EENA Operations Document

Digital Transformation of Cities

Smartcities and Emergency Services

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1 Executive Summary

Cities have a major impact on economic and social development of nations. They are true platforms where people live and work, where companies carry out their activities and services are provided.
Given this scenario, public authorities should take aspects such efficiency, sustainable development, quality of life and wise resource management into account.

To achieve this, the application of technology and communications is essential. A city can be considered as a Smartcity if it uses technology to manage their critical infrastructure efficiently and to offer public services interactively.

Emergency services need to play an important role in the definition of Smartcities because these services are responsible not only for helping people in critical situations, but also for predicting risks.
The inclusion of emergency services and procedures in the Smartcity model should give more and better information and resources.

2 Introduction

Cities represent the evolution of our society, according to the latest reports from the United Nations, cities will concentrate 70% of the world's population in 2050 in existing and in emerging regions. This means that in 35 years, 6.300 million people (the entire world population of just 7 years ago) will coexist in urban environments. Therefore, supporting critical infrastructures are becoming larger and more complex and we must strive to turn these urban spaces into efficient and sustainable environments. These two major challenges require intensive actions to support and accelerate the development and transformation of our current cities into smart spaces to serve citizens.
The term Smartcity is used to refer to all processes that aim to make cities more efficient and liveable.
These principles should apply in particular to aspects such as:

- Technological infrastructure: networks of information and communication mechanism, intelligent platforms, eco-efficient infrastructure, etc.
- Energy strategy: use of renewable energy, storage and use of energy, etc.
- Management and protection of resources: land use and resources based on sustainability criteria, cooperation between administrations, etc.
- Services provision: development of new collaborative models to integrate public and private, joint service models, etc.
- Government: data accessibility, transparency in management, implementing sustainable policies, etc.

A city can be defined as 'smart' when investments in human and social capital and in modern communication infrastructure support sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance.

These new cities should be more habitable and friendly to people as they become more efficient by the use of technology and resources.

3 The benefits for people living in a Smartcity

Smartcities use information and communication technologies to drive economic competitiveness, environmental sustainability, and general liveability. By leveraging broadband as a core element of their development, smartcities of the future will:

- Foster economic growth
- Improve the lifestyle of citizens
- Create opportunities for urban development and renewal
- Support eco-sustainability initiatives
- Improve the political and representative process
- Provide access to advanced financial services

Smartcities will realise these opportunities by taking advantage of public and private partnerships in which telecom service providers and communication technologies solution providers bring in their assets expertise and experience.
Smartcities can be identified (and ranked) along six main axes or dimensions. These axes are:

- Smart economy
- Smart mobility
- Smart environment
- Smart people
- Smart living
- Smart governance.

These six axes connect with traditional regional and neoclassical theories of urban growth and development. In particular, the axes are based on theories of regional competitiveness, transport, information, communication technologies, economics, natural resources, human and social capital, quality of life and participation of citizens in the governance of cities.

Smart People	• Education • Inclusive society • Embrace creativity
Smart Economy	• Entrepreneurship and innovation • Productivity • Local and Global interconnectedness
Smart Environment	• Green Buildings • Green Energy • Green Urban Planning
Smart Government	• Supply and demand policy • Transparency • Open Data • e-Government
Smart Living	• Health • Safety • Culture
Smart Mobility	• Mixed modal access • Clean transport • IT oriented transport

3.1 Smart Environment

In this area the objective is environmental sustainability of cities, that means actions on what produces large impacts on the environment, such as water consumption, energy and raw materials (e.g. waste generation and pollution).
Included in this area are the promotion of renewable energies, smart metering systems of energy and water consumption, smart grids supply management utilities, monitoring and control of pollution, renovation of buildings and urban facilities, sustainable urban planning, efficiency, reuse and recycling of resources, among others. Intelligent provision of public lighting services, management of municipal solid waste and integrated management of the water cycle are also contemplated.

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3.2 Smart Mobility

In this area, the development of an integrated, effective and with low environmental impact transport and logistics system is intended.
For that, the work is focused on promoting sustainable, safe and interconnected transport systems that integrate buses, trams, trains, subways, bicycle and pedestrian paths. Clean and non-motorised options are prioritised. It is also crucial to provide useful and real time information to citizens in a way they can save time, make faster transfers and reduce their carbon footprint.
It also requires corresponding boost to the operation and functioning of urban transport infrastructure and a set of complementary urban services such as car parks, service stations and charging of electric cars, among others. Managers of these systems use technology to provide better service. Additionally, citizens provide information to the system in real time. This feedback is used to improve the planning of services.

3.3 Smart living

This area includes aspects on how information and communications technology affect lifestyle, consumption and human behaviour in cities, as well as how they generate healthy and safe lifestyle for citizens.
Smartcities should create safe spaces, protect infrastructure and sensitive areas against threats and be able to react quickly and effectively to emergencies.
This area incorporates intelligent video surveillance services, security systems supported by the use of cameras, cybersecurity against attacks on essential public services, transport safety, command centres and control for emergency management, public alerts for missing persons, tracking systems using global navigation satellite system technology and intelligent solutions over video surveillance applied to heritage protection and infrastructure.

3.4 Smart People

Cities, in cooperation with other regional governments, are major players in the education of citizens. Municipalities have a wide range of training programs, e.g. kindergartens, schools of music, dance or theatre, computer-use lessons for seniors and local language schools for foreigners.
This area covers training in digital skills and education in key fields for the development of creativity and urban innovation. Examples are digital tools for education (e.g. preschools using tablets and computers), digital platforms to provide local training and education through open massive online courses.

3.5 Smart Economy

Within this area not only e-commerce and internet business on an urban scale are included, but also new forms of production and delivery of services in which digital tools play a key role. Therefore, new business models needed for its implementation are foreseen. Promotion and creation of urban clusters and business ecosystem around digital business and entrepreneurship are crucial. They should be based on local and global interconnectedness with the flows of goods, services and global knowledge.

Examples of the smart economy of cities include:

- digital spaces (billboards and marquees) able to offer information of interest to citizens and visitors and commercial offers proximity in real time;
- support of services for entrepreneurs and local businesses that increase the chances of selling online;
- digital accessibility services provided by retailers that at the same time are commercial tools to connect these businesses with social networks, etc.

Additionally, this area includes applications that allow, for example, customised and online commercial offers via mobile phone. Tourist information services, online reservations, recommendations, incident management, suggestions, complaints, claims can also be considered. Therefore, secure data networks, high capacity and reliability for companies and municipal services with high security requirements should be taken into account.

3.6 Smart Governance

The city management is changing. Citizens are demanding more information provided in real time. They want to participate in the management of their cities and that procedures and services are delivered in the fastest and most convenient possible way. Citizens also demand greater transparency and availability to municipalities data.

Smart governance means transparency and open data. This implies an intelligent and integrated government that can provide services the city needs and interact with all actors. It requests intelligent data processing with high interoperability.
Smart government also requires strong public-private partnerships with different local actors with shared goals This area of activity is by its nature a transverse component, to the extent that can orchestrate and integrate some of the other areas (or ideally all).

To achieve an intelligent government, cities have different programs and applications that make open and interoperable communication possible. The creation of inclusive platforms of all products and services for smartcity monitoring and exploitation is another way to optimise and unify the management.

4 Examples of Emergency Services in the Smartcity.

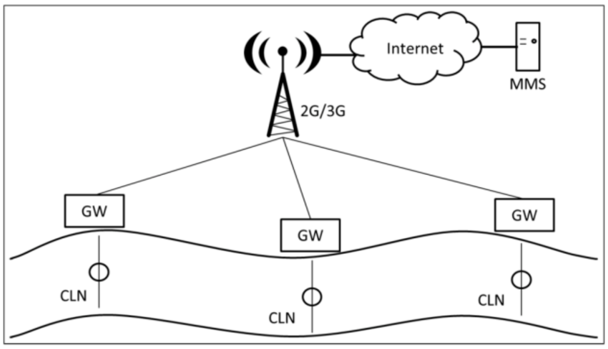
As cities grow, public safety becomes a more complicate task because it is necessary to secure and manage more resources and agents. In this area the use of technology reports a significant benefit.
Any application that optimises the capacity and response time of emergency services is useful in the environment of cities.

4.1 Video surveillance and public security

In this context, applications can range from video surveillance services with focus on controlling certain areas with cameras, to applications that ensure control of mass events using sensors located in "hot spots" to anticipate possible emergency situations in agglomerations.
In Chicago, for example, a service that helps fighting crime using advanced digital surveillance systems has been installed. It allows to redirect the cameras to where a shot has sounded, and therefore it is equipped with audio sensors. It also allows to record the calibre of the weapon fired and the scene, even before calling the police.
Another example is the Autonomous City of Ceuta (Spain). They have more than 250 cameras around the city connected to the emergency services. The camera images are combined with video analysis in real time which offers many advantages to maintain security.

4.2 Pollution control.

Pollution control is a common problem of almost all cities in the world. Sensors can be used to monitor pollution as explained in the following example:
The GOLDFISH project was an EU-funded project for river pollution monitoring in developing countries. It had Several sensor clusters, with floating WiFi antennas, deployed along a river's course downstream. Sensor clusters messages sent to a Gateway installed on the riverbank. This gateway sent the messages, through a backhaul technology, to an Internet server Where data was aggregated over a map. The communication challenge in this scenario was produced by the antennas' movement and backhaul network availability. Since the antennas were floating on the river, communications could be disrupted at any time. Also, 2G / 3G availability near the river was not constant. For non-real-time applications, a Delay / Disruption Tolerant Network (DTN) -based solution was proposed where all nodes supported persistent storage capabilities and DTN protocols for reliable communication through waiting for minutes or hours before any transmission could be possible. A mechanical backhaul visits the river bank periodically to automatically collect sensor data to be carried to an Internet-covered spot. The proposed forwarding protocol delivers around 98% of the messages for this scenario, performing better than other well-known DTN routing protocols.



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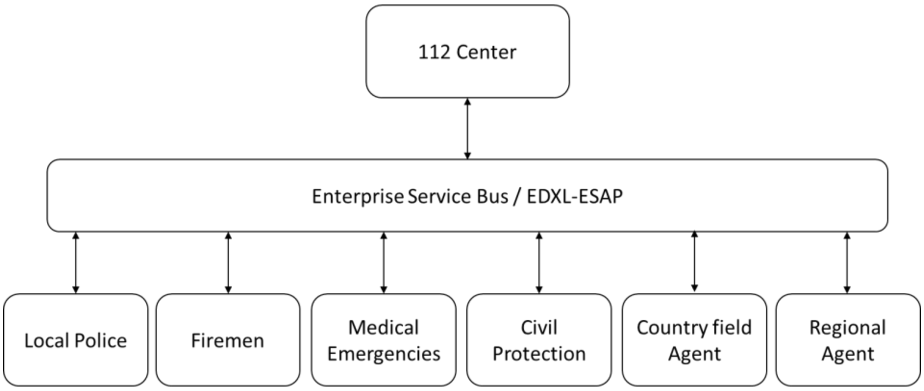
4.3 Emergencies Enterprise Service BUS

Enterprise Service Bus can be described as a platform that automates the exchange of standardised information between a coordinating centre and the various operative groups responsible for attention, response and coordination of emergencies.
The integration platform provides a framework where heterogeneous systems from different technologies using various integration mechanisms can be integrated.
The BUS is designed to translate messages between services, and therefore, it transforms dynamically and smoothly messages exchanged by services' endpoints using interoperable high performance standards. This way, consumers and service providers are not confronted to the complexity of using different transport protocols and message formats.

Examples[1]: Catalonia and Castilla y León (Spain) Interoperability Emergency and Safety Platform

The regional government of these two regions have deployed an Interoperability Emergency and Safety Platform (IESP) based on the Enterprise Service BUS technology in order to improve the quality of the service given to their citizens. They have integrated the information system of the 112 centre with other groups and operational agencies involved in emergency response.



The objective was to make a flexible and configurable integration for new stakeholders. A media gateway is used for the integration of new emergency response organisations. Information about incidents are updated in real-time. This way, voice communication is not needed any longer.

The flow of information is the following:

a. When the 112 centre receives an emergency call, the 112 call-taker introduces the information in the system. The technical platform determines the emergency response organisations that should be informed, accordingly with established protocols.
b. The 112 emergency platform generates messages to be distributed through the communications gateway. The gateway is responsible for the location of the target systems and the adaptation of the emergency messages accordingly to the data needs.
c. The notifications for new warnings appear in the organisations' applications with all associated data. Data communication is in real time and does not require any manual process.
d. Notifications of updates that occur in the course of incidents follow the same process (i.e automated messaging), as well as distribution through the integration bus.
e. The interoperability of information to be exchanged via bus is achieved through the establishment of standard protocols for exchanging information in emergencies.

[1] References: http://112.gencat.cat/es/ and http://www.112.jcyl.es/

Sharing information between the 112 centre and the emergency response organisations has the following critical points:

- Ensure the quality and the completeness of the information
- Ensure that information is distributed in to the response and coordination organisations.

IESP introduces the following benefits:

- Provision of a unified platform that provides interconnection services
- Security management, auditing, information distribution, etc.
- Avoid point to point communications between organisations.
- Integrity and security in delivery of messages.
- Exchange of information and services via a standardised protocol EDXL-ESAP.
- Generic model for interoperability applicable to any organisation that joins.
- Reduced response time.
- Increased efficiency.
- Quality and completeness of the information.

4.4 Flood Alert System

Due to the impacts of climate change, the risk of floods and other natural disaster has increased. This includes extreme weather events such as heavy rainfalls and flash floods. 10% of the world's population live in coastal cities, where the risk of coastal flooding and incremental sea level rise is high.

Managing flood risks can protect human life and economic activities. In most cases forecasting floods and knowing the flooding areas becomes a critical factor in minimising damages. On the other hand, as water becomes an increasingly scarce resource, need to be managed into more productive uses during times of heavy rainfall.

Wireless Sensor Networks are a cost-effective and scalable alternative for detecting early flood signs, forecasting floods, and monitoring flooding areas. Sensors can be spread along the course of a river to measure increased water levels and generate alerts wirelessly by SMS or Internet database posting. Later, this data can be analysed in a centralised platform. The network can also be used to monitor weather conditions and rainfall, making easier and more accurate the forecasting of floods, and determine the likeliness of flooding in areas close to the coast, river, etc. The sensors can be placed on top of pylons and recharge their batteries with solar panels.

Covering long distances is also an issue in this scenario since the goal is to monitor coast areas or river courses using radio links in the frequency bands of 2.4GHz, 900Mhz and 868Mhz using the 802.15.4/ Zigbee protocols.

Example: Harris County Flood Warning System[2]

When it begins to rain, data-collecting sensors at each gage station transmit rainfall amounts via radio frequency every time 0.04 inches of rain is measured by the sensor. Sensors that transmit bayou/stream levels report every 0.10-foot rise in water levels. The sensors transmit data to two primary repeaters located in the Huffman and Clodine areas. The repeaters then relay the data to primary and back-up base stations located at Houston TranStar and at the Harris County Appraisal District. The data is monitored daily by Harris County Flood Control District staff to ensure the gages are properly functioning and transmitting accurate data.

The data reported by the Flood Warning System is checked for accuracy on a daily basis. A technician reviews the sensors' data for inconsistent information and makes corrections as necessary. A large amount of inconsistent data coming from a specific sensor usually indicates that a site needs maintenance. In this case, a field technician is sent to the location to investigate and to repair the problem.

The data collected is used by the Harris County Flood Control District and other agencies for numerous purposes. The most important use of the data is during times of excessive rainfall and flooding when local emergency managers and the National Weather Service issue warnings and advisories to the public. The information also

[2] References: http://www.libelium.com/products/waspmote/ and http://www.harriscountyfws.org/

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is analysed by the Flood Control District to develop post-flood reports. These reports detail the extent and impact of flooding, including an approximation of the number of structures inundated. In addition, the Flood Control District uses this information to perform engineering analyses for identifying locations of future projects as well as determining the effectiveness of its constructed projects. The River Forecast Centre and private companies acquire the information for use in gage-adjusted radar rainfall, which uses the rainfall data to determine the accuracy of the National Weather Service's radar.

5 Smartcity Platform and benefits for Emergency Services

Emergency Centres and the professionals who work for them must be able to anticipate risks to people and properties. They also must manage available resources with maximum efficiency when the emergency has already occurred.
Improvements and benefits provided by Smartcities to citizens are also reflected in what concerns the management of emergencies. These benefits are based primarily on the ability of Smartcities' platforms to provide added value information from many different sources, as well as the possibility of providing interoperability services to different PSAPs.

Having the ability to receive information in real time, allows emergency groups to anticipate risks and improve response capability. It can contribute to save lives and to make cities safer places.
This information is based on data collected by sensors deployed by many emergency response organisations or other stakeholders. These data are unified and treated within the common platform. This way all organisations connected to a common Smartcity platform are able to provide and get information and processed data.

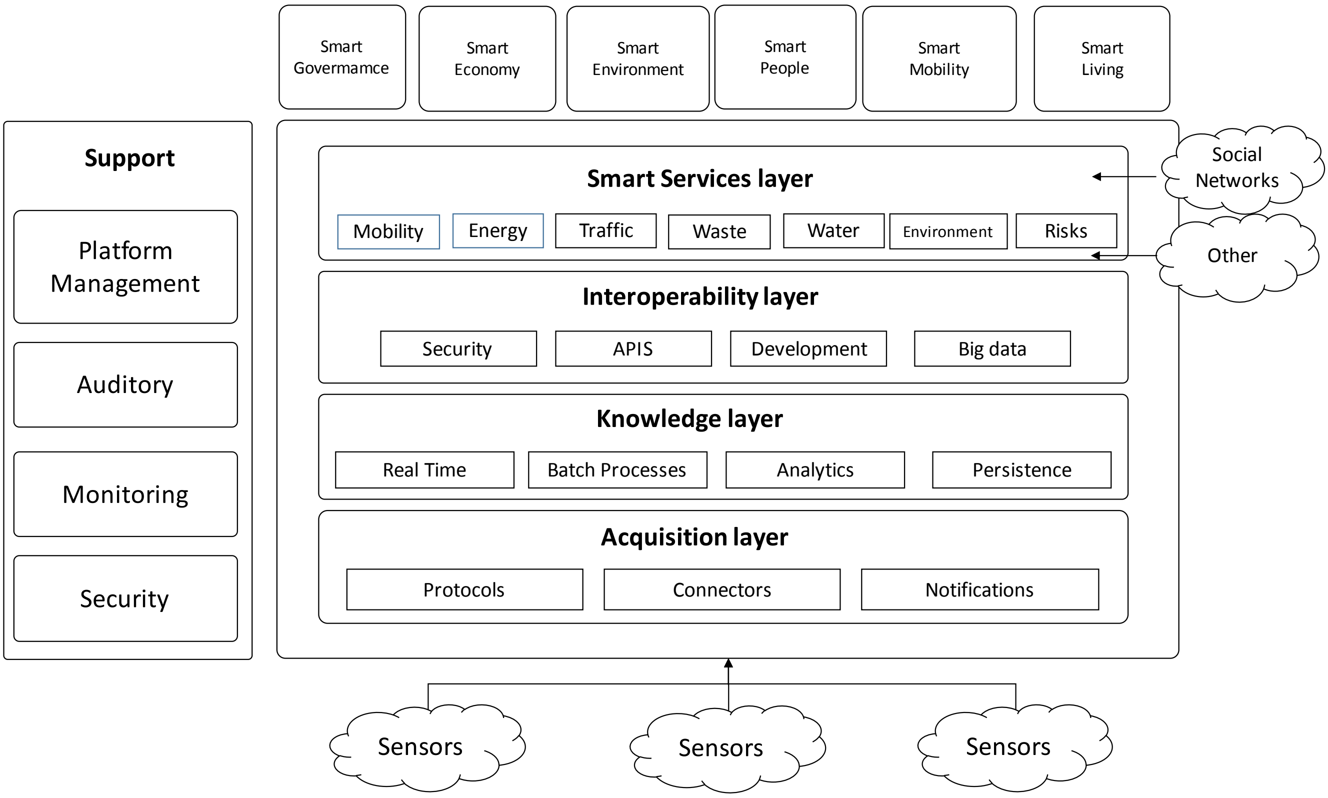
Some of the new tools that are evolving thanks to these new data sources are real-time maps, risk-based geographic information data systems, automatic early warning mechanisms and Civil Protection systems.
These mechanisms also allow the possibility of comparing the information provided by citizens with the one obtained from sensors and other organisations' systems. This way, it is possible to identify incorrect or fraudulent alerts and improve resource efficiency and cost savings.

Smartcities can provide Emergency Centres with connected and interoperable services and also a new communication model related to social networks. New communications networks that allow people to be permanently connected and the massive use of social networks allow the creation of a new warning and alerts system based on information given by people who are in the scene and can provide valuable information about a risk situation or an event in progress.

Emergency services have now the possibility to use social platforms to identify potential risks. In case of already ongoing emergency situation, they can use them to improve their response and their efficiency. For that, Smartcities services must be supported by information systems able to work together and improve the services given to citizens.

The smartcity ecosystem is a broad partnership between the public and private sector. City planners and developers, non-governmental organisations, IT system integrators, software vendors, energy and utility providers, the automotive industry, and facility control providers, as well as technology providers for mobile technology, cloud computing, networking, Machine-to-Machine (M2M) and Radio-Frequency Identification (RFID), all have a role to play.

These systems are divided into four logical layers, each of which will have specific tasks:



5.1 First Layer: Data Acquisition

Data is everywhere, it is rich and complex, so it is important for Smartcities to have a way to acquire information from the real world and take it to the platforms where it will be processed and analysed.
A data acquisition layer is needed to receive data from the environment. This layer will collect data from the real world and turn it into digital information. To do so, this layer is made up of sensors deployed around and inside the city, they are able to collect various types of data and send them to a unified platform. Once this data reaches the platform, it is necessary to have a set of protocols and connectors in order to read and translate this data. Having a rich set of protocols is mandatory for this kind of platforms.

Sensors are electronic devices capable of performing measurements on the environment, the magnitude will depend on the nature, design and purpose of the sensor. The use of sensors is widespread in industrial design for decades, however, now the need of using them in a remote and unattended way arises. This will require to solve two basic problems, first, a power supply has to be provided to allow sensors to use electricity, secondly, it is necessary to connect the sensor to a Gateway to allow it to send the data resulting from the measurements to a centralised platform.

Providing power to a sensor can be easy if it is deployed near to a power supply. If there is a need to deploy a sensor in a remote location where there is no access to a stable source of electricity, it will be necessary to connect the sensor to a battery that allows operation for a sufficient time, once the battery is exhausted, it will be necessary to replace it. Therefore, when such sensors deployments are planned it will be necessary to design adequate logistics that includes the battery replacement and charge.
Another possibility is to perform the deployment using sensors that incorporate a battery, in this case, the battery life also defines the life of the sensor, and when this is finished, it will be necessary to replace the sensor.

Some types of sensors:

- Heat sensors-> Fire detection
- Water sensors -> Floods
- Smoke Sensors -> Indoor Fire
- Gas presence -> Gas Leakage
- Pollutant Presence -> Contamination
- Radiation intensity -> Radiation Leakage
- Light presence -> Light Outage
- Vehicles -> Fleet Management
- Presence -> Task Forces, Personal security

A set of sensors communicating to each other or to a gateway and managed by a centralised platform receive the name of Wireless Sensor Networks (WSN).

Data can be sent using various methods among which the new WIFI and M2M based are predominant. These technologies allow unassisted mode deployment for sensors, these can send information periodically and without the need of complex installations. This new type of sensor can send information of all kinds, from many different places and in real time.

The communication patterns required by sensors is based on sending small frames of information periodically, and this makes M2M gateways one of the best solutions to use in this kind of deployments.
M2M gateways offer the following key benefits:

- A local intelligent node turns raw data into useful information
- A hub for cross-sector service and application convergence or "joined-up thinking"
- A secure node bridging broadband WAN and local area sensor networks, wireless and/or wired, which can even connect legacy-installed sensor/actuator nodes
- An aggregation node for a multitude of low-energy, low-cost sensor/actuator nodes

Factors to consider when designing a WSN based on M2M
Scale: Wherever there is a clustering of M2M devices of sufficient scale, there is a potential to overload the cellular network. They don't have to be data-hungry devices; a localized peak in signalling traffic alone might be enough to cause failure at a cell level. Use of a gateway can alleviate signalling (and data) congestion.
Security: M2M device deployment will be widespread and they will often appear in fairly public places. As such, they will be susceptible to both physical and network intrusion. Recent publicity around the growth of malware attacks directed against smart phones is a testament to this.

Data deluge: Even if only transmitting small amounts of data once a day, millions of such devices will generate massive amounts of data—not all of it necessarily useful. Service providers may prefer that only useful data is transmitted, which is where a gateway performing some sensor or algorithmic translation can help by filtering out unnecessary data.

Distributed intelligence: An intermittent connection, the need for filtering of data or for autonomous operation at a local level requires local storage and processing of data.
The "rebound" effect: Increased deployment of M2M technology must not cancel out the original cost and energy efficiency benefits. Low-power and cost-effective nodes are the key factors. A gateway can help with scaling, bridging between low-energy wireless networks and mainstream network infrastructure.

Communication networks
Communication networks play a fundamental role in the development and deployment of services associated with Smartcities as they are fundamental infrastructures that enable communication between devices, between people and between people and devices. The networks involved in these deployments are very heterogeneous, so interoperability and transparency will be essential.

This element of the technology value chain facilitates the other links that make up the Smartcity, unified communications regardless of the standard network and communication protocols used. The biggest challenge

of these technologies is precisely to manage the growing number, dispersed and heterogeneous machines, sensors and actuators distributed throughout the city.
In this context, fixed networks, whose capillarity help offload wireless networks will be needed. But in the field of Smartcities, wireless networks are truly help complete the concept from the point of ubiquity. That is why this section focuses particularly on them.

Currently, there are many wireless technologies trying to meet the needs related to bandwidth, range and power consumption.
There is no best technology for all areas, but each one of them has a number of features that make it a suitable solution for a different environment. In the following table there is a comparison of mobile communication protocols with their fundamental properties.

	Physical level and MAC	Range	Bit rate	Intake	Standards
ZigBee	802.15.4-2003 DSSS CSMA-CA	10-100m interior ~1Km exterior	250Kbps (2.4GHz) 20Kbps (868MHz) 40Kbps (915MHz)	Peak 50mW (2.4GHz) Stand by: <1µW	De facto Standard
Wavenis	Proprietary	200m interior – 1km LOS	from 10kb/s to 100kb/s	18 mA RX 45 mA TX Stand by: 2µA	Proprietary
Wireless MBus	EN 13757-4:2005	60-80m interior, 500 m exterior	from 16 Kbps-66 Kbps, to 100 kbps	22 mA RX, 37 mA TX Stand by: 0,2uA	Standard
Z-Wave	Proprietary	30m interior 100m exterior	40-100Kbps	20mA Stand by: 1µA	Proprietary
WiFi low power GainSpan Wi-Fi	802.11b/g DSSS CSMA-CD	50-70m interior <300m exterior	1/2/5.5/11Mbps	60mW Stand by: 5 µW	Standard
WiMAX (Altair's ALT2150 Chipset lowpower)	Based in IEEE 802.16	Hasta 75 km	hasta 75 Mbps	230mW-49 mW	Standard
PLC Watteco	Power Line	50m (Objective: 150m)	10Kbps (Objective: 40Kbps)	Less than ZigBee y Z-Wave	Proprietary
PLC NEC	Power Line		100bps-30Kbps	25mW	Proprietary
GSM/GPRS (Telit GM862 Quad module)			Up to 85,6 Kbps	Stand by 2,6 mA GPRS cl.10(max): 370 mA	Standard

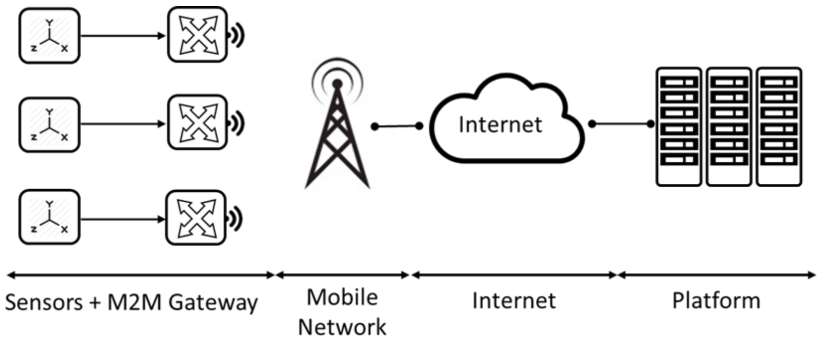
Communications in the Smartcity often arise at different levels. In a first stage, there is a proximity network that includes repeaters to collect and encrypt sensor data from elements in their proximity range.
On a second stage, repeaters send the data to other elements in the network. These elements are called gateways. To stablish end to end communication, proximity network can be used, for example, mesh networks (with Zigbee wireless technology, for example) and then a network of higher transport, such as GPRS or 3G. In the case these that gateways are connected to fixed networks, technologies such as ADSL or fibber optics.

As an example, in the case of applications that manage car parks in cities, it is necessary to distribute sensors placed inside a plastic capsule inserted into the tarmac at each parking space, forming a mesh network of wireless communications which it is connected through a series of repeaters with a gateway, gateway which in turn sends the data to a central server via the Internet. That is, in this application various transmission technologies are involved. The right management of the heterogeneous and from ubiquitous nature network is vital for the proper service operation.

Possible deployments for a WSN

- One Gateway per device

The first possibility is to join each of the sensors to a Gateway so that each sensor is connected to a wireless network individually. This deployment is suitable for sensors attached to moving objects that need to connect to the network no matter where they are.



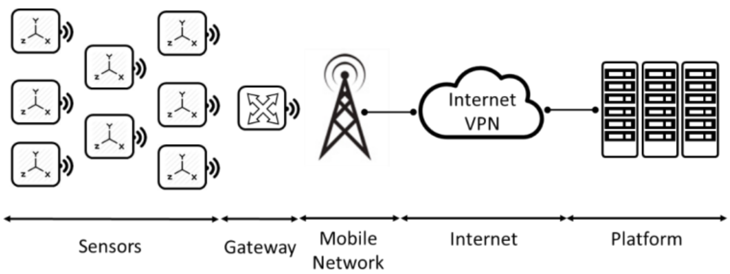
The main advantage associated with this model is its simplicity, since each of the sensors transmits information individually.
The disadvantages of this model resides in its cost, since the deployed and its ability to collapse the communication network is multiplied hardware, since different sensors need have a bandwidth to transmit itself.

Uses:
- Vehicles
- Task Forces

- One Gateway for a group of sensors

When sensors are placed in a fixed spot, they can join a network sharing a Gateway that is around them, when this happens we can say that sensors have a topology of mesh network, in which each node relays data for the network. All mesh nodes cooperate in the distribution of data in the network.

The topology of mesh networks has great advantages in flexibility and reliability compared with other network topologies. The self-organising management approach of network nodes can greatly improve the robustness of the network, resulting in a smart mesh networking technology. It also saves installation costs, since a single gateway can service connectivity to a group of sensors.



Uses:
- Metering.
- Structures stability.
- Pollution.
- Light intensity.
- Street Lights.

Smartcity platform's Acquisition Layer can help Emergency Services to receive and enrich real time events that can improve their overall operation standard. Having the opportunity to receive data from many information sources (sensors, social networks…) deployed in different locations can provide a better "picture" of what is happening in a precise moment, allowing emergency services to take better decisions.

Security

WSN can be powerful tools for collecting and transporting data, but also dangerous if they are insecure. This why it's critical to assure that WSN are of trust, security and privacy compliant.

Some of the issues that need to be considered in WSN security are

- Protec the system from malicious attacks by assuring integrity and reliability.
- Protect the nodes against tampering, protect the communication channel
- Use logging/ audit functions to detect attacks.
- Encrypt algorithms and data.
- Secure routing in the network layer.
- Secure data aggregation.

5.2 Second layer: Data processing

Cities produce huge amounts of information than need to be processed or other ways remain unused. This information comes in a large number of specific technologies and formats (such as traffic information, parking spaces, bus timetables, waiting times at events, event calendars, environment sensors for pollution or weather warnings, GIS databases, etc.).

Data processing layer allows Smartcities to store all the information needed to provide services under the Smartcity and on the other for analyse it to extract information and create knowledge.

Technologies that facilitate data processing, analysis, homogenisation, storage and visualisation in big databases or data warehouses are extremely important for Smartcities.

Some of the challenges these technologies need to face are:

- The wide scale production of big data that are continuously produced.
- The scaling of traditional small data into data infrastructures, enabling datasets to be shared and analysed in new ways.
- The creation of linked data that seeks to transform the internet into a 'web of data', enabling all documents to be rendered as data and to be harvested and linked together.
- The publishing of open data, making data publicly available and free to use.
- The development of new data analytics that often rely on machine learning techniques which can cope with and draw insight from very large datasets (e.g., data mining and pattern recognition; data visualisation and visual analytics; statistical analysis; and prediction, simulation, and optimisation modelling).

Quality of information (QoI)

Another challenge to face is the different types and quality of the data that is collected and needs to be processed. Smartcities use information coming from heterogeneous sources including various types of the Internet of Things (IoT) data such as traffic, weather, pollution and noise data. The Smartcity data usually have different Quality of Information(QoI). QoI of each data source mainly depends on three factors:

- Errors in measurements or precision of the data collection devices.
- Noise in the environment and quality of data communication and processing.
- Granularity of the observations and measurements in both spatial and temporal dimensions.

Furthermore, various environments have different requirements that will determine the efficacy of using the data in the Smartcity applications; some systems have energy restrictions; some wireless networks could rely on low bandwidth or intermittent connectivity. Most of the smartcity applications also have to deal with huge volumes of data, with high velocity, dynamicity and variety of types of data.

The QoI issues become more challenging when various data with different QoI are going to be integrated in an application to extract higher-level information and/or to provide actionable information to other services and applications.

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Data Processing
The processing of big amounts of data plays a central role in decision making, forecasting, analysis, patterns development, customer experience, etc. New information systems, social networks and connected users produce data that needs to be process in order to extract information from it.
Platforms capable of processing huge amount of data quickly in an effective way relay on new hardware and software basis such as:

- Batch Processing
- Real time Processing
- Hybrid Processing

Batch processing is the solution to process large volume of static data. In a simplistic way, batch processing uses static data because it works with data that are already in the system (data storages). This paradigm does not take into account new data once a batch processing has started.

Real time processing on the other hand deals with velocity of Big Data such as processing streaming data but with low latency. This processing paradigm is based, more or less, on the same principles as those of batch processing such as distribution and parallelism. In order to achieve low latency, this processing paradigm analyses small sets of data that are stored in memory. So real-time processing is something like an infinite sequence of small batch processing where the information is in memory instead of disks.
Hybrid processing appears because many application domains require the combination of batch and real-time processing paradigms.

Batch processing manages the master dataset, which is not changeable and is stored in a distributed file system, batch results loads and exposes the batch views in a data store so that they can be queried; Real time processing deals only with new data that require low latency.
To obtain a complete result, the batch and real time views must be queried and the results be merged together. Synchronisation, results composition, and other non-trivial issues have to be addressed at this stage, which is a part of the Combination layer.

Data Storage
The idea of having one single data repository in a common platform for all organisations is one of the most powerful concepts in the Smartcity. Information management also needs certain levels of protection, security and assurance of privacy and the processing data layer is the one to provide them. Smartcity data management is a complex task. Real time data consumption, different formats, complexity of geolocation data and the integration into a complex data model which ideally represents the entire city are factors to be taken into account.
In this context, it is necessary to have tools that simplify information management: extraction, homogenisation and storage structures that are easily accessible.

In this sense, data warehouses or data stores are tools widely known in all sectors where it is necessary to store and process large amounts of information. In these stores useful data are stored as an intermediate step. The data are later transformed into useful information for the different organisations. Decision support systems, executive information tools and information display systems help the subsequent tasks of analysis. It is also important that the data warehouse allows queries from applications or end users without affecting system operation.

In the case of Smartcities, data warehouses must take into account in their design two fundamental characteristics: handling large amounts of data in real time and the need for information to be geographic. The use of "spatial data" adds location information to data. In this case, the geographic component is not only an aggregate, but it is another dimension. It allows us to model the complexity of the city. Tools for analytical processing not only must hold a high performance in multidimensional consultations but additionally must allow to visualize results spatially: as mentioned, visualisation techniques are particularly relevant in the context of the Smartcity.

A layer of analysis and control is necessary to make the best possible data available and even anticipate human behaviors. In this sense data mining techniques become indispensable.

In this platform layer tools facilitate the monitoring of the most important events that are happening in the city and help, for example, to detect alarms in real time through notifications. In addition, information will be aggregated and presented differently and at different levels depending on the target audience, trying to present it in the most intuitive way.
Depending on the purpose of the query and the different subject areas, the city views may be presented in different ways. This platform layer is therefore essential for the definition and monitoring of objectives and policies governing the operation of the Smartcity.

Smartcity platform's Data processing layer can help Emergency Services to access different types of rich and real time data, useful for their activity at a very low cost.

Several applications require real-time processing of data streams from heterogeneous sources. Some examples for Smartcities are management of transportation, energy supply and garbage collection. More concretely, in the framework of emergency and disaster management data gathered by emergency management sources, citizens' usage of social networks, and mobile devices could be mentioned.

Possible information repositories built on the platform of Smartcities accessible by emergency services are:

- Resource Catalog.
- Critical infrastructures catalog.
- Maps risk.
- Building maps.
- Aerial photographs.
- Events databases
- User behaviour
- LIDAR and 3D maps
- Statistical data.
- Weather information and forecasts.
- Behaviour patterns.
- Etc.

5.3 Third layer: Interoperability

Nowadays, to connect IT platforms from different providers, developed in different times and for different purposes is critical. The ability to exchange information in an effective way is the key to construct more intelligent platforms. The best way to construct this effective communication is through interoperability and standards.

There is no single definition of the word interoperability, however, the following definitions are probably the closest to a common understanding and collectively capture the meaning of the term
"Interoperability is the ability of two systems to interoperate using the same communication protocol"
"Interoperability is the ability of equipment from different manufacturers (or different systems) to communicate together on the same infrastructure (same system), or on another while roaming"
"the ability of two or more systems or components to exchange data and use information"

There are different categories of interoperability to consider: technical interoperability, syntactical interoperability, semantic interoperability and organisational interoperability
Technical Interoperability is usually associated with hardware/software components, systems and platforms that enable machine-to-machine communication to take place. This kind of interoperability is often centred on (communication) protocols and the infrastructure needed for those protocols to operate.

Syntactical Interoperability is usually associated with data formats. Certainly, the messages transferred by communication protocols need to have a well-defined syntax and encoding, even if it is only in the form of bit-tables. However, many protocols carry data or content, and this can be represented using high-level transfer syntaxes such as HTML, XML or ASN.1
Semantic Interoperability is usually associated with the meaning of content and concerns the human rather than machine interpretation of the content. Thus, interoperability on this level means that there is a common understanding between people of the meaning of the content (information) being exchanged.

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Organisational Interoperability, as the name implies, is the ability of organisations to effectively communicate and transfer (meaningful) data (information) even though they may be using a variety of different information systems over widely different infrastructures, possibly across different geographic regions and cultures. Organisational interoperability depends on successful technical, syntactical and semantic interoperability.
The implementation of the interoperability layer must contemplate at least the following levels

- Transport level: Allow communication between services.
- Network protocols and communication level: standards that support the transmission of messages between services.
- Service description level: Allows complete description of services to be consulted, identified, and consumed.
- Services level: Type software to execute the services.
- Business processes level: to define and execute business processes and flows.
- Service records level: Mechanisms of publication and service discovery.
- Policy Level: define the functional and non-functional policies according to the capabilities of services.
- Security Level: Responsible for security aspects such as authentication, authorisation, privacy, integrity, confidentiality, and secure communication.

Business processes are deployed within this interoperability layer and designed to provide one or more responses to the triggering of an event and in them much of the system intelligence resides.
The implementation and deployment of business processes is usually performed using SOA (Service Oriented Architecture) and using workflow as BPEL engines. Business processes must be defined by experts in emergencies and civil protection, to do so, they need to plan what answer the system has to give in certain conditions or situations. Usually, these business process can be abstract as logical trees.

Finally, the system, using information obtained from the different services and combining the rules defined in the processes can make decisions and recommendations in a quick and accurate way. Later, these business processes can come together to build more complex processes.

Smartcity platform's interoperability layer can help Emergency Services connecting and exchanging information between the different emergency and civil protection agencies as well as integrating processes that affect these organisations.

The deployment of an interoperability layer at national or regional level can be extremely beneficial for communication and exchange of information between emergency centres and security forces. The exchange of reports and messages between emergency telematics groups can improve the coordination and, therefore, reduce response times and improve service quality.

5.4 Fourth layer: Presentation of information

Presentation layer is the access point for users to the Smartcity platform.
This layer must therefore act as a front end for every single user or service trying to get or post information from or to the system. To do so, many different interfaces must be built, taking into account all type of possible uses of the information.

The purpose of these interfaces is to provide ways for external users and services to access platform's information in a simple and secure way. Once a user or service has called one of these interfaces from outside the platform to get or post a piece of information, interfaces will start to call inner functions in the system until a response is returned.

The main advantages of using this layer is that external agents don't need to know how the platform works to use it, they just need to call the interfaces that are published. The other advance is that external agents cannot access restricted information or damage the platform.

The concept of the presentation layer has already been widely used in the past, but now it has to deal with a new situation brought by the multi-device access paradigm. This means that these interfaces will be accessed many times per second by machines, but also people using their mobile devices.

This layer can show access points like:

- APIs
- Mobile Applications
- Websites
- Web services
- Etc.

Emergency services can take advantage of the services layer by accessing end user APIs and websites where they can find added value information. They also can use this layer to provide services to citizens.

Some good examples of how a city can make its inner data accessible to public are the following:

- http://datosabiertos.malaga.eu/dataset
- https://amsterdamsmartcity.com/
- http://www.smartsantander.eu/
- http://dublinked.ie/ y http://dublindashboard.ie/pages/index
- http://opendata.bcn.cat/opendata/en/catalog

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7 EENA recommendations

Stakeholders	Actions
European Authorities	European authorities should continue to foster the creation and development of Smartcities' services. Not only by founding projects in member states, but also by giving guidance about best practices.
National and Regional Authorities	National and Regional Authorities should also foster the creation and development of Smartcities' services, not only by funding projects, but also by developing policies that help this services to grow and to stay accessible for public organisations.
Emergency services	Emergency services should find the best way to use Smartcities' services around them. This actions can include asking regional or national government to implement these services or adapt their own infrastructure to use them.
National telecommunication regulator and Network Operators	National telecommunication regulator and Network Operators should help governments and companies by adapting policies and technological infrastructure to these new services.

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