Video Surveillance Of Public Places And Highways: Case Of Kinshasa City

Authors: ANUNGA KOKANA Pauline[1], DIAMBOTE DIASILUA Ange[2], TSHODI TOLEMBO Michel*[3].

[1, 3:] Computer Lab of Notre Dame of Tshumbe University, Sankuru, Kasaï Oriental, DRC

[2:] Department Of Mathematics and Computer Science, University of Kinshasa, Kinshasa, DRC

Abstract

The theft, traffic accidents, popular demonstrations leading to vandalism and other incidents along the public highways are common events in the Town of Kinshasa.

A major challenge in Democratic Republic of Congo (DRC), the country of application of this study is the positive result of the investigations pushed on in the evoked known cases.

Video surveillance of key public places of the City-Province of Kinshasa, the capitol of DRC has become a critical need.

Surveillance will make it possible to detect thieves, vandals and the negligent drivers. Observation help the police force captures the perpetrators, and deter future bad acts.

This research is thus a feasibility study, proposing of the ways and means of implementing of an Internet Protocol (IP) Metropolitan Network for video surveillance and protection of public places and highways.

The material aspects and software requirements to the implementation of the solution are proposed. However, they are not the only ones to exist. The question of security of the network is not tackled; it remains a breach open to other researchers or us in later studies.

Keywords : Video surveillance, IP, Multimedia survey, IP camera, WIMAX, PC surveillance, video encoding.

1. Introduction

Technology appears to be advancing faster than ever, and no area of technology evolves faster than Internet and Communication Technology (ICT).

With an aim of applying these rapid advances to improve security and safety for people in Kinshasa and other similarly challenged cities, we presents:"Video surveillance of public places and highways: Case of Kinshasa City".

Indeed, the advent of ITC has offered multiple possibilities to the modern man. This state-of-the-art technology proposes effective solutions owing to the fact that it makes it possible to rapidly merge masses of information, to process such information, and use it for the general good which can be used to prevent crime in advance of bad acts, and prosecute criminals when prevention proves impossible.

It is estimated that between 65,000 to 500,000 cameras are in place in London and more than 4 million in the United Kingdom on the whole. In 2007, the number of cameras "authorized" in public spaces in France was estimated at 340.000 but could reach a million before long. [10]

According to a recent BBC article, there is a video surveillance camera for every fourteen people in the United Kingdom. People in London are caught on camera up to 300 times a day. [15]

In addition, if the integration of the ITC became very prevalent in many Nations, this modern means of security solutions is not currently used in the DRC. Moreover, the absence of index which can be used to prosecute criminals makes the execution of an investigation more challenging.

Research and development addressing these challenges have not achieved conclusive successes, owing to the deficiency of modern surveillance equipment with regard to monitoring modern highway systems.

The study undertaken examines the effectiveness of the contribution of the ITC in toward the security of the public highways of the Congolese capital.

From the same point of view, it is also reasonable to ask whether, in terms of prevention and detections of congestions and accidents, violence and other crime, whether the speed of intervention and prosecution of negligent drivers and criminals via the captured videos, whether the new tools proposed are capable of providing increased security and safety for citizen and visitors to Kinshasa?

We are persuaded of the technical possibility to easily identify criminals and unpatriotic as well as flow of the road traffic using the system described and suggested here.

Wide Area Networks (WAN) and Local Area Networks (LAN) have been implemented to address some similar needs, but not at the scale and scope required for the mission proposed here.

To our knowledge, compared to that we propose to undertake, the delivery of visual contents via wired and wireless network has not yet been analyzed or approached in-depth in our region.

The assumption that we formulate is that, proper implementation of an ITC based video surveillance system would support human expertise in the safety and security to cause a significant reduction of the security crisis in Kinshasa.

The work which occupies us is limited to the delivery of the captured video stream from cameras placed on the key sites considered. This network will have to be managed by a central server, assisted by 6 secondary servers. The decision support systems and the coordination of optimal decisions from the captured data is beyond the scope of this effort.

"Video surveillance of the public places: Case of Kinshasa city" is the aim. To begin, we will try to make a review of the terminology and literature; we will then propose a solution of implementation of the system and finally drawing conclusions.

2. Video surveillance overview

2.1. Definition

The video surveillance is a system of cameras and transmission of images, laid out in a public space or deprived to supervise it. [10]

Video surveillance is a broad term for the remote observation of location using video camera. The video camera captures the appearance of a scene (usually in the visible spectrum) electronically and is transmitted to another location to be observed by human, analyzed by a computer or stored for later observation or analysis. [7]

Images obtained with this system can be treated automatically and/or viewed then filed or destroyed. The purpose of the monitoring is to control the conditions with respect to safety, the safety or the execution of a particular procedure.

It can thus be used in the following fields:

- Prevention of criminality;
- Road safety;
- Industrial Safety;
- Facial recognition,… [10]

2.2. Formats of the video stream

The transport and the storage of the video stream can be of two natures: analogical or numerical.

However, the numeric video stream has very interesting characteristics which make it prefer with that analogical and thus allows him to supplant the video analogue. Let us quote among these characteristics:

- The storage capacity required by analogue systems is larger, and expands linearly with the recording time;
- The analogue signal is in the form of waves (curved), of this fact very sensitive to the disturbances which can involve an important modification of the signal while the digital video is in binary format (alternating 0 and 1) or histogram. This makes it less sensitive to disturbances;
- Each duplication (recopy) and reading of a digital signal always resemble very accurately the signal of origin, while each analogical video recopied experiences losses as copies are created and as one reads the contents; [14]

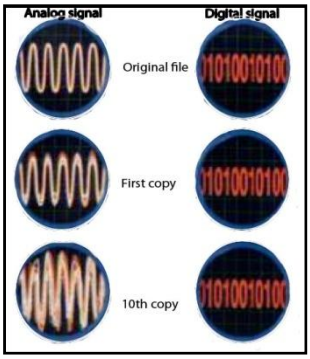

Fig. 1 Analog signal and numeric signal [Source 14]

2.3. Architectures

The field of the video surveillance presents two architectures. One called to closed circuit and the other open circuit.

a) Closed Circuit Television

In an installation of video surveillance in closed circuit (or CCTV, Closed Circuit Television), the system consists of a network of cameras and monitors belonging to a structure or organization not having means for distributing the signal outside the organization. [4]

The following figure presents architecture in closed circuit.

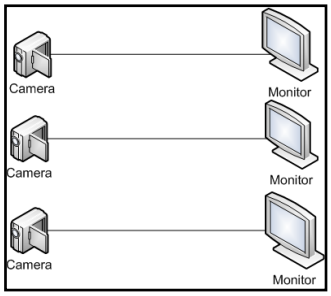

Fig. 2 CCTV architecture

b) Open CCTV Circuit

The role of a video surveillance system is to achieve a well defined task of safety for a site but this becomes more complicated the user wishes to monitor multiple sites. It is completely legitimate that it can reach its remote system and that in full safety. In this sector, progress was accomplished thanks to electronic, data-processing technologies and telecoms. The term OCCTV (Open Closed Circuit Television) was created to describe this type of application. [4]

This architecture includes additional constraints in terms of material, safety to manage storage and rights of access to the stored contents.

In the present study, architecture to be implemented is well that with open circuit.

2.4. Video stream compression

Video compression is a method of data compression, which consists in reducing the quantity of data, by minimizing the impact on visual quality of the video. The interest of video compression is to reduce the transmission and storage costs of the video files. [11]

However, the price to be paid is that a strong compression involves a degradation of the video signal. [3]

There are two great organizations which develop standards of compression of images and video: the ITU and the ISO.

To reduce the high costs of media to distribute these sequences, the following techniques are generally used to carry out desirable reductions of visual data:

- Reduce color nuances within the image;
- Reduce the color resolution with respect to the prevailing light intensity;
- Remove small, invisible parts, of the picture;
- Compare adjacent images and remove details that are unchanged between two images.

2.4.1. *H.264 compression method* [3]

H.264 is the latest generation standard for video encoding. This initiative has many goals. It should provide good video quality at substantially lower bit rates than previous standards and with better error robustness – or better video quality at an unchanged but rate. The standard is further designed to give lower latency as well as better quality for higher latency. In addition, all these improvements compared to previous standards were to come without increasing the complexity of design so much that it would be impractical or expensive to build applications and systems.

An additional goal was to provide enough flexibility to allow the standard to be applied to a wide variety of applications: for both low and high bit rates, for low and high resolution video, and with high and low demands on latency. Indeed, a

number of applications with different requirements have been identified for H.264:

- Entertainment video including broadcast, satellite, cable, DVD, etc (1-10 Mbps, high latency);
- Telecom services (<1Mbps, low latency);
- Streaming services (low bit-rate, high latency) and others.

2.5. What is Multimedia [8]

Multi-media is the combination of several types of data on the same support or in the same application.

Many people refer to the data having to be read in a well defined time interval with generally an interaction of the user - such audio pure, the videos, images, telephony - to qualify the multi-media.

Such a reference proves completely erroneous, because they are there only the audio on line or the animated images.

3. Network video components and features

3.1. Enumeration of the stations

The present study proposes an architecture with seven sites, including one primary (or central) and six secondaries.

Their specific localization remains confidential for reasons for discretion, an important aspect if comes to materialization.

3.2. IP Camera

It is important to note that four distinct types of systems of surveillance camera exist:

- The cameras connected to a simple control screen, without recording which allow just the monitoring on line certain rays. It is the most economic system;
- The system of analogue cameras, with a recording limited in the duration;
- The system integrating both analogue and digital cameras. This evolution of the simple analogue system makes it possible to introduce new functions like the detection of disappearance of objects (change detection) and the counting of objects or people;
- Consultable digital cameras via Internet: one speaks then about camera IP. [6]

An IP camera is an autonomous surveillance camera which is integrated where one wishes it and connects oneself using an Ethernet cable or wireless thanks to the Wifi, practical when it is possible. [12]

Also commonly called Network camera, an IP camera is, as its name describes, a camera with an IP-Network connection. The Network camera is a key driver in the network video resolution. [6]

The IP camera can provide the following advantages:

- Ability to use hi-resolution (megapixel) cameras;
- Consistent image quality, regardless on distance;
- Ability to use Power over Ethernet (PoE) and wireless functionality,
- Full access to functionalities such as Personal Area Network (PAN), tilt and zoom; audio and digital inputs and outputs over IP, together with video;
- Camera settings and system adjustments over IP; and
- Full flexibility and scalability. [6]

The camera is connected to the Internet via a router or the box of an Internet service provider allowing him to be remotely visible via Internet. [12]

IP Cameras, although more expensive, are the future of the video surveillance because their flexibility and the standardization of the protocols allow the transport of the image and the sound at lower costs by existing Intranet and Internet networks. Equipped with a processor and an OS (operating system), they are able to treat in-house various events such as detection of movements and noise, and also to generate actions like the release of an alarm, the advertisement of a message, etc

They can in particular address a video sequence recorded on detection of movement or release of alarm directly by email or other communication link.

The quality of the image returned by the material of video monitoring is the most important detail in video surveillance, and on this point, camera IP, quite different from a webcam, brought a resolution going until several Mega Pixels. A great choice of models is available: fixed, domes, interior or external. [6]

We propose for this solution the cameras Axis P1344-E, camera IP which shows the following characteristics:

- Video Quality HDTV;
- H.264 Compression;
- Superb quality of image with 1MP/HDTV 720p
- Functions day/night
- Multiple H.264 flows
- Numerical PTZ
- Easy installation with development postpones local Stockage remotely
- Usable in outside, conforms to standard IP66

Fig. 3 AXIS P1344-E IP Camera

3.3. Wireless Network video.

Since the arrival of wireless, the technology of networks radio operator IP evolved to get more band-width, more essential range and more safety, important parameters for the transport of video surveillance.

It thus becomes easy to deploy cameras and to connect them to an urban network, with the advantage that same architecture can serve connection to Internet.

Telegraphic technologies were deployed a few years ago, however, they have constraints primarily related on the availability of the distributer, the distance from the site user compared to this distributer and to the type of data to be conveyed. Though the optical fiber solved these problems, it brought others of them, and not the least, in particular the very high cost and the need for the administrative procedures and techniques of long life.

Wireless technology offers multiple advantages in particular the deployment of a communication network, the possibility of extending an existing telegraphic network by offering new possibilities of modularity and mobility. [2]

For example, installing a wireless network in a parkway or a highway could be cheaper and easier than the alternative of pulling cable through the ground or the right-of-way.

There exist three topologies available in the installation of a wireless networking: Point-to-Point (PTP), Point-to-Multipoint (PtMT) and Wireless Mesh Network.

Point-to-Point Topology, also shortened PTP or P2P is the simplest topology of the wireless networking, where information is transmitted of a point to another.

Following the directional nature of the system, the directional antennas are used to produce the largest possible band-width on the connection. [6]

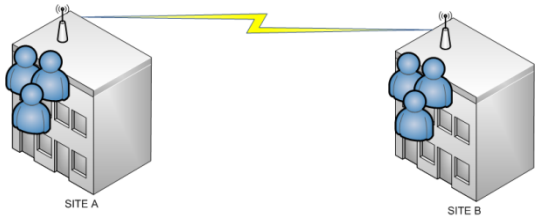

Fig. 4 Point-To-Point topology

A Point-to-Multipoint Network (sometimes abbreviated PTMP or P2MP) is the most common type of wireless network is an Frequency Modulation radio transmitting radio signals to many radio receivers. The central point uses an omnidirectionnal antenna, while surrounding point use directional antenna. [6]

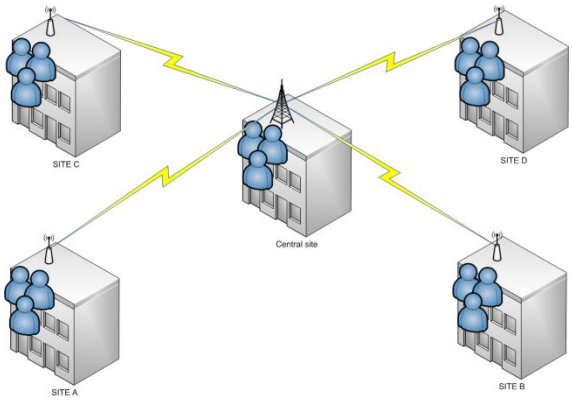

Fig. 5 Point-To-Multipoint topology

The Wireless Mesh Network (WNM) technology is a radical network form of the ever-evolving wireless network that marks the divergence from traditional centralized wireless system such as cellular networks and Wireless Local Area Networks (WLANs). It is characterized by dynamic self-organization, self-configuration and self-healing to enable quick deployment, easy maintenance, low cost, high scalability and reliable services, as well as enhancing network capacity, connectivity and resilience. The primary advantages of a WMN lie in its inherent fault tolerance against

network failures, simplicity of setting up a network, and the broadband capability.

Unlike cellular networks where the failure of a single base station (BS) leading to unavailability of communication services over a large geographical area, WMNs provide high fault tolerance even when a number of nodes fail.

Although by definition a WMN is any wireless network having a network topology of either a partial or full mesh topology, practical WMNs are characterized by static wireless relay nodes providing a distributed infrastructure for mobile client nodes over a partial mesh topology. [8]

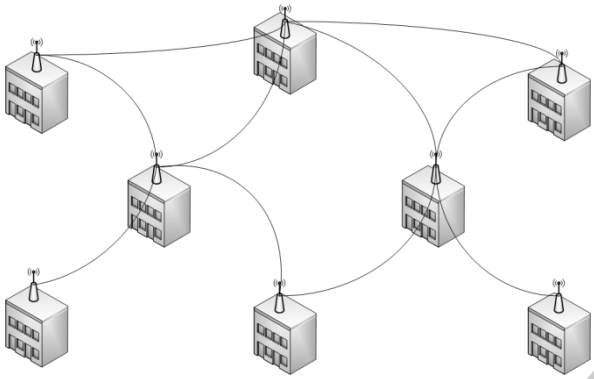

Fig. 6 Wireless Mesh Network Topology

The topology of this study is in PtMP, where not only the various checkpoints gathered in zones observe their own flow, they also transmit it to the central location.

The beam antenna Alvarion BreezeUltra is a suitable solution with this architecture in the sense that it meets all the conditions to ensure a transmission of quality with regard to the distance, the flow and topology,…

Its features include:

- Allows multiple topologies to the choice, that it is P2P, PTMP,…
- Supports the traffic of data, voice and video simultaneously;
- A band-width Provides up to 300Mbps;
- Very large Range energy up to 75km (46miles). [1]

3.4. Storage and visualization

Design of the modern video surveillance must includes a consideration for storage, as storage is one of the considerable elements of the video Network.

If budget is available, virtually, any size of storage system can be accommodated, which means that any frame rate, number of cameras, and retention time can be handled. [6]

Modern technology presents some architectures of storage, each one with its specificities, advantages and disadvantages based on the cost, scalability, the performance and complexity.

In the following lines some architectures used in video storage will be presented.

a) On-Board storage

The On-board video storage is a method that in which the video flow is stored directly in the memory of camera. This method can be used if camera captures images on event.

All network cameras includes some level of Random Access Memory (RAM) that can be used to store a few minute worth of video, but the capacity of memory is limited by high-cost of RAM. The video captured can be sent via Internet to Master server storage to night or at any moment.

It is cheaper because no server, client post or network infrastructure is needed. The camera is directly linked to the central site.

Nevertheless, it is not appropriate to public places or highways survey because this application needs real-time and continuous capture and storage. The capacity of camera is not sufficient for continuous captures and storage. In addition, the RAM the content will be erased any time the power is lost at the camera location. [6]

a) Single Server Storage

This architecture is very used in small and medium-size installations of up to 50 cameras. The storage device (hard disk) is located in the same PC that runs the video application server. [6]

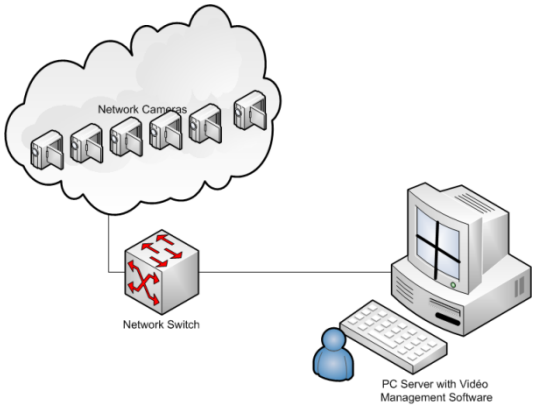

Fig. 7 Single Server Storage architecture

b) Network Attached Storage (NAS)

Network Attached Storage (NAS) provides a single storage device directly attached to a Local Area Network and offer shared storage to all clients on the network. [6]

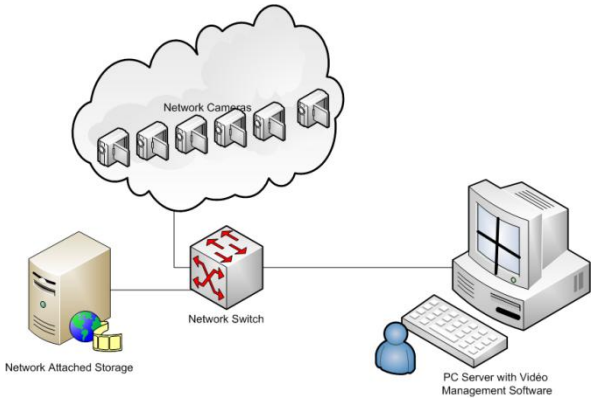

Fig. 8 Networks Attached Storage architecture

c) Storage Area Network

A SAN is a high speed, special purpose network storage devices. It is connected to one or more servers via a fiber channel. Users can access any of the storage devices on the SAN through the server, and storage is scalable to hundred of terabytes or even Petabytes.

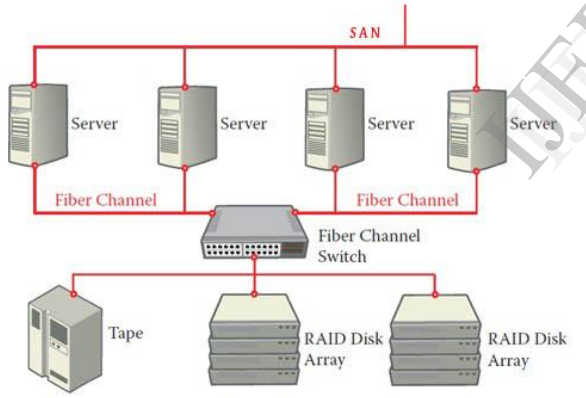

Fig.9 Stored Area Network Architecture

d) RAID Architecture [16]

A Redundant Array of Independent Disks (RAID) techniques making it possible to distribute data on several hard drives in order to improve either the fault-tolerance, or safety, or the performances or a combination of these for the storage unit.

Since its creation, the principal characteristic of architecture RAID is its capacity to combine many peripherals of cheap storage and a current technology in a single matrix, so that this grouping offers an increased capacity, reliability and/or performances, it at a cost largely lower than a peripheral of single storage is equivalent exploiting state-of-the-art technologies.

3.5. Network Video Software

The network video software is gathered in two categories: the software side Client and the software side Server.

The software side server thus makes it possible to define certain parameters of the camera and the safety of the network (format of encoding, authentication of the cameras and the stations client, management of storage, etc.) while the software side customer just makes it possible to the personnel of safety to visualize the flow captured by the various cameras.

This software is often delivered in accompaniment of the hardware (camera, digital recorder, etc.).

The software Axis 216FD Network Camera is an example. [6]

3.6. Important accessories

a) Vandal-proof

In some surveillance applications, cameras are at risk of hostile and violent attacks.

We saw in the preceding chapters that the choice of a camera depended on several parameters. However a parameter quite as important as the others is the ability to prevent tampering and damage to the system.

The vandal-proof is a case which makes it possible to protect the camera and the objective against the environment and the climatic conditions (figure below) and from deliberate harm by those who do not want their actions observed. [4]

Fig. 10. Bosch Vandal-proof

b) Lighting

The site considered must, in order to obtain anticipated results, have sufficient lighting.

With this intention, we propose the installation of the cameras on the luminous posts on which the projectors for public lighting are installed, though certain cameras have faculty to capture flow even under conditions of insufficient lighting while car-being regulated.

Indeed, the problem of lighting is sufficiently solved in the Congolese metropolis to make an alarming detail of it.

3.7. Solution Architecture

The video Network to implement includes seven (7) sites as described previously. Among these secondary sites, they are in particular a large stage, and busy hotspots in the capital.

Each site has an architecture of storage of the type "individual server" while the central location implements a SAN architecture.

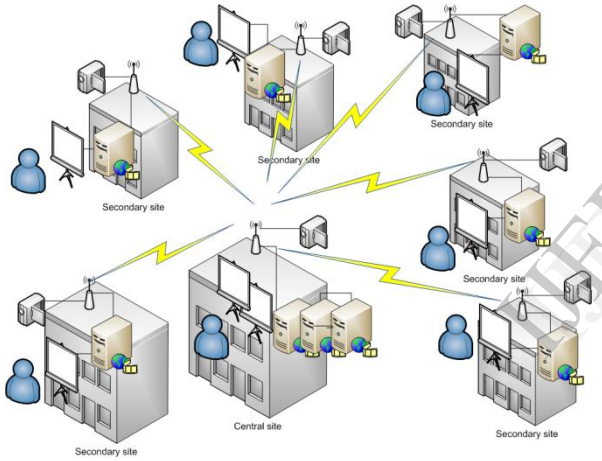

Fig.10. Solution architecture.

Conclusion

The present study related to the transmission of the video stream in an IP network. It is different from other video surveillance systems that are limited exclusively to capturing the video stream from a camera.

Because, unlike them, the realization of the study encourages the use of broadcasting video streams over IP that requires network hosts to be addressed by the IP, with a long-range transmission of multimedia streams and highly advanced technical flow storage.

The objective that we identified at the beginning of this study was to develop a system capable of make up for to the human failures as regards safety in order to equip the public authority in charge of safety with a modern tool with monitoring.

This modern tool offers many advantages over the human observer, in particular discretion with any hair and permanence overall in the monitoring of the ways and public places of the Congolese capital.

At the start, we determined a certain number of concepts on the level of the overview of the video surveillance in an IP network.

It is indicated to point out our study assigned a noble mission: establishment of the video material suitable to carry out not only observation of the event in real-time along the way selected, but also the facilitation, by the means of the filed video streams, of the control of the investigations of criminal activity for which the criminal was not immediately captured.

Moreover, a similar installation can be useful, without additional material, to observe and assist in the control of traffic around the posts of public lighting in the town of Kinshasa where electric cables are the target of thieves.

However, the effectiveness of this application could not be achieved without a sufficient lighting of the public highways.

The duty of any citizen is to contribute to the construction of its country. For our part, we think that, the effort for if not of the eradication at least of the considerable reduction in the cruel acts of slaughter, thieves and armed robberies,… is worth one's weight in gold in a city or a site in prey to the insecurity.

As, without false modesty, let us be us convinced and in right to affirm as present research does not miss interest. It belongs from now on to the reader who, certainly, are joined our concerns to worry about materialization urgently of the advanced proposals in present research.

Références

[1] Alvarion®, *Breeze ULTRA™ Capacity Unleshead*, 2012.
[2] Alvarion®, *La vidéosurveillance sans fil*, white paper, Rev. A., Mars 2008.

[3] Axis communications, *An explanation of video compression techniques*, white paper, 2008.
[4] Beddiaf L., *Vidéosurveillance: Principes et Technologies*, Ed. Dunod, Paris, 2008.
[5] Minoli D., *IP multicast with applications to IPTV and mobile DVB-H*, Wiley&Sons, Hoboken, 2008.
[6] Nilsson F., *Intelligent Network Video, Understanding Modern Video Surveillance System*, CRC PRESS, London, 2009.
[7] Senior A., *Protecting privacy in Video surveillance*, Springer Ed., London, 2009.
[8] TANENBAUM A., *Computer Networks* (4th Edition), Pearson Education, Amsterdam, 2001.
[9] Yan Zhang, Jijun Luo, Honglin Hu, *Wireless Mesh Networking, Architectures: Protocols and standards*, Auerbach Publications, 2007.
[10] **http://fr.wikipedia.org/wiki/Vid%C3%A9osurveillance, February, 2013.**
[11] http://fr.wikipedia.org/wiki/Compression_vid%25E9o, March, 2013.
[12]http://www.juste1oeil.com/devis.cfm, December, 2013.
[13]http://www.panoramasprl.com/Actualites/chiffres-important-sur-la-videosurveillance-et-causes-principales-sur-les-incendies-domestiques.html, **January, 2013.**
[14] http://patrick.dallagnese.free.fr/tpe/,January, 2013.
[15] http://www.vdtsi.com/milestone/13.pdf, February, 2013
[16] http://fr.wikipedia.org/wiki/RAID_(informatique), March, 2013.