New Aspect on Wireless Communication Networks

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***Abstract*—** This paper provides a detailed picture on computer networks and especially on wireless networks, focusing on specific characteristics of wireless systems. By using MIMO technology (Multiple Input Multiple Output), network logon ca be realized at distances much greater. The use of antennas allows reception and transmission of multiple data streams simultaneously, and the router gives a much better quality of data transmission and added safety. For network security is available WEP encryption on 64 or 128 bits. Technology and wireless services now offered by manufacturers and retailers are moving quickly to satisfy all communication needs. Requests for services and improved functionality, both in public domain and in the business domain, led to the development of wireless technology to offer type services of "anywhere / anytime" for transparent interconnection of voice / data / video with existing network and Internet access through service providers.

***Keywords*—**Wireless networks, IEEE standards, MIMO technology

I. Introduction

A wireless network provides users the opportunity to communicate and access information without using cables. This provides freedom of movement and ability to extend applications in different parts of a building, of a city or almost anywhere in the world. In most cases, wireless networks transfer data such as e-mail messages or files, but their improved performance has led to the opportunity to achieve and audio and video communications. Wireless networks use radio waves and at the infrared as a medium of communication between users, servers and databases.

Because more users can simultaneously send information's on network, data must be fragmented into small units and easier to handle. These units are called „packages" or „frames". Packages are the basic unit in networks. If data are fragmented in packets, individual transmissions will be accelerated so that each computer on the network will have many opportunities to transmit and receive data. Structurally, the packages may contain multiple data types including: information (messages or files) or certain types of data control commands for the computer (such as service requests). Components of package are grouped into 3 sections according to Fig.1.

Header	Data	Postamble

Fig.1: Components of package.

Historical and technical standard for the Internet is TCP/IP (Transmission Control Protocol/Internet Protocol). The TCP/IP model was developed by US DoD (US Department of Defence) in need of a network that could survive in any conditions. Computer networks are obtained by interconnecting computers under the network management operations run by the processor specialized and logical by a communications software installed on a network. A computer network is a set of autonomous computers interconnected through communication environment to ensure sharing by a large number of users of all physical and logical resources (the basic software and application) and information (databases) available to all networked computers. Medium communication that connects computers of physically consist various types of cables: coaxial cable, fibber optics, phone line, etc, of wave (guide wave) with specific frequency bands or even satellite communications [17], [21].

Network topology is the study of the arrangement or mapping of the elements (links, nodes, etc.) on a network, in particular physical interconnections (real) and logical (virtual) between nodes (Fig. 2). Mesh topology is a network that is designed for transporting data, instructions and voice transport services through network nodes. Because this topology we dispose of connections continue even there exist damaged or blocked connections. In a mesh network where all nodes are interconnected the network is called fully connected.

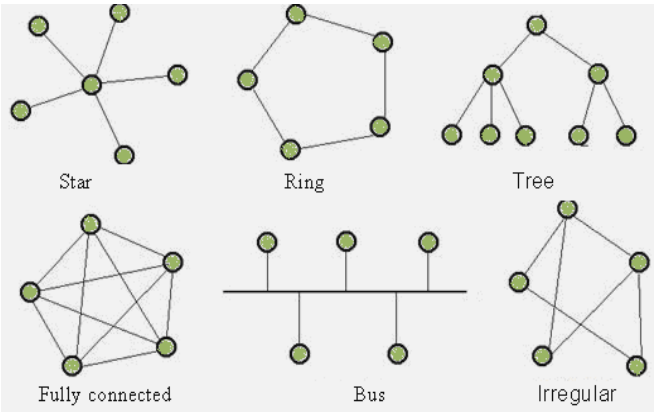

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Fig. 2: Computer network topologies.

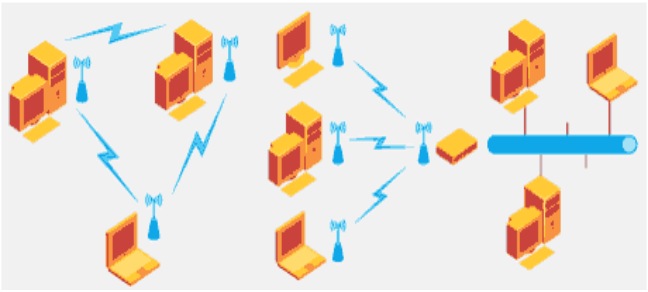
A Wireless Local Area Network (WLAN) is a flexible data communication system used as an extension or an alternative to a LAN cable into a building or a group of buildings nearby. Using electromagnetic waves, wireless device send and receive data through the air, eliminating the need for cables and making a mobile LAN wireless network.

Wireless LAN technology has been named by analysts and opportunity to revitalize the IT&C market. Integrated wireless networks allow not only insurance of greater efficiency and strategic competitiveness, but and a unitary and performance management. Instead of twisted cable (UTP), fibber optic or coaxial cables which are found in the composition of most computer networks, wireless networks transmit and receive data via electromagnetic waves. LAN active components convert data packets into radio waves that are transmitted directly to other wireless devices or by an access point which serves as a bridge (gateway) between wireless network and wired network.

They are two ways of achieving a wireless network:

Ad-hoc – connect multiple computers together. No connectivity with a wired network or the connection to the wired network is made through a computer with dedicated software. Generally is used for a small number of computers located in a small area. Each computer is connected to the other without the need for other.

Infrastructure – communication is done through an active device called access point. A connection between two computers is made through the access point where are connected each computer. This procedure allows a large range of coverage by using multiple access points connected. It is also the preferred working mode if is desired interconnection network with a wired or wireless network between a large number of wireless clients [12].



a) b)

Fig. 3: Ways of achieving a wireless network:
a) ad-hoc; b) infrastructure.

WLAN use electromagnetic waves of radio fields (RF) and infrared (IR). The first type is the most common because radio waves pas through walls and other solid objects, while the IR radiation, a light can not penetrate opaque objects and has a much smaller range. In most cases it is necessary to create a connection between the WLAN and LAN. This is done by so-called access points. An access point is a transmitter/receiver radio connected to a LAN cable. It receives stores and transmits date from/to devices in the WLAN and the LAN and has a range running from 30 m to 300 m. Compared to a traditional LAN, using a wireless network brings significant advantages:

- link is by the air, through radio waves. I will never happen as someone to prevent of a wireless network. It's like you have a switch, the difference is that the wires are invisible;
- user no longer depend on cable pulled in office, are free to move anywhere within the coverage;
- maximum number of users is significantly higher than using a switch in a network cable, conventional;
- a wireless network offers compatibility with the latest technologies in IT&C. For example, you can connect PDAs, laptops, the latest models of mobile VoIP, etc;
- if the headquarters moves, the wireless network can move at the same time an does not require major changes to the new location (the money used for conventional network cabling is lost when the headquarters moves);
- a wireless network is ready for use faster than a conventional (if a wiring can take days or even weeks, a wireless access point may be ready for operation in a few minutes).

The concept transposition of "wireless communication" in reality involved vision, perseverance and above all, optimism. In a relatively short time, wireless communications have evolved from novelty status to an integral part of everyday life. The question that now imposes is: "What are the possibilities?" Responses generates a growing demand for us, sophisticated wireless services that justify the fact that we are moving towards a converged world -voce/date/video.

The standard is defined as a document, established by consensus an approved by a recognized organization that provides for common use and repeated use rules, guidelines or characteristics for activates or their results in order to obtain the optimum degree of order in a certain context. IEEE 802.11 **(**IEEE - I*nstitute of* E*lectrical and* E*lectronics* E*ngineers***)** was initiated 1990 and completed in 1997 to cover the networks that provides wireless connections between base stations, portable and on the move on the local area. The standard provides rate 1Mb/s and optional 2 Mb/s on the rays of 25-300 m. IEEE 802.11n is an IEEE wireless standard that significantly improves the passing speed and the coverage. Is the only standard that operates in both band 2.4 GHz and 5 GHz and the first model that standardizes the use of MIMO antenna (Multiple-Input, Multiple-Output). This is compatible with the old standards, which means that an 802.11n device ca communicates and work with old 802.11 equipment. 802.11n standard defines a number of characteristics with the role of increasing the speed, coverage, efficiency of transmission and rehabilitee of the channel communication. Such as: OFDM (Orthogonal frequency-division multiplexing), binding channel, beam forming, frameworks aggregation, multiple paths.

To design a reliable wireless network must take account of the efficient use of the electromagnetic spectrum from the area. Interferences, regardless of their type, influence negative data transmission, which lead to low reliability of wireless transmissions compared to those achieved by wired infrastructure.

With the total elimination of the interference, or cancellation of the negative effect they have on

communication, data transmission should be as reliable as a transmission cable, and having at the same time the advantage of mobility. On these considerations are based transmission technology on spectrum distributed that eliminates the disadvantages of a regular radio broadcasting by combining the useful signal with a pseudo-random sequence and "spreading" it on a frequency band higher than the band that would be occupied thought a classic method of modulation (as block diagram in Fig. 4).

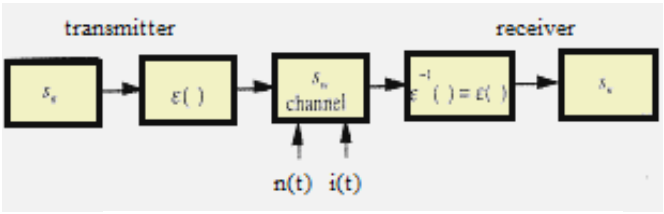


Fig. 4: Explanatory block diagram for transmission in the distributed spectrum.

COFDM technology was designed specifically for indoor wireless networks and offers much higher performance compared to spread-spectrum technology. COFDM works by splitting a high-speed data carrier into several sub-carriers of lower speed, which are transmitted in parallel. Each high-speed carrier has a bandwidth of 20 MHz and is "broken" in 52 subchannels, each with a bandwidth of about 300 kHz. COFDM uses 48 of these subchannels for data, while the remaining four subchannels are used for error correction. With 48 channels transmitted in parallel, resulting a transfer rate of 54-Mbps.

Similar to wired networks, wireless networks facilitate communication activities such as transfer files, peripherals sharing, Internet access and e-mail, access to databases shared, infrastructure for VoIP and Video Conferencing. Radio networks for data transmission provides unquestionably several clear advantages over wired versions: mobility, flexibility, scalability, very short time of installation and expansion, increased reliability and availability (through the existence only of network nodes and not through the existence of difficult pathways monitored and managed).

Do not forget that there are cases in which communications can be achieved only through a radio network, namely: industrial or public campuses (factories, airports, stations, etc.) that we can not find safe routes for cables, crossing barriers (railroad, highways, bridges, lakes, forests, etc.), difficult historic buildings wired, working groups organized ad-hoc at conferences, fairs, exhibitions and others.

Solutions already devoted in the 2.4 GHz band, provide on the same communication infrastructure data, voice, multimedia transmissions. With the evolution of wireless technologies have increased the maximum distances that can be made radio links, transmission quality, flexibility and security level.

The benefits of wireless solutions are reflected in a few keywords:

speed - wireless connections provide transport capacities up to 400 Mbps (Gigabit Ethernet compatible)

distance - if a radio link point-to-point can reach up to 35 km depending on the location ,and range of point-multipoint cell may reach to 10 km (maximum distances depend on the local radio regulations),

low-cost - wireless access solutions have the lowest cost of installation and maintenance and offers the highest level of performance compared with other broadband solution,

security - complex mechanisms for authentication and encryption algorithms ensure a high level of security necessary current applications.

To these are added an essential element, know-how of the designer, resulted in professional services specializing in wireless networks: technical and economic projects, site survey, analysis of radio spectrum, visibility analysis, planning and optimization of channels used, analysis of transport capacity and bandwidth requirements, studies of the route and setting repeating points, installation and configuration of wireless terminals, the design and manufacture of support structures, optimizing network management, security audit etc.

II. 802.11N FEATURES

802.11n standard defines a series of characteristics with role of increasing speed, coverage efficiency of transmission and reability of the channel communication [7], [9]. [10]. To ensure the compatibility with previous, 802.11n has to accept three modulation techniques at the physical level, utilised by the old standards: DSSS (Direct Sequence Spread Spectrum), CCK (Complementary Code Keying) and OFDM (Orthogonal Frequency-Division Multiplexing). 802.11n is the first from 802.11 standards incorporating the use of MIMO antenna design that can significantly increase the communication speed and coverage. Also, 802.11n incorporates a series of other features in support of superior:

802.11n improves the OFDM physical standards used by 802.11a/g standards. These improvements increase data speed for a single stream from 54 Mbps to 65 Mbps. Only 802.11n equipments can benefit from the speed of 65 Mbps.

Biding channels: previous 802.11 standards use only a 20 MHz channel, but 802.11n can link two channels together to form a dual-channel band with of 40 MHz. Doubling the bandwidth of the channel is an very important feature of 802.11n. SDM (Space-division multiplexing): 802.11n equipments an divide a transmission stream into four separate streams (called „spatial streams"). Each spatial stream is transmitted through separate antennas. More spatial streams means a higher speed of data because through the same channel can transmit more information.

Beam forming: is a technique that focuses radio signals directly tots the antenna destination. When radio signals are focused, the receiving antenna receives a higher energy signal. Beam forming improves coverage and interference tolerance.

Frames aggregation: frames aggregations allow transmission of several frames pached into one larger. So this increase network efficiency in mix mode by increasing the percentage of time when 802.11n equipment use channel, compared with older equipment.

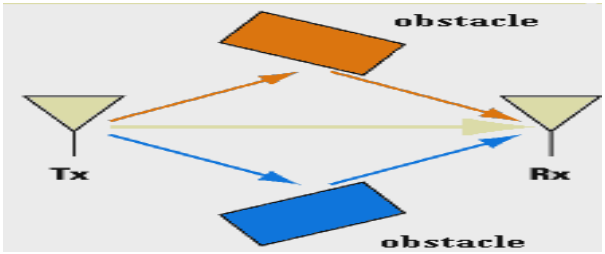
Economy MIMO energy: low feature energy MIMO, do this temporary by use only a single antenna.

RIFS (Inter-frame spacing reduced) allows a station to transmit in bursts frameworks, exploiting to the full access to communication channel.

Tab. 1: IEEE 802.11 specifications.

Approved standard	July 1999	July 1999	June 2003	Not yet ratified
Maximum speed data	54 Mbps	11 Mbps	54 Mbps	600 Mbps
Modulation	OFDM	DSSS or CCK	DSSS, CCK or OFDM	DSSS, CCK or OFDM
Radio Frequency band	5 GHz	2.4 GHz	2.4 GHz	2.4G Hz or 5G Hz
Number of Spatial streams	1	1	1	1, 2, 3 or 4
Channel width	20 MHz	20 MHz	20 MHz	20MHz or 40 MHz

Multiple paths: Italian scientist Guglielmo Marconi made the first tests in 1896 what showed that radio waves can pass beyond the horizon line. The initial discovery of the NLOS transmission (Non-Line of Sight) led to extensive research of multiple communications on multiple. Multiple paths is the phenomenon that occurs when radio frequency signals reflected from objects found in the path of the transmission channel between transmitter and receiver (Fig. 5a). Multiple paths causes' interference, attenuation and phase shift of the original signal. Long time, multi–paths effects (Fig. 5b) were seen as sources of signal degradation, which should be considered when designing a system wireless.



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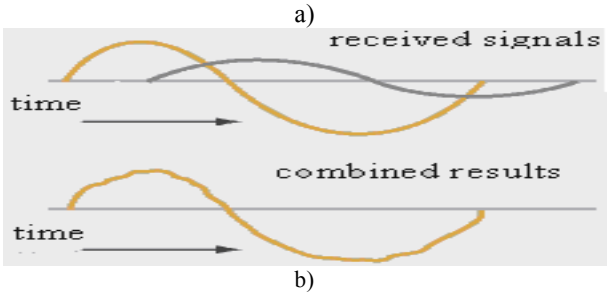


b)

Fig. 5: Explanatory: a) multiple paths; b) effects of multiple paths.

In 1993, to counter the effects of transmission on multiple paths, Arogyaswami Paulraj and Thomas Kailath proposed the concept of using spatial multiplexing MIMO antenna model [1], [2], [5]. Then, in 1996, after 100 years of Marconi's first tests, Greg Raleigh (PhD student at Stanford) and Gerard J. Foschini (engineer at Bell Labs), separately, have developed new approaches to MIMO technology, which were the basis for 802.11n [3], [4].

Methods of security. Wireless networks are relatively less secure than wired network because of easier access of unauthorized persons found in coverage areas of access points. But there are several methods of security, some less powerful and some that may provide even greater certainty than a wired network.

1) Hide SSID (network name). Theoretically this security measure does not allow displaying network name when someone scans as wireless networks.

2) Access Control List (ACL) is defined by a list of MAC address (Media Access Control) of the Access Point take into account when establishing a connection with a client.

3) Wired Equivalent Privacy (WEP) is a medium-level security method that uses RC4 encryption algorithm. This method is better than the above but not sufficient.

4) Wi-Fi Protected Access (WPA / WPA 2) is a powerful technology for secure wireless networks. Of all the solutions to secure wireless networks presented so far based on the WPA (1 or 2) are most effiency. The major difference between WPA and WPA2 consist in encryption algorithm used. For WPA is used TKIP (Temporal Key Integrity Protocol) and for WPA 2 is used CCMP AES (Advanced Encryption Standard - Counter Mode CBC - MAC Protocol).

III. Multiple-Input, Multiple - Output Technology

A. *Description of technology*

Technology Multiple-Input, Multiple-Output (MIMO) is a technology that uses multiple antennas on the sides of transmitter and receiver (MIMO technology is called the technology "smart antenna"). MIMO exploits the fact that radio frequency signals usually are reflected by the objects found in their way generating the phenomenon called multiple path. MIMO uses a technique called spatial multiplexing that transmit multiple data streams at the same frequency, but through different spatial channels. MIMO take transmission over multiple channels and converts from a shortfall in benefit. MIMO make a channel more effective because a spatial multiplexing increases the speed ratio baud / hertz. "Multiple-input" component of MIMO means that a MIMO WLAN equipment sends two or more radio signals to multiple antennas, and "multiple-output" means that two or more radio signals to several antennas, and "multiple-output" means that two or more radio signals coming from multiple antennas and reach the radio equipment [8].

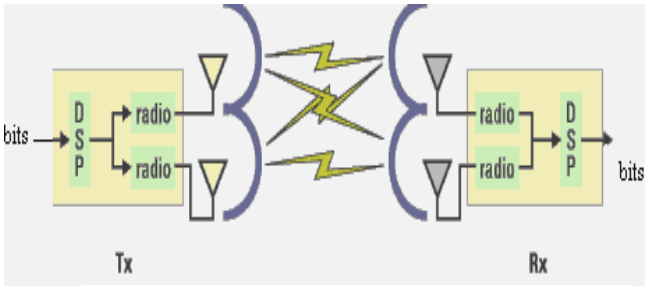


Fig. 6: Explanatory on the multiplexing technique used in MIMO technology.

MIMO is a significant innovation and a technology which has been adapted to work for a few more wireless standards beside the 802.11, such as 4 G standards. MIMO uses a technique called spatial multiplexing to transport two or more data streams simultaneously on the same frequency channel. Spatial Multiplexing underlying 802.11n standard and has the potential to double the bandwidth of the channel when two streams of data are sent. Generating multiple spatial streams requires multiple transmitters and receivers and different ways, unrelated for each stream that is sent through the environment (Fig. 6). Multiple paths can be obtained using polarized antennas or multiple paths in channel. Multiple paths are a common phenomenon in wireless channels, where the signal is reflected by walls and objects. Reflections that combine distorts the signal receive. While the old standards - 802.11b - working to prevent the effect of multi-path, MIMO multi-transmitters use multi-paths as advantage. Receivers in MIMO systems are able to process information very well from each multi-path, removing the mixture of components out of phase which sometimes produce distortions in the signal. A MIMO system has a certain number of transmitters N and a certain number of receivers M (Fig. 7). The signal from each of the N transmitters can reach each of the M channel receivers on different channels. MIMO works best if these paths are distinct spatial, resulting in reception of signals that are uncorrelated. Multi-paths helps channels decorrelation and thus increase the efficiency of spatial multiplexing [12].

Fig. 7: System MIMO NxM.

B. Technology features

b1) Wireless performance is usually characterized by graph "crossing speed and area covered". Speed of movement is usually represented on the y axis, and the covered area on the x axis in a Cartesian coordinate system. Crossing speed will decrease as the receiver move away from the transmitter, as the area covered increases. Fig. 8 shows this curve for three configurations of access points: 802.11g (gray), 802.11n with 2x2 MIMO (dark blue) and 802.11n with 3x3 MIMO (blue).

Curves show that as the speed decreases, the distance increases. Chip manufacturers are expected to 802.11n speed crossing to be greater than at least five times over the 802.11g, and coverage of two times greater. However, it is important to note that actual performances are dependent on many factors, including environmental interferences, system design of the network and structure of buildings. Therefore, 802.11n performance may vary from one firm to another, from one building to another [13], [14], and [20].

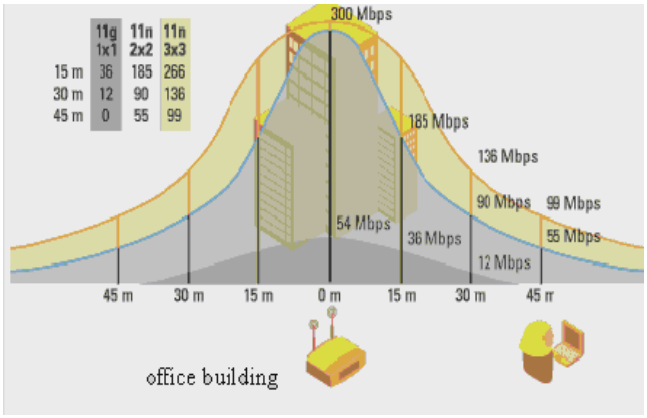


Fig. 8: Graph crossing speed - area covered.

b2) 802.11n equipments can operate either in the 2.4 GHz band or in the 5GHz. Tab. 2 shows ranges of particular frequency bands, the use and regional allocation.

Tab. 2: 2.4 GHz vs. 5 GHz.

Frequency band	Use, Regional allocation
2.403-2.483 GHz	802.11b/g, 802.11n, Bluetooth, microwave ovens. ISM band in the USA, available in almost all countries
5.150-5.250 GHz	802.11a, 802.11n, 802.16 fixed / mobile USA (U-NII), Canada, Europe, Japan, China
5.250-5.350 GHz	802.11a, 802.11n, 802.16 fixed / mobile USA (U-NII), Canada, Europe, China
5.470-5.725 GHz	802.11a, 802.11n, 802.16 fixed / mobile USA (U-NII), Canada, Europe, Central and Latin America, Middle East, Asia
5.725-5.825 GHz	Cordless phones, 802.11a, 802.11n, 802.16 fixed / mobile. U-NII band in USA

b3) Operating Modes: an 802.11g device can be configured to operate in three modes: compatible mode with the old standards, mixed mode and Greenfield mode Compatible mode configure a station to operate like an 802.11a or 802.11g device. In this way, 802.11n station is presented as an 802.11a / g equipment. This mode can be used when a company buys new 802.11g/a/n equipment, but she does not want to migrate to 802.11n operation. Mixed mode configured the station to function as a 802.11n equipment, but must coexist with old 802.11 equipment on the same channel of communication. In the mixed configuration, 802.11n should safeguard the older equipment 802. 802.11n preamble looks like one 802.11g. This contains a small field data indicating the time in which the transmitter emits. 802.11g equipments must comply with this information and wait for 802.11n device to end transmission before using the channel. This mechanism is very

effective because the additional information added to the preamble consumes only 8 microseconds, ensuring compatibility of 802.11g. Greenfield mode assumes that in the network works only 802.11n stations therefore is not necessary any protection. Greenfield mode offers the highest performance possible, higher than that of mixed mode. The stations can use channels with double-width without to adapt at the old devices which use only a single width channel. The problem with the Greenfield mode is that if a non-802.11n equipment reaches the coverage of 802.11n which operating in Greenfield mode, 802.11n equipment will not protect the traffic from the old device and will confuse with the packages of the old standard. Most antennas of the access points of the firms and homes are an omni-directional antenna that radiates energy uniformly in all horizontal directions. Moreover, a directional antenna focuses most of the energy in one direction (Fig. 9).

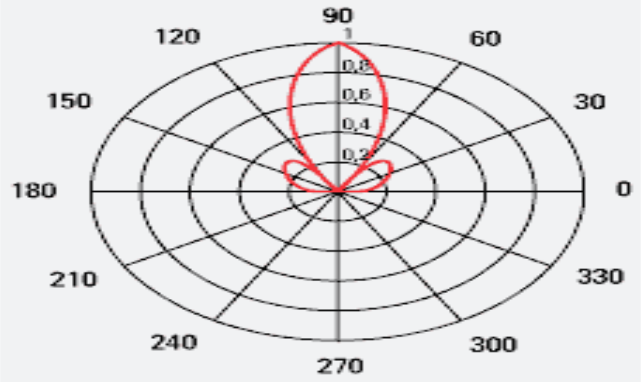


Fig. 9: Radiation pattern of a directional antenna.

b4) Beam forming formation (TBF) is a technique which uses directional antennas to increase coverage of wireless systems and indirectly to improve crossing speed. TBF uses a series of transmitting antennas which have the same signal, except that the magnitudes and phases are adjusted at each transmitter, so resulting a concentrated capabilities (notebook, desktop, PDA, Play Station) that is a laptop with plate Integrated wireless and a desktop on which beam. If the destination of receiver is known before, TBF will direct the beam in that direction. TBF focused energy, and therefore improves the signal strength witch reaching the receiving station [11].

b5) There are two types of frames aggregation: transport aggregation and packet aggregation. 802.11 stations of the older type (e.g. 802.11b) need more time to transmit a frame of the same size frame of the same to an 802.11n station, because the transmission speed is smaller. As a result the old stations consume a quantity of time in excess on wireless channel compared with stations 802.11n. 802.11n standard is trying to compensate this loss by allowing 802.11n equipment to put together in a single frame; more frames (Fig. 10).

Transport aggregation combines several IP packets in a single frame 802.11n with a single CRC for the nivel control of medium access (MAC). Packages aggregation combines several individual frames 802.11n in a single frame aggregate 802.11n. Each 802.11n individual frame has its own CRC.

b6) Inter-frame spacing reduced (RIFS) reduced the delay between transmissions of frames, increasing efficiency for OFDM case. RIFS allows a station to retain control of the wireless channel for transferring extra frames. RIFS is a designed technique for sending in bursts frameworks.

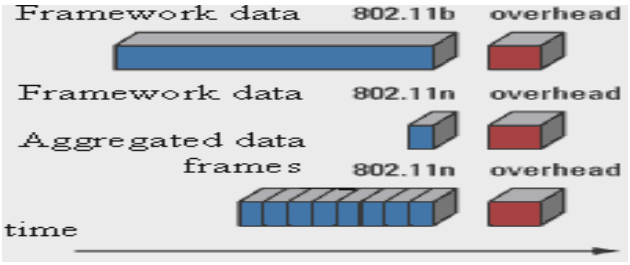


Fig. 10: Frameworks aggregation.

b7) In a MIMO system there is two ways of saving energy. MIMO energy saving reduces power consumed by using a single MIMO transmitter [19]. This mode saves energy by switching off one or more MIMO transmitters. Saving energy with MIMO is different from U-APSD mode (Unscheduled Automatic Power Save Delivery) 802.11. U-APSD is used mainly for Wi-Fi mobile (Wireless Fidelity). U-APSD off all transmitters and receivers for a predetermined period of time. During the U-APSD mode, the access point must temporarily store the designed frames. When the station resumes the service access point transmit to the station the frames temporarily stored.

IV. Wireless Network Configuration

Wireless networks can operate in ad hoc mode or infrastructure mode. It will discuss only about infrastructure mode. Infrastructure mode is used to connect computers with wireless network adapters (wireless) to a wired network, using a wireless router or access point. To make a wireless network we need a wireless router or Access Point (in this case a Linksys wireless router WRT54GL [15]) and equipments with wireless connection capabilities (notebook, desktop, PDA, Play Station) and in special a laptop with wireless plate integrated and a desktop on which I attached a wireless adapter that connects through via USB to desktop.

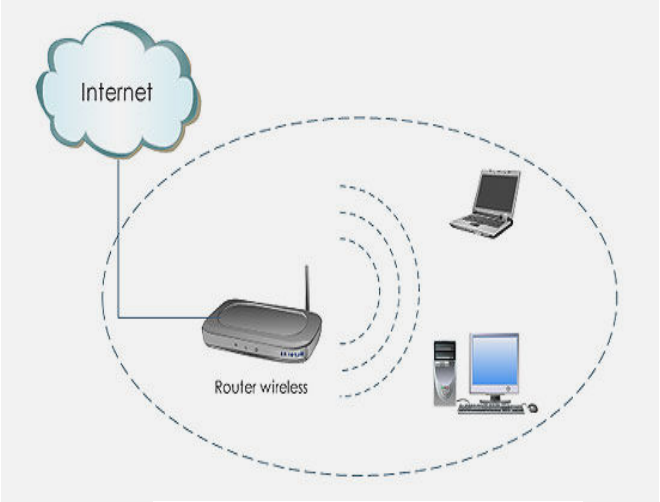
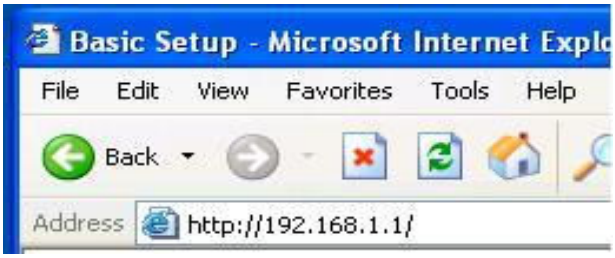


Fig. 11: Explanatory on wireless network architecture.

In the first stage using a computer connected to the router via cable is accomplish Internet connection settings and then the wireless connection settings (Fig. 11).

To configure a router is used, for example, the Linksys WRT54G wireless router. This router supports the 802.11g standard and is compatible also with 802.11b standard. Using a computer connected to the router via cable is accomplishing Internet connection settings. This will use Web-based Utility to configure the router. Utility can be accessed via web browser using a computer connected to the router. For the basic settings of a network, most users use these two options:

- Basic Setup (basic configuration), in the setup screen are introduced basic settings provided by your ISP.
- Management, is clicking the Administration tab and then the Management tab. The router's default password by factory is admin. To secure your router change the default password. There are seven main tabs: Setup, Wireless, Security, Access Restrictions, Applications & Gaming, Administration and Status. Additional tabs will be available after you click on one of the main tabs. To access Web-based Utility launches Internet Explorer or any browser and enter the default router IP address, 192.168.1.1, in your browser, and then press the Enter key. A window requesting some password to enter in basic settings of the router (Fig. 12a). Leave the user name field blank. The first time when you open Web-based Utility, use the default admin password (it is possible to set a new password from the Administration tab management tab of display), then click on the OK button (Fig. 12b).



a)

b)

Fig.12: Explanatory router programming:
a) entering IP address; b) set password.

V. DESIGN AND IMPLEMENTATION STEPS OF A WIRELESS NETWORK

Wireless networking achievement for streaming video can be make following next steps:

- Survey site.
- Network design and radio design.
- Execution of necessary infrastructure and mechanical installation - supports.
- Installing video cameras used for surveillance.
- Installation of wireless equipments on the supports.
- Installation of PTZ devices.
- Configuring the active equipments, connecting at video cameras and PTZ commands, tests of functionality.
- System optimization, as the parameters resulting from previous stages.

Survey site, or determining the optimal location points of active equipments. Before choosing technical solution, a team of specialists will move into the area of interest to determine the locations where they will locate wireless devices for a sure coverage of the perimeters concerned. Making and designing a wireless network is make following a field study to obtain information on location, type of relief, allowances and connection points, taking into account the configuration of the land revealed topographic map at scale 1:100.000 and the indications of the GPS receiver.

To determine the type of equipment and antennas and their positions is take account of: the distances between locations, heights locations and absolute differences between them, routes and running routes the vehicles engaged in fuelling operations, guard, aircraft etc. and their speeds, points position for equipments, buildings configuration and deserved areas served, parameters and performance of active equipments and the used antennas.

Following the data obtained from site survey, wireless network is designed, determining the points of installation, type of equipments and antennas, connecting manners so that:

- To allow obtaining radio parameters at optimal levels;
- Transfer rate must be high and constant to obtain a clear image and in real-time deserved perimeter;
- PTZ commands (pan, tilt, zoom) to operate effectively, reliably and with minimum response time;
- The radiated power by the equipments and antennas do not affect radio transmissions in the frequency bands used in the

area (this feature is valid to Videocomm Technologies products working in 2.4 and 5 GHz band);
- Design network is not influenced at hi's turn by existing radio equipments in the area and other equipments or devices that generate electromagnetic field.

There are four critical variables to be considered in a survey site, before final installation of wireless video equipments:
- Depending on building height, tower or structure, should be evaluated the path witch will be crossed by wireless video signal between transmitter and receiver. Direct visibility is defined as unobstructed line which connects the transmitter to receiver;
-If is trying to transmit through a curtain of trees must be taken seriously in consideration the decrease of the transmission distance introduced .Making a field test is the best way to establish direct line of vision and a signal maximum strength. Ideally, the field test should be performed when the trees are leafy. If you install winter, leaves which appear in spring, may lead to elimination of the RF link;
- Great attention should be given to unexpected traffic that can obstruct the route of transmission. For example, a truck with trailer swung at maximum may be much higher than one might think. Trucks and other large vehicles can be an important factor when trying to broadcast over a road or highway. The transmitter and receiver are at a greater height, the success rate is higher;
- Metal objects located between transmission and reception antennas can not be ignored, including here transmission lines, which may be more difficult to see. Each high-voltage cable which intersecting transmission line may be the equivalent to an attempt to transmit through a solid steel pipe 3 m thickness. Pillars of the microwave may seem fragile, but may be equivalent to a solid steel door that blocks transmission. The basic rules when determining the range are recalibration and overestimation of its. It is recommended temporary to test each wireless device before being permanently installed .Because it uses a public band radio frequency, there is no law on these frequency and interferences must be accepted, if exit. Here are some examples of sources of radio interference: other video equipments in the 2.4 GHz band in the area, other wireless data transmission networks, LAN or WAN, in the 2.4 GHz band.

Calculation of electric field intensity. It's take account of the fact that a transmitter that emits a constant power (measured in W) generates an electric field that depends on the type of transmission and the antenna which is connected the transmitter. Because the electric field generated is not directly proportional with the emission power level, in the equivalent equation for calculating, appear and other parameters [6]:

$$\frac{PG}{4\Pi d^2} = \frac{E^2}{Z_0}, \tag{1}$$

where: Z_0 is the characteristic impedance of free space [Ω], P is the transmit power [W], G is the amplification / numerical gain of the antenna, d is the distance unto the centre of the electric field whereat measurement is made [m], E is the intensity of the electric field [V/m], but $4\Pi d^2$ is the radiated surface area whose radius is d.
From the formula for calculating the antenna gain g, expressed in dBi, G is calculated as:

$$g = 10 - \log_{10}(G), \tag{2}$$

and the characteristic impedance of free space is:

$$Z_0 = 120\Pi. \tag{3}$$

Apparently radiated power (*EIRP*) can be withdrawn from the previous formula, resulting:

$$E.I.R.P. = P = \frac{4\Pi d^2 E^2}{GZ_0} = \frac{4\Pi d^2 E^2}{120G\Pi} = \frac{d^2E^2}{30G}. \tag{4}$$

If the antenna gain [16] is 3 dBi and the distance whereat measuring is made is 3 m will be obtained $G = 10^{\frac{g}{10}} = 2$ and

$$E.I.R.P = \frac{d^2E^2}{30G} = \frac{9E^2}{30.2} = 0{,}15E^2.$$

RF budget calculation. It will calculate the RF link budget for video transmission into account the parameters of the technical specifications of some equipments and the losses on free space calculated by the relationship:

$$P_L = 32.4 + 20\lg(F) + 20\lg(D) \tag{5}$$

where: P_L is the free space attenuation [dB], F is the RF frequency on which transmission is carried [MHz], D is the distance between the two locations between which the wave propagates [km].

For example, for a frequency of 5.8 GHz is obtained P_L =113.689 dB. Sensitivity of RF signal is the minimum power level of the RF signal necessary to ensure the receptor entry for ensures a certain level of performance (BER - Bit Error Rate). Entering all the above data in the RF budget calculation formula:

$$B = EIRP - P_L + G_R - P_C \tag{6}$$

Result B = -90.439 dBm > R_s = - 94 dBm.

In conclusion, the received signal strength is above the threshold of sensitivity of the receiver by about 4 dB, which means that the longest link (2 km) will have a safety margin of 4dB ("fade margin"), sufficient to have a reliable communications in any weather.

For a link of 600 m only difference is the free space attenuation is calculated for a distance of 600 m in relation (5) and will be P_L= 103.231
By a similar process like as the above will be obtained B = -79.731 dBm > R_s = -94 dBm.

Is observed that the received signal strength is above the threshold of sensitivity of the receiver by about 14 dB, with a safety margin of 14 dB communication may take place in any weather conditions.

PTZ positioning system. It consists of:

-Two RF units that operate in free license band of 2.4 GHz keeping the specifications for this frequency band, placed in protected enclosures for any weather conditions, the standard IP-67 [7];
- Two rubber-duck antenna type omnidirective with 0 dBi gain;
- 12 VDC power sources;

To keeping the regulations in force for the 2.4 GHz frequency band which allows a maximum EIRP of 100 mW (20 dBm) and taking into account the antenna transmission / reception has 0 dB gains, it will add an RF cable of 3 lengths with damper role to keep the *EIRP* within the limits imposed at European level. According to the formulas above P_c= 2.25 *B* and

$$EIRP=P_{out}-P_e=19.21 \text{ dBm} < 20 \text{ dBm} = \text{maxim } P_L=32.4+20\lg(F)+20\lg(D)=106.024 \text{ for } D=2 \text{ Km}$$
$$B = EIRP - P_L + G_R - P_c = -89 \text{ dBm} > R_s = -107 \text{ dBm}$$
$$P_L = 32.4 + 20\lg(F) + 20\lg(D) = 95.56 \text{ for } D = 0.6 \text{ Km}$$
$$B=EIRP - P_L + G_R - P_c = -78.54 \text{ dBm} > R_s = -107 \text{ dBm}$$

We have a safety margin of 18 dBm, 28.5 dBm respectively for the link of 600 m, sufficient to ensure a reliable communications in any weather conditions.

Wireless transmission solution is widespread especially in the airport [18], in proportion of 65% all airports have installed hot spots which serving public area applications, from Internet access to service tickets on-line reservations, purchases of consumer goods etc.

Frequencies in working equipment included included in their casement are free at European and local level, provided that certain parameters specified in standards are respected (emissive less than 100 mW for the band of 2.4 GHz and the intensity electric field less than 70 dB V/m band 5.7 GHz).

Systems are designed for zero maintenance, that once installed they operates without intervention of the service team a long time, because of mechanical components and active devices very reliable, adequately protected against atmospheric weather by IP-67 specific means.

For example the series of TCO-5816Q9 equipments are designed to meet the toughest environmental conditions and provide high resolution video image, in real time. The solid housing type IP 67, resistant to all weather conditions, makes possible the transmission distances of up to 7 km in applications where wired solutions are not possible, convenient or economically profitable [22].

Operating in free ISM 5.8 GHz band, this equipment includes a unique video-scrambling system which provides an extra level of security and additional protection of video transmission.

VI. Conclusion

A Wireless networks are clear benefits (mobility, flexibility, ease of installation, low maintenance cost and scalability), but also some disadvantages (use demanding equipments for operating parameters - temperature, humidity - and is need special location of equipment, shall vulnerability to weather - lightning, lightning - the rate of transfer is slow - 54Mb / s to 144Mb / s - and use different operating standards 802.11a, 802.11b, 802.11g, 802.11n).

Wireless networks are relatively less secure than wired network because of easier access of unauthorized persons in coverage areas of access points, but there are several methods of security, some less powerful and some may also provide substantial security than a wired network.

MIMO technology is a technology that uses multiple antennas on the sides of transmitter and receiver (therefore it is called the "smart antenna" technology). MIMO exploits the fact that radio frequency signals reflected by objects found in their way, resulting the phenomenon called multiple paths. MIMO uses a technique called spatial multiplexing that transmit multiple data streams at the same frequency, but through different spatial channels. MIMO take transmission over multiple channels and converts from a shortfall in benefit. MIMO make a channel more effective because a spatial multiplexing increases the speed ratio baud / hertz. “Multiple-input” component of MIMO means that MIMO WLAN equipment sends two or more radio signals to multiple antennas, and "multiple-output" means that two or more radio signals to several antennas, and "multiple-output" means that two or more radio signals coming from multiple antennas and reach the radio equipment. Setting up a wireless network is made by experts in the field.

Radio networks for data transmission provides unquestionably several clear advantages over wired versions: mobility, flexibility, scalability, very short time of installation and expansion, increased reliability and availability (through the existence only of network nodes and not through the existence of difficult pathways monitored and managed).

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