KIET IJCE KIET International Journal of Communications &Electronics

Volume. No. 3, Issue No.1, Jan – March 2015, ISSN: 2320 - 8996

A New Wireless Communication Technology: Radio over Fiber

Shelly Garg[1]
Department of Electronics &Communications[1],
Indus Institute of Engineering and Technology, Jind (Haryana)
s.singla428@gmail.com[1]

Abstract: Radio over Fiber is an upcoming wireless standard which is being designed to seamlessly integrate many different standards as well as integrate broadband communication wirelessly. This paper will give a brief overview of the beginnings of wireless technology and how it has evolved to what it has become today. This paper will discuss features of Radio over Fiber operating at Millimeter Frequency Spectrum wireless communication technique. Also provide comparison with existing mobile communication techniques up to fourth Generation.

1. Introduction

For the future provision of broadband, interactive and multimedia services over wireless media, current trends in cellular networks, both mobile and fixed are to reduce cell size to accommodate more users and to operate in the microwave/millimeter wave frequency to avoid spectral congestion in lower frequency bands and the radio frequency bands for wireless communication systems are shown in Table 1.1. Thus, it demands a large number of base stations to cover a service area and cost-effective BS is a key to success in the market. This requirement has led to the development of system architecture where functions such as signal routing/processing, handover and frequency allocation are carried out at a central CS, rather than at the BS.

Table 1.1 Radio Frequency Bands for Wireless Communication Systems

Band No.	Frequency Subdivision	Frequency Range	Wavelength
4	VLF (very low frequency)	Below 30kHz	Greater than 10 km
5	LF (low frequency)	30 to 300kHz	10km to 1km
6	MF(medium frequency)	300 to 3000kHz	1km to 100m
7	HF(high frequency)	3 to 30MHz	100m to 10m
8	VHF(very high frequency)	30 to 300MHz	10m to 1m
9	UHF(ultra high frequency)	300 to 3000MHz	1m to 10cm
10	SHF(super high frequency)	3 to 30GHz	10cm to 1cm
11	EHF(extremely high frequency)	30 to 300GHz	1cm to 1mm

Furthermore, such a centralized configuration allows sensitive equipment to be located in safer environment and enables the cost of expensive components to be shared among several BSs. An attractive alternative for linking a CS with BSs in such a radio network is via an optical fiber network, since optical fiber has low loss, is immune to EMI and has broad bandwidth [1]-[5]. Wireless broadband technologies promise to make all kinds of information available anywhere, anytime, at a low cost to a large portion of the population. New wireless subscribers are signing up with an increasing demand of more capacity for ultra-high data rate transfer at speeds of 1Gbps and up, while the radio spectrum is limited. This requirement of more bandwidth allocation places heavy burden on the current operating radio spectrum. Radio over technology (RoF) has been proposed to over these problems [4]-[10]

2. Comparison Evolution between existing Mobile Communication Techniques

The purpose of this section is to give an overview of the evolution of wireless technology from the first generation (1G) to the fifth generation.

2.1. First generation wireless (1G)

First generation wireless technologies were designed to transmit voice wirelessly in the 1980s. Network signals were analogue and used Frequency Division Multiple Access (FDMA) to carry voice channels and could not support sending data from one point to another. This first generation of wireless communication was very unreliable, and not many users could use their cell phones at one time. It consumed more bandwidth to avoid inter carrier interface. Disadvantage was crosstalk which caused problem on other frequency and also disrupt transmission.

2.2. Second generation wireless (2G)

Second generation technology was deployed in the 1990s and uses circuit-based digital technologies. 2G systems were created to increase the capacity over the analog system. It used time Division Multiple Access(TDMA) 2G also has facility of Circuit-Switched Data(CSD) which provided data transmission via Internet Protocol(IPV4) GPRS was introduced in 2000 but slow speed 56kbps to 115kbps (kilobit/sec). compared with first-generation systems, higher spectrum efficiency, better data services, and more advanced roaming were offered by 2G systems.

2.3. An Update to Second Generation (2.5G)

2.5G Deployed in 2003 which implemented High Speed Circuit Switched Domain (HSCSD) Data rate 236.8kbps to 384kbps by using EDGE (Enhanced Data Rate for GSM Evolution) .It is considered a stepping stone between 2G and 3G technologies [5]-10]. Faster data transmission is also possible, yet transmission of video is still very slow with 2.5G.

2.4. Third generation wireless (3G)

3G was introduced to help to solve the problem of global communication and lack of standardization. 3G allows simultaneous use of speech and data services at higher rates and better spectral efficiency. More diverse multimedia contents like mobile TV, audio-video conferencing, video on demand, fax services and other broadband applications for entertainment and business solutions. High speed internet surfing includes UMTS (Universal Mobile Telecommunication System) and WCDMA (Wideband Code Division Multiple Access) which offer speed up to 1.92Mbps [6]-[9].

2.5. Upgradation to 3G (3.5G)

3.5G Upgraded and enhanced with higher data speed and capacity. Down-link speed 3.6, 7.2 to 14Mbps which was made possible with HSDPA (High-Speed Down-link Packet Access. Further increase of speed 42 to 84Mbps was achieved with HSPA (High Speed Packet Access) It is also referred as 3G+,3G Turbo,3G EDGE [8]-[10].

2.6 Fourth Generation(4G)

Fourth Generation (4G) is the next generation of wireless networks that will replace third Generation (3G) networks. 4G is intended to provide high speed, high capacity, low cost per bit, IP based services for video, data and Voice (VoIP).4G is all about an integrated, global network that's based on an open system approach. Constitute of 4G has not been standarized yet. It is non-backward compatible with new higher frequencies bands [8]-[12].

3. Radio over Fiber Technology

Radio over Fiber (RoF) technology uses optical fiber links to distribute RF signals from a central station to multiple remote access units due to its ability to provide simple antenna front ends, increased capacity, and multi radio wireless access coverage. It involves modulating the radio frequency (RF) sub-carrier onto an optical carrier for distribution over a fiber network. RoF technique has been considered a cost-effective and reliable solution for the distribution of the future wireless access networks.

The transmission of radio signals over fiber, with simple optical to electrical conversion, followed by radiation at remote antennas, which are connected to a central CS, has been proposed as a method of minimizing costs. The reduction in cost can be brought about in two ways. Firstly, the remote BS or radio distribution point needs to perform only simple functions with small in size and low in cost. Secondly, the resources provided by the CS can be shared among many BSs. This technique of modulating the radio frequency sub carrier onto an optical carrier for distribution over a fiber network is known as RoF system. This approach is in Fig.1.1. To be specific, the RoF system typically comprises a central CS, where all switching, routing and frequency management functions are performed, and an optical fiber network, which interconnects a large number of functionally simple and compact BSs for wireless signal distribution.

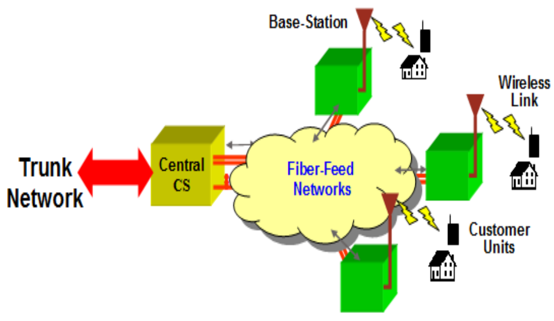

Fig. 1.1 Block diagram of the Fiber- Wireless Approach

The BS has no processing function and its main function is to convert optical signal to wireless one and vice versa. Since RoF system was first demonstrated for cordless or mobile telephone service, a lot of research efforts have been made to investigate its limitation and develop new, high performance RoF systems. Table 1.2 shows that RoF is needed for future broadband sevices.

4. Conclusion

In order to deploy next-generation mobile networks, there is a greater need for service portability and interoperability with the proliferation of mobile and portable digital devices, which requires devices to be connected seamlessly. The expansion of wireless ubiquity will drive an increased volume of consumers to access and rely on mobile networks creating a need for greater economies of scale and lower per bit cost. In response to this remarkable development, the metro and core networks of the telecommunication infrastructure have experienced a tremendous growth in bandwidth and capacity with the wide deployment of fiber optic technology in the past decade.

Table1.2 A Brief Comparison Evolution between RoF with existing Mobile Communication Techniques

Technology/ features	1G	2G/2.5G	3G	4G	RoF (Beyond 4G)
Deployment	1984	1999	2002	2010	2015
Data Bandwidth	2Kbps	14.4-64Kbps	2Mbps	200Mbps to 1Gbps	1Gbps and higher
Standards	AMPS	2G:TDMA,CDMA ,GSM 2.5G:GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Switching	Circuit based	Circuit based	Packet based	Circuit and packet switch	Packet Switch
Core Network	PSTN	PSTN	Packet Network	Internet	Internet

REFERENCES

[1] C. T. Lin, J. Chen, P. C. Peng, C. F. Peng, Wei-Ren Peng, Bi-Shiou Chiou, and Sien Chi, “Hybrid Optical Access Network Integrating Fiber-to-the-Home and Radio-Over-Fiber Systems,” IEEE Photonics Technology Letters, Vol. 19, No. 8, April 15, 2007.

[2] H. Chettat, L. M. Simohamed, Y. Bouslimani, and H. Hamam, “RoF Networks: A Comprehensive Study,” International symposium on wireless pervasive computing 2008 (ISWPC 2008), May 7-9, 2008.

[3] H. Schmuck, R. Heidemann, and R. Hofstetter, “Distribution of 60 GHz signals to more than 1000 base stations,” Electronics Letters, Vol. 30, No. I, January 6, 1994.

[4] L. Smoczynski, and M. Marciniak, “A Comparison of Different Radio over Fibre System Concepts with regard to Applications in Mobile Internet and Multimedia”,http://rp.iszf.irk.ru/hawk/URSI2002/URSI-GA/papers/p1726.pdf.

[5] N. Mohamed, S.M. Idrus, and A.B. Mohammad, “Review on System Architectures for the Millimeter-Wave Generation Techniques for RoF Communication Link,” IEEE International RF and Microwave Conference Proceedings, December 2-4, 2008.

[6] P. Kaur, and R.S.Kaler, “Radio over Fiber Networks,” Proceedings of National Conference on Challenges & Opportunities in Information Technology (COIT-2007) RIMT-IET, Mandi Gobindgarh, March 23, 2007.

[7] T. Koonen, “Fiber to the Home/Fiber to the Premises: What, Where, and When?,” Proceedings of the IEEE, Vol. 94, No. 5, May 2006.

[8] J. Z. Sun, J. Sauvola, D. Howie, “Features in future: 4G visions from a technical perspective,” Global TelecommunicationsConference, 2001.GLOBECOM'01,IEEE, Volume:6, 25-29,Nov.2001, pp:3533 - 3537 vol.6.

[9] S. Y. Hui, K. H. Yeung, “Challenges in the migration to 4G mobile systems,” Communications Magazine, IEEE , Volume: 41 , Issue: 12 , Dec. 2003, pp:54 – 59.

[10] Pereira, Vasco & Sousa, Tiago. “Evolution of Mobile Communications: from 1G to 4G”, Department of Informatics Engineering of the University of Coimbra,Portugal 2004.

[11] Robert Berezdivin, Robert Breinig, and Randy Topp, “Next-generation wireless communications concepts and technologies,” *IEEE Communications Magazine*, March 2002.

[12] Jiangzhou Wang, *Broadband Wireless Communications: 3G, 4G, and Wireless LAN*, Kluwer Academic Publishers, Hingham, MA, USA, 2001.

.