Performance of RoF in P2P network using PSK and DPSK modulation format

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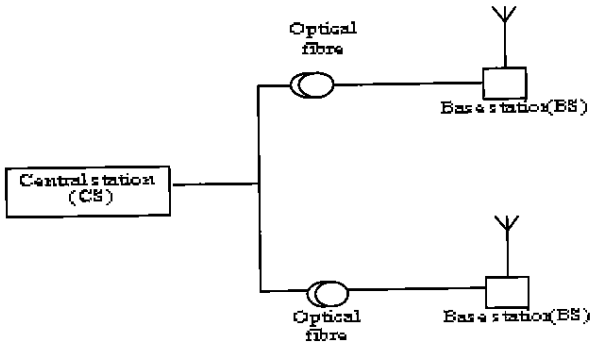
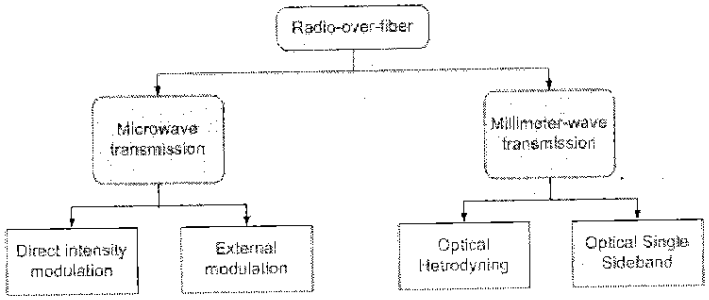
Abstract ?Radio over fiber (RoF) systems is one of the technologies which carry microwave signals and distributed it using the optical fiber cable from the control station to the base station. The combining of wireless and optical networks is a potential solution for increasing capacity as well as decreasing costs in the network. The overall purpose of the project is to simulate the radio over fiber in point-to-point (P2P) network and compare the modulation performance of RF using Phase Shift Keying (PSK) and Differential Phase Shift Keying (DPSK). The performance of both modulation techniques are compared through simulation by using Optsim provided by RSoft. The performances are characterized through Bit Error Rate (BER) for eye opening and input power. For PSK modulation technique, the transmission power is -16 dBm, with bit rate at 1.25 Gbps and the frequency up to 1 GHz. It is found that the performance of PSK modulation is better than DPSK modulation technique in most of simulation results because it have a high sensitivity for detection and good tolerance to nonlinearity of transmission line.

Keywords: *Radio-over-fiber, point-to-point, control station, base station.*

adio-over-Fiber (RoF) technology use of optical fibre links to distribute radio-frequency (RF) signals from a central station (CS) to base station (BS). In narrowband communication systems and (Wireless Local Area Network) WLANs, RF signal processing functions such as frequency up-conversion, carrier modulation, and multiplexing, are performed at the BS, and immediately fed into the antenna [1]. RoF makes it possible to centralise the RF signal processing functions in one shared CS, and then to use optical fibre, which offers low signal loss to distribute the RF signals to the BSs, as shown in Fig. 1. BSs are simplified significantly, as they only need to perform optoelectronic conversion and amplification functions. The centralization of RF signal processing functions enables equipment sharing, dynamic allocation of resources, and simplified system operation and maintenance. RoF technologies are of great interest for many potential applications such as broad-band wireless access networks, sensor networks, radar and satellite communication systems. The key function of a radio-over-fiber network is to distribute microwave and millimeter-wave signals over optical fiber to take the advantages of the low loss, low dispersion, and large bandwidth of optical fiber links [2].





optical (e/o) conversion functions and chromatic dispersion in the fibre. Usually from previous research in RoF, direct intensity modulation [3] and external modulation [4] are the famous modulation techniques have been applied in microwave transmission. While for millimeter-wave the modulation techniques are optical heterodyning [4] and optical single sideband (OSSB) [5].

So in this paper we presented PSK and DPSK as the modulation format in RoF systems. We use external modulation technique to compare both modulations format by using OptSim. In designing the system, the parameters such as eye opening and power transmit are been chosen against bit error rate (BER).

SIMULATION SETUP

The model simulation setup for both modulation techniques are depicted in Figure 3. For DPSK modulation technique, the intermediate frequency (IF) is modulated by 2.5 GHz at 1.25 Gbps. It was generated by using CW laser source and electro absorption modulator. While for PSK modulation technique, the intermediate frequency (IF) is modulated by 1 GHz at 1.25 Gbps. The different between this simulation setup only at the demodulation input port for PSK which it require electrical carrier reference. This is because the PSK need a coherent reference signal at the receiver. While for DPSK does not require a coherent reference signal. The differential demodulator uses the previous symbol as the reference for demodulating the current symbol. The wavelength of the IF is 1550 nm. The output from optical modulator is amplified by erbium-doped fiber amplifiers (EDFA) in order to compensate the loss from the modulator modulation. The EDFA gain was fixed to 20 dB. The optical local oscillator (LO) signal is generated by using a laser diode with a wavelength of 1547 nm and CW power at 0 dBm. For DPSK, the LO frequency is set at 30-GHz and 1 GHz for PSK. After the following transmission over 50 km in fibre the signals are preamplified by SOA because as an optical signal propagates through an optical fibre, it gets attenuated and the optical power level decrease. The signal will filtered by a optical bandpass filter. The optical bandpass are designed to pass only a specific wavelength range. At the receiver, photodetector are used to converts the optical energy into an electrical current that is then processed to recover the information.

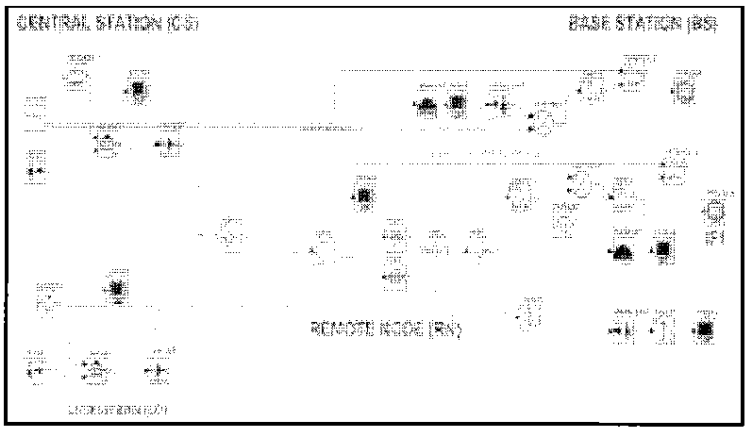


Figure 3: Basic simulation setup for RoF point to point network.

The simulation has been successfully simulated and the results are analyzed. In this section the results are divided into two parts to see the performance against BER

A. The Effect of power transmit on BER

The study on BER performance is carried out against the power transmits depicts in Fig.4. The power transmit range in this simulation is from -20dBm to -10dBm. At -20 dBm, the BER for PSK modulation is about 7.229×10^{-28}, while for DPSK modulation is 1.74146×10^{-17}. It shows that the patterns for both modulation techniques are the same. In practice a minimum requirement BER is from 10^{-9} to 10^{-12}. From the graph, the suitable power transmit is about -16dBm. This system is suitable in wavelength division multiplexing (WDM) technique. In WDM fibre radio networks have the potential to provide high bandwidth wireless access to a large number of users, using the high capacity offered by WDM optical networks. Other than that, this PSK modulation technique requires less power transmit which can reduce the optical power budget. However, for this study, the system only designs for single intermediate frequency (IF) to see the comparison between two different modulation formats.

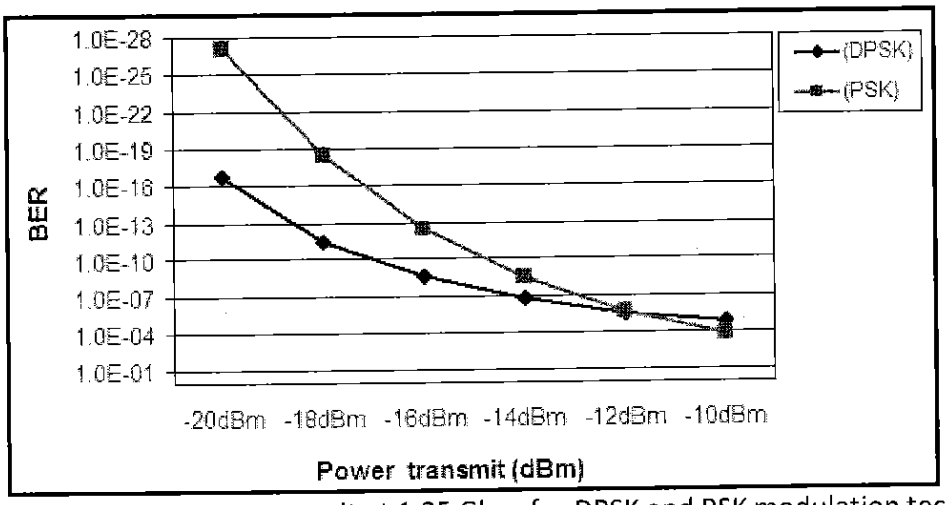


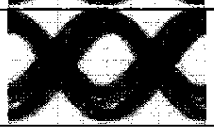
Figure 4: BER versus power transmit at 1.25 Gbps for DPSK and PSK modulation techniques

B. Eye opening

Table I shows the eye opening is taken from several samples in order to see the different effect on BER against the eye opening. For both modulations, as the BER increased the eye openings become closer. Other wise, when BER is low the wide opening can be seen in the results. It means that the percentages of bits that have errors in the transmission are less. Thus the decreased values of BER make the eye open very well.

TABLE I

Eye diagram at different BER for both modulation techniques.

BER	Eye opening for PSK modulation	BER	Eye opening for DPSK modulation
10^{-28}		10^{-17}	
10^{-13}		10^{-9}	
10^{-6}		10^{-6}	

CONCLUSION

Recently RoF is becoming trend for many researches in today's optical wireless communication field. This is because this technology intended to provide broad band wireless communications for mobile users. From the finding it concludes that the modulation technique is playing a role to overcome the transportation problems in RoF system. By looking at both modulation format , it shows that the PSK format gives better performance because it have high sensitivity for detection and good tolerance to nonlinearity of transmission line. In contrast with DPSK, the information is encoded in differential phase shifts so it is more sensitive to the phase noise. Because of these negative aspects, DPSK has not been considered as a good transmission format. Future work need to be done at different kind of networks and other modulation format to see the system limitation and practical implementation of the RoF system.

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