

# Comparative Analysis Of Radio Over Fiber Link Types

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**Abstract:** In this paper, we compared three radio over fiber link types to evaluate their relative performance for the transmission of wireless signals having multiple radio channels. These links differ in terms of modulation techniques; either a direct modulation or external modulation using a Mach-Zehnder modulator (MZM) & a reflective semiconductor optical amplifier (RSOA) or electro absorption modulator (EAM).

**Keywords:** Radio over Fiber, next generation wireless systems, VCSEL, Q-Factor, SOA.

## I. INTRODUCTION

Next-generation networks, which are capable of transmitting both wired and wireless data simultaneously, have been regarded as the most promising systems for the fulfillment of various services required by several customers. It becomes important what techniques can be used on the implementation of next generation networks depending on the IT (Information technology) environments of each country. Among all of these technologies, a Radio over fiber technology has been considered as an attractive solution for effectively supporting the fixed and mobile services to various subscribers. The concept radio over fiber means to transfer information over optical fiber by modulating the light with the radio signal. RoF uses analog transmission rather than digital optical transmission and therefore suffers from impairments due to noise and distortion. So, the requirement of high speed and bandwidth in communication are new approaches to research and study to provide better connectivity to the users, it's also called the real time communication [3].

Our concept is to compare the link types of RoF technology by using different types of modulations i.e., direct modulation and external modulation. Millimeter wave band is used here to provide densely packed communication for the personal area networks [1], it improved the utilization of spectrum by frequency reuse concept and the other factors cause mm-wave wireless networks to have significantly reduced cell coverage (<10 m), a high density of antenna units, and an extensive high-capacity feeder network. So, it also takes the advantage of high bandwidth of radio over fiber network to refine remote antenna unit (RAU). Radio over Fiber network has three sections: central unit, remote node and remote antenna unit (RAU) is able to connect MIMO (Multiple Input Multiple Output) which increase the throughput and spectral efficiency of the system. Remote antenna unit have distributed antenna

which provide transparent transmission to the mobile node. Remote node converts signals optical to electrical and vice versa [2]. The distributed broadband wireless system has DPSK modulation scheme with the line width of 15 and fiber length 10 km. Here, wavelength used is 1550 nm with quantum noise and single pole filtering 'OFF'.

In this paper, we experimentally present the use of an optically injection locked VCSEL to realize a directly modulated 50 GHz RoF system carrying multi-Gb/s wireless signals. The VCSEL has advantages for low-cost data transmission. The use of a laser means that multi-gigahertz modulation is possible, and the stimulated emission is directional, rather than the isotropic spontaneous emission of LEDs [4]. Because the light is emitted directly from the surface, single or multimode fiber can be directly butt coupled with an inexpensive mounting technology, and the coupling efficiency can be very high. For external modulation using RSOA distribution network could be deployed with Wavelength Division Multiplexing (WDM) techniques in order to increase capacity and flexibility. For reduced deployment costs in WDM optical access networks, reflective semiconductor optical amplifier (RSOA) devices have been developed as remote modulators [5], For external modulation using EAM, we used electro absorption modulator instead of MZM because EAM has many advantages over the MZM such as low driving voltage, dc drift free, low power consumption, small size, broad operational bandwidth, and monolithic integration capability with other semiconductor devices [6].

## 2. SIMULATION SETUP AND DESCRIPTION

Radio over Fiber communication system has been setup with the help of OPTSIM 5.3 for both direct as well as external modulation. The simulation setup is shown in figure 2, figure 3 and figure 4.

In direct modulation, the RF signal is fed to the VCSEL (direct modulated laser) from the transmitter. The modulated signal is transmitted through optical fiber of 10 km length and 20 Gbps bit rate. In external modulation, the RF signals transmitting from the transmitter and the optical signal from a CW Laser are fed to an external Modulator (here electro absorption modulator & MZM). A 20 Gbps data source is used. The modulated signal is transmitted through optical fiber of 10 km length. At the receiving section a PIN

photodiode is employed in order to convert optical signal into electrical form.

modulation, external modulation using RSOA and external modulation using EAM.

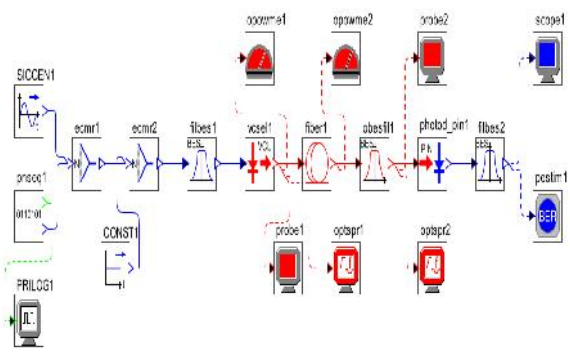


Fig 2: Direct modulation simulation setup

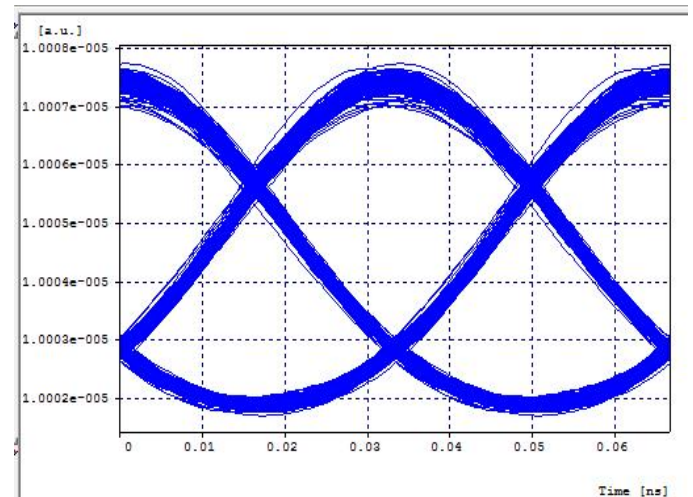


Fig 4: Eye Diagram of direct modulation at 10 km fiber length

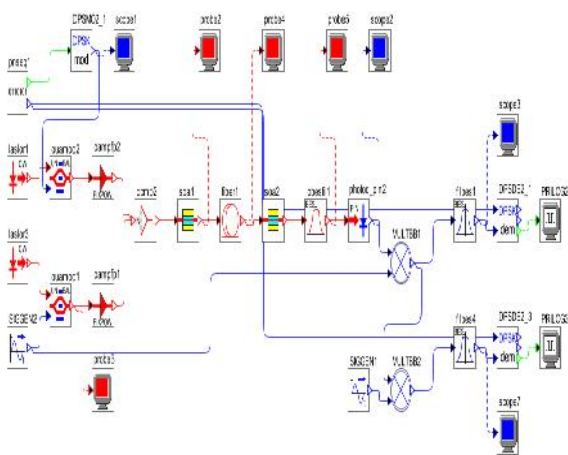


Fig 3: External modulation using SOA simulation setup

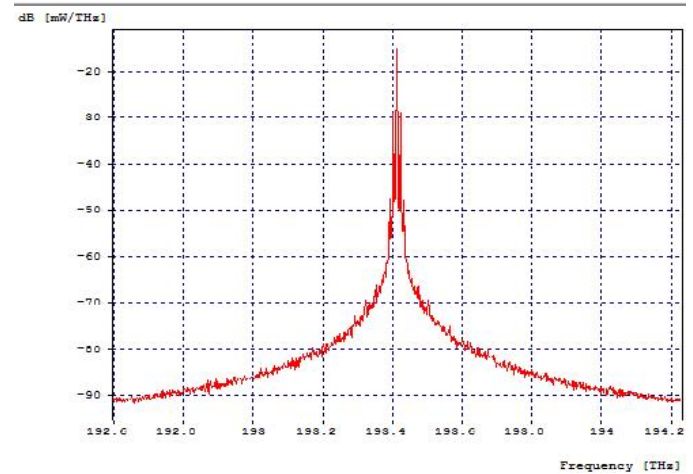


Fig 5: Optical spectrum of direct modulation

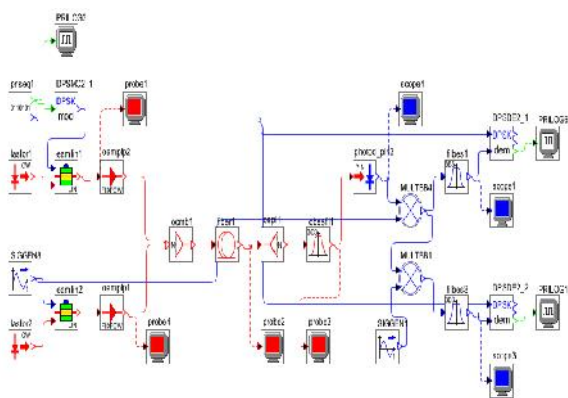


Fig 4: External modulation using EAM simulation setup

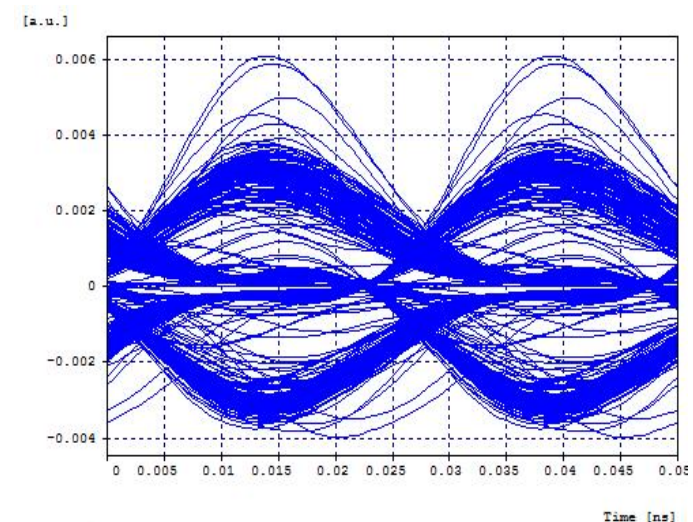


Fig 6: Eye Diagram of RSOA at 10 km fiber length

### 3. RESULT AND DISCUSSION

These are results of direct modulation and external modulation (using EAM and RSOA) respectively. The performance of direct and external modulation is compared in terms in BER, Eye Opening, Eye Closing, Q-Factor and Responsivity. Figure 4 & 5, figure 6 & 7 and figure 8 & 9 shows the eye diagram and optical spectrum of direct

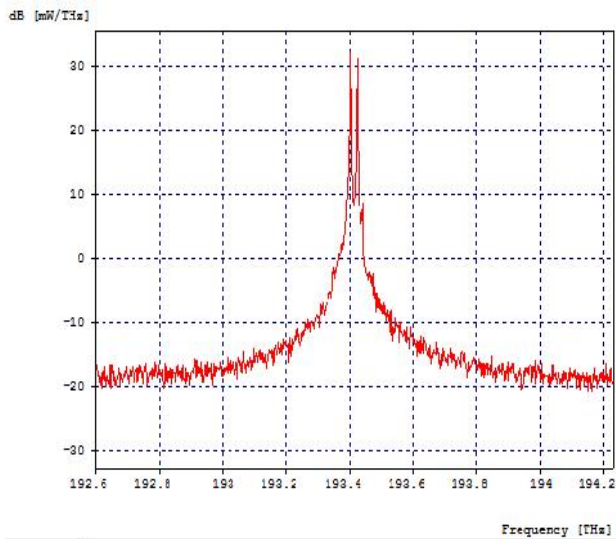


Fig 7: Optical spectrum of RSOA

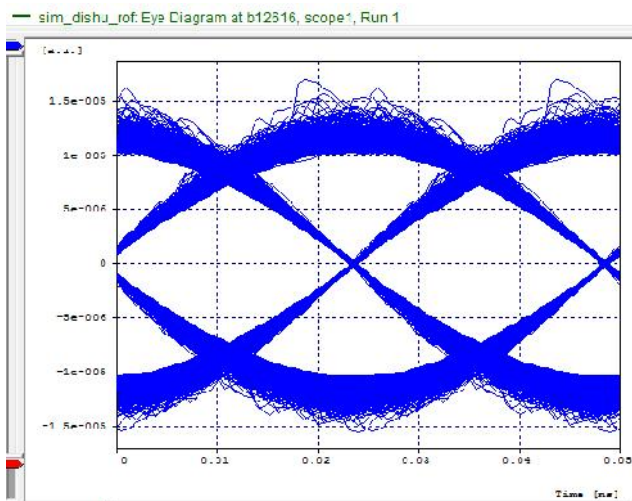


Fig 8: Eye diagram of EAM

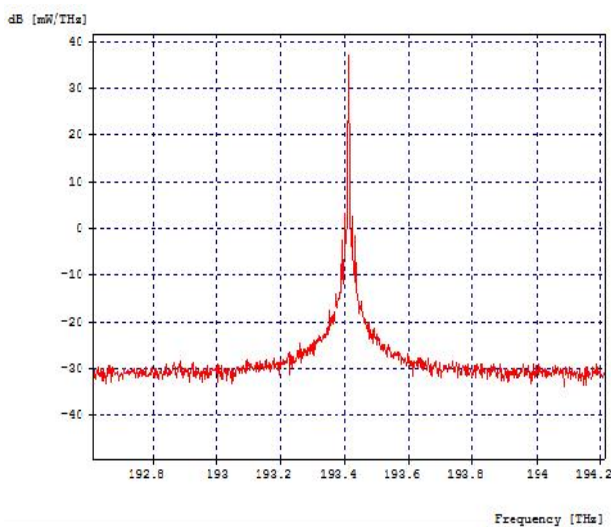


Fig 9: Optical Spectrum of EAM

#### 4. COMPARATIVE ANALYSIS OF RESULTS

Following tables are showing the results of different link types.

Table no. 1

Modulation Techniques	Q-Factor (db)	Eye Opening (a.u)	Eye Closing (db)	BER
Direct Modulation	22.7996	7.3143 e-01	1.033229	1e-40
External Modulation using RSOA	11.4563	0.0001487	12.33060	1e-40
External Modulation using EAM	24.9856	1.5588e-05	0.636221	9.8e-05

Table no. 2

Modulation Techniques	Power before fiber(dbm)	Power after fiber (dbm)
Direct Modulation	-46.0541	-48.082
External Modulation using EAM	-23	-17.7441
External Modulation using RSOA	9	10

#### 5. CONCLUSION

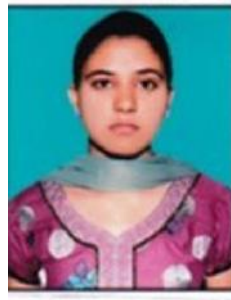
Radio over Fiber offers various advantages over the other technology. High Throughput, High Efficiency, Low Attenuation, Large Bandwidth and Easy Installation and Maintenance are the main advantages of Radio over Fiber technology. In this paper, we used two types of modulation techniques: Direct Modulation and External Modulation. According to the Optsim results External Modulation (using EAM) is best over the other techniques.

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