Broadband Wireless Access Systems

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Summary – The paper observes the variety of broadband wireless access systems (BWA systems). The view focus is on the fixed access systems, used to solve the "last mile" problem. The purpose of BWA systems where noted along with their services, structural properties, basic technical characteristics and an equipment array. A comparative system analysis was carried out.

I. Introduction

The fast development of the telecommunication market, especially in the field of information services (Internet, IP-telephony, virtual LAN, video-conferencing) and television, digital techniques introduction led to the necessity of large information flows maintenance, usually over 64 Kbit/s. To solve the "last mile" problem traditional technologies – copper and optic circuits (ISDN, xDSL, satellite technologies, modems in cable TV networks) are not always reasonable to use for the end-user. The more optimal in cost and information flows are the systems, based on broadband wireless access (BWA) – LMDS, MVDS, MMDS, BWS, WLL, PMP and oth.

II. Broadband Wireless Access Systems

Broadband wireless access systems have passed several stages in their evolution and are divided in systems with nomadic and fixed terminals. The first are GSM, CDMA, GPRS, UMTS, W-CDMA, CDMA-2000 (3xRTT), ETSI HIPERLAN2, WLAN technologies. The second group contains LMDS, MMDS, MVDS, BWS, WLL, PtP, PMP [1-12], and also local systems CTB [13] and МИТРИС [14-17]. They are also called Fixed Broadband Systems.

Let's observe such systems as LMDS, MVDS and their component parts Point-to-Point (PtP) and Point-to-Multipoint (PMP). Development of LMDS, MVDS technologies is carried out in several different projects at universities of Virginia, Ohio, Madrid, London, Ottawa [1,2,6] and the row of companies (Alcatel, Ericsson, SpectraPoint, Wavetrace, CableAml, NetroCorp, P-Com, Cisco, Motorola, Bosch, Siemens, Harris, Hughes and other).

All the systems differ with function and structure, equipment, software and, thus, parameters. There are also multi-layer (usually, two-layer) structures of LMDS (MVDS). On Fig.1 the two-layer LMDS CABSINET system is shown. Its peculiarity is the presence of Base Stations at two microwave frequencies – 40(30) GHz and 5.8 (2.4) GHz. This allows to increase the distance of the signal propagation comparing to one-layer LMDS.

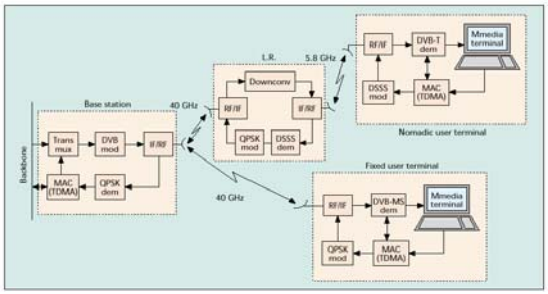

Fig.1. CABSINET Structure

An Alcatel BWA system [3] on the base of Alcatel 7390 и Alcatel 7385 – is the multipoint, local, cellular system with the high capacity (up to 34 Mbit/s in the 90^0 sector), which works 34 in the frequency 27,5 – 29,5 GHz with the distance range of 5-7 km. The structure of the system is shown on Fig.2.

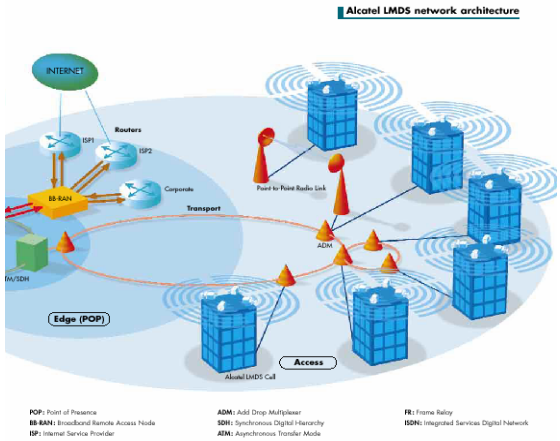

Fig.2. Alcatel LMDS Network Architecture

The basic system components are: digital base station (DBS), co-polarized base station (Co-Pol RBS), cross-polarized base station (X-Pol RBS), co-polarized radio terminal (Co-Pol RT), cross-polarized radio terminal (X-Pol RT), network terminal (NT), wireless digital base station IP (7385DBS), wireless antenna unit (7385AURE), wireless customer terminal (7385SURT). Base Station consists of RBS and DBS, and works as a hub, with the network terminal capacity up to 4000. Each transceiver with an antenna serves the sector of 90^0. Four RBS form a cell. BS provides considerable number of services in voice transmission and a high rate data exchange, supports E1, ATM (OC-3). Transmitter power is under 100 W. Due to coding and quadrature modulation technique the BER of 10^{-14} can be achieved.

Customer Terminal (CT) consists of antenna, radio terminal (RT) and a network terminal (NT). CT is

connected to the BS using the digital radiochannel. Each RT works with 8 network terminals in duplex providing 8 Mbit/s. CT enables 2 Mbit/s, interfaces E1, 10Base-T, X.21, POTS and IOBT for IP-telephony.

The Network Management Center (NMC) maintains the operation of the equipment where the system of network management is realized. The use of TDMA and ATM with the dynamic radio capacity redistribution enables to transmit more data bursts in the available bandwidth and to provide multiservice for the end user.

Broadband Wireless Access System of Ericsson MINI-LINK™BAS is designed on the base of a cellular coverage [4]. The system is realized using ATM and TDMA technologies with QPSK modulation and bandwidth of 28 MHz for a channel. The sector of 90^0 provides 37 Mbit/s for each terminal, what enables and effective transmission of bursts. The systems structure Point-to-multipoint (PtMP) is a moduled and a scalable one. MINI-LINK™BAS consists of the Radio Node and customer terminals (see Fig.3).

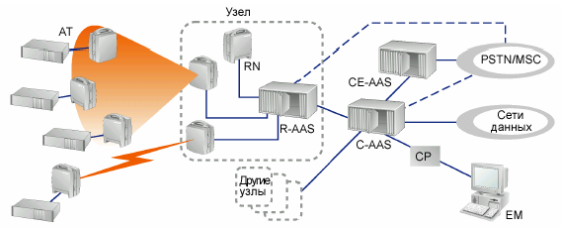

Fig.3. Ericsson Mini-Link™BAS System Structure

Indoors the Radio Node components are accommodated in racks R-ASS that provide information flow and local links in-between. Different equipment options are provided [4], which makes the system characteristics, such as operation frequency and data rate, to be flexible. Link between different block of the system are realized according to European Standards on Fiber-Optics SDH, PDH.

The management system provides the equipment configuration management, traffic channels switching, data logging for the equipment performance control.

MINI-LINK™BAS is used to organize robust data exchange channels for various business customers, service providers (PSTN, ISP), PBX, LAN-LAN.

An experimental LMDS system of the Polytechnic University of Madrid operates in the frequency range of 28 and 31 GHz (500 MHz bandwidth at 28 and 300 MHz at 31 GHz). The system consists of the head system, base station, management center, different customer terminals (Fig.4). It uses multi-access to the various types of data by means of various access decks and has 5 cells with the distance range of 8 km each using QPSK and 64QAM modulation It basically using the equipment of CableAml [5].

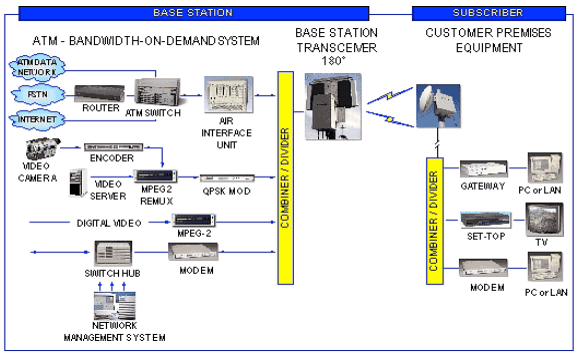

Fig.4. CableAml system structure

Base Station consists of a hub, modem, transceiver and an antenna. Terminal equipment includes the outdoor unit – antenna, transceiver and an indoor unit – modem, set-top box and oth.

The frequency platform operates one fixed bandwidth for downlink and another band for uplink channels for the symmetric QPSK-modulated flow rate of 2 Mbit/s and 16QAM-modulated 10 Mbit/s flow rate.

Platform Bandwidth-on-Demand is based on ATM and TDMA. The downlink for group of customers is 45 Mbit/s. For the uplink due to TDMA the data flow optimization is provided real-time.

Digital Video Broadcasting Platform is intended for television programs, QPSK and 64QAM-modelated, from different satellite transponders.

The system developed under to the COMMUTE project [6] is aimed for digital video broadcasting purposes at 40 GHz frequency range according to the technical standards for MVDS systems.

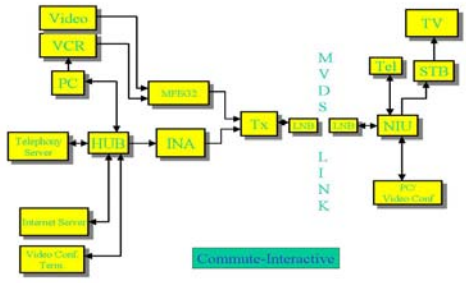

Fig.5. COMMUTE system structure

The project assumes the realization of 4 MPEG-coded TV-programs, IP-telephony, Internet flow, real-time Video-on-Demand. The system is based on the transmitter-receiver configuration, where transmitter gets data from different analogue and digital sources (satellite, fiber-optics, DSL).

Analogue signals are coded to MPEG-2 and are then multiplexed with data from other sourced. Modulated with QPSK and converted at 40 GHz these signals are then transmitted through a omi-directional or directional antenna. Customers receive the signal using a small dish (15 cm diameter) and a set-top box (see Figure 6). The equipment used is mostly manufactured by such companies as Marconi, Sony, Thomson, ComTel [6].

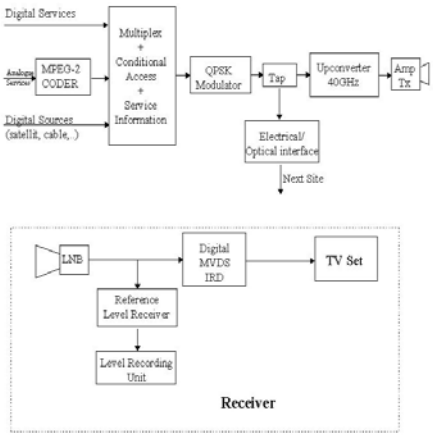

Fig.6.Transmitter and Receiver of the COMMUTE system

Broadband wireless system AlReach developed by Hughes Network Systems [7] (Figure 7) allows to realize to types of architecture: Point-to-Point and Point-to-MultiPoint using ATM and TDM. This system provides the Universal radio flows of up to 45 MBit/s, while using QPSK, 16QAM, 64QAM modulation at 24, 26, 28 GHz.

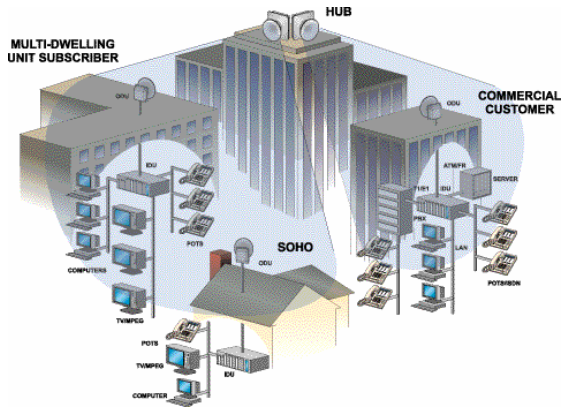

Fig.7. Hughes AlReach 900 system structure

Netro-Corp [8] broadband wireless solution is presented by two systems: AirStar System and Angel System.

First is the multiservice two-layer multipoint cellular system with base stations, customer access systems, network management system AirView and a CellMAC system for static multiplexing and high-effective data flow optimization (see Fig.8). It works with TDMA and QAM-modulation under SMTP-management and provides wide range of interface options. The operation frequencies lie in the 39 GHz range.

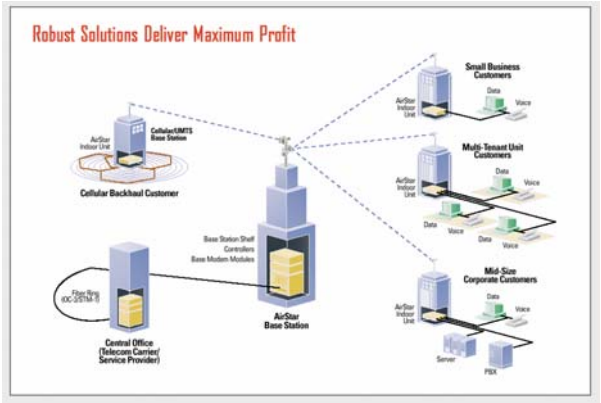

Fig.8. Netro-Corp Airstar System

Angel System is the second layer system which uses OFDM-technology in the 1.9, 2.3, 3.5 GHz ranges to provide VoIP and 10 Mbit/s data flow. It uses FDD duplexing, QPSK, 16QAM, 64QAM for up- and downlink channels.

Multiservice solutions of Harris [9] ClearBurst™GB and ClearBurst™MB (Figure 9) are the Point-to-Multipoint systems in 35-40 GHz range, based on digital radionetworks.

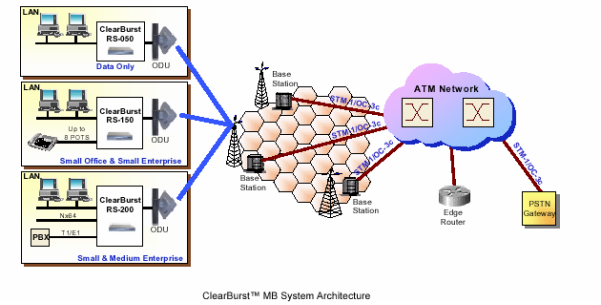

Fig.9.Harris Clearburst™GB system

Architecture of systems can be formed on the cellular principle and consists of base station, remote stations and various terminal components in order to realize wide range of customer services including high resolution digital video broadcasting. Wide range of equipment provides system flexibility which allows to alter the coverage angle (30, 60, 90, 180 degrees), performance and modulation techniques, operation frequencies.

In contrast to other systems, the Siemens (P-com) system [10] supports two access methods – TDMA and FDMA and provide the widest range of services, including LMDS, DSL, FrameRelay, VPN, PSTN, ISDN, Internet.

QuickStream – is a Point-to-MultiPoint system, which operates in the 10 – 40 GHz range and uses ATM-cell multiplexing, where the cell size is determined by the operation frequency, data flow and other requirements.

Quickstream consists of the main base station and many remote stations that are managed by network software (see Fig.10).

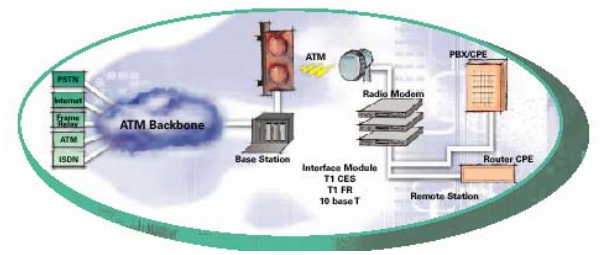

Fig.10. Siemens Quickstream system

Base Station exploits sector directional antennas (from 15 to 90 degrees), outdoor unit (ODU), indoor unit (IDU). ODU consists of antennas and transceiver part, IDU has modulators, demodulators, access controllers, etc.

Every remote station also consists of ODU and IDU parts. Remote IDU has an ATM interface, connected to ATM service modules, multiplexers and xDSL equipment, FrameRelay and all electronic equipment including modulators, digital multiplexers, encoders, decoders, oscillators and other.

Due to the support of modulation technique altering (QPSK, 16QAM, 64QAM) Quickstream provides the optimal band for every customer both for downlink and for uplink. Network software provides system management and is linked to Siemens management networks.

Quickstream supports up to 200 MBit/s on sector, 40 MBit/s on each remote station and overall capacity can reach up to 4.8 MBit/s.

SpectraPoint™ Model 2200 is the first broadband system point-to-multipoint (PMP) that is purposed for the new worldwide networks [12]. LMDS on its base operates at 28 GHz and is designed on a cellular bases consisting of base stations, customer premises, network interfaces, software management system (see Fig.11). LMDS provides various services at the distance range of 3-5 km up to 80000 customers per base node. This is achieved by using the generalized access decks and the dynamic management of an uplink (45 – 155 Mbit/s) and a downlink (2 – 25 Mbit/s) streams with a QPSK modulation.

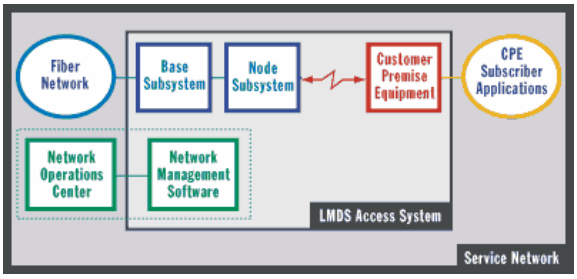

Fig.11. SpectraPoint Model 2200 system

III. Conclusion

The systems observed differ with services they provide, their structure and parameters. The structure is generally a multipoint network, one- or two-layered. The system and components structure choice depends on the standards used, network protocols, access methods, modulation and coding techniques.

The promising technologies for the use in BWA systems are ATM and IP protocols, TDMA (TDD, ATDD), FDMA access methods, VOFDM and COFDM technologies, QPSK and nQAM modulation methods. Encoding frequently uses the convolutional coding and Reed-Solomon/Trellis-coding.

The component parts of BWA systems are radio units, situated outdoors; processing blocks that perform the switching, coding and modulation; network equipment – hubs, routers and the management software. The quality of these components realization influences on the services provided by the system. This explains the necessity of the systems structure, parameters and characteristics optimization.

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