A SURVEY ON DIVERSE DISPERSION COMPENSATION TECHNIQUES IN ROF SYSTEMS

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Abstract – Recently there has been observed a huge requirement of Bandwidth in wireless and wired communication with the advent of bandwidth demanding applications like video based interactive and multimedia services. Congestion and limited frequency spectrum has haltered the speed of communication systems to Megabits-per-second (Mbps) only. To achieve high data rates, the viable solution is bandwidth and the most assured path to Gbsps is the utilization of radio signals which occupies wideband. Fiber optic is the perfect intermediate for mm-wave communication owing to less cost as well as wide bandwidth. The resultant technology is known as the ROF technology. Radio over Fibre in mm-wave band is the promising technology to meet challenges of next generation communication systems. Bandwidth hungry services cause the traffic in the microwave band. To eliminate the congestion in this band researchers are focused to develop the solution. Frequency region of mm-wave frequency spectrum is the ultimate solution for the future very high speed communication systems. The use of these waves offers the architecture of cheap wireless and small size transmission that is able to provide the suitable terminal mobility.

Keywords – wireless communication, bandwidth, radio signals, radio over fibre, frequency, bandwidth.

I. INTRODUCTION

In initial phase of telecommunication, services like GPRS and GSM agreed with low information rates. But, currently, the users demand services that are capable of providing them with a faster transmission, anytime anywhere and flexible solutions. Also, the rapidly growing number of users will limit the available bandwidth. One possible solution is to reduce the cell size for accommodating more number of clients. This is known as micro-cells or Pico-cells concept. Another method involves utilization of new operational bands because there is already congestion in the unlicensed ISM frequency bands. Currently, several designers are preferring millimeter-wave as the new operational band [1]. It lies in 40 to 90GHz optical frequency region and offers higher bandwidth. But, some other problems will arise when these methods are implemented. Greater number of base stations (BSs) will be needed to server large area the entire service area if size of cell is reduced. On the other hand, increasing the frequency will require more equipments, maintenance and installation costs. Radio over Fiber (RoF) concept is developed for eliminating these issues. RoF is a spectacular incorporation of optical and wireless networks leading to high information rate, high capacity and mobility solution.

The concept of RoF involves modulation of light by a radio signal followed by transmission through optical fiber in order to support wireless applications. In conventional optical systems, transmission of digital signal occurs. Fundamentally, it is an analog system because it involves distribution of radio signals, direct to radio carrier frequency which is transmitted between control unit and BS. However, the information signal can be digital. RoF network comprises of transmitter and receiver which are joined by optical fiber. At transmitter, the laser source is modulated by an electrical signal. The resulting signal is in optical domain which is further transmitted through the optical fiber. At receiver, photodetector converts back the information signal into electrical form. Figure 1 depicts the framework of RoF network.

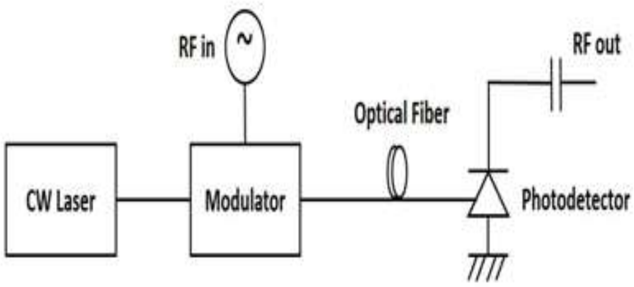

Figure 1: Topology of RoF network

A modulation of the radio signal over the intensity signals to provide solution and facilitate the wired as well as wireless is terms as the radio over fiber. However, this technology is also used for more than one task such as to cater the services in cable television (CATV), in satellite transmission base stations. The name radio over fiber is generally used for the wireless [2].

Radio over fiber has wireless access and signals are communicated over the fiber optic between the main station and radio access antennas. It enables the system of base station to serve minimum one user recipient which falls across its range. They are categorized in two sections based on the range of frequency to be transmitted.

a) Architecture of radio over fiber consists of a radio signal with a signal of high frequency such as 10 GHz is applied on light signal prior to the fiber optic. Due to this architecture, a wireless are evenly distributed to radio access point as well as modulated from O/E. Prior to the emergence of signal to base station, it is boosted and radiated by the radio access points. Consequently, there is not a necessary to convert up/down is needed at the different stations, so it provide non complex as well as low cost system architecture at the base station.

b) In intermediate signal over fiber system, a small frequency radio signal less than the usual 10 GHz is incorporated for the laser intensity signal prior to fed to the fiber optic. Subsequently, a signal which is wireless are transmitted over optical medium at the intermediate frequency.

II. OPTICAL FIBRE

The fiber used in optical communication contains a cylindrical glass core via which the light will travel. The core is enveloped by another cylinder made of glass known as cladding. For protection of these cylinders, they are wrapped up by a plastic jacket. The refractive index of the core is slightly higher than the refractive index of cladding. It is as shown in figure 2.

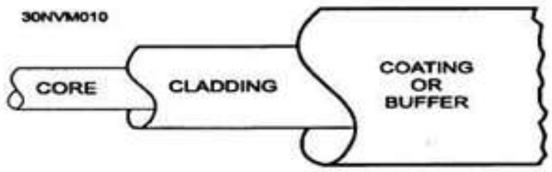

Figure 2: Structure of Optical Fibre

The working of fiber optics is related to the phenomenon of total internal reflection which is defined as the condition when the incident light is at an angle that is greater than a threshold value (known as critical angle) denoted by ^{0}c, then the light is totally reflected back. No refraction takes place.

Optical fiber are generally classified as-

1. Single mode fiber (SMF)
2. Multimode Fiber (MMF)

The size of the core in SMF is typically of 9 microns whereas in MMF, it varies from 50 microns to 62.5 microns. Modes in a multimode fiber are the multiple paths by which the light can travel. A specific wavelength is there known as the cut off wavelength, for which a single mode fiber can become multimode fiber when it is below this threshold value. Distortion effects occur more in the multimode fiber due to the various paths taken by the light signal to travel.

III.BENEFITS OF RADIO OVER FIBRE

RoF is an incorporation of both optical and wireless domains. So, it exploits the advantages of both the techniques. Some of the benefits are described below [3]:

- Enormous bandwidth and high data rate: The radio signals are preferably transmitted over fiber because it offers huge bandwidth, up to THz. High bandwidth also supports high speed for processing the signals. This may be more difficult to implement electronically.
- Low attenuation: Signals transmitting through optical fiber suffer much less attenuation than through other media (such as metal cables). The signal travel further when optical fiber is used, reducing the need of repeaters.
- Low complexity: RoF uses the concept of BS. BS only comprises of an optical-to-electrical converter, amplifiers and an antenna. This implies that the signal generation circuitry and resource management is shifted to a centralized location which is shared among several BSs, thus simplifying the network.
- Dynamical allocation of resources: The resources are controlled at the central station (CS). Thus, resources like bandwidth will be allocated dynamically according to priority and demand.
- Lower cost: The expensive and complex equipments utilized for processing the signal are placed at CS. Simpler, lighter and smaller remote antenna units are kept at BSs. Thus, the system can be easily installed and maintained resulting in reduction of system cost.
- Security: RoF does not suffer from radio frequency interference because signal transmission occurs in light wave form. It provides security to the signals that are transmitted through the fiber.
- Future-proof: Fiber optics is developed to support data rate in Gbps. Thus, they are capable of handling the data rate required in future high speed networks. RoF technique is also bit-rate and protocol transparent.

IV. BACKGROUND

S.j.b yoo et al. (1996) demonstrated a tunable wavelength conversion module by employing the effects of FWM inside semiconductor optical amplifier. It was evident that the use of aforementioned system supports the high data rates. In order to simulate and validate the results, they presented the many demonstrations. They analyzed the system for two different bit rates such as 2.5 Gbps as well as 10 Gbps. They also offered the wavelength conversion along with spectral investigation reliant on time resolving [4].

S Sugumaran et al. (2014) proposed the wavelength division multiplexed system by usig the simulation software optiwave optisystem. Work demonstrated was considered the effects of the channel spacing in the WDM system and their effects along with the nonlinear effect such as four wave missing. It was perceived that in the WDM systems, FWM deteriorate the performance of the system very efficiently. Moreover, these effects were seen by changing the length of the optical fiber. It was concluded that use of uneven frequency spacing in the WDM systems can lower the effects of four wave mixing [5].

Norliza Mohamed et al. [2016] the authors proposed a reliable with optimum cost wireless communication system using optical fiber. These systems are efficient for fiber and free space applications because these systems provide higher bandwidths. Radio-over-fiber technology is introduced to give the better capacity and mobility at higher frequencies. When the mm-wave signal is transmitted through radio over fiber systems the link affected from the power fading effects. Therefore, the objective of this work is to consider the moderate of power fading for projected arrangement of high optical frequency signal. There are 3 different signal generation technologies are based on SBS [6].

A.khawaja et al. [2008] The proposed radio over fiber system uses the single mode and multimode fiber link for the transmission of millimeter wave. Mach-Zehnder modulators operating at 1550nm is used to determine the multimode fibers over bandwidth of 0-50Ghz. Multimode fiber links are good for the used in low cost distributed antenna system [7].

P Hartmann et al. [2003] demonstrated a wireless LAN demonstrator system which is for the first time uses uncooled directly modulated DFB lasers to transmit video signals over 1km of worst-case multimode fibre, this being beyond the classical fibre bandwidth. Introduction In recent years there has been much developmental work on uncooled lasers that can be directly modulated at speeds in excess of 10 Gb/s. However they have shown that such lasers also achieve the stringent levels of linear performance required for applications [8].

J.J.O'Reilly et al. [1992] the proposed system describe the distribution of millimeter wave and also the optically generation methods. The method is determined at 36GHZ. An electrical line width is controlled by the resolution bandwidth of spectrum analyzer due to this it is observed that there is no scattering of electrical signal after travelling through the 8km fiber [9].

Guohua Qi et al. [2005] proposed system is using an optical phase modulator and a optical fixed notch filter to accomplish and allocate the two wide bands of millimeter wave that are continuously tuned with each other. The filtration of optical carrier from the phase modulated optical spectrum results generation of even order harmonics and cancelation of odd order harmonics at the output of photodetector. To suppress the odd order harmonics the dispersion compensation is required. Two band mm-signals that is 37.6 to 50GHZ and 72.2 to 100GHZ with high quality signal are generated when the electrical signal is modulate from 18.8 to25GHZ. When optical intensity modulator is used, the system is free from the DC biased drifting problem [10].

Chul Soo Park et al. [2007] the authors defines a frequency tripling method for photonic frequency up conversions by using the SBS. A dual electrode electro- optic modulator and a single optical source are used to additionally accomplish the frequency up conversion and tripling. Intermediate frequency and micro wave radio frequency signals are used to operate the each electrode of electro-optic modulator. Dual electrode EOM produces suitable optical side band although the pump signal is used to transmit the IF signal. After the SBS takes place, one of the third optical side band is amplified by the narrow gain spectrum of SBS. After the photo detector, carrier signal at 32.493GHZ having narrow line width is amplified by the 20dB and all other signals are suppressed by 20 dB is achieved. The IF signal at 1 GHZ is up converted around 32.493GHZ signal and tripled from the RF 10.831GHZ signal. Frequency conversion and tripling is takes place simultaneously. The data rate is exceeds to 75.1 $dBIdrHZ^{2/3}$ and this signal is appropriate for wireless communication system following the analog fiber optic link [11].

Y.-K. Seo et al. [2002] authors defines a IF signal with optical local oscillator using semiconductor amplifier. Optical intermediate signals are up-converted signals and the amplifier is using cross gain modulation. This gives a high conversion frequency which is independent to incident light wavelength and polarization. It can be used in radio-on-fiber system applications where many wavelength-division multiplexing IF signals are contributed by only one remote Local Oscillator signal [12].

Qing Wang et al. [2006] demonstrated a proposal to generating a frequency-tripled mm-wave signal based upon four-wave mixing (FWM) using a SOA. In this optical network, an optical phase-locked loop (OPLL) is used to achieve the two phase-correlated optical wavelengths. FWM process is achieved in SOA by OPLL used as two pumps. At the output, two idlers having spacing of wavelength three times more than the two pump wavelengths are resulted. Two outpouring fiber Bragg gratings arranged as optical notch filter to remove the two pump wavelengths. An mm-wave signal having the frequency three times higher than the OPLL reference source is achieved by defeating the two idlers at photo detector [13].

Zhensheng Jia et al. [2008] proposed an effective photonic frequency-tripling methodology for 60-GHz RoF network. System is proposed to visualize the mm-wave, microwave, and baseband signal formation simultaneously. For the generation of new alternating subcarrier modulation method for high tolerance dispersion of fiber the vestigial sideband filtering is used with optical carrier suppression. The generation and accurate transmission of data i.e 2.1-Gb/s on 63-GHz mm-wave and microwave signals of 21-GHz over 50-km SMF without dispersion rectification is clearly achieved by the given approach. Power penalty with value less than 1.0 dB is achieved for both signals [14].

Tianliang Wang et al. [2009] authors proposed a mm-wave RoF network to accommodate the downlink service. This is done by using four-wave-mixing effect in SOA for the creation of mm-wave. At the central station, microwave source is 5.4-GHz. The optical carrier suppression modulation scheme and semiconductor optical amplifier are employed to simultaneously generate 32.4-GHz (sextuple fundamental) optical mm-wave and data signal. The data signals are unconverted signals. The downstream is received by a high-speed photodiode and base data are recovered through an electrical mixer at the BS. Proposed systems results show that the downlink 2.5-Gb/s data is efficiently travelled through 20-km SMF with power penalty less than 0.15-dB [15].

Jian Zhang et al. [2007] demonstrated and analyzed a efficient 4GHz-40-GHz frequency quadruple for RoF system is using a modulation method for optical carrier suppression in two cascaded intensity modulators. Four-fold microwave or mm-wave signals are optically generated. There is no need of notch filters (optical/ electrical) to eliminate the residual components from the generated carrier signal. Tandem intensity modulation with pi/2 phase shifting in between two driving signals is used to greatly reduce the limiting high drive voltage [16].

V. CONCLUSION

With the ever-increasing expansion as well as requirements for high capacity in internet based applications, high speed optical fiber communication has in recent times turn out to be a necessary part of information communications. The high speed augments the spectral employment which outcome into improved system capacity as well as reduces overall cost. Fiber optic reliant systems are used for the prolonged reach transmission systems. To release the full potential of optical systems as well as attain higher transmission capacity, numerous researches on dispersed managed systems have been reported. The objective of a fiber optic communication system is to send the maximum number of bits per second over the maximum possible distance with the less errors.

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