MEDIAN: Wireless Professional and Residential Multimedia Applications

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Abstract: A newly proposed 150 Mbit/s ATM based indoor wireless LAN system is presented. The main operational characteristics of the system as well as the technological requirements and some basic solutions are discussed.

1. Introduction

The MEDIAN Project (Wireless Professional and Residential Multimedia Applications) is realized under the scope of the European Community Telecommunication Project ACTS (Advanced Communication Technologies & Services) under the Project number AC006. The Project involves twelve European partners reaching a budget of about 12 million ECU.

In this paper the main goals and recent development achievements of the MEDIAN system are briefly presented.

2. Objectives of the Project

The main objectives of the MEDIAN system are:

- development and future standardization of a high speed wireless customer premises local area network for multimedia applications in the 60 GHz range (with an throughput up to 155 Mbit/s) connected to the fixed ATM network.
- to implement a pilot system, which consists of a base station and two mobile stations providing a 150 Mbit/s duplex transmission
- to demonstrate the performance in real-user trials

3. Operational Description of the System

MEDIAN in his final evaluation stage will be a wireless broadband customer premises network containing all usage and maintenance functions necessary to operate as a local area network (LAN), metropolitan area network (MAN) or as a wide area network (WAN). The final MEDIAN system will be very flexible in terms of configuration and extension. It will be designed in a modular approach, which is explained as follows.

I. LOCAL Customer Premises Network (LCPN)

The main application will be a local CPN with different possibilities of configuration. These configurations depend on the user specifics like desired size of area of coverage, desired number of simultaneous users and the geographical environment of application. Four different scenarios of application are identified:

a) one MEDIAN Server Station (MSS) without Remote Stations (MRS)
b) one MEDIAN Server Station (MSS) with Remote Stations (MRS)
c) more than one Server Station without Remote Stations
d) more than one Server Station with one or more Remote Stations

II. METROPOLITAN CPN (MCPN)

A wide area of application of the final MEDIAN system is seen as a metropolitan CPN. Users might be local city governments, town-wide spread institutions like public transportation, universities, different business offices of companies. The terms *metropolitan* and *CPN* seem to be inherently contradictory. But this is not the case because only limited usage (case f) or even no usage (case e) of the public switching network with its different operators are necessary to perform a MCPN.

e) more than one of the LCPN connected using a private broadband link (one or more access points to the public world are possible)
f) more than one of the LCPN connected using a public broadband link (more than one access points to the public world are necessary)

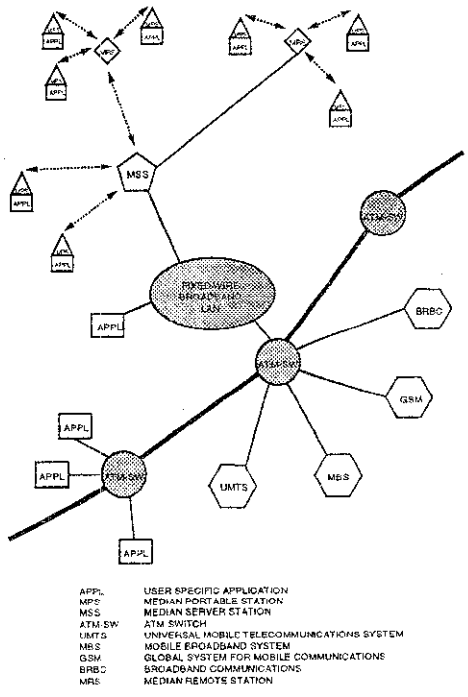

Fig.1 Scenario of Application

III. WIDE AREA CPN (WACPN)

This kind of application will have users in global operating companies, national governments or international institutions.

g) one or more LCPN and/or one or more MCPN connected using a public link.

An intermediate evaluation stage of the MEDIAN system will be just a wireless extension of a fixed wired broadband customer premises network, which can be a broadband LAN, MAN or even WAN. This phase of MEDIAN system will use all network specific functions of the so called *"Mother Network"*. At this time of development only a limited amount of network intelligence is needed in the MEDIAN server station, it will look like a translator from the *"fixed wired"* to the *"wireless"* language which is demonstrated in Fig. 1.

4. MEDIAN Subsystems

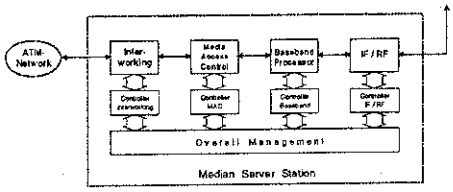

Fig. 2 Subsystems (blocks) of the Median Server Stations

Both Median Server Station and the Median Portable Stations consist of the same subsystems. These subsystems are interworking (IW), media access control (MAC), baseband processor (BBP) and IF/RF. The interworking subsystem will substantially be different for MSS and MPS, as well as the MAC subsystem. Baseband processor and IF/RF subsystems are the same for all stations in the case of high power portable stations. Low cost portable stations have simpler baseband processors, allowing smaller bit rates. All subsystems need controller connections which are linked to an overall management unit.

5. MEDIAN Demonstrator

The possible outlook of the MEDIAN cell (coverage area of one remote station) is presented in the Fig. 3 and Fig. 4.

The main objective of the MEDIAN demonstrator is to show the feasibility of high data rate transmissions up to 150 Mbit/s (net) over a 60 GHz RF-link in an indoor environment. The demonstrator will provide proof of the overall MEDIAN concept.

The MEDIAN demonstrator consists of two portable stations (MPS1), and (MPS2), supporting up to 150 Mbit/s and 34 Mbit/s data rate, respectively, and of a server station (MSS) capable of supporting the maximum bit rate. The MSS is connected via an ATM switch to the ATM network. The portable stations and the server station are placed in a MEDIAN Demonstrator Cell (MDC). MDC is defined as a cell where one MEDIAN remote station (or server station) can support the portable stations. There are no additional RF sources of 60 GHz signal in the close environment.

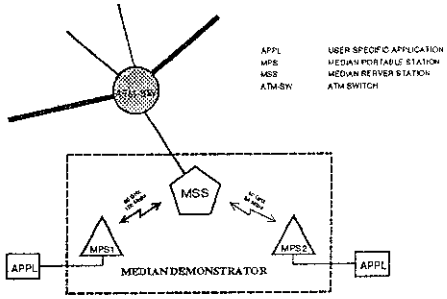

Fig. 3 MEDIAN demonstrator scenario

The MEDIAN demonstrator should provide (demonstrate) the:

- full duplex connection MSS to MPS1 at a maximum data rate up to 150 Mbit/s
- full duplex connection MPS1 to fixed ATM network via MSS at maximum data rate
- full duplex connection MPS1 to MPS2 via MSS at limited data rate (34 Mbit/s)

The practical realisation and final definition of the MEDIAN demonstrator cell depends on:

- utilized environment
- used antenna system
- hardware limitations (trade off cost /performance)
- power budget
- safety constrains

The MDC should represent a final MEDIAN cell able to fulfil the MEDIAN user requirements as close as possible. Working methodology for definition of MDC require iterative evaluation of the above mentioned factors.

The MEDIAN cell and the MEDIAN demonstrator cell have the rotation symmetrical look in general. The server station (or remote station) antenna are placed at the ceiling. The antenna height is 3 meters. The MPS antenna is expected to be placed at 1.2 - 1.5 m height.

The Median demonstrator consists of one Median Server Station, one full data rate Portable Station 1 and one limited data rate Portable Station 2. The sever station provides the connection to the fixed broadband network (B-ISDN) and the portable stations are linked to the user specific application.

6. System Characteristics

Frequency Band

A 1 GHz sub-band from 58-62 band (recommended by European bodies) is utilized for RF design. The relevant channel used for MEDIAN system is about 200 MHz.

Modulation

DQPSK-Coded Orthogonal Frequency Division Multiplex (COFDM) scheme is used for modulation. The usage of COFDM scheme is beneficial for the simplicity of the system (no equalization is needed) in the case of multipath

channel. However, due to the nature of the COFDM a linear amplification is required, working with a high CREST factor as well as a good synchronization. Additional problems as out-of-band emission have to be also considered. For the practical realization point of view higher level modulation techniques are not considered. That results in smaller spectral efficiency of the system, but it is not critical due to available band.

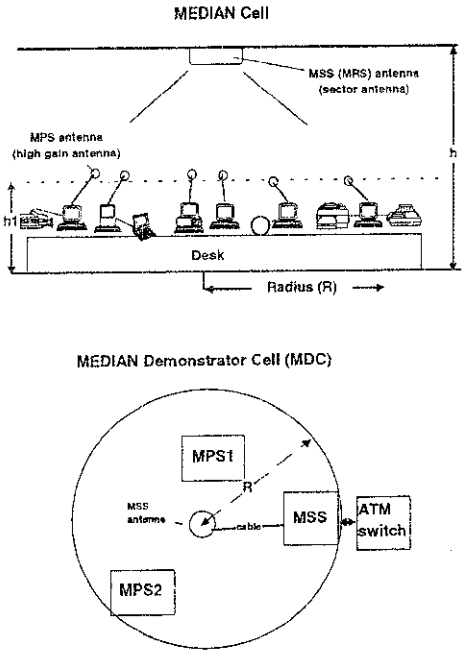

Fig. 4 MEDIAN Demonstrator Cell (MDC)

Coding

Various coding schemes are investigated as potential candidates for the MEDIAN system. They are analyzed according to the following criteria: the best BER performance in the case of measured 60 GHz indoor channel (omni directional antenna to omni directional antenna; horn antenna to horn antenna; omni directional antenna to horn antenna) of identified typical working environment, under influence of nonlinear amplification and nonideal A/D converters. The commercial availability of the high data rate components is also considered.

Access Technique

An Adaptive time division multiplex access scheme is proposed. The schemes allows the different data rates ATM packets assignment for MEDIAN portable stations.

Safety Criteria

A electromagnetic exposure is an important factor for user acceptance of the system. Nevertheless of considering the recommended limit exposure values [2] a system designer try to reach a mean power density level much below prescribed limits. Moreover, more sophisticated studies of the 60 GHz radiation influence are initialized by the MEDIAN project.

Standardization

The work in MEDIAN System will contribute to the future standardization of the 60 GHz band.

7. Technology

The practical implementation and user acceptance of the MEDIAN System require high performance of the system (according to the user requirement) and low cost manufacturing.

Concerning 60 GHz transmission, that implies the utilisation of MMIC components, which are small and cheap having almost the same quality as classic waveguide components. It can be expected to have well designed packed sub components of the whole 60 GHz MMIC RF parts in a couple of years, which suits with the evaluation dynamic of the MEDIAN System quite well. Commercial MMIC products are available at lower frequencies. Therefore it is expected to realise the RF parts of the demonstrator utilising classic discrete components. The most critical 60 GHz circuits are: linear HP amplifiers (required for COFDM scheme), high stabilised LOs and good quality LN amplifiers. The baseband technology require fast FFT chips and codecs, which are at moment conditionally available. For the system demonstrator certain functions such as the FFT/IFFT have to be implemented in parallel processing units. The optimal coding scheme can not be realised at the moment using commercially available components. Therefore the demonstrator will utilised well known block coding solutions.

8. Conclusion

An operational description of the newly proposed indoor communication system at 60 GHz, based on 150 Mbit/s ATM data transmission is presented. MEDIAN is planed to be a wireless extension of fixed integrated broadband communication networks (B-ISDN).

9. Acknowledgements

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10. References

[1] CEC-Deliverable MS2, "Draft System Design", AC006/MED/PAR/DS/P/006/, Bruxell, March 1996

[2] CENELEC European Prestandard, ICS 29.020; ENV 50166-2, January 1995