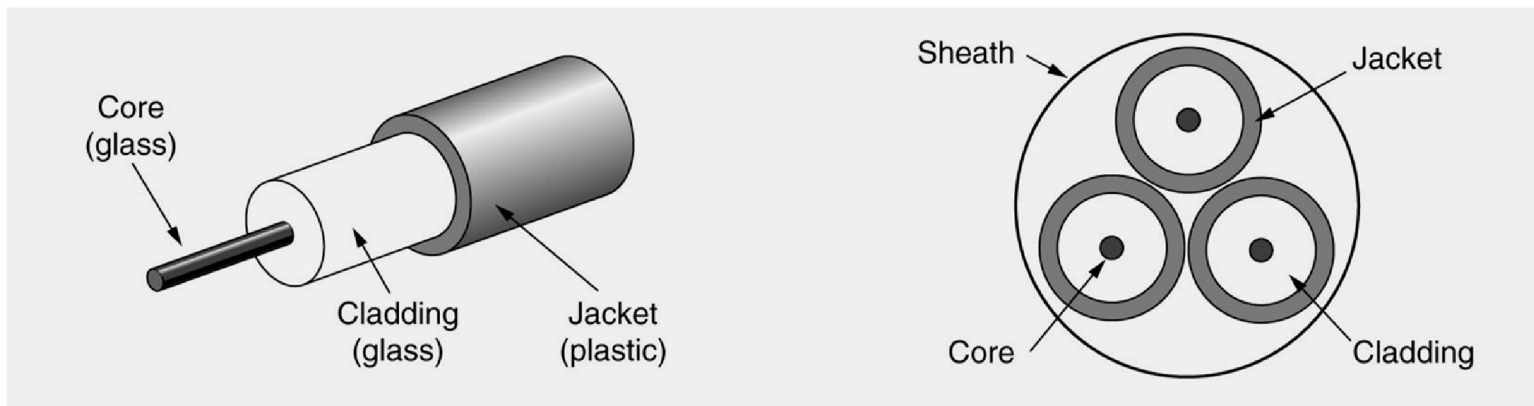
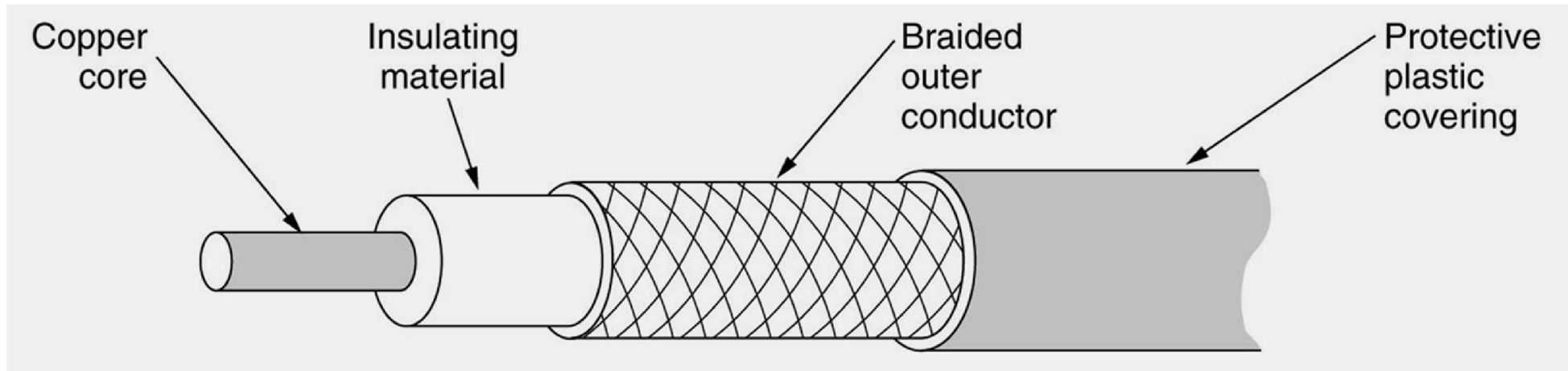


Transmission Media

- The ***Transmission Medium*** is the path along which the signal travels.
- The type of medium determines the type of signal to be used and can affect the reliability of communications.
- Conventional networks use copper wire:
 - Low resistance to electrical current,
 - The terms ***copper*** and ***wire*** are used interchangeably,
 - Prone to interference from other wires close-by,
 - This interference can be minimised by using ***Twisted Pair*** wiring and ***Co-axial*** cable.

TP, Co-ax and Optical Fibre Cables

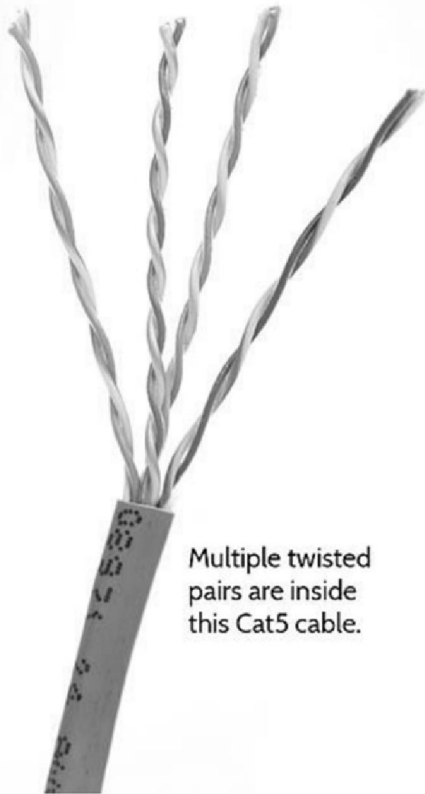


Twisted Pair

- Characteristics:
 - Comprised 2 insulated copper wires twisted together,
 - These twists reduce ***crosstalk***,
 - Typically many pairs are bundled in a protective sheath,
 - Very cheap and easy to use,
 - BW: Cat 3 = 16MHz., Cat 5 = 100MHz., Cat 6 = 250MHz.
- Applications:
 - In office buildings for phone and computer connectivity
 - Residential telephone – the local loop.

Twisted Pair Cables

CAT5



Multiple twisted pairs are inside this Cat5 cable.

CAT6



A buffer runs along the center of this Cat6 cable.

CAT7



Each twisted pair is shielded in this Crestron Cat7 cable.

Coaxial Cable

- Characteristics:
 - Comprised of central copper conductor and a hollow outer cylindrical conductor,
 - A surrounding sheath holds the inner conductors in place,
 - BW: 1GHz.
- Applications:
 - Cable TV,
 - Long distance telephone network,
 - Computer connectivity (LANs).

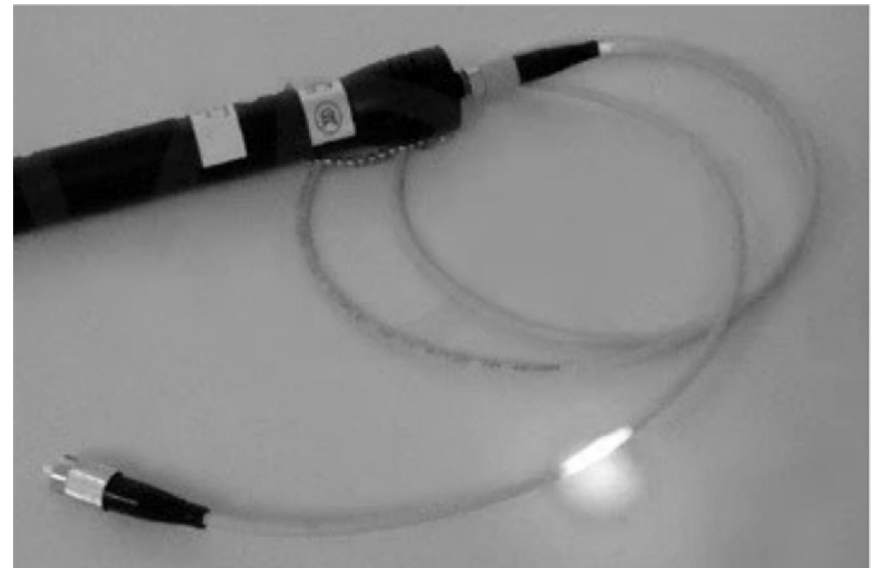
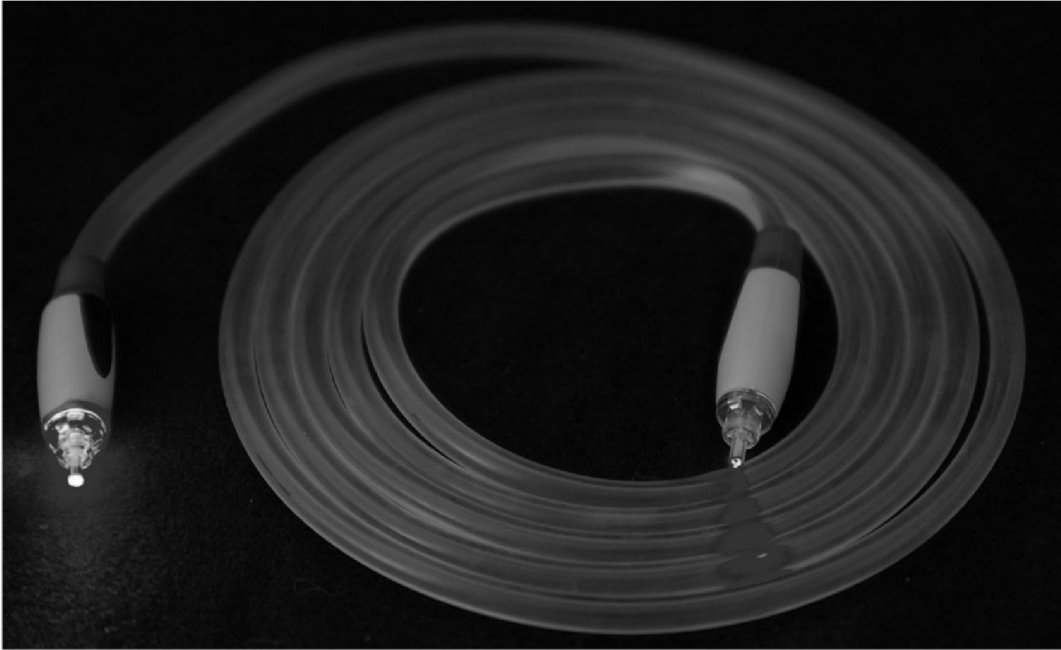
Co-axial cable



Optical Fibre

- Characteristics:
 - Comprised of thin flexible transparent glass fibre core,
 - This core is surrounded by glass or plastic cladding with a lower refractive index,
 - Outer sheath provides rigidity and protection,
 - Several fibres may be bound in a single jacket,
 - Two types of light source used:
 - Light emitting diode (LED) - low cost,
 - Injection laser diode (ILD) for higher data rates and greater distances.

Fibre Optic cable and a faulty cable



Optical Fibre

- Applications:
 - Long distance telephone connections,
 - Metropolitan trunks,
 - Rural exchange trunks,
 - Local loop (becoming more popular),
 - LANs.

Optical Fibre V Coaxial Cable

- Optical Fibre cables offer the following advantages over Co-axial cables:
 - Electromagnetic isolation i.e. no interference,
 - Lower Attenuation hence greater repeater spacing (50km v 5km for copper),
 - Greater Capacity – up to 10 Gbps over many km's,
 - Requires only single core for complete circuit:
 - Hence smaller in size, lighter in weight.

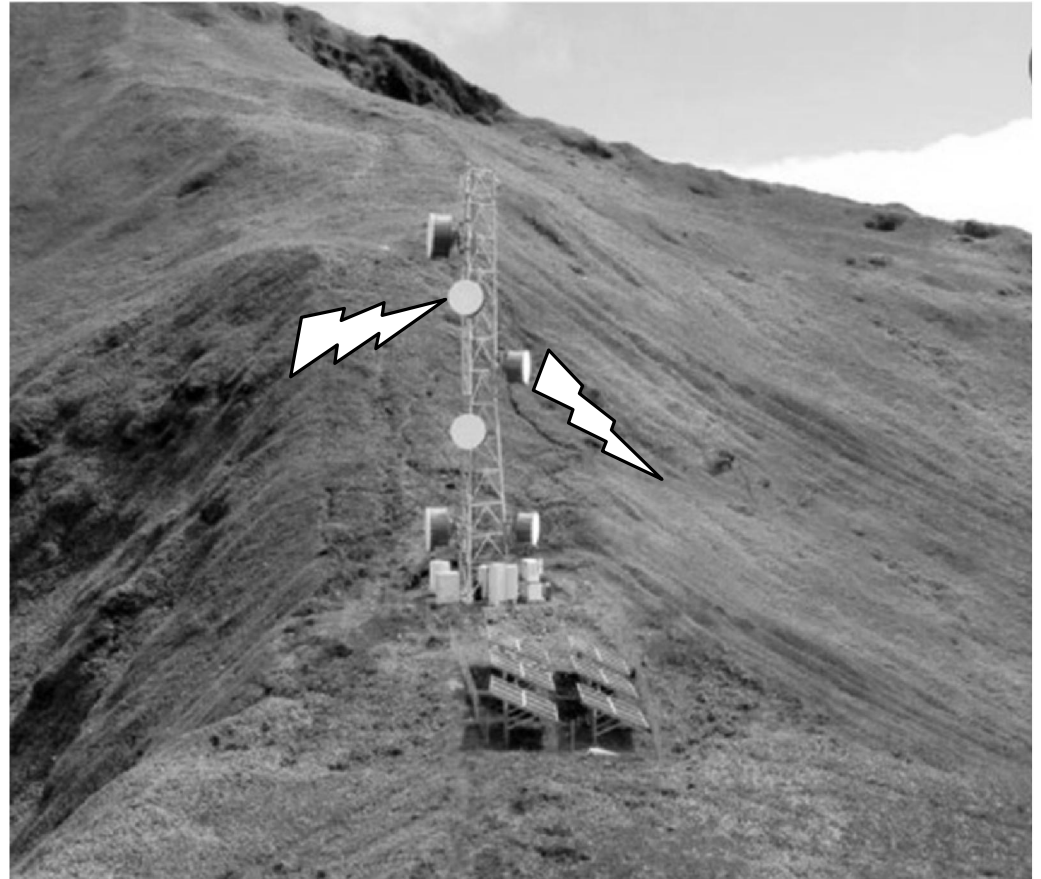
Wireless Transmission

- Two configurations:
 - *Omni-directional* e.g. radio station,
 - *Directional* e.g. microwave/satellite links.
- Radio Transmission characteristics:
 - Networks that use EM radio waves are known as ***Radio Frequency (RF)*** networks,
 - There is no physical connection between stations,
 - Transmission is achieved using an antenna.

Terrestrial Microwave

- Characteristics:
 - Microwaves travel at higher frequency than RF. Typically 2 – 40 GHz.,
 - This higher frequency allows for a larger bandwidth which implies a high data rate e.g. 120 Mbps,
 - Waves are focused into a narrow beam by a parabolic dish antenna,
 - Waves are received by a similar dish antenna,
 - Line of sight required (although not always possible),
 - Prone to interference from rainfall and other dishes,
 - Prone to misalignment in storm.

Terrestrial Microwave Links



Terrestrial Microwave

- Applications:
 - Back-to-back installations used on long haul links (this is their main application).
 - Also used where there are difficulties laying cables e.g. mountain top installations.
 - Very common with mobile phone networks e.g. the **3 Network** relies heavily on MW links.

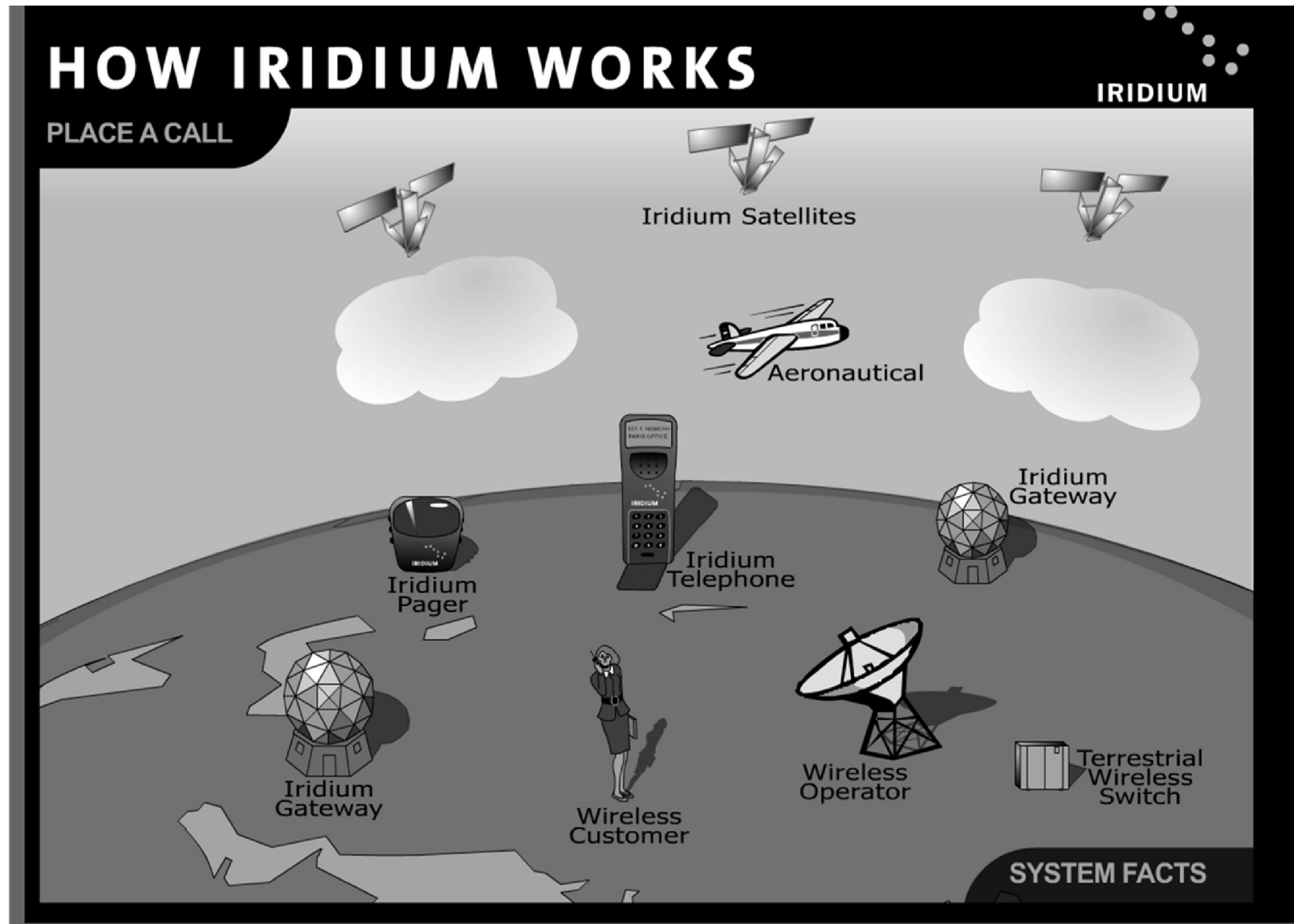
Satellite Microwave (aka Satellites)

- Satellites can link two or more ground stations – i.e. they act as a *relay*,
- Satellites use two different bands (frequency ranges) to communicate:
 - Different frequencies allow full duplex comms.,
 - There are *up* and *down* links each using different frequencies.
- Two types of Satellite (GEOs and LEOs):
 - GEOs remain stationary over a point on earth,
 - LEOs move rapidly across the sky.

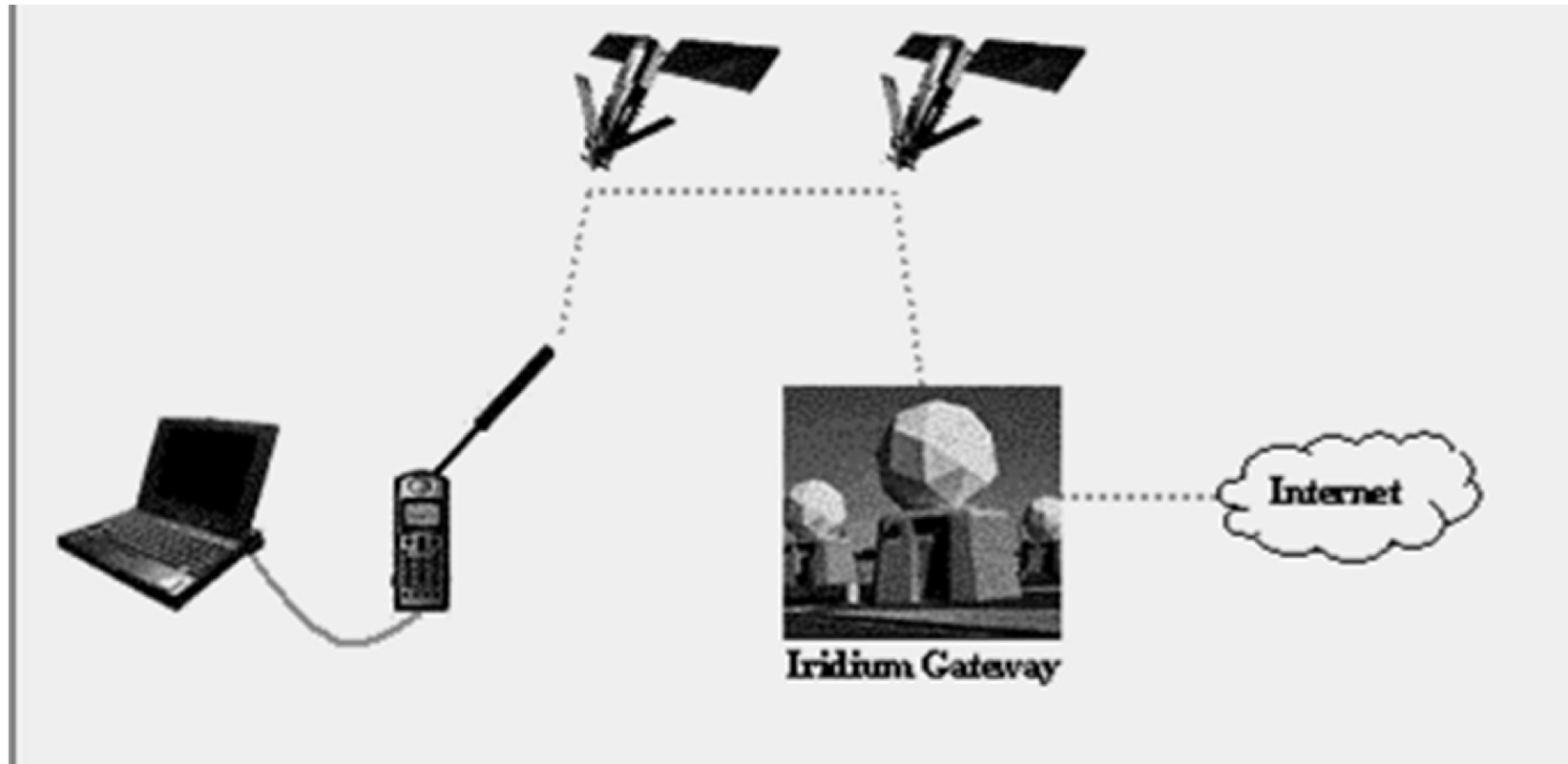
Satellites

- Characteristics:
 - Originally operated in range 1 – 10GHz.,
 - The 4/6 GHz band is now saturated,
 - 12/14 GHz now open for service.
 - Inherent propagation delay (time delay) approx. 0.25sec.
- Applications:
 - Television distribution,
 - Long-distance telephone transmission,
 - Private business networks.

The Iridium Satellite Network



Using Iridium Network for Computer Comms.

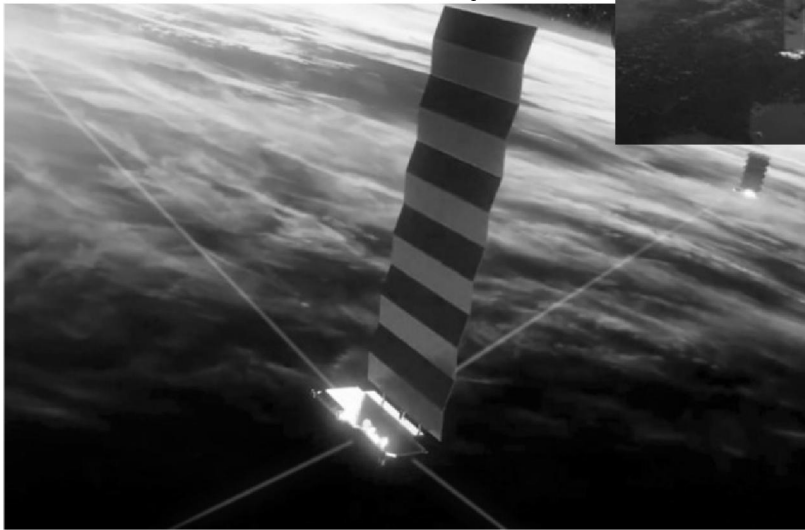
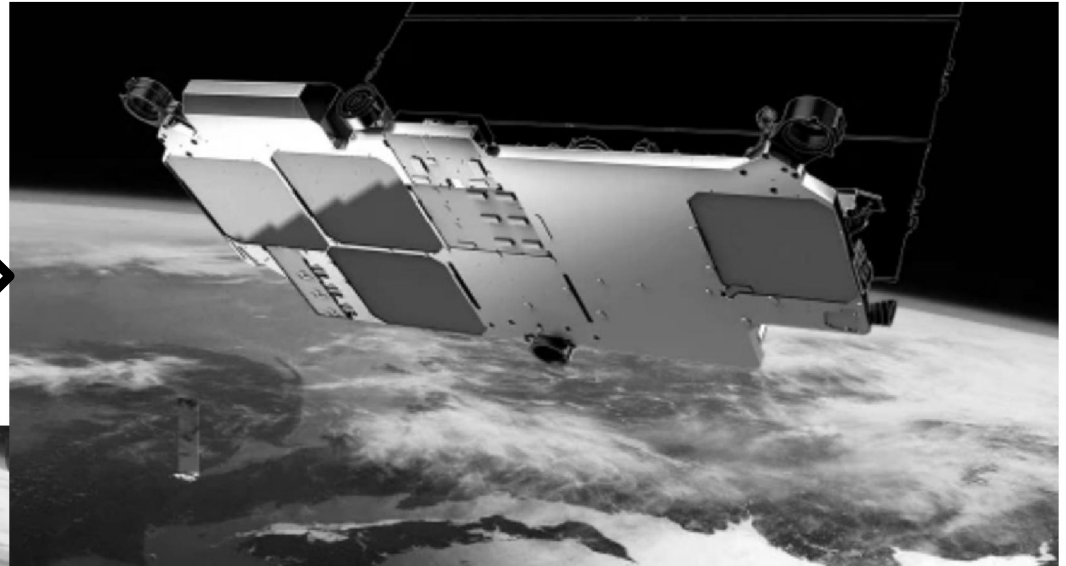


Elon Musk's Starlink Network

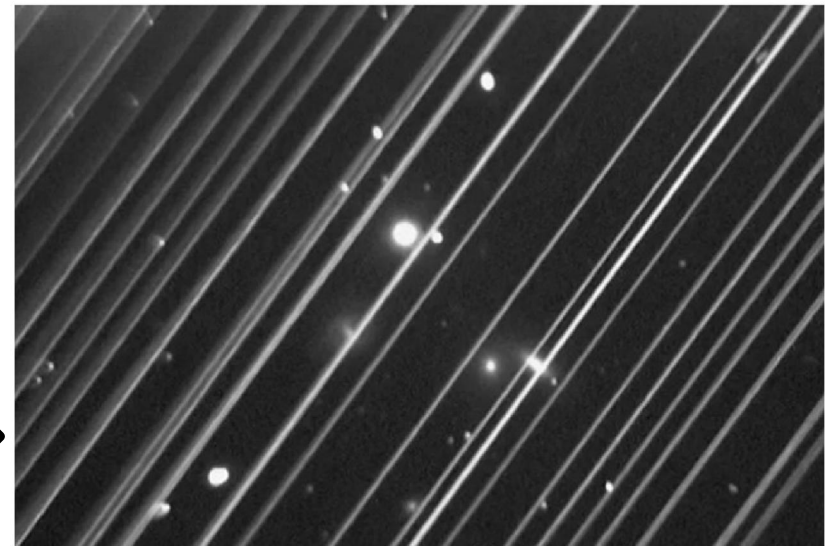


Falcon 9
Launcher

Starlink
Satellite



Environmental Impact



Infrared

- Characteristics:
 - Does not require antennae or special license to operate,
 - Uses LED,
 - Very low cost,
 - Cannot penetrate obstacles i.e. requires line of sight.
- Applications:
 - Remote controls,
 - Computer-to-computer connectivity e.g mobile phones etc.

Bluetooth

- Characteristics:
 - Uses the 2.4 GHz. ISM band (Industrial, Scientific and Medical),
 - Uses low power implies short range (approx. 10m),
 - Comprises 79 channels of 1MHz. each,
 - Uses a type of encoding called FSK which provides for 1 bit per Hz. i.e. 1Mbps per channel,
- Applications:
 - Connection of a variety of computing devices

The E-M Spectrum

