Study of Radio over Fiber with Different Coding Channel – A Review

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ABSTRACT
The full form of RoF is Radio over Frequency technology. Present generation is the era of the network. Thus, the entire information interchanges over the network and the data traffic may occur on the network due to excessive data being transferred. Radio over Frequency is a technique that offers access to the bandwidth of channel. Hence, it is utilized to regulate traffic over the network in the condition of wireless networks. In this paper, mainly attention on communication channels such as ophthalmic wireless communication (OWC) and free space optics (FSO). Multiple encoding formats such as NRZ, CS-RZ, DRZ, and MDRZ are also discussed in this paper to transmit information along with modulation signals

Keywords
RoF (Radio over Fiber), RAU,Radio Frequency, Radio Fiber, Base Stations,MU (Mobile Units)

1. INTRODUCTION
In current age, the information has moved through the network. This will increase the data traffic on the Internet. For timely delivery of data it is mandatory to control this traffic of data. ROF is an extensively used approach to control data traffic. Optical wireless technique is used for the connection of network in ROF. Intensifying the range of broadband is very challenging with ROF. It is due to the congested radio frequency spectrum. Broadband is used through mobile terminals to established high speed multimedia tools in optical wireless networking. Fiber over Radio is a technique that is used to transmit data through a wireless network by modifying signals. In the change of the signal, the optical signal is modulated with a radio signal. [1]

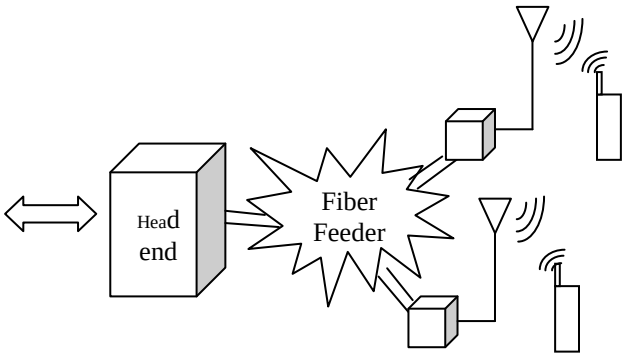

Figure 1 Concept of radio over fiber system

Signal variation can be performed openly by using radio signals, or intermediate occurrences can be used for modulation. In order to enhance the volume per unit area, a higher operating frequency, i.e. 6 GHz or more is required. The signal is transmitted from the base station using a linear optical fiber link. In RAU, only transformation devices like optoelectronics and amplifiers are used. [2] All procedures used for ROF are effective due to the low data loss and wide bandwidth range for the transmission of data. The costs of maintenance and installation of such a system are quiet high. To decrease the system's cost, you require using a simple radio antenna unit. This signal is connected with a centralized head to reduce the cost of the system. Using ROF technology, the signal and the centralized head are combined.

Radio over fiber technology arranged a single shared location to centralize RF signal processing. A link is used to allocate the RF signal to the RAU or the base station in optical fiber link. In the case of network architecture, switching, routing and all other OAM, operation management maintenance is completed through CS. For wireless distribution, antennas are interconnected. The foremost action performed through the BS is to process the optical signal into a radio signal.

2. ADVANTAGES AND DISADVANTAGES
As we all know, each method has some benefits and drawbacks. In the same way, RoF has the following advantages and disadvantages:

2.1 Advantages of ROF technology
Some of the advantages and benefits of RoF technology are given below:

- Low attenuation loss
- High bandwidth
- Resistance to radio frequency intervention
- Informal installation and maintenance
- Multi-operator and multi-service process

i. **Low attenuation loss:** It is problematic and costly to scatter electric signals at high frequencies. Thus, in order to transfer a high frequency signal, expensive equipment supporting communication over long distances is requisite.

ii. **Wide Bandwidth**: The radio over fiber makes use of optical fiber to transfer information over the wireless network. The benefit of using optical fiber is to deliver high bandwidth.

iii. **Immunity to Radio Frequency Jamming:** The key characteristic of optical fibers is that it gives EMI, a capability for electromagnetic interference. In the case of optical fibers, the data transmits in the form of light and uses fiber. Most of this optical fiber cable is preferable even at short distance [1].

iv. **Easy Installation and Maintenance:** Implementation and maintenance of the RoF system is unpretentious. This is because complicated and

expensive equipment is occupied in this head end. Therefore, RAU is much easier. For example, in the case of photo detectors, RF amplifiers and antennas are utilized in the system. Different RAUs share modulation and switching devices situated at the head end. Such a system can run quicker as compared to other systems. Because of all the deployment of the system, maintenance and installation of the system is simplified.

v. **Multi-Operator and Multi-Service Operation**: Each RoF system enables the operational flexibility. In case of microwave generation method, system is generated of signal format transparent. It is one of the gains of the RoF system.[1]

2.2 Limitations Of RoF Technology

The RoF system is an analog transmission system. It discovers light and modulates the analog signal. Therefore, as with analog systems, signal distortion and nose-like signal disturbances are also important in RoF. These complications are used to restrict the sound figures and dynamic range NF and DR limit, correspondingly. DR signifies the dynamic range and plays a vital role in mobile systems like GSM [3] as base station power coming from the MU continuously fluctuates. This means that the power received from the MU closest to the base station is located farther from the base station, but higher than that within the similar cell range.

3. COMMUNICATION CHANNEL

This section describes the various communication channels used for fiber optic.

3.1 Optical Wireless Communication (OWC)

OWC uses near infrared frequency light for communication. The OWC system still contains three central communication fragments which are the transmitter, the propagation channel and the receiver. Figure 2 shows the basic illustration of the OWC system. OWC systems are not significantly diverse from free space optics and fiber optic communications, but the variance depends on the propagation medium. The OWC channel is reflected to be a vacuum, which is estimated to be free of atmospheric attenuation factors [9]. Because of the moderate bandwidth [10], it provides high security, low price, less power consumption, and high rate. A wireless optical channel element, which is also a free-space optical element, can be applied for huge distances where atmospheric reduction is not the main penalty source, but directivity angle. For example, satellite communication [11] [12].

3.2 Free Space Optics (FSO)

Transmitting a visible or infrared beam modulated via the atmosphere to realize optical communication is called Free Space Optics communication. The FSO shown in Figure 3 shows a typical free-space optical link, not via conductors such as wires and fibers, or some type of waveguide. Another important feature of the FSO is that it is meaningless by electromagnetic interference and radio frequency interference and plagues the wireless communication system severely. The FSO system is used for disaster recovery applications and temporary connection, and the cable network is in place. Free space optical communication is simply affected by atmospheric distortion. FSO is the most protected and becomes a high speed medium for data transmission [14 - 24].

Figure 2 represents the basic working of FSO communication channel which is comprised of source, transmitter medium, a receiver, an atmospheric channel etc.

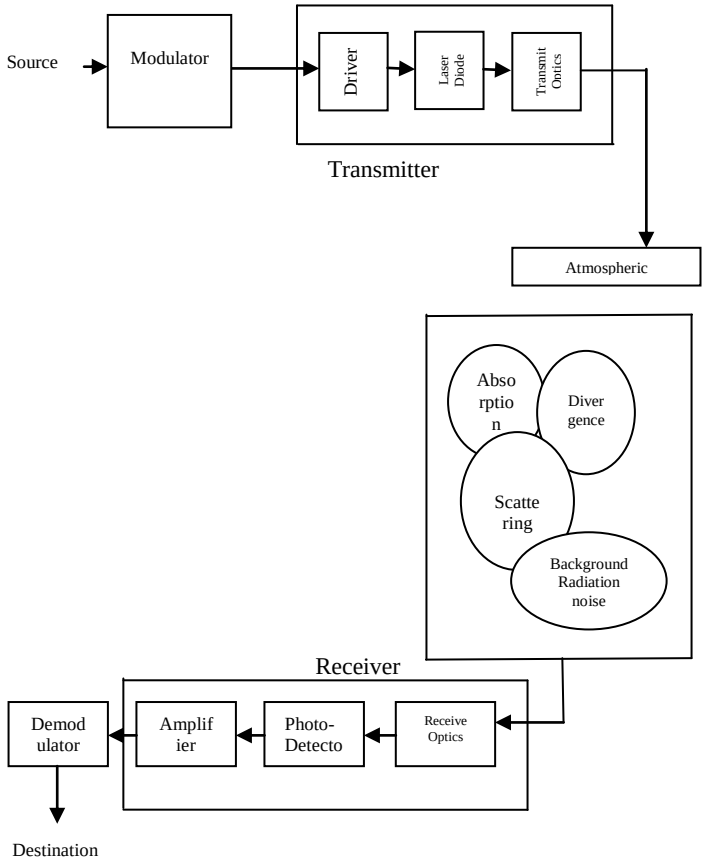

Figure 2 Working scenario of FSO

4. CODING FORMATS

Succeeding are the coding formats that are used in radio over fiber communication:

a) Non Return-to-Zero (NRZ)
b) Carrier Suppressed Return-to-Zero (CS-RZ)
c) DRZ

4.1 NRZ Format

Figure 3 express the graphical presentation of NRZ transmitter end. It incorrect beneath the set of ASK i.e. Amplitude Shift Key. Initially the NRZ coding format was extensively used in several research works.

NRZ is most widely used encoding scheme which deals with various levels for various symbols. In this the signal did not return to zero at the time of clock interval. The NZR encoding scheme is categorized in two formats on the basis of the signals i.e. Unipolar and Bipolar. In unipolar NRZ the bit '1' is depicted by positive and bit '0' is depicted by voltage 0. Whereas in bipolar the bit '0' is represented with negative sign. This can be represented as below:

$$A_1(t) = +V, 0 \leq t \leq T_b \qquad (1)$$
$$A_0(t) = 0, 0 \leq t \leq T_b \qquad (2)$$

At the receiver end, it can possible that a clock signal is not present. Therefore, it can be extorted by utilizing the receiver signals.

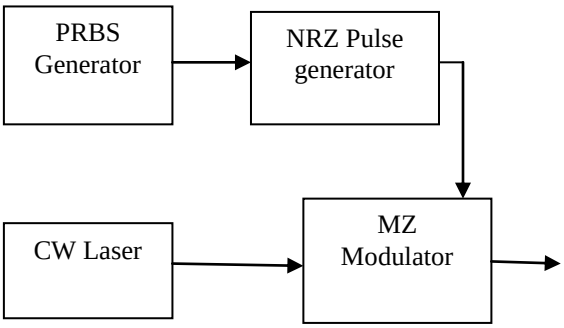

Figure 3NRZ Modulation

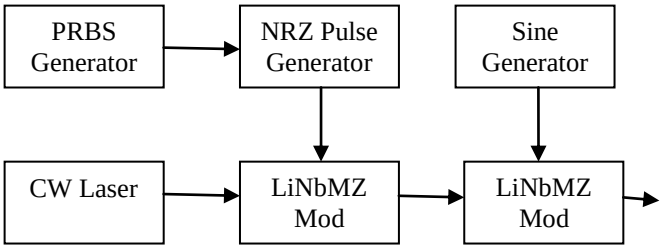

Figure 4 CS-NRZ Modulations Scheme

4.2 CS-RZ (Carrier suppressed return-to-zero)

Fig.4 (b) demonstrates the schematic of CS-RZ transmitter. It has constricted optical range then the conservative RZ format and high acceptance to group velocity dispersion (GVP) and diverse consequence of self-phase modulation (SPM) [5].

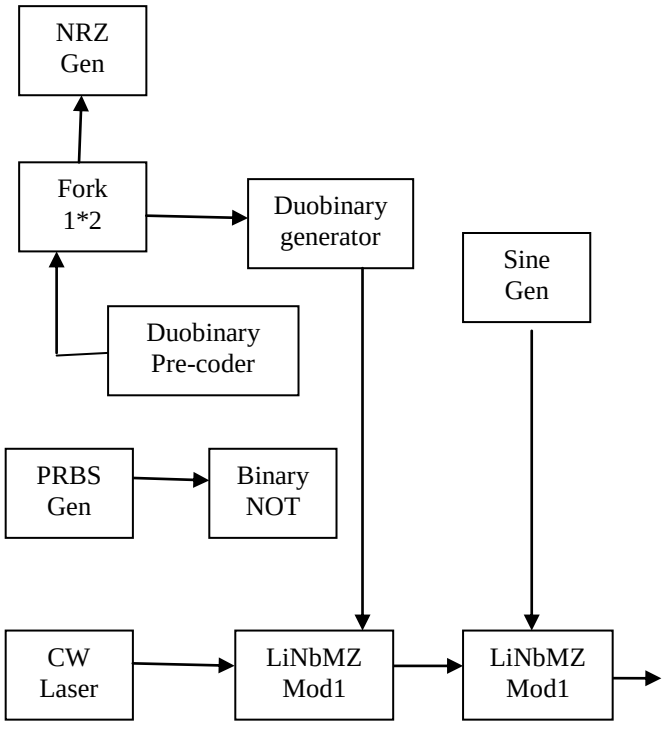

Figure 5 DRZ Modulation Scheme

4.3 DRZ (Duobinary return-to-zero)

Format Fig.1(c) determines the schematic of DRZ transmitter. Owing to their optical modulation bandwidth, DRZ organization is very attractive. It can be compressed to the data bit rate B that is half- bandwidth of NRZ arrangement 2B [9].

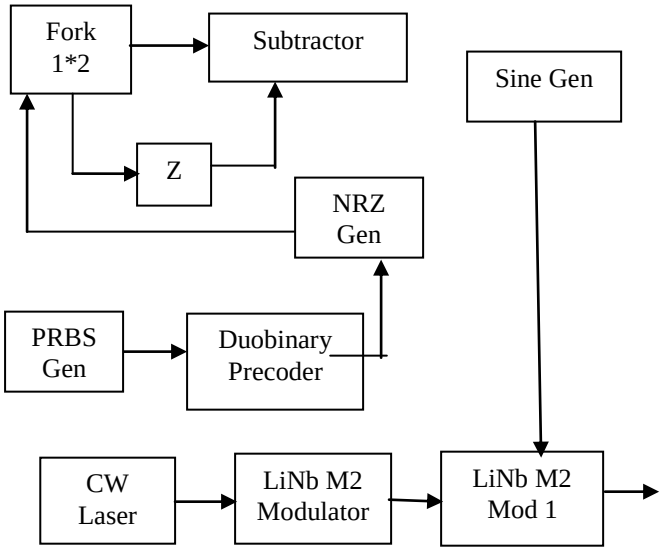

Figure 6 MDRZ Modulation Scheme

5. RELATED WORK

Malti [1] , (2012), portrayed the WDM system consequent to downstream by using CSRZ i.e. carrier blocked return-to-zero, duo binary return-to-zero (DRZ) and the diverse duo binary return-to-zero (MDRZ) modulation organizations. The WDM-PON system was evaluated by changing the input power from 0 to 20 dBm for various modulation formats in order to find the best modulation format for the high bit rate optical transmission system. Furthermore, we analyzed bit rates of 2.5 Gb / s and 5 Gb / s at the maximum of 130 km for the Q value and the eye opening of CSRZ, DRZ, MDRZ data format. CSRZ was superior to DRZ and MDRZ, and it turned out that the system demonstrated the best performance at input power Pin = 15 dBm.

JyotiChoudhary [2] , (2014),analyzed the 16 channels and comparison analysis with the high-density wavelength division multiplexing (DWDM) fixed gain (DWDM) using various variation methods (NRZ, zero carrier suppression, duo binary return to zero, modified duobinary return to two reverse). Based up on EDFA Q factor, eye diagram, bit error rate, compensation structure (Pre, Post and Mix compensation) at distinct bit rates (10 Gbps, 20 Gbps and 40 Gbps) using standard and dispersion compensating fiber. On a comparison basis, the mix compensation was superior to the preceding and following compensation techniques, and improved results were obtained even at a high bit rate (40 Gbps) of MDRZ (Modified Duobinary Return to Zero) modulation method.

HeenaGoyal [3] , (2015),analyzed the performance of optical communication system by using free space optical (FSO), optical wireless communication (OWC), single mode fiber (SMF). The data stream was transmitted at 20 Gbps using several channels under attenuation of 1 dB / km, 2 dB / km, 3 dB / km. Comparisons were made on the Q factor,

BER, and received optical power. In the OWC system, it was analyzed that the signal could be transmitted with better Q factor, minimum BER and higher received power.

Ali Hussein Radhi [4] (2013) et al, defined a big problem to reduce the bit error rate of the lowermost power penalty in the case of RoF system. In this paper, the author was evaluated the performance of 5 Gbps OOk signal and WFDM system with 5 base stations within 6 km range. This was an announcement from the author that the recommended methodology had lower BER and was skilled than the other techniques. The BER value received with the proposed technique can be negotiated in the case of multimedia and real-time applications.

Anisha A.P [5] (2015),discussed about that RoF is a technology that converted signals in the form of light. An optical fiber cable is the medium used for transmission. Full duplex communication was done in RoF using WDM, wavelength division multiplexing and optical add - drop multiplexers. WDM was used for the objective of transferring various signals via a single mode fiber medium, but OADM is used for data transmission in both downlink and uplink. The author used several line coding techniques here. The simulation of this technique was carried out using Opti wave's Opti System 12.0.

Virendra kumar [9],(2014) , focused on optimal transmission on a single fiber with linear and nonlinear dispersion. Since then these parameters reduced the overall effectiveness of the system, it was a major concern. Loop control is another term used in this paper that is mandatory for the optical transmission system. Loop control was generally used to improve the length of the optical fiber. Erbium - doped fiber amplifier used to enhance the efficiency of the signal on the channel. The simple concept of this paper was to analyze the modulation scheme of RZ and NRZ. Both techniques were used to evade crosstalk between signals on the optical fiber throughout transmission. Therefore, both methods were evaluated and their performance examined, respectively. Finally, we compare based on Q factor BER, eye diagram, average input power, and confirmed the advantages and disadvantages of RZ modulation technique.

Sreenesh Shashidharan [13], (2002) et al, designated that the two technologies were combined through radio frequency technology and become more efficient from a performance point of view. RoF is the technology used to access and control the bandwidth of the wireless system. It is used to control data traffic on wireless network systems. In addition, because it provided a large capacity multimedia service, it was also used for real-time multimedia applications. The RoF system was designed using Opt system 10, which utilizes both radio frequency and optical fiber. There was a link consisting of a central node or base station, remote access unit, and fiber optic.

Table 1 Review table of related work

S. No.	Author	Paper	Objectives
1	**Malti [1], (2012)**	Comparison of CSRZ, DRZ and MDRZ Modulation Formats for High Bit Rate WDM-PON System using AWG	To develop a WDM-PON by using CSRZ, DRZ and MDRZ coding scheme along with the variations in input data rate.
2	**JyotiChoudhary [2] , (2014),**	Comparative analysis of DWDM system using different modulation and dispersion compensation techniques at different bit rates	The objective of this study was to analyzed a 16 channel based DWDM system by using various coding formats such as NRZ and DRZ etc.
3	**HeenaGoyal [3] , (2015),**	Performance Analysis of Optical Communication System using Different Channels	The aim of this study was to analyze an optical communication system by using FSO and OWC communication channels.
4	**Ali Hussein Radhi [4] et al**	Performance Analysis of Radio over Fiber System with Ook Based Dwdm for Fiber to Home Network	The objective of this paper was achieved by evaluating a 5 station base WFDM system of 5 Gbps Ook signals.
5	**Anisha A.P [5],**	Full Duplex Transmission in RoF System using WDM and OADM Technology	To achieve full duplex transmission in radio over fiber system by using WDM and OADM in both cases i.e. downlink and uplink by using opti-systems.
6	**Virendra kumar [9] ,**	Design and Performance Analysis of Optical Transmission System	To improve the length of optical fiber by using loop control and to design a communication system by using EDFA, RZ and NRZ mechanisms.
7	**Sreenesh Shashidharan [13] et al,**	Accurate calculation of eye diagrams and bit error rates in optical transmission systems using linearization	The objective behind conducting this study was to design such a communication system by using Opti system 10 which can utilize both radio frequencies and optical fiber channels.

6. CONCLUSION

An evaluation of ROF technology has been described in this paper. In this technology several coding formats are described with communication channels using wireless over fiber technology. The main compensations of ROF technology are low attenuation loss, extensive bandwidth, informal installation and maintenance. The major disadvantage of ROF technology is signal disturbance such as noise and misrepresentation to be omitted in the future.

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