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Optical Fibre Communication versus Wireless Communication

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ABSTRACT: Optical fiber which are long, thin, made with pure glass about the diameter of human hair and it is a dielectric waveguide or medium in which information (voice, data or video) is transmitted through a glass or plastic fiber, in a form of light. -Optical fiber communication system consists of three basic elements:- 1) the optical transmitter 2) optical fiber cable 3) the optical receiver. Jacques Babinet> < John Tyndall included a demonstration of it in his public lectures in London, 12 years later. Tyndall also wrote about the property of total internal reflection in an introductory book about the nature of light in 1870. Multimode fiber :-If the diameter of the core of the fiber is large enough so that there are many paths that light can take through the fiber, the fiber is called "multimode" fiber. 2) Single mode fiber :-Single- mode fiber has a much smaller core that only allows light rays to travel along one mode inside the fiber, the fiber is called ‘’single mode’’ fiber. Advantages 1) Enormous bandwidth 2) Low transmission loss 3) Immunity to cross talk 4) Electrical isolation 5) Signal security 6) Flexibility 7) Reliability 8) Ease of installation 1) High cost and most expensive 2) Fragility 3) Affected by chemicals 4) Opaqueness (exposed to radiation) 5) Scattering

I. INTRODUCTION

Wireless and optical communication differ in many ways, but perhaps the key differentiator between fixed wireless links and optical communications systems is in the bandwidth. Fiber optic cables are almost capable of supporting unlimited bandwidth, which translates to Gb/sec data rates. Fixed wireless links (and all wireless systems), since they are sending signals through free space rather than through an optical fiber or other confined medium, operate within fixed segments of frequency spectrum that must be licensed for different applications to avoid interference from too many signals within the same frequency range in the same location. As a result, the limited bandwidth of any wireless system will also limit the amount of data that can be transferred between points at any one time.

The bandwidth of an optical fiber is potentially as wide as the optical portion of the electromagnetic (EM) spectrum, or about 10 THz or more. Of course, to harness such bandwidth, a transmitter and receiver are needed at both ends of a link.[1]

FIG.1

Wireless communications systems are licensed for their use of frequency bandwidth to avoid congestion within one band Because they send signals through free space rather than through a "captive" propagation medium such as an optical cable. (FIG.1)

Similar to the way that frequency bandwidths are divided in wireless systems using frequency division multiplex (FDM), optical communications systems use forms of wavelength division multiplexing (WDM) to increase capacity over optical fiber lines by using different wavelengths through the cable for different carriers. By multiplexing or combining different carriers at the optical transmitter and demultiplexing or extracting the separate carriers at the optical receiver, the data rate of a single fiber line can be dramatically increased into the Tb/s range.[2]

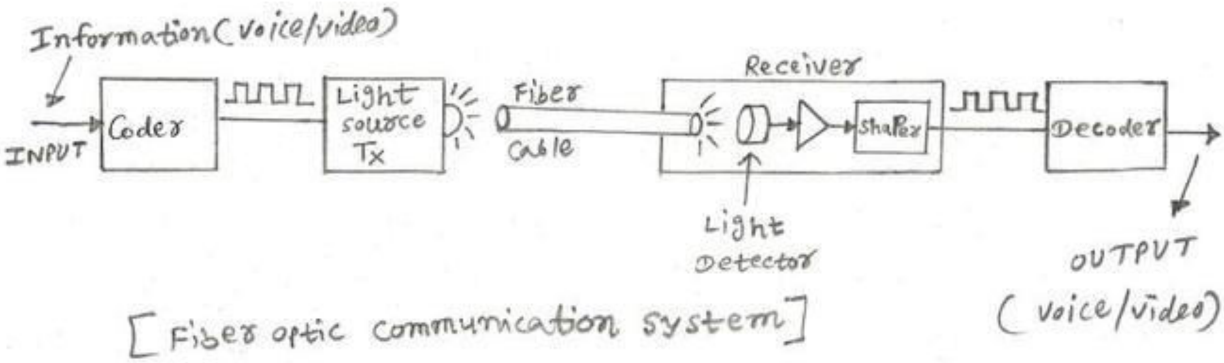

FIG.2

Just as some optical energy is lost as a function of distance through an optical cable, some EM energy is lost by microwave signals propagating through the atmosphere, with loss increasing as a function of distance and increasing frequency. As a result, while bandwidth is available for wireless communications at millimeter-wave frequencies and even as high as THz frequencies, the practical range of any wireless communications system based on such high frequencies will be limited, with THz communications limited to the near fields of the antennas, essentially within the same room.[3]

Fiber-optic networks have a key advantage over wireless communications technology: they are immune to the effects of electromagnetic interference (EMI). EMI is often present in an enclosed space like an office building, caused by multiple RF sources and signal leakage and reflections, and can wreak havoc on wireless communications. For that reason, and because of the difficulty of "eavesdropping" on a fiber-optic network, optical communications systems are often used as the communications backbone for surveillance systems in buildings. For the difficulty of installing a fiber-optic network, it has its rewards of amazing bandwidth and robustness (FIG.2)

II. DISCUSSION

The steps describe the data flow through optical communication system.
• Step-1: The information (voice, video, data) to be transmitted will be converted into the form compliant to medium. Appropriate coder or converter is used for this purpose which converts analog signals into digital pulses. A/D converter can be used for this. The computer data can already be in the digital form.
• Step-2: The optical transmitter device (such as LED) is used to flash light source ON and OFF based on digital pulses. Infrared beams are also used in the transmission of information. The other optical transmitter device is solid state laser.
• Step-3: The light beams are fed appropriately into fiber optic cable so that it can be transmitted over long distances.
• Step-4: At the receiving end, optical receiver devices such as photocell or light detector is used to detect light pulses. This devices convert electrical pulses into electrical signal. Amplifier is used to amplify and reshape the signal back to digital form.
• Step-5: The digital pulses are fed to decoder which coverts digital pulses into voice/video form. D/A converter is used for this purpose.• To support long distances optical repeaters are used along the path of fiber optic chain.

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However, the type of communication which uses Electro-Magnetic waves as medium of communication is known as wireless communication. It uses different frequency bands based on distance coverage and terrain requirements. Various types of modulation schemes are used which helps in achieving different bandwidth/data rate.[4]
There are different types of wireless communication which include satellite communication, microwave line of sight communication, cellular communication (GSM, CDMA, LTE etc.), short range wireless communication (WLAN, Bluetooth, Zigbee, Zwave, LoRaWAN etc.).

III. SOME NEW DISCOVERIES

first_page
Underwater Optical Wireless Communication (UOWC) is not a new idea, but it has recently attracted renewed interest since seawater presents a reduced absorption window for blue-green light. Due to its higher bandwidth, underwater optical wireless communications can support higher data rates at low latency levels compared to acoustic and RF counterparts. The paper is aimed at those who want to undertake studies on UOWC.

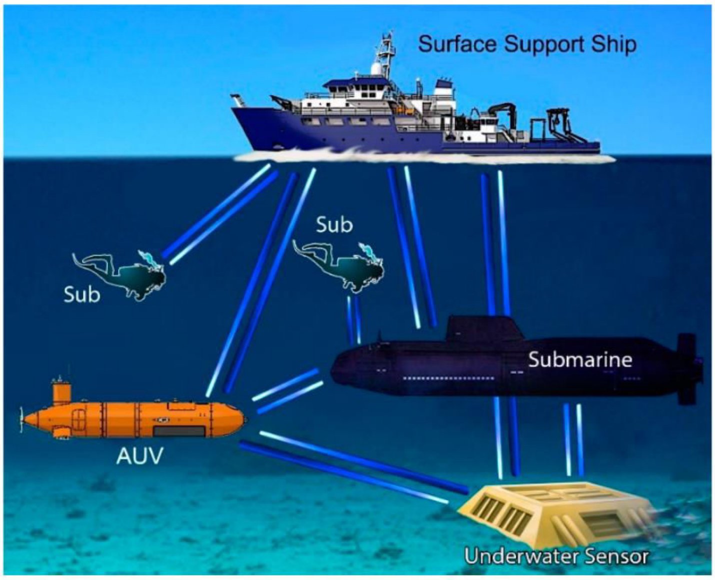

FIG.3

It offers an overview on the current technologies and those potentially available soon. Particular attention has been given to offering a recent bibliography, especially on the use of single-photon receivers.(FIG.3,4)

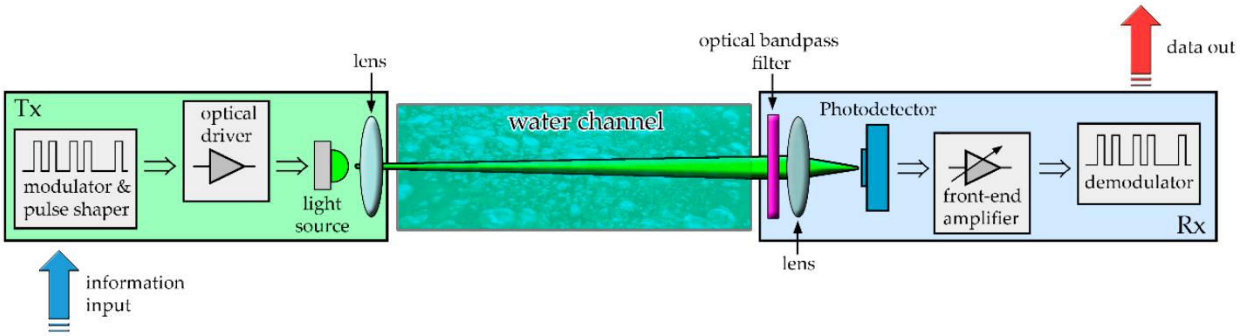

FIG.4

IV. CONCLUSION

Communications have relied on signals propagating through the air from the earliest drumbeats. Wireless communications technologies make effective use of that signal transport medium even as the appetite for more and

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faster voice, video, and data grows. Still, light has been another long-time form of communications, literally "as far as the eye could see," and optical communications has advanced at a pace equal to or exceeding the evolution of wireless communications. The technologies are much different, but each has its place, its strengths, and its weaknesses. Wireless communications relies on the transmission and reception of RF/microwave signals modulated with the information to be carried while optical communications uses modulated light beamed through fiber-optic cables. For a fair comparison of the technologies, fixed wireless systems will be compared to optical communications systems because of the lack of mobility for optical links.(FIG.5)


1.

FIG.5

In the case of fixed wireless communications, the infrastructure is installed in discrete locations, with line-of-sight (LOS) paths between the locations so that radio waves can propagate through the atmosphere without obstructions. The extreme example of a long LOS wireless link is a satellite, with a clear path between an earth station and the satellite orbiting Earth. A more typical example is the collection of cellular communications antennas and their towers found on hills or high points in the terrain, often along roadways. Wireless communications infrastructure can be found in these single locations, and readily accessed for maintenance. Signals from multiple individual fixed wireless links are routed through relay stations that join multiple connected wireless links for nearly instantaneous wireless communications across long distances.

The infrastructure of an optical communications system, on the other hand, is distributed from one communications location to another. Fiber-optic cables must be installed from one point to the next to enable optical communications. The quality of those cables is important to the performance of an optical communications system, as is the integrity of the splices between sections of optical cable. Whereas a fixed microwave link sends information through the air between two points, a fiber-optic link depends upon these cables, which must be installed with care and then maintained over time, since they can deteriorate and wear out. Optical cables can break or be cut and must be repaired, but first the fault must be found, often in many miles of optical cable, and this is not a trivial task. Business models for laying fiber-optic cables typically assume a 50-year lifespan for the capital investment of installing the optical network equipment, which may also include links to individual subscribers, known as fiber-to-the-hole (FTTH) optical communications.[5]

Although the speed of light through a vacuum is well known (186,000 miles/s), light slows down when it is not in a vacuum (such as outer space). It can slow down significantly when it travels through a medium such as the glass or plastic fibers used in optical cables. While fixed wireless systems are designed for LOS links between transmitter and receiver, optical communications systems typically do not have the luxury of a straight path and must often wind around corners through a city or in an office building for their signal paths. As with light reflecting off walls around a corner, every bend in the cable decreases the speed of the light propagating through that cable.

As a result, in terms of pure communications speed, fixed wireless links typically provide faster connections than optical links. The connection speed is usually measured in terms of a system's latency, which is essentially the time required to receive and respond to a signal. It takes into account signal switching and any delays through the propagation medium. The latency of a fiber-optic system is typically longer than that of a fixed wireless link for the same distance, and increases significantly with increases in link distance compared to a fixed wireless link.

Perhaps the key differentiator between fixed wireless links and optical communications systems is in bandwidth. Fiber-optic cables are capable of supporting almost unlimited bandwidth, which translates to Gb/s data rates. Fixed wireless links (and all wireless systems), since they are sending signals through free space rather than through an optical fiber or other confined medium, operate within fixed segments of frequency spectrum that must be licensed for different applications to avoid interference from too many signals within the same frequency range in the same location. As a result, the limited bandwidth of any wireless system will also limit the amount of data that can be transferred between points at any one time.

The bandwidth of an optical fiber is potentially as wide as the optical portion of the electromagnetic (EM) spectrum, or about 10 THz or more. Of course, to take advantage of such bandwidth, a transmitter and receiver are needed at both ends of a link. While the components for an optical transmitter, such as a light-emitting diode (LED) or laser transmitter, and a photodiode-based receiver are fairly common and low in cost, the data speeds of systems using these components is still limited to the low Gb/s range rather than the Tb/s range.[6]

Because of the enormous bandwidth available using fiber-optic cables, they are often used to route signals from fixed and mobile wireless base stations to their carrier's signal switching stations for making interconnections to customers. Fiber-optic cables have replaced metal cables in many fixed communications installations, such as in warehouses and office buildings, and serve as communications backbones in many types of wireless communications systems, including in base stations for the latest 4G LTE mobile wireless communications systems. Likely, optical communications links will serve similar functions in emerging 5G mobile wireless communications systems.

Similar to the way that frequency bandwidths are divided in wireless systems using frequency division multiplex (FDM), optical communications systems use forms of wavelength division multiplexing (WDM) to increase capacity over optical fiber lines by using different wavelengths through the cable for different carriers. By multiplexing or combining different carriers at the optical transmitter and demultiplexing or extracting the separate carriers at the optical receiver, the data rate of a single fiber line can be dramatically increased into the Tb/s range. The two chief WDM methods currently in use in optical communications systems are dense WDM (DWDM) and coarse WDM (CWDM), which has less wavelength channels with wider spacing than DWDM. The result is lower data rates, but CWDM systems can be implemented with lower-cost components without the need for the stability and precision required by the closely spaced carriers in DWDM optical communications systems.[7]

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