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Radio over Fiber Technology

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Abstract: *Radio over fiber is an analog transmission in which radio frequency is modulated with laser diode. It is an integration of wireless and fiber optic network .Today the peek requirement is capacity of the channel so optical communication has come in picture. The future provision of multimedia and broadband the radio over fiber systems are good option. In this paper, four signals are transmitted for 120 km. through single mode fiber with erbium doped fiber amplifier. Two base stations are introduced at 40 km. each to add and drop a particular signal. The well known advantages of fiber such as low loss, light weight, large bandwidth, small size, low cable cost are very useful in optical communication. Warless sensor network is used where battery recharge or replacement is impossible so network life time is more important. In this paper we are presenting a heterogeneous network in which various energy efficient technologies are used .It is an essential technology for the provision of access to broadband wireless communication in a range of application. Their transmission properties are very useful in their implementation as the backbone of a wireless network.*
Keyword: *Erbium-doped fiber, central station, Optic-system software, Radio over fiber, semiconductor,*

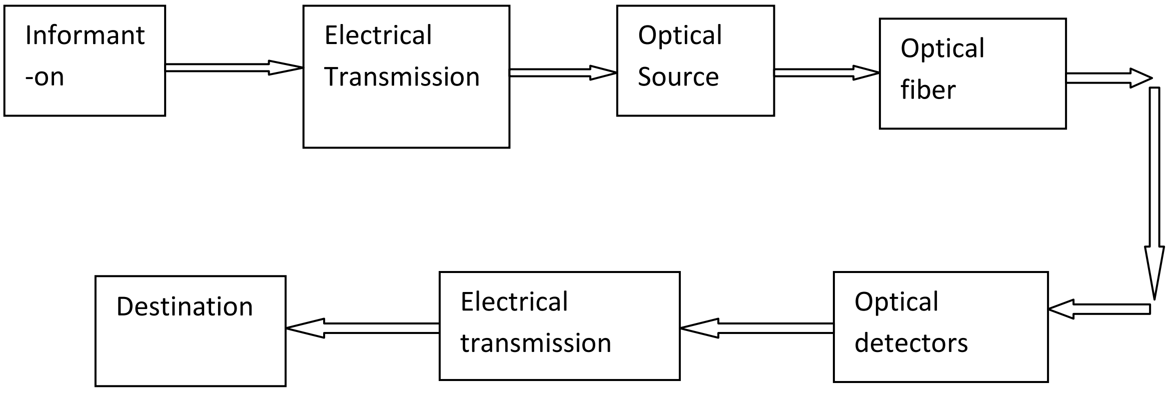
I. Introduction

Optical communication is a form of communication that uses light as the transmission medium. Radio over fiber [1] is an analog optical link transmitting modulated RF signals. It serves to transmit the RF signal to and from central station to base station. The main requirements of radio over fiber link architecture are duplex operation (i.e., downlink-uplink) [1] reasonable length , need a few millimeter-wave components only in the base stations and also need of only few high performance optical components.

RoF systems are now being used for enhanced cellular coverage inside buildings. It has introduced as a cost effective approach for reducing radio system costs because it simplifies the remote antenna sites and enhances the sharing of expensive radio equipment located at central stations. The frequencies of the radio signals distributed by RoF systems span a wide range (usually in the GHz region) and depend on the nature of the applications.

II. Radio Over Syestem

Radio over Fiber (RoF) is an optical fiber link to distribute modulated RF signals from a central location to remote antenna units. The RoF systems are introduced to replace a central antenna with a low power distributed antennas system (DAS). RoF system is consisting of many base stations, which are connected to a single central station. RoF systems centralize the RF signal processing function in one shared location, and use optical fiber link to distribute the RF signals to the RAUs or BSs [2]. RoF based wireless access network architecture is proposed, as a promising alternative to broadband wireless access network. In network architecture, the CS performs all switching, routing and network operations maintenance. Optical fiber network interconnects a number of simple and compact antenna BSs for wireless distribution.



III. Application of radio on fiber

- **Cellular network:** mobile traffic is relayed between base station and central station via ROF system.[3]
- **Wireless LANs:** can be used to distribute wireless LAN signals operating at 2.4 GHz to 5 GHz.[3]
- **Video distribution system:** it can be used for MANs, wired and wireless network.[2]
- **Vehicle communication and control:** ROF can be used for intelligent transport system, road- to-vehicle communication system.[2]

IV. Advantages of Radio over Fiber system

- *High bandwidth*
- *Low attenuation*
- *Immunity to radio frequency interference*
- *Low power consumption*
- *Multi service capable*
- *Dynamic resource allocation*
- *Light in weight*
- *Free form electrical risk*
- *Easy to install*

V. Introduction of different components used in ROF system

Wavelength division multiplexing:

WDM [4] is used to multiplex the different optical signals on a single optical fiber by using different wavelengths of laser diode. . This allows for a multiplication in capacity of an optical fiber by adding new channels, each channel on a new wavelength of light, in addition to enabling bidirectional communications over one strand of fiber. This is a form of frequency division multiplexing (FDM) but commonly it is called wavelength division multiplexing.

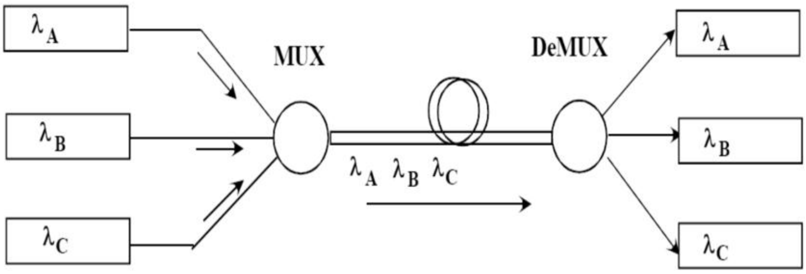


Fig 5.1 wavelenght division multiplexing

optical add-drop multiplexer

OADM [5] is a technique that is used in WDM for multiplexing and routing different optical signals to or from the optical network. It consist of optical multiplexer or optical demultiplexer, a path between optical mux and optical demux, a set of ports for adding and dropping optical signals ,a specific wavelength is added or dropped by circulator and FBG (fiber brag grating)s

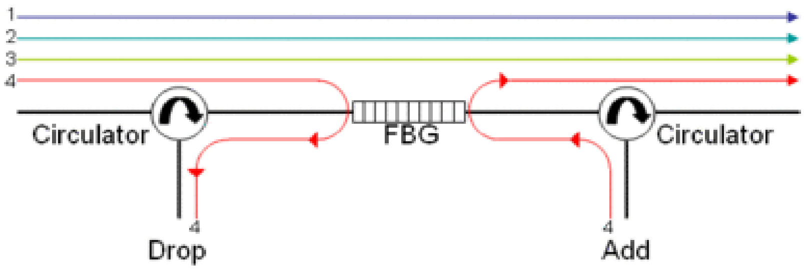


Fig.5.2 optical add- drop multiplexing

Erbium doped fiber amplifier

EDFA [6] is a optical amplifier used in optical communication. When optical signals are transmitted over a hundreds of kilometer then it require amplification .In optical communication there may be in-line, pre and post amplification. EDFAs are used for long distance communication with fiber loss less than 0.2db/km. For wavelength near to 1550 nm.

Laser diode

A laser diode is a device whose active medium is a semiconductor similar to that found in a LED. The most common type of laser diode is formed from a Ntype and Ptype material as p-n junction which is powered by injected electric current .A laser diode is formed by doping a very thin layer on the surface of a crystal wafer. Laser diodes form a subset of the larger classification of semiconductor p-n junction diodes. Due to forward biasing two type of charges are introduced in device. Holes are injected from the p-doped, and electrons from the n-doped, semiconductor.

Photodetecter

When a photon with energy greater than the band gap Eg is incident on the semiconductor, this energy is absorbed by the material and generates an electron-hole pair that is an electron in the conduction band and a hole in the valence band. When the pair is created within the space charge region, the electric field in the junction separates the charges and drifts them to the neutral regions. The carrier drift generates a photocurrent in the external circuit that provides an electrical signal. The photocurrent lasts the time needed for the electron and hole to cross the depletion layer and reaches the neutral regions. When the drifting hole reaches the p-type region it recombines with an electron entering the p side form the negative electrode that is from the power supply. .

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VI. Simulation setup and design analysis

In this proposed method two data signals are generated by two laser diode having different frequencies which feeds to Mach-Zender modulator [7] where incoming signal from pseudo-random bit sequence mixed with NRZ signal is modulated with it. And two- tone video signals are generated by combing of two analog signals with different frequency that is 500 MHZ mixed with 525 MHZ by directly modulated laser diode and second video signal is combined with 600 MHZ with 625 MHZ. These four signals are multiplexed by WDM and amplified by EDFA and then these multiplexed signals are transmitted to single mode fiber for 40 km. At base station one required signal (1552 nm.) is dropped and then 1552 nm. Is added by OADM after each 40 km.

At the receiver side all these signals are demultiplexd with DWDM, now these four signals feed on four different photodetecters and shown on different visualizer.

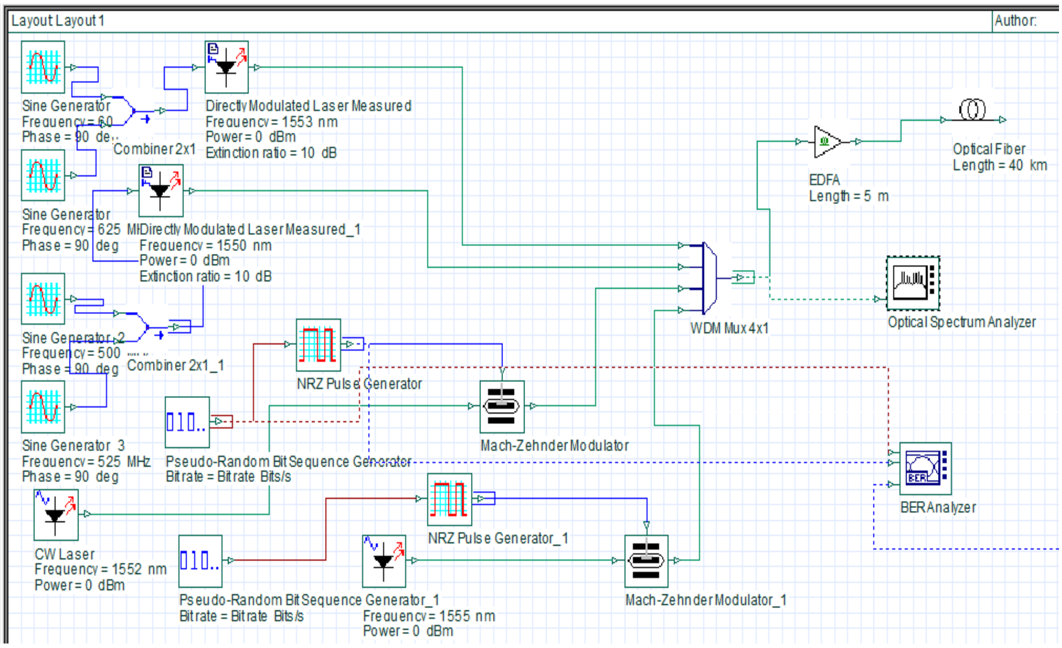


Fig.6.1 Central station

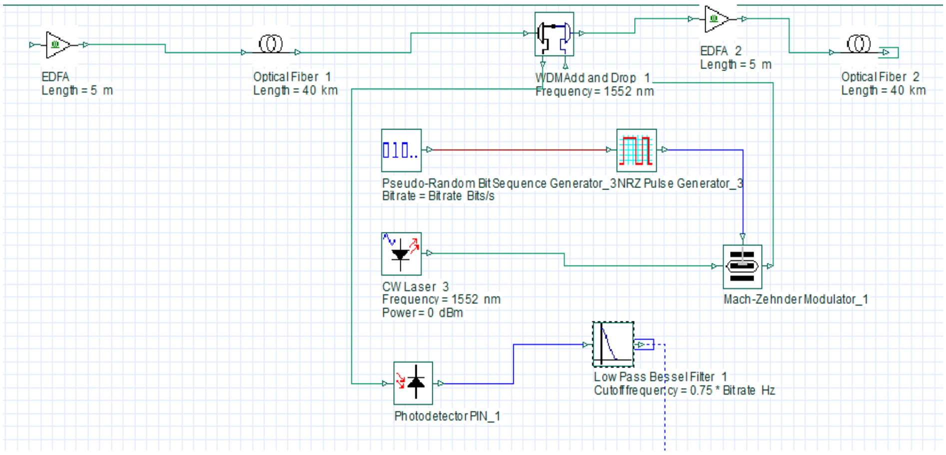


Fig 6.2 base station

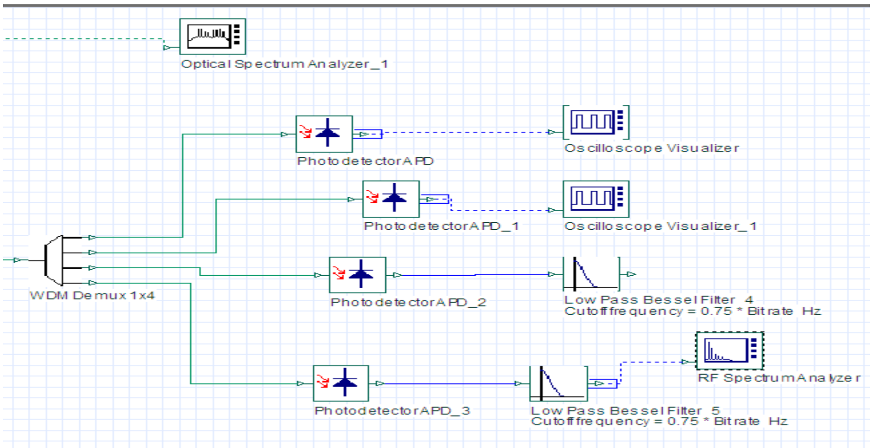


Fig 6.3 Receiver Station

VII. Result and discussion

Four signals 1550 nm, 1552 nm, 1553 nm, 1555 nm is shown in optical spectrum analyzer at the output of MUX in the central station as in fig.7.2. And video signal is shown in fig.7.1. The whole Radio over Fiber system consists of wavelength division multiplexing and optical add-drop multiplexing techniques. This is simulated using Opt system 10. WDM technique is used to transmit four different signals through a single fiber for long distance. OADM technique enabled us to transmit both down-link and uplink data via the same single-mode fiber. EDFA is used to amplify the signals after every 40 km of the transmission link. . At the receiver station some noise signals are presented with required signals but desired signals are detected easily due to higher amplitude of that signals. The proposed system is suitable for high bit rate and long-haul microwave optical links.

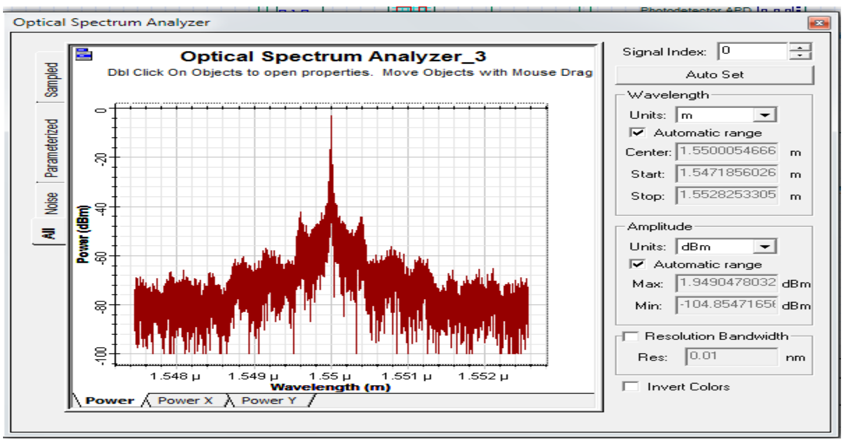


Fig 7.1 Video signal at the central station

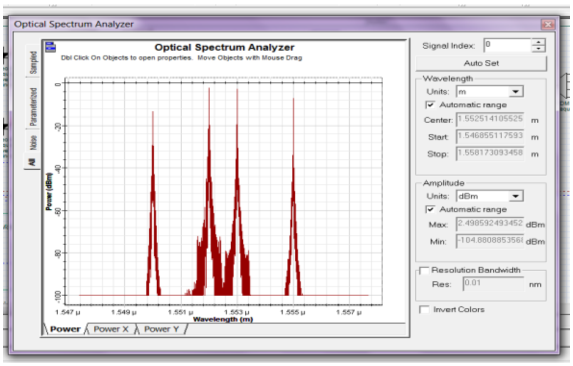


Fig 7.2 Transmitted signals at the central station

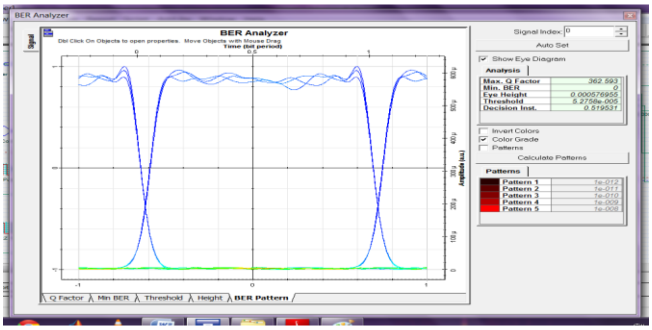
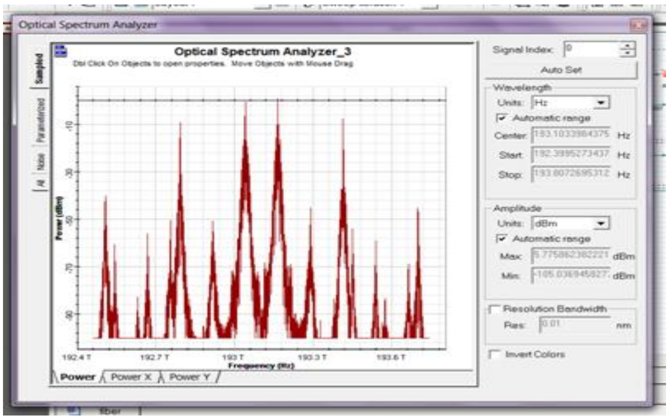


Fig 7.3 Eye diagram at base station



7.4 Received signals at the receiver

VIII. Conclusion

In this paper we have visualized four signals at MUX fig.7.2 , video signal at the Central station fig.7.1 and eye diagram at base station fig.7.3 then these signals is presented at the receiver which is shown in optical spectrum analyzer as in figure 7.4.This proposed technique full duplex data and two-tone video signal consist of wavelength multiplexing and optical add -drop multiplexing is stimulated on optisystem 10 .WDM is used for multiplexing of different four signals to transmit on single fiber.s

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