

# DESIGN OF NON-COLLISION BROADBAND WIRELESS CHANNEL FOR DELIVERING OF MULTIMEDIA INFORMATION

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**KEYWORDS:** *Wireless access, non-collision channel, multimedia information, radio relay.*

## ABSTRACT

The main objective of the paper is to introduce an idea of constructing a new technology for wireless broadband to deliver multimedia information with high efficiency. The needed fundamental and applied investigation for the development of the new technology and the design of the software and hardware tools on the base of this new technology are outlined. The technology will allow delivering multimedia information and services with data speeds up to 100 Mbps and can be applied to solve the last-mile problem.

## INTRODUCTION

Digital TV gives a possibility to provide a wide spectrum of new services. This means more programming choices for viewers and interactive video and data services. Digital broadcasting, customization of the TV content, increasing demand in interactivity and mobility – all of these factors insist on working-out of new technologies for multimedia information delivery. The delivering of the multimedia information and services can be improving by broadband wireless (Atakishchev et al 2004).

Recently the development of the wireless information networks are recognized as one of the major directions in the progressing of the telecommunication industry. On one hand, this is determined by the intensive growing up of Internet and on the other hand – it is due to adopting new progressive methods for coding, modulation and transferring of wireless information. Now it is obvious that the wireless broadband networks are beyond competition concerning the operativeness and efficiency of settling, mobility, price, and variety of possible applications.

One of the main advantages of the dynamically developing wireless technologies is in their potentialities for organization of “point-to-point” broadband radio channels that are profitably distinguished by their cost and productivity from the microwave radio relay lines.

The strong demand for broadband information delivery and access on the base of the popular standard *IEEE802.11x* is now satisfied by devices, that realize half-duplex regime and CSMA/CA (Carrier Sense Multiply Access/Collision Avoidance) method for multiply access, but this does not correspond to the modern requirements for the efficient transferring of fast expanding volumes of multimedia information. Sudden drop in the productivity evolves from the collisions that arise between packets, which are transferred in the opposite directions in the half-duplex channel.

Investigations on the increasing of the broadband wireless channels efficiency are conducted in many research and development world centers because of the current demand for wireless broadband information transfer.

For example, OFDM (as specified by the IEEE 802.11a) is a multicarrier modulation (MCM) scheme in which many parallel data streams are transmitted at the same time over a channel, with each transmitting only a small part of the total data rate. OFDM is used for wireless digital radio and TV transmissions, particularly in Europe.

OFDM is competing with CDMA (Code Division Multiple Access). While it has more robust transmission capabilities, it is currently more expensive to implement. Other techniques, such as UWB (Ultra WideBand) are also available. Cisco has developed a scheme called VOFDM (Vector OFDM).

When traffic volumes increase, distributing traffic across available networks makes sense to avoid congestion, delay and breakdown - and this requires developing of new instrument and software tools. Different transmission techniques are used to overcome wireless transmission problems and to improve the bandwidth. For example, in (Glinos et al 2004) the algorithmic issues related to the delayed multicast technique for video-on-demand delivery are examined.

The progress in the investigations results in the fact that the wireless broadband access is preferred by the users that change their connections from analogue lines while the

companies increase the speed of proposed channels. With the extended range of various mobile devices now it is more convenient to connect to the IP networks by wireless radio channel and not by cables which limit the mobility. At that, the IEEE 802.11 protocol ensures several megabits per second as transfer speed in all of its modifications.

Futhermore it is observed that the market demands on the multifunctionality of services. There is a need of ability to transfer the multimedia information during videoconferencing, to provide for VoIP and IMS services and the wide spectrum of other services in digital TV (VOD, games, media-adapters, pear-to-pear connections, etc.).

So the wireless networks devices with well developed communications capabilities and high speed of transfer of the multimedia information have to be developed.

### BUSINESS MODELS RELATED TO DIGITAL TV

Digital TV combines two specific types of communication channels: channels for TV broadcasting and interactive feedback channels. Creating of new value-added TV services can be ensured by designing of technical platform that facilitates new business possibilities (Daskalova and Atanasova 2007). The new functionality requires different degree of the feedback. For example, in (Atanasova et al 2007) a framework for interaction with semantic content describing multimedia information in Digital TV is considered. Interactive feedback channel allows the user to be an active participant in:

- Receiving additional information
- Playing an online game
- Video on Demand

Different user interactivity defines different services and these services can be provided by mobile tools that give wireless access for users.

Mobility is defining as the future of the Digital TV and multimedia data transfer. The mobile technology may make the Digital TV to be ubiquitous. The wireless technology can be implemented in remote areas where traditional networks are not feasible. And specifically wireless can be used in video broadcasting. New wireless broadband systems put the focus for multimedia traffic at comparable highbit rate of several Mbps.

Wireless technology can cover these new segments of the Digital TV business market while utilizing its existing infrastructure. Wireless is recognized as the cheapest way to provide multimedia information access, personalized content services and quality of service to the customers. The most beneficial direction is to develop and deploy wireless systems where they are unique: mobility and access over inaccessible areas.

Multi-service (All-in-one service, broadband Internet, VoIP, video conferencing, IPTV, e-commerce and surveillance) for broadband data transmission in the highly constrained networking environment requires an emphasis on networking and data protocol design as much as on wireless transmitter and receiver technology.

### NON-COLLISION BROADBAND CHANNEL

With the improvements in the bandwidth and associated speed it is now possible to transfer video and other forms of streaming data communications over packet-based wireless networks.

In packet-based networks such as asynchronous transfer mode (ATM) network or frame relay networks the communication is realized by packets delivering. However, during heavy traffic conditions, packets may be delayed and lost. This may cause poor performance of communications and multimedia data transferring. Collisions in the multimedia data (packets) transfer that is lost or delayed due to inadequate or unavailable capacity may result in gaps, silence, and clipping of video and audio at the receiving end (Vishnevskiy et al 2005).

Data packets are manipulating by queuing that is the commonly accepted tool for data communications flows.

Queuing is constructed to examine packet headers and to make decisions for routing data flows. But this techniques results in traffic delay or jitter. In wireless environment the queuing construction is used only to enable packet and radio-frame processing (Agamanolis and Bove 2003). For multimedia data delivery the overall added delay in real-time traffic should be held less than 20 milliseconds because of wireless systems are usually more bandwidth constrained and therefore more sensitive to delay than their wire line counterparts.

Also, there can be losses in speed in the packet-based networks because of the time needed for communication establishment.

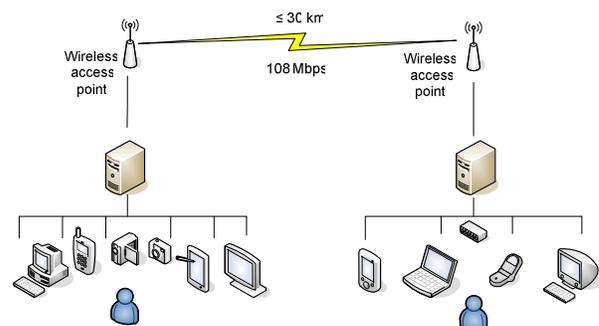


Figure 1: Wireless Network Distribution of the Multimedia Information

The bandwidth limitation of a wireless communication channel also has to be taken into the consideration. A bandwidth of a wireless channel (narrow or broadband) is always limited due to the limitation of available frequency spectrum. With this limitation, the only way to accommodate more users is to devise techniques that enable more efficient use of the given spectrum. That is exactly the reason why the latest the third generation (3G) wireless systems adopt Code Division Multiple Access (CDMA) for channel sharing since it is more efficient than other sharing techniques.

Traffic congestion, out-of-sequence data packets, latency and jitter may influence on the multimedia information delivery (Vvedenskaya and Suhov 2007). In addition, wireless access introduces high inherent bit error rates, limited bandwidth, user contention, and radio interference.

Thus, there is a need for a method and apparatus that can ensure and increase the quality level (Sharma, Ganesh, and Key) of the multimedia communications system.

This paper is aimed to introduce a concept and need of new algorithm for the optimal dividing of the radio bands and receiving/transmission channels into two channels working in opposite directions that excludes a possibility of collision and ensures significant simplification of the access channel mechanism (Vishnevsky 2007). Transferring only in one direction will avoid collisions between packets. Every transition direction will utilize a full duplex regime.

Thus the reduction of needed resources with sudden increase of the operating speed of the wireless channel can be achieved (Figure 1).

For the design of the non-collision wireless channel, it is also necessary to develop:

- a concept and new algorithms on the channel level that will use in maximal range the non-collision nature of the channel by excluding random impediments obstacles during transfer which are foresighted by CSMA/CA method for collision avoiding;
- control algorithms to govern the queue in the transmission with multiplexing of different kinds of traffic. The algorithms have to render limitations on the efficiency indices for every traffic category.

Beside that, new methods of adaptive control for reliability of the transfer are needed that regulate the bounds for the repeated transfer and duration of packets lifetime. The methods depend on the type of packets transferring from the multimedia traffic and take into account the bounds of efficiency criteria as minimal value of the traffic capacity and maximal admissible variation for the time of packets transfer (Vishnevskiy and Semenova 2008).

The new algorithms for the channel level have to prevent collision by avoiding random delays during transfer. These random hold-ups are used by the CSMA/CA method for collision handling. The proposed non-collision channel has to rule the queue of the transmission during multiplexing of the traffic with different categories. Furthermore, limitations on the performance measure for every traffic category have to be taken into account.

Computer simulations have shown that the proposed approach (Figure 2) can prevent the collisions in the broadband wireless and to increase the speed approximately by 30-40%.

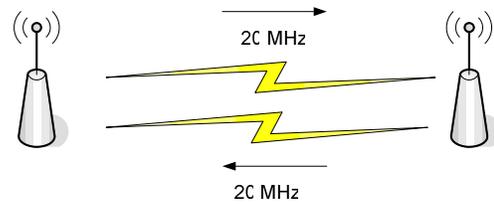


Figure 2: Non-collision Wireless Network

## EXPECTED RESULTS

To realize the idea to its industrial implementation, it is required to conduct research on the creation of new technology for high speed transfer of multimedia information. On the base of this research, the experimental sample model of the duplex channel apparatuses can be constructed.

The main results are expected in the field of investigations on:

- principles of high frequency tract that can provide possibility of full duplex work with minimal interference;
- schematic design solutions for realization of non-collision broadband wireless channel for multimedia data transfer;
- new methods and algorithms for minimization of fluctuation of the time for packet transfer and selection of optimal parameters for block confirmation and packet aggregation that are adaptive to changed conditions of wireless transfer of information;
- a set of mathematical and simulation models for estimation of productivity of non-collision wireless channel where the input traffic has a highest priority;
- methods for differential handling of packets during multiplexing of different types of the traffic.

The industrial model of the constructed gears of the duplex channel can prove the research ideas and simulation results.

The software and hardware realization of the new technology for the wireless transfer of the multimedia information will provide construction of the reliable non-collision channel with the nominal speed of the transfer up to 100 Mbps and the distance up to 30 km that will be better than existing solution. It has to be mentioned that the cost of the existing microwave radio relayed channels with similar characteristics are approximately tenfold comparing to the proposed solution.

## CONCLUSION

The Digital TV has its visible benefits. But the demanded interactivity and mobility insist on the development of new technology for wireless multimedia information transfer.

The goal of high-quality data transmission over a shared wireless broadband access system requires new and creative approaches to system hardware and software design.

An additional challenge is the problem of contention among users for limited wireless bandwidth. The system must handle service requests from multiple users in a medium of radio which is subject to interference and noise. This makes efficient bandwidth allocation difficult in existing schemas.

The proposed approach for the wireless network infrastructure may enhance the quality of services provided to the users by various communications systems (including data, voice and multimedia services).

The simplicity of the proposed schematic design and software realization of the devices constructed on the base of the proposed technology will provide low cost and high competitiveness on extensive market of the wireless appliances.

The research work will bring as a result the industrial production of the apparatus, instrument tools and appliances for the wireless non-collision channels. The need for such instruments is very high when multimedia data is transmitted and this technology will be helpful in resolving the last-mile problem and providing the mobility to the users.

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