Future of multi-gigabit wireless communications

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Abstract. *The article reviews the main approaches to development of multi-gigabit wireless communications in future. This work includes information of usage 60 GHz frequency band, describes advances in wireless technology such as 3G and 4G. The work presented in this thesis is intended to support the design of low-cost 60-GHz transceivers for Gb/s transmission over short distances. Also this information comprises research into the characteristics of typical 60-GHz channels, the evaluation of the transmission quality as well as the development of suitable baseband algorithms.*

Keywords

Multi-gigabit wireless communication, 60 GHz frequency band, technical future

1 Introduction

The widespread availability and use of digital multimedia content has created a need for faster wireless connectivity that current commercial standards cannot support. This has driven demand for a single standard that can support advanced applications such as wireless display and docking, as well as more established usages such as network access.

Demand for very high-speed wireless communications is proportionally growing with respect to the increasing data rates reachable by optical fibers. The emerging research trend in computer networks is to cut more and more cables and to provide mobile and nomadic users with a data rate at least comparable with that one of wired Ethernet. GbE standard is now widespread and 10 GbE standard has been available since 2002.

2 Theoretical Part

While established and well-known fiber-optic data-transfer devices can provide multigigabit per second data rates, infrastructure costs and deployment time can be too expensive for some applications. Wireless links can be used to bridge the gaps in the fiber network and they can be deployed very rapidly, without the need for costly and complex trenching actions. Multigigabit wireless applications will include fiber segment replacement in future 3G and 4G backhauls, in distributed antenna systems, in enterprise connectivity, and in consumer-level applications, such as HDTV.

Future home and building environments are a domain where, in the coming decade, large quantitative and qualitative changes can be expected in services and applications, that ultimately will benefit from wireless multigigabit/s communication. Therefore, the need for such high data rates arises both in short-range scenarios and in medium-long range scenarios.

The unlicensed 60 GHz frequency band has great potential for wireless applications. However, due to the unlicensed nature of the band, wireless networks operating in the 60 GHz band are likely to suffer from interference. Where a very huge bandwidth for multigigabit wireless communications can be made available as free spectrum without interference issues? The unique possibility is to look at EHF.

Recently, there has been a lot of interest in the development of 60 GHz systems for the indoor [1] and outdoor [2] applications, because this bandwidth has been allocated in many countries as free spectrum. The world-wide availability of the huge amount of license-free spectral space in the 60 GHz band provides wide room for gigabit-per-second (Gb/s) wireless applications.

A commercial 60-GHz transceiver will, however, provide limited system performance due to the stringent link budget and the substantial RF imperfections. The particular motivation is the high attenuation (10-15 dB/km) caused by atmospheric oxygen for a band approximately 8 GHz wide around 60 GHz

However, because of higher propagation loss due to oxygen absorption at this band, it is not suitable for very long links. Further, the FCC has made available 13 GHz of spectrum in the 70-95 GHz (away from the oxygen absorption band, in order to facilitate longer range communication) for semi-unlicensed use for directional point-to-point "last mile" links. Above 60 GHz, both for long and short range, there is a lack of discussion on modulation, equalization, and algorithm design at physical layer. The possibility to use innovative and advanced radio interfaces based on IR UWB transmission technique, to realize multigigabit/s communications beyond 60 GHz [4], [5].

The 60Ghz band promises to provide a means of achieving very high data rate communications. With its 5-7GHz of bandwidth this band will allow communications in the range of gigabits per second. Of course, the band is not without its challenges. Path loss is more severe and implementing a highly integrated transceiver in CMOS will be challenging at the very least. CMOS has the advantage that it can support very large amounts of digital processing in a very small area and for very low power. The key to building advanced communications systems in CMOS, especially at a 60GHz carrier frequency, is to leverage the digital computational power of CMOS.

In addition high power sources are difficult to modulate at rates greater than several hundred Mbit/s so Gbit/s class systems, which require both high power and high speed are difficult to implement. Achieving sufficient power density with high modulation rates, whilst minimising overall power transmitted requires the use of multiple sources.

The data rates available using wireless communications typically lag those available using wired systems by approximately an order of magnitude for equivalent systems[1]. Gigabit Ethernet to the desktop is available using cable, but wireless networks that offer throughput of greater than 100Mb/s to the user, such as IEEE 802.11(n) are only just becoming available. The demand for wireless bandwidth will continue, with multi-techniques such as Multiple-InputMultiple-Output (MIMO) required to obtain capacity in crowded low-frequency regions of the spectrum. In particular, a MIMO configuration with space-time signal processing isused to establish a robust wireless link, even under NLOS conditions. [3]

There is also a move to higher regions of the spectrum, with 60GHz systems being developed IR UWB communication system is sensitive to typical H/W not idealities beyond 60 GHz (Phase Noise, Timing Jitter, LNA and HPA distortions) and compares its performance with the ones of a more classical continuous wave communications system based on FSK modulation.

The exploitation of such higher frequencies represents the most suitable solution to develop a cooperative global information infrastructure in order to guarantee the so-called "Gigabit Connectivity" through aerospace links making such a radio segment a potential "backbone on the air" for global wireless connectivity. Therefore, the use of "beyond Q/V bands" will be the necessary condition to develop a multipurpose network, as integration of terrestrial and space systems, in order to support forthcoming high-data-rate services demands.

W band (75-110 GHz, respectively 4 -2.7 mm) could represent the answer to these needs due to the high bandwidth availability, short wavelength, reduced interference, small antenna size, allowing to propose many innovative services that need high-volume transfers.

Currently, however, the performance behaviour of any solution for data transportation over W band frequencies across the Troposphere is still unknown, since no scientific and/or telecommunication mission has been realised, either on an experimental basis or in an operating mode. Therefore, missions in W band have to be studied in order to perform a first empirical evaluation of the Troposphere effects on the radio channel.

The focus of the analysis and performance evaluation of future missions for the exploitation of W band too for satellite communications aiming at designing a full line of P/Ls operating in such a frequency range. [6], [7] The design and performance analysis of missions to perform a first empirical evaluation of the Troposphere effects on the W band radio channel represent the preliminary useful step for realising a "System of Systems" which is able to meet the highquality data transmission requirements for a large number of end-users and data-oriented services.

3 Conclusion

There is increasing interest in developing 60 GHz multi-gigabit datarate wireless systems for short range wireless communication in homes, offices and small coverage areas. Interest in this application has been stimulated by the rapid advances in Silicon based technologies where single chip solutions appear possible operating at gigahertz frequencies.

Standards are still under development and major technical challenges still exist to reach the price points desired to allow broad deployment and thus the large volumes anticipated for target applications. [8]

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