Research Article

REVIEW ON RADIO OVER FIBER FOR WIRELESS BROADBAND ACCESS TECHNOLOGY

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ABSTRACT

The interest for broadband services has driven examination on millimeter-wave frequency band correspondences for wireless access network due its range accessibility, and conservative size of radio frequency gadgets. Radio-over-Fiber (ROF) is viewed as financially savvy, down to earth and moderately adaptable framework arrangement for long stretch vehicle of factory metric frequency band wireless signals. This paper presents a review on radio over fiber for wireless broadband access technology

.**Keywords**: Radio over fibre, wireless communications, boradband

I. INTRODUCTION

The breadth and maturity of microwave photonics have expanded dramatically over time. A wide range of uses for optical fiber as a transmission medium for analog radio signals has arisen since the earliest pioneering experiments in the 1970s, propelled by interest in harnessing the advantages of optical fiber as a transmission medium [1].

Radio waves are transported and distributed over optical fiber as the most common commercial use of microwave photonic technology. First articles suggesting optical fiber feeder lines to increase wireless range in radio communication systems were published over 30 years ago [2]. Optical-wireless network convergence has progressed ever since. Many wireless networks employ fiber-optic remoting, including indoor/in-building distributed antenna systems (DAS) and outdoor mobile phone networks (Cellular). Establishing end-to-end integrated network solutions that can supply reliable service to both fixed and mobile consumers is without a doubt an advantage in today's competitive environment [3].

There has never been a time in history when the potential of wireless networks has expanded at such a rapid speed. According to the International Telecommunication Union, intelligent gadgets with vast storage capacity and the proliferation of broadband multimedia services have combined to produce an unprecedented demand for wireless access to high-speed data communications networks [4]. To realize integrated optical/wireless networks that can reliably and cost-effectively support current and future capacity demands, traffic growth rates, new services, and multiple wireless standards, emerging advanced radio-over-fiber technologies must overcome several challenges seize new opportunities [5].

Physical transmission of radio frequency (RF) and optical wireless networking communication is standard in today's world [6]. Too many people use up all radio frequency spectra, making it increasingly challenging to create internet services in new bands. In an indoor context, high-speed multimedia services may be set up utilizing optical wireless networking, with a large amount of unlimited bandwidth. Consequently, optical signal transmission and detection are impervious to fading and may be used to offer physical security at the level of the communication environment inside the building [7]. When existing communications equipment and wavelengths are repurposed in other building sections, it allows for more variation in how wavelengths are used in other building portions. The optical medium, on the other hand, is far from ideal. While shadowing is not a concern in diffuse optical wireless networks, multipath propagation may significantly influence pulse dispersion and inter-symbol interference, which can be detrimental [8].

Radiated light modified in RF (Radio Frequency) and sent via optical fiber is known as Radio Over Fiber (RoF) technology. The RF is transferred at 5.8 GHz, utilizing this project's point-to-point approach. The frequency has been determined to provide the end-user with a higher quality service. Optical components and methods are used to distribute microwave (electrical) signals [9]. When it comes to cost, RoF technology has been recommended since it gives functionally simple base stations to fiber drop points that are linked to a central base station (CBS) through an optical fiber. The fiber drop point in this project provides wireless transmission to the end-user so that no thread is required to be installed inside the end-user's home [10].

This is why ROF is a particularly appealing method for wireless access network architecture since optical fibers can transmit microwaves and millimeter-waves across vast distances. High-frequency signals may be conveyed via optical components using ROF. An optical fiber connection or network connects a Central Site (CS) and a Remote Site (RS)/user end in a ROF system. System requirements for ROF technology have one crucial advantage: cost-effective and straightforward circuits [11].

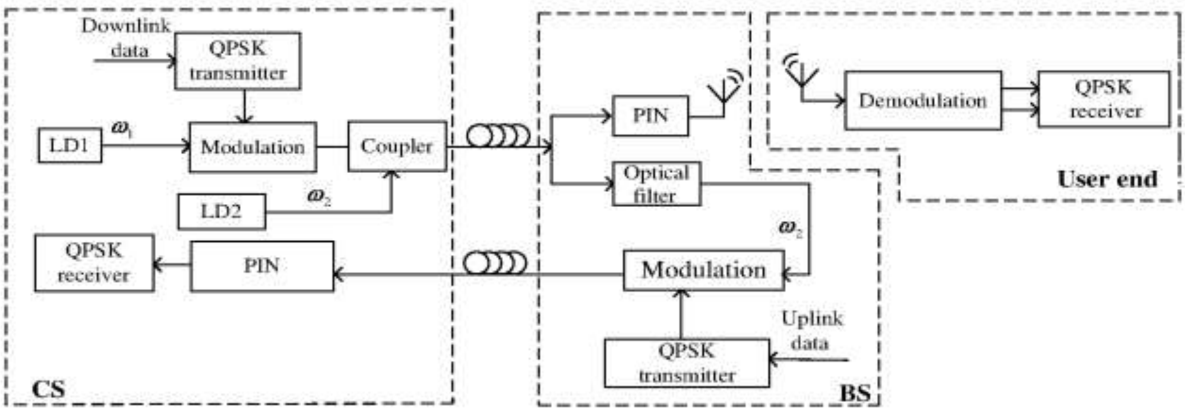

Fig.1.1 Block Diagram of Radio over Fibre

A modulated IF signal, baseband data, or the actual modulated RF signal that was modulated are all examples of electrical signals that may be provided. The optical password generated due to this process is then sent through the optical fiber connection to the destination station. The light detector is responsible for converting the data back into electrical form at this point. Figure 1.1 depicts a block diagram of the ROF. Figure 1.1: ROF block diagram to support various essential future wireless systems, such as wireless local area networks (WLAN), intelligent transportation systems (ITS), and fourth-generation cellular systems, a ROF connection using a direct modulation approach has been created. GSM, UMTS, wireless LAN, and other wireless applications require that the electrical signal be made to fulfill the wireless application's standards [12].

II. BENEFITS OF RADIO-OVER-FIBRE SYSTEMS

A few of the advantages that ROF technology provides include reduced power consumption [13]. This wide bandwidth allows for the multiplexing of several radio channels, the capability of transmitting radio signals over existing dark/dim fibers (dark fiber can be used with WDM techniques), inherent immunity to electromagnetic interference, and the ability to operate transparently because the RF to optical modulation is typically independent of the baseband-to-radio modulation.

2.1 Increased Immunity

The electrical distribution of high-frequency microwave signals, whether in free space or via transmission lines, is a complex and expensive endeavor that requires extensive planning. Optical fibers, which have much reduced losses, are an alternate method. Single Mode Fibres (SMFs) composed of glass (silica) are commercially available and exhibit attenuation losses of less than 0.2 dB/km and 0.5 dB/km in the 1.5 m and 1.3 m windows, respectively according to industry standards. Polymer Optical Fibres (POFs), a more contemporary optical fiber, display increased attenuation, ranging from 10 to 40 dB/km in the 500 - 1300 nm wavelength range, compared to other types of optical fibers. Compared to available space propagation and copper wire transmission of high-frequency microwaves [14], these losses are much reduced. As a result, by delivering microwaves in optical form, transmission lengths may be expanded by many orders of magnitude while the needed transmission powers are significantly lowered.

2.2 Extensive Bandwidth

Apart from the tremendous capacity for transferring microwave signals, the vast bandwidth provided by optical fibers offers several other advantages. As a result of processing data in the optical domain, it is feasible to employ lower-cost, lower-bandwidth optical components such as Laser Diodes and modulators while still handling high-bandwidth signals [15, 16].

2.3 Resistance to Interference from Radio Frequency Waves

When it comes to optical fiber communications, they are impervious to electromagnetic interference is very appealing, especially for microwave transmission. Because signals are sent via the fiber in the form of light, this is the case [17]. As a result of their immunity, fiber cables are favored even for fast connections at mm-wave frequencies.

2.4 Installation and maintenance are simple

In RF systems, complicated and costly equipment is housed at the Switching Centres (SCs), allowing distant base stations to be more easily maintained and controlled. For example, most ROF approaches do away with the need for a local oscillator and associated equipment at the Remote Station (RS) [18]. The installation and maintenance costs are reduced as a result. Because of the enormous number of antenna sites necessary for mm-wave systems, ease of installation and low maintenance costs of RS are very significant criteria.

2.5 Radio-Over-Fiber for Fi-Wi Systems

Figure 2.1 depicts a fiber-wireless system for cellular networks comprised of fiber and wireless (the fiber-wireless downlink) [19]. This technology can enhance frequency reuse while still enabling broadband access since it provides a micro/picocell scenario for cellular radio networks.

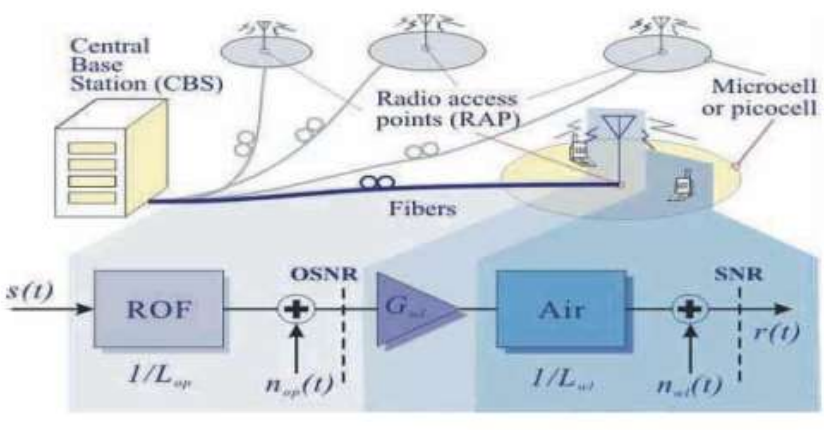

Fig.2.1 Fiber-wireless solution for cellular radio networks

III. SUPPORTING MULTIPLE WIRELESS STANDARDS

It may be valuable to investigate the impact of broadcasting several wireless standards over a single RF connection. The data rate of today's 4G wireless technologies is up to 20 Mbps, while the bit rate of IEEE 802.11's wireless local area network (WLAN) technology is up to 54 Mbps [20]. By combining these two technologies, the available bit rate for apps may be increased while still allowing users to move about freely.

IV. ISSUES WITH THE FI-WI SYSTEM

There are a plethora of essential considerations to take into account. Due to economic concerns, signal processing is advised not to be performed at the Radio Access Point (RAP). The portable device or the central base station should thus be compensated due to the situation. Several users may share the cost of signal processing by having it done at the main base station due to the uneven distribution of complexity, which decreases the total system cost. As a second issue to consider, it is recommended that the compensation for the combined fiber-wireless channel be handled as a collaborative effort. This is a complex problem because of the time-varying multipath wireless channel and the nonlinear optical channel involved [21].

Furthermore, it is necessary to develop other techniques for linking the two ends. Another difficulty with ROF is the nonlinear distortion caused by the optical link. This is the third concern with ROF. The laser diode employed in a multiuser environment is mostly to blame for this issue. There have been several different solutions presented for the nonlinear distortion issue.

V. SOLUTIONS FOR THE ISSUES

5.1 Nonlinearity Compensation

Baseband models for the ROF connection were constructed, and two distinct pre-distortion techniques for nonlinearity were presented; one of them is now being implemented in an FPGA platform." Using a look-up table, the pre-distortion is accomplished in the first method [22]. Adaptive filters of higher order are taught to simulate the ROF connection in the second method inversely. The simulation findings demonstrate excellent performance gain with each technique, albeit occasionally needing a power backoff. Thanks to asymmetric compensation, most signal processing can be done at the base station. This is accomplished by performing pre-distortion on the downlink and post-distortion on the uplink.

5.2 Estimation and Equalization

Intersymbol interference (ISI) may occur at high bit rates, even if the ROF provides a stable broadband connection that supports the transmission of several channels simultaneously. A severe problem arises even in the uplink due to the nonlinearity, which makes the linear dynamic range an extreme concern [23]. When the received signal first travels via the wireless channel (resulting in route losses, fading, and shadowing), a wide linear dynamic range is required in the uplink before accessing the optical fiber; a broad linear dynamic range is needed. There have been many studies conducted on estimating and equating rapidly fading dispersive linear channels. Nonlinear channel estimation and equalization techniques are necessary for the Fi-Wi system because the ISI is coupled to the nonlinear distortion of the optical connection [24], resulting in the need for nonlinear channel estimation and equalization methods.

5.2.1 Estimation

Estimation and equalization of the concatenated fiber-wireless system should be performed to minimize the effects of nonlinear and ISI distortions. The linked fiber-wireless channel must be estimated to achieve equalization and linearization of the linear and nonlinear channels. Both wireless and optical channel noise (quantum, thermal, and relative intensity) are included in our estimate techniques, as illustrated in Figure 2.1. It should be mentioned that we used numerous maximal-length pseudo-noise (PN) sequences to conduct our identification. In spread spectrum communications, multiple PN sequences are already frequently employed [18].

5.2.2 Equalization

After the channel has been examined, it is necessary to design a sound equalizer to correct for the linear and nonlinear parts of the track. Because the fiber-wireless uplink is a Wiener system, a decision feedback equalizer (DEF) of the Hammerstein type was required. This equalizer utilizes two separate compensation modes to reduce linear and nonlinear aberrations effectively. Commercialization of this modular design [18] is a distinct possibility. Using a polynomial filter, you can simulate an optical connection in reverse. Using a linear DFE setup, you can compensate for the dispersion caused by the wireless channel in the receiver.

VI. APPLICATIONS OF RADIO-OVER-FIBER TECHNOLOGY

RF technology may be used in several different ways. As portable devices and personal computers become more powerful and widespread, the need for mobile broadband connections to local area networks (LANs) will increase. Because of this, higher carrier frequencies will be employed in an attempt to meet the increased capacity requirements. Wireless LANs, for example, now operate in ISM bands at 2.4 GHz with a maximum carrying capacity of 11 Mbps, which is an improvement over previous generations (IEEE 802.11b). Higher carrier frequencies are required for next-generation 5 GHz broadband wireless networks, which can offer 54 Mbps per carrier and are deployed in a wide range of environments. By raising the frequency of the page, it is possible to generate micro-and pico-sized cells.

When it comes to wireless communications networks, ROF technology offers various applications. As a result of the increasing demand for broadband services and the ever-increasing number of mobile consumers, mobile networks are under continual pressure to expand their capacity. As a result, it is feasible to transfer mobile traffic (GSM or UMTS) between the SCs and the base station.

Using satellite communications to transmit information was among the first practical uses of ROF technology. In one of the applications, antennas might be transferred to satellite earth stations. In this scenario, optical fiber lines shorter than one kilometer in length that operates at frequencies ranging from one gigahertz to fifteen gigahertz are used. This method may be used to place high-frequency equipment in a central location.

According to the researchers, video distribution is a promising application area for ROF systems. Consider the case of Multipoint Video Distribution Services (MPVS), for example (MVDS). The Mobile Video Distribution System (MVDS) is a terrestrial video broadcasting system that uses cellular technology. A tiny return channel has been added to the original architecture to improve performance to make the service more user-friendly. Small communities may benefit from the availability of MVDS services. The frequencies used by this service are in the 40 GHz band. The largest cell size is around 5 kilometers in diameter at these frequencies. Relay stations are required to widen the coverage area [25]

The notion of a Mobile Broadband System (MBS) will allow fixed-line broadband integrated digital network (B-ISDN) services to be extended to mobile consumers. The MBS system must support any additional B-ISDN services that may be introduced in the future. As a result of the requirement that each user's data rate be 155Mbps, carriers are pushed into mm-wave frequencies. This suggests that if ROF technology is used to generate the high-frequency mm-waves, the full-scale deployment of MBS networks will be economically feasible [13].

VII. CONCLUSION

It has been fueled by the need to meet current and future capacity needs and support various wireless standards. The development of convergent optical/wireless networks may also benefit microwave and millimeter-wave wireless systems via radio-over-fiber networks.

A wide variety of tasks may be accomplished with the RoF. The notion of multiplexing, on the other hand, is gaining traction. The WDM of the RoF keying concept may be used in this case. A wide variety of broadband and mobile generating technologies will be supported by the WDM-OFDM initiative when they become available in the future. High-speed Internet access and radio frequency (RF) technologies have been seamlessly integrated into optical networks like WDM, OFDM, and OFM, for example. Consequently, many options will be available with OFDMA for mobile. According to the author, who discovered that RoF-WiMAX was being explored and developed, the future architecture supports a broad range of optical and radiofrequency communication protocols.

Baseband signals must be converted to radiofrequency and sent via a fiber-optic connection using an IQ modulator, which must be included in the system. A photodiode optical demodulator or a Mach-Zehnder optical modulator and photodiode optical demodulator may improve a fiber-optic call transmission's bit error rate (BER). For the 4th generation, cellular networks, OFDM modulation, and the development of radio-over-fiber technologies are strongly recommended. The results and calculations presented in this article should be used to design a compensation policy that assures service quality and availability for all parties.

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