THINK INDIA JOURNAL

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Radio Over Fibre Technology

Akhil Gupta (Corresponding Author), Aditya Bakshi, Shakti Raj Chopra, Sandeep Kumar Arora, Gurjot Singh Gaba

School of Electronics and Electrical Engineering
Lovely Professional University
Phagwara, India
akhilgupta112001@gmail.com

Abstract— This paper provides a modern and emerging aspect of the wireless communication, which is basically an integration of two basic pillars of wireless communication, being emerged for the provision for the unmetered wireless broadband access named as radio over fiber technology. The paper defines the introduction to the radio over fiber technology and the features, quality parameters and challenges for the technology.

Keywords—ROF, Subcarrier multiplexing, Wavelength division multiplexing.

I. INTRODUCTION

Today's world is running virtual to make the things go real, in sense of communication and daily routine work, being carried out on just a click of the mobile device installed in front of the person. For that work to be carried on and communication to happen a huge data and a network is required at all the time and everywhere and obviously at reduced costs. Various proposals and research carried out on to make the same possible with different technologies such as optical communication, radio communication, microwave communication and various others [1]. Due to some drawbacks of earlier ones and newly proposed schemes with some advancement and according to the applications, different technologies are practiced. The explosive growth of internet and the success of 4G in today's scenario had a profound impact on the perception about the communication. The technology emerged and most trending comes out with the quality of service they provide with the word "always on" as the priority of the users and the service provider. The basic of all is the increase in mobility and data rate of the technology, they provide [2]. Currently the scenario of the broadband wireless communication systems can be well described with the help of Fig. 1, which tells the mobility and data rate provided by the services and technologies. Generally there's a tradeoff in between the coverage and capacity for all the technologies. The basic technologies are covered with the in Fig. 1 with the tradeoff while some important and future of broadband service have the ROF technology, and power line communications [3].

This paper discussed about the radio over fiber technology and its various features. Radio over fiber technology is the recent and most acceptable technology in communication systems with the least of interference and power loss.

The technology is gaining the maximum of market shares due to increasing traffic due to high data volume applications [4]. In the RF technology, there are certain limitation of high losses and congestion in the frequency spectrum, while the optical communication is limited due to maximum bandwidth of the signals that can be carried out and actual loss of light. The reasons being the constraints for limiting the pure RF and optical communications, a new research carried out by merging in both the technologies for the betterment of the use named as radio over fiber technology. The heredity and intermixing of the features of two always results in the betterment of the scenario, so the same had been carried out in the Radio over fiber technology. The ROF is an integration of microwave and optical networks as a solution for increasing capacity and mobility of the devices with a significant reduction in the cost of the network for accessing. The ROF concept uses the propagation of information over the optical link by modulating the light with the RF signal either directly by the radio signal or at some intermediate frequency. The first section of the paper describes the technology and its various aspects with the various advantages and disadvantages of the technology while the paper is concluded in the further section.

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

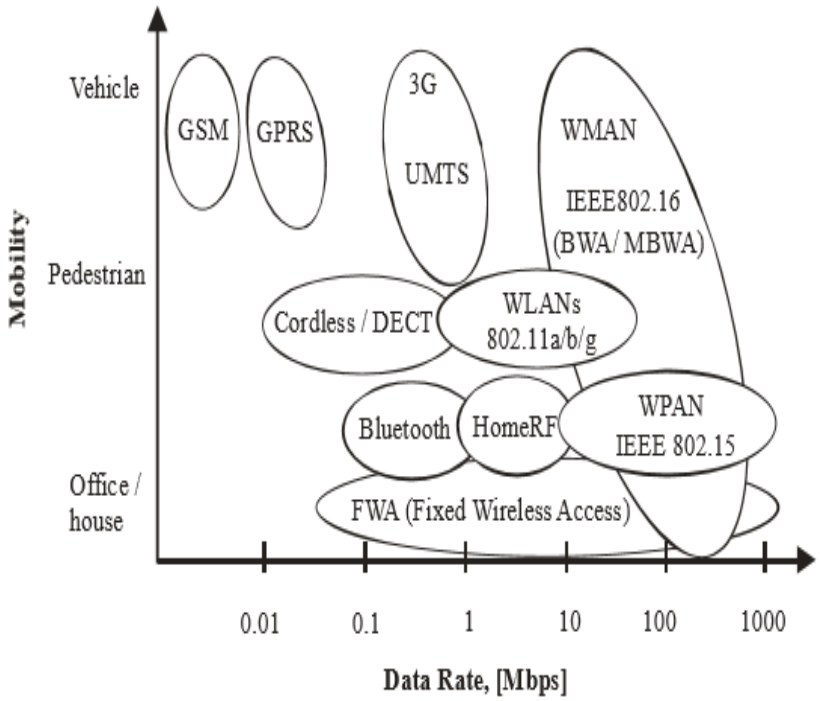

Fig.1 Overview of wireless networks

II. RADIO OVER FIBRE

A. The Technology

The ROF technology entails the use of RF antennas at remote locations via some remote antenna units (RAU), while the whole backbone network is working over the optical fibre network and optical components [5]. The better depiction of the network could be made by the Fig. 2. The carrier in between the network is obviously the optical system but the connectivity with the users is done by radio frequency signals after the demodulation. The green portion in Fig. 2 defines the radio link while the red defines the optical link.

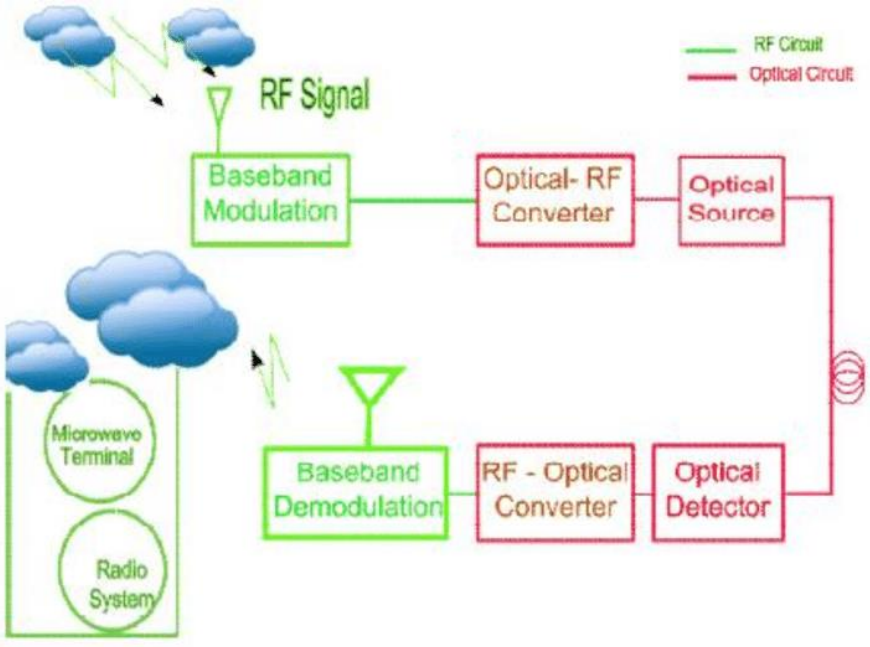

Fig.2 Basic diagram of ROF

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

As the various RF signal processing functions such as carrier modulation, multiplexing and frequency up-down conversion are performed at the base station, the same is done in the ROF by the head end station. The head end is the distributor of all the RF signals to all the users nearby or with in the radio range of the head end after various processing carried out on the raw RF signal modulated with light on the optical link. The head end connectivity is shown in Fig.3, which tells the basic concept of the ROF head end connected with remote antenna units and further with the mobile units and keeping the fibre link connectivity at the backbone network on the other side.

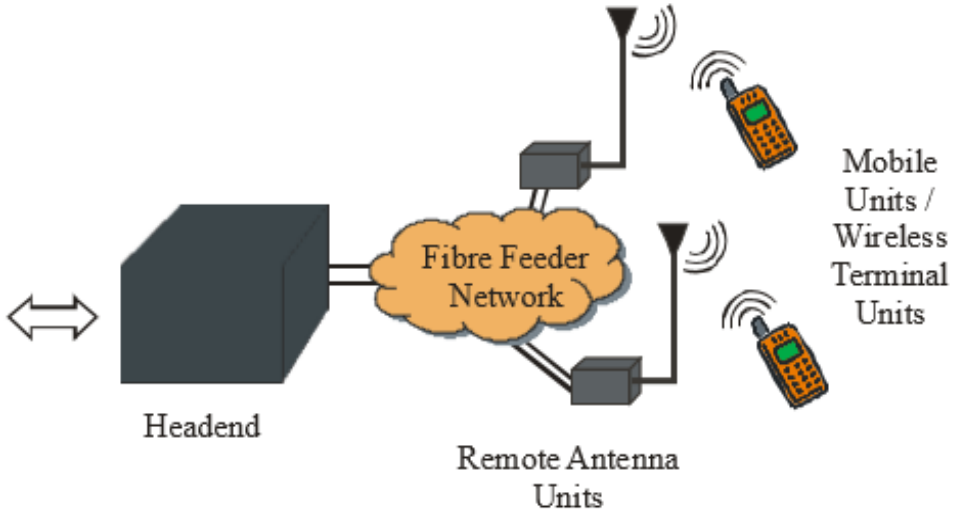

Fig.3 The ROF head end concept

The fibre feeder network is basically a fibre link connecting the head end and the remote antenna unit through which the processed signal is passed to the antenna. This all is done to make the system more robust because the radio signals are more susceptible to transmitter, receiver, and transmission link impairments.

There are various methodologies to incorporate the ROF technology out of which here the three basic are introduced with their performance parameters. In subcarrier multiplexing (SCM), the multiple signals are multiplexed in the radio frequency domain and transmitted at similar some bandwidth, which takes the significant advantage of maturity of microwave devices over the optical devices because the coherent detection of microwave signals is more easy and less complex then coherent optical detection. The attenuation of the signals is moderate in this case with chromatic and polarisation mode dispersion (PMD), stimulated brillouin scattering (SBS) and an achievement of reduced bit error rate (BER) [6]. The SCM technique used in ROF is better explained with the Fig. 4.

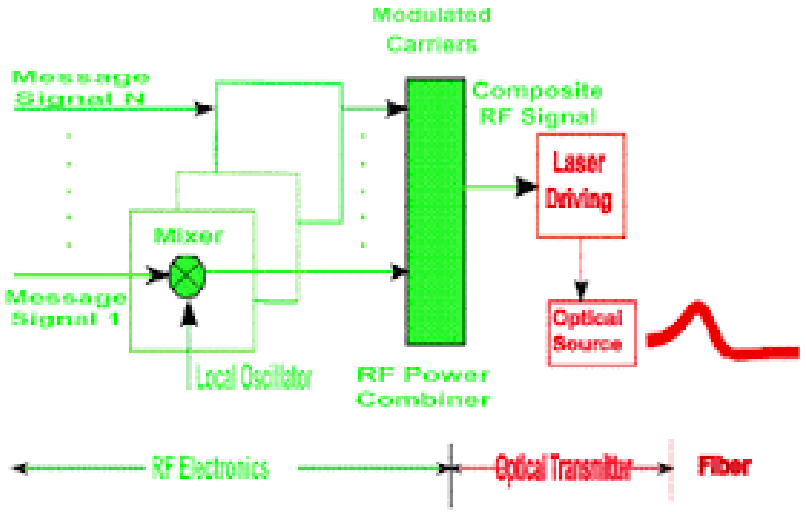

Fig.4 Schematic diagram of subcarrier multiplexing

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

The various signals are multiplexed at same optical bandwidth using the local oscillators and RF combiner components, which further are transferred to the optical link by the help of laser driver [7].

The Wave division multiplexing (WDM) is somewhat different from SCM in turns of bandwidth used. WDM uses different bandwidth for the different RF signals imposing individually onto the main fibre link. WDM exploits the efficient fibre network bandwidth. The WDM provides a huge data rate up to 1Tb/s with a channel spacing of 100 GHz. The most important aspect of WDM is channel spacing, which if reduced to 50 GHz would result into harder to operate at even low data rates. The attenuation in WDM is quite low comparatively with SBS and FWM scattering and dispersion being chromatic, which in turns to increase the BER [8]. The WDM mechanism is shown in Fig. 5, where each RF signal is processed by an optical source and optical fibre, then to a WDM multiplexer.

These individual fibres for each signal are merged or multiplexed at the multiplexer to make a single optical fibre to carry out the whole traffic of all the generated optically different bandwidth signals from different RF signals [9].

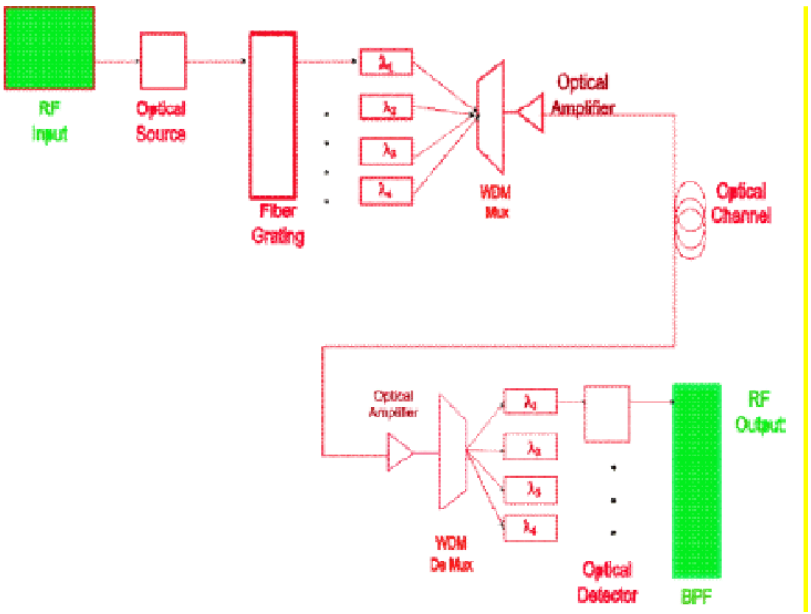

Fig.5 ROF using WDM

Optical Frequency Multiplexing (OFM) is a technique using a single optical source with different RF signals to be multiplexed depending on the frequency selected at the central station, which is further carried out by a single optical link. It is a flexible and cost effective technique enabling multiple functionalities to the wireless access networks. At the antenna station the back conversion of the RF signal is carried out from the optical signal before transmitting to the mobile devices [10].

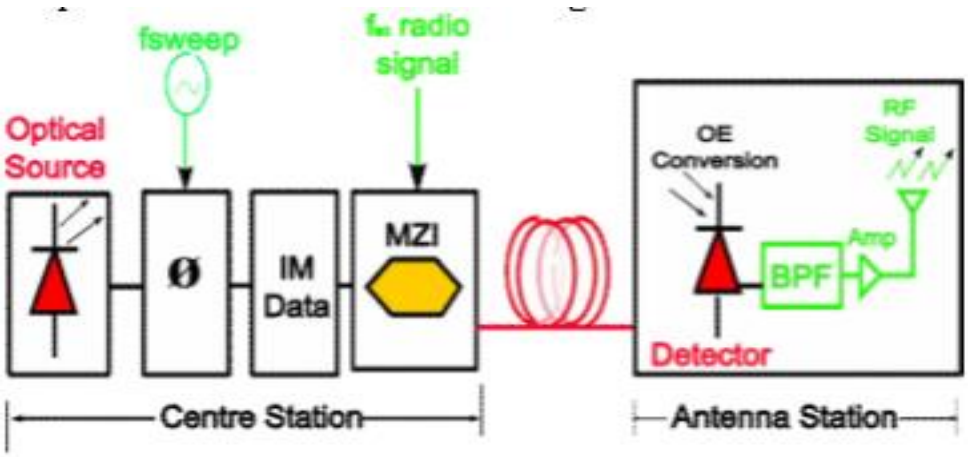

Fig. 6 Schematic Diagram of OFM ROF

The main goal of ROF is the flexibility with the existing optical network with high data rates and reduced cost, which is somewhat achieved in a better way by the use of OFM ROF and is shown in the Fig. 6. In OFM the attenuation is low with SBS scattering and chromatic dispersion with high BER [11].

B. Advantages

- Low attenuation loss because of significant role of optical links for the transmission.
- Larger bandwidth for transmission because of enormous optical fibre bandwidth namely 850 nm, 1310 nm and 1550 nm bandwidths mostly used.
- Immunity to RF interference because of the light, as the medium to carry the traffic.
- Easy installations and maintenance due to the complex and expensive equipment's being present at only the head end, making the RAU's simpler. This arrangement reduces the cost.
- Multi-operator and multi-service operation system to make the system linear and transparent.

C. Challenges

- ROF is ultimately being an analogue communication system has signal impairments such as noise and distortion, which the limits the noise figure (NF) and dynamic range (DR).
- The lack of standardisation for the ROF components and increase the deployment opportunities.

III. PROPOSED WORK

The different multiplexing techniques used by the ROF for the deployment has some additional features which are considered as the backbone for the proposal of new method for the ROF technology. A combination of WDM and SCM could make the ROF system with low attenuation and less BER, while individually either of them does not offer the same. The same could be implemented with a combination of OFM and WDM techniques for the betterment of the ROF system.

IV. CONCLUSION

Finally, after making all the pros and cons being considered at the same platform of ROF, the conclusion comes to being the OFM ROF as a best candidate for the wireless communication technologies with reduced cost for maintenance and deployment of the architecture because of the flexibility with the currently existing optical network at larger bandwidths and low attenuation. The different methodologies like WDM, SCM and OFM existing could be improved in sense to provide the less attenuation, high data rate and more flexibility. While making an additional methodology for the ROF as a combination of multiple multiplexing and signal processing techniques. The future work on these technologies has already been done in [12-17].

REFERENCES

[1]. A. M. J. Koonen *et al.*, "Perspectives of Radio over Fiber Technologies," *OFC/NFOEC 2008 - 2008 Conference on Optical Fiber Communication/National Fiber Optic Engineers Conference*, San Diego, CA, pp. 1-3, 2008.

[2]. M. M. Sisto, S. LaRochelle and L. A. Rusch, "Carrier-to-noise ratio optimization by modulator bias control in radio-over-fiber links," in *IEEE Photonics Technology Letters*, vol. 18, no. 17, pp. 1840-1842, Sept. 2006.

[3]. P. J. Rigole, S. Nilsson, L. Backbom, T. Klinga, J. Wallin, B. Stalnacke, E. Berglind, and B. Stoltz, "114-nm Wavelngth Tuning Range of a Vertical Grating Assisted Codirectional Coupler Laser with a Super Structure Grating Distributed Bragg Reflector," IEEE Photonics Techn. Lett., Vol. 7, No. 7, pp 697 – 699, 2010.

[4]. J. Yu et al, "Radio-over-optical-fiber networks: introduction to the feature issue", Journal of Optical Networking, Vol. 8(5) , pp 488-481, 2014

[5]. R. Hui et. al, "Subcarrier Multiplexing for High-Speed Optical Transmission", Journal of Lightwave Technology, vol. 20, no. 3, pp 417-428, 2015

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

[6]. M. Sauer, A. Kobyakov and A. B. Ruffin, "Radio-Over-Fiber Transmission With Mitigated Stimulated Brillouin Scattering," in *IEEE Photonics Technology Letters*, vol. 19, no. 19, pp. 1487-1489, Oct.1, 2007.

[7]. S. R. Chopra, A. Gupta and H. Monga, "An LTE Approach with MIMO by Using Suboptimal Selection of Antenna," *2018 International Conference on Intelligent Circuits and Systems (ICICS)*, Phagwara, pp. 167-172, 2018.

[8]. R. Kausar, A. Gupta, I. B. Sofi and K. Arora, "Bit Error Rate Based Performance Evaluation of LTE OFDMA System," *2018 International Conference on Intelligent Circuits and Systems (ICICS)*, Phagwara, pp. 161-166, 2018.

[9]. A. Gupta, S. Dogra, I. B. Sofi, "Performance Evaluation of Spatial Multiplexing Using Different Modulation Techniques in MIMO System for Small and Large Scale Fading Channel", International Journal of Sensors Wireless Communications and Control, Vol. 9(2), pp. 188-202, 2019.

[10]. S. R. Chopra, A. Gupta, H. Monga, "Performance Analysis of Space Time Trellis Codes in Rayleigh Fading Channel", In Harmony Search and Nature Inspired Optimization Algorithms, Springer, Singapore, pp. 957-967, 2019.

[11]. A. Gupta and S. R. Chopra, "Designing and Testing of Quadrifilar Helix Antenna for NOAA Weather Satellite," *2019 6th International Conference on Signal Processing and Integrated Networks (SPIN)*, Noida, India, pp. 785-790, 2019.

[12]. R. Devi, R. K. Jha, A. Gupta, S. Jain, P. Kumar, "Implementation of an intrusion detection system using an adaptive neuro-fuzzy inference system for 5G wireless communication network", AEU-International Journal of Electronics and Communications, 74, 94-106, 2017.

[13]. A. Gupta and R. K. Jha, "Security threats of wireless networks: A survey," *International Conference on Computing, Communication & Automation*, Noida, pp. 389-395, 2015.

[14]. A. Gupta, R.K. Jha, "Power optimization using massive MIMO and small cells approach in different deployment scenarios", Wireless Networks, Vol. 23(3), pp. 959-973, 2017.

[15]. A. Gupta, R. K. Jha, P. Gandotra, S. Jain, "Bandwidth spoofing and intrusion detection system for multistage 5G wireless communication network", IEEE Trans. on Vehicular Technology, Vol. 67(1), 618-632, 2017.

[16]. I. B. Sofi, A. Gupta and R. Kausar, "Performance Evaluation of Different Channel Estimation Techniques in MIMO System for Hata Channel Model," *2018 International Conference on Intelligent Circuits and Systems (ICICS)*, Phagwara, pp. 155-160, 2018.

[17]. M. Singh, K. Arora and A. Gupta, "Equalization in WIMAX System," *2018 International Conference on Intelligent Circuits and Systems (ICICS)*, Phagwara, pp. 330-333, 2018.