WIRELESS OPTICAL COMMUNICATIONS

ABSTRACT

This paper deals with the Wireless Optical Communication (WOC). In this paper we mainly discuss the problems with the conventional methods of communication such as Permissions, License fees, Lack of International standardization, Wastage of power and Security and how this new technology of WOC can be used to overcome these problems, along with its own set of advantages. We also discuss about the competitions it is facing and how it stands apart, and finally how low cost user friendly devices built using this technology can be used in the Rural Indian Scenario.

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INTRODUCTION :

As the term wireless optical communications (WOC) suggests, this is a group of technologies that use light to communicate through the air, and require clear line of sight between units. Modern systems typically use lasers or light-emitting diodes to produce the light at one end, while photo diodes at the receiver sense the incoming light, and send an appropriate signal to a connected computer.In the telecommunications space, WOC systems are in use in niche applications, mostly for high-bandwidth applications needing to transfer hundreds of megabits per second, over distances typically less than a kilometer. Recent developments promise to bring WOC into the realm of inexpensive consumer products.

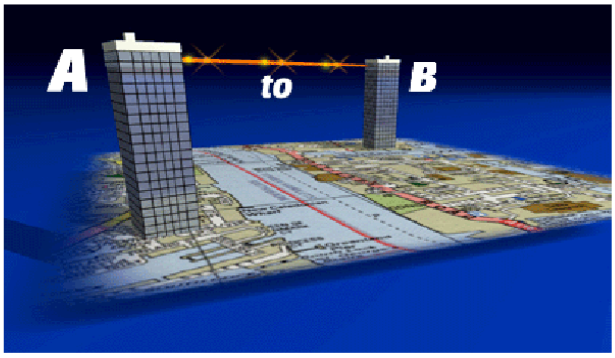


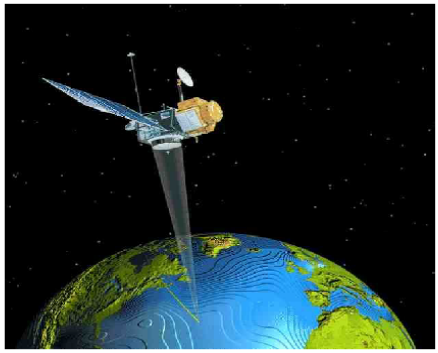
Fig: In WOC the channel used is Air

CURRENT SCHEMES OF WIRELESS COMMUNICATIONS:

In the last decades, the use of wireless has grown at a furious pace. The advantages of wireless are rapid deployment, without the need to dig trenches for cables, and seek permissions for right of way. A big advantage of wireless is in allowing people to communicate while they are mobile. The systems in common use are:

- Satellite

While satellites in low-earth orbit are sometimes used for communication, the most common are geostationary satellites, which are stationed approximately 34000 km away. These are particularly useful to bring communications to remote areas, and are also well suited to situations where the same content has to be delivered to a large number of people, as in the case of radio (Worldspace) and TV. Satellites, of course, are expensive to make and to maintain.



- Radio

Over the years, a plethora of systems for radio communication have been developed. These use a variety of frequencies, as well as protocols for modulating the carrier frequency with data, and cover ranges from a few to thousands of kilometers. Perhaps the best recognized examples of such communication are the microwave towers scattered around the countryside.

- Mobile Phone

With the advent of mobile phones, wireless communications reached the man in the street. Here too, there are several systems in use, both analog and digital, in a variety of frequencies and incompatible standards. GSM and CDMA have emerged as the dominant systems in this space. Such systems can also be used for sending data at fairly slow speeds -- 9.6 kilobits per second is typical. They also need an expensive central switch - mobile phones cannot talk directly to each other.

PROBLEMS WITH CONVENTIONAL WIRELESS COMMUNICATIONS:

- License fees

As users and uses for wireless communication have increased, radio spectrum has become increasingly scarce. Auctioning thin slices of it has become highly lucrative for governments. Typically, such license fees are not just one-time, but annual.

- Lack of International Standardization

Despite the best efforts of organizations such as the ITU, major markets, such as the US, Europe and Japan, have not always been able to agree on what frequency to use for which purpose. As a result,

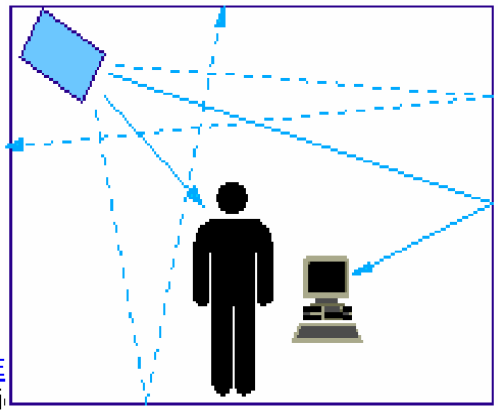
the same product cannot be used across countries, a situation mobile phone users are familiar with. This reduces the level of mass production possible, leading to higher cost.

- Wasteful of power

Radio transmissions are hard to focus. As a result, only a very tiny portion of the energy transmitted is actually picked up by the receiver. This problem, or course, becomes more acute as the distance between sender and receiver increases, and is the bane of satellite communications. Particularly in rural areas, power is scarce and expensive. For instance, if solar power is used, it is not unusual for the power source to cost as much as the rest of the communication equipment.

- Security

Because radio transmissions expand outward in a large cone, people other than the desired recipient can pick up the transmission. Unless quality software encryption is employed, which still happens rather rarely, radio communication is easy to intercept. Illegal use of radio communication is also fairly easy to detect.



WHY OPTICAL WIRELE

Optical communicati rket, except to the extent required to protect the human eye from a strong beam. Under the IEC 8025 standard, to be unconditionally safe, devices must conform to a CLASS 1 designation This permits viewing at any range over any duration even using optical aids such as binoculars.

The miliwatts of power typically used by modern optical communication systems are well below such limits. Since the frequencies used are unregulated, they attract no license fees, while the same frequencies can be used all over the world, eliminating the need for different models for different countries. A solution for South Asia could therefore easily be exported.Laser beams can easily be focused very narrowly. "Laser pointers are cheap examples demonstrating mill radian collimation from a millimeter aperture. To get similar collimation for a 1 GHz RF signal would require an antenna 100 meters across, due to the difference in wavelength of the two transmissions.

A similar advantage is seen at the receiver, where compact lenses can be used for optical beams, while radio signals need large and unwieldly antennae at the receiver end as well, to obtain significant improvement in efficiency

INDUSTRY PROBLEMS:

The narrow beams used in wireless optical communications need to stay focused, even through wind and vibration. This requires special hardware for automatic alignment. Then again, weather and flying birds can interfere with quality reception. Consequently, the difficulties faced by the industry include:

- High-speed, high cost niche

The products available in the market provide orders of bandwidth more than what the consumer needs, at a price she cannot afford. They are used when other methods are infeasible, or when a large amount of bandwidth needs to be provided at short notice, for instance during a conference.

- Competition

Telecommunications is an industry with a high rate of innovation, with a variety of systems in use, which WOC must compete with. These include systems both, in the wired and wireless space. Only those that offer broadband connectivity are discussed here.

➢ Optic Fiber

Much investment has taken place all over the world in this technology, which for long-distance high-bandwidth traffic has no equal. However, there are limitations: Almost 90 percent of all office buildings in the United States have no fiber connection. To link a building with fiber costs between $100,000 and $200,000 and often involves a provisioning delay of four to 12 months. Given the cost and time required, it is not realistic to expect optic fiber to reach all our villages any time soon.

➢ 3G

Telecommunications companies have invested heavily in this, which is supposed to deliver broadband connectivity to mobile phones. Exorbitant license fees have already heavily burdened this technology. In addition, there does not appear to be global agreement on the frequencies and protocols to be used. Besides, the technology isn't available yet. In the absence of clear demand at the price point that the telecom service providers will need to charge, many have delayed their deployment plans, leading some experts to believe that this technology is stillborn.

➢ 802.11b

This standard defines equipment for wireless Local Area Networks of PCs, and has a normal range of a couple of hundred feet. However, innovative people found a way, using highly directional antennae, and a low-loss cable between PC and antenna, to extend the range to several kilometers. The 2.4 GHz frequency employed is delicensed in many parts of the world.

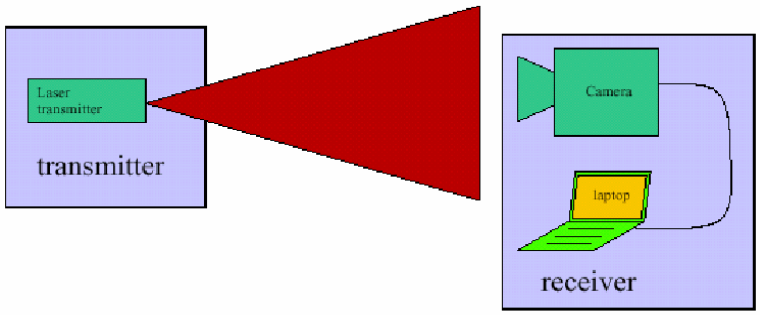
As a result of the high volumes of production this allows, the cost of the hardware is only a few thousand Rupees, which might make it attractive for interconnecting villages. While in India an announcement was made that the technology will be delicensed for indoor use, it is not clear when outdoor use over such distances will be similarly treated. While permission can be obtained for outdoor use from the government, at present, fairly steep license fees are levied. A fall in price of the hardware combination of computer, 802.11b card, cable and antenna to a level that the average villager can afford is not expected any time soon.

RECENT DEVELOPMENTS IN WOC:

The advantages of wireless optical, and the problems its competitors face, make this area very promising, and naturally the subject of considerable research around the world Two examples from work done at the University of Berkeley are described below,

- The Video Camera, laser pointer combination

Using a standard CCD camera with a 1-inch aperture lens as the receiver, and a laser radiating less than 2mW average, M. Last and others were able to establish communications during the day time over a distance of over 20 km. Since the camera scans at 60 frames per second, they were only able to receive at 4 bits per second, albeit from dozens of sources simultaneously. A village wishing to exchange short messages with neighboring ones could set up such a system using off the shelf components very quickly.



- The high speed solution with custom hardware

Using imaging hardware in which each pixel can be independently processed and therefore "is a fully independent megabit/second receiver" and automatic beam steering using computer-controlled stepper motors, it is possible, for a few hundred dollars, to make communication equipment that has a range of several kilometers, and the ability that the equipment at each ends locates the other automatically. Data throughput in megabits per second - enough for quality video conferencing - is easily achievable.

ADAPTING THE TECHNOLOGY TO THE INDIAN RURAL SITUATION:

Any product for rural India must take into account the limited purchasing power of the average villager. A low-cost end-user device would go a long way to making this technology a success in India. A laser pointer, photo diode, some simple electronics, a loudspeaker and microphone could be combined into a small package and made in large quantities for a couple of hundred rupees.
This could provide the farmer in the field voice communication with the village, of a quality better than FM radio - all he would need to do, would be to point the device towards the camera mounted at a high point in the village. For one-way communication via Morse code, the farmer would only need a cheap laser pointer.

CONCLUSION:

Wireless optical communication has advanced far enough, that it encompasses all the benefits of conventional wireless - quick devlopment and mobile communication, while delivering a million times more bandwidth than a GSM phone, providing much higher security and consuming far less power. Since, unlike conventional wireless, optical devices operate in globally unregulated frequency bands, they have an unrestricted global market. To make this technology marketable in rural South Asia, an end-user device costing under $10 is needed.

A telephone handset that communicates optically with the base station would fit the bill.Our electrical industry has an understanding of the manufacturing processes of Opto-electronic equipment. Moving in a hi-tech direction such as this is becoming imperative for companies threatened by competition from across the Chinese border.

Refrences:

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