



Public safety digital transformation

VISUAL COMMAND & CONTROL IN PSAPS



As our lives become evermore digitised, how will the PSAP change to respond to citizens' needs? What does the future hold for control room technology?

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EUROPEAN EMERGENCY NUMBER ASSOCIATION

Public safety digital transformation: Visual command & control in PSAPs



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EXECUTIVE SUMMARY

For the first time in history, there are more people living in urban areas than in rural areas. Moreover, this migration is set to continue. Meanwhile, emergency services are facing a growing and more diverse range of threats driven by, for example, natural disasters and the risk of terrorism.

This changing nature of the threat landscape sits alongside the digital transformation of our world. The Internet of Things (IoT) is driving a revolution in how cities are organised. Cities are leveraging integrated information and communications technology (ICT) to help solve problems with transportation, energy supply, social infrastructure, economic stability, physical infrastructure and security. A combination of new technology and business model innovation is transforming the way safety is delivered with a shift from detection and response to prediction and prevention.

Although often seen as moving slower than other industries, public safety stakeholders are embracing technology and new solutions to provide more intelligence, visual command and dispatch, situational awareness and operational efficiencies. The emergency services industry has started to see disruption of its digital transformation journey with a range of emerging technologies, new competition and evolving business models delivering enhanced safety outcomes for our future.



This document will focus on the evolution of PSAP to visual command, the related technologies, and provide an overview of the PSAP of the future.



The number of data inputs streaming into a PSAP are significantly increasing. The stresses placed on call takers will increase quickly if PSAPs are not well-positioned to handle the enormous amount of data.



1 | WHY DOES THE PSAP NEED TO EVOLVE TO VISUAL COMMAND & CONTROL?

A growing problem for cities worldwide, public safety has faced challenges in many fields, including production, environment, technology, and information. Governments are in urgent need of ensuring the protection of their people against public safety threats such as accidents, natural disasters, and malicious attacks.

It is common sense that with a fixed level of intelligence, the more comprehensive and relevant information we obtain, the more probable it is that we make correct decisions. The way in which information is combined and presented is also important. Imagine that we face a pile of various materials, which, despite providing comprehensive information, takes a significant amount of time and labour to extract key information and figure out relevance.

Traditional Public Safety Answering Points (PSAPs) and command control centres have a number of limitations. Some were established a long time ago and may have only voice information functions, provide information that is stored on computers, and do not support a comprehensive understanding of on-site situations. Some may be integrated with monitoring centres to provide video information about on-site situations, but such a video platform is usually separated from the main control platform and needs heavy manual watch. In addition, to check different data such as location information, emergency services' resources and traffic conditions, operators have to switch between different computer platforms, which is quite inconvenient.

However, whilst the requirement for traditional technologies will continue, there is strong growth in a number of emerging technologies that will transform emergency services solutions and technologies over the next decade.

On the other hand, the number of data inputs that stream into a PSAP are now significantly increasing, largely driven by the fact that both the Next Generation 112/Next Generation 911 systems are Internet Protocol (IP) - based and broadband/multi-media enabled. The call taker's stresses will rise quickly and profoundly if PSAPs are not well-positioned to handle the enormous amount of data.

This is not a matter of increasing staff, even if that were possible—which it is not given the budget restraints under which many if not most PSAPs operate today. Even if adequate funding was available, there is no reasonable number of staff that would be capable of processing the enormous amount and new types of data that will be available in the future. Instead, PSAPs will need to make a number of technical, operational and policy changes.

With the aforementioned challenges listed, PSAP planners can begin first by dividing this part of the PSAP evolution into two major areas. The first is to deal with all new technology introduction while the second is to deal with soft issues and updates such as people, processes, and management.

This document will focus on the new technology introduction part.

1.1 | EMERGING TECHNOLOGIES AT THE CENTRE OF PROTECTION COMMUNITIES

Evolving networks and intelligence-driven services, data and video analytics, biometrics, IoT, cloud computing and big data technologies are changing the traditional methods of security, operations and protection.

This emerging trend has been picked up over the past years in EU initiatives as "Digital Transformation".

Digital transformation is not necessarily about digital technology, but about the fact that technology, which is digital, allows the integration of digital technology into all areas of a business, fundamentally changing how we operate and deliver value to public safety industries.

It is fuelled by increasing digitization (for example the number of mobile devices), connectivity (the ability to connect devices, people and processes) and data. This process is happening across industries to transform and change existing business models, consumption patterns, socio-economic structures, legal and policy measures, organisational patterns, cultural barriers, etc.¹ and to improve operational efficiencies and customer satisfaction.

Although often seen as slower proceeding than other industries, stakeholders are embracing technology and new solutions to provide more intelligence, situational awareness and operational efficiencies.

These technologies include:

- **Video surveillance** – growth in IP cameras and video analytics
- **Mobile applications and broadband communication** – development of data networks and emergence of broadband mission critical communications
- **Access control** – improved reliability of biometrics and growth of digital access control systems
- **Screening and detection** – improved sensors, quicker throughputs, identification of contraband material and better detection of chemical, biological, radiological, nuclear and explosive materials
- **Big data** - make better and faster decisions using data that was previously inaccessible or unusable
- **Internet of Things** - help cities meet their public safety goals by offering real-time monitoring/analytics and improved decision-making
- **Artificial Intelligence** - AI helping to improve the call taking process

1.2 | KEY TECHNOLOGIES & TRENDS IN PUBLIC SAFETY

The aim of new technology is to break down data silos and barriers that have prevented information sharing to allow public safety agencies access to the right information to inform real-time and intelligent decision making. Mission critical operators must have the ability to easily monitor and interpret multiple sources of information, making decisions that can impact an entire organisation.

The designers, project managers, programming engineers and technicians must integrate the right visual components for the command centre. Visual components provide a huge visual space to display data, physical navigation rather virtual, which leads to a more natural pan and zoom, and finally an easy way to collaborate due to their large shared space.

Through visual command integration, such as real-time threat intelligence, situational awareness, and integrated response and collaboration, agencies can respond to changing situations while accessing the information necessary to complete their missions. Emergency organisations can be provided with real-time intelligence analysis, allowing all personnel to take appropriate action based on a common operating picture and enabling organisations to gain situational awareness and risk resilience on an unprecedented scale.

For example, police and fire departments can leverage smart analytics to identify and capture data relevant to homeland and national security. They can combine information from multiple sources to create a complete picture of the situation they face. Moreover, cutting-edge ICT systems have transformed crisis and disaster management – helping determine the location of injured people, which rescue crews are already at the scene, what kind of aid is needed, and more. The right technology gives public safety agencies an accurate overview of circumstances, enabling them to effectively manage their operations, and efficiently coordinate human and technical resources. As a result, help arrives sooner, and exactly where it is needed.

2 | THE VIEW OF VISUAL COMMAND AND CONTROL - THE PSAP TRANSFORMATION

One of the pillars of the future PSAP will be digital transformation through the implementation of new technology enabling related groups to work together and facilitating multiagency collaboration to develop operational and response procedures.

A converged visual command & control-based PSAP will help implement preventative measures before an incident occurs, efficient dispatching when incidents do occur, and process optimisation in their aftermath, improving the efficiency of public safety and emergency management. Here we list the common services that will be supported by PSAPs.

2.1 | SERVICE REQUIREMENTS: INTEGRATES INTELLIGENCE, COMMAND & ACTION

The future PSAP will feature full situational awareness, panoramic-view, real-time decision-making, and the integration of operations. These features will bring additional requirements for traditional command centres (shown in *Figure 1: Example of Services Flow*).

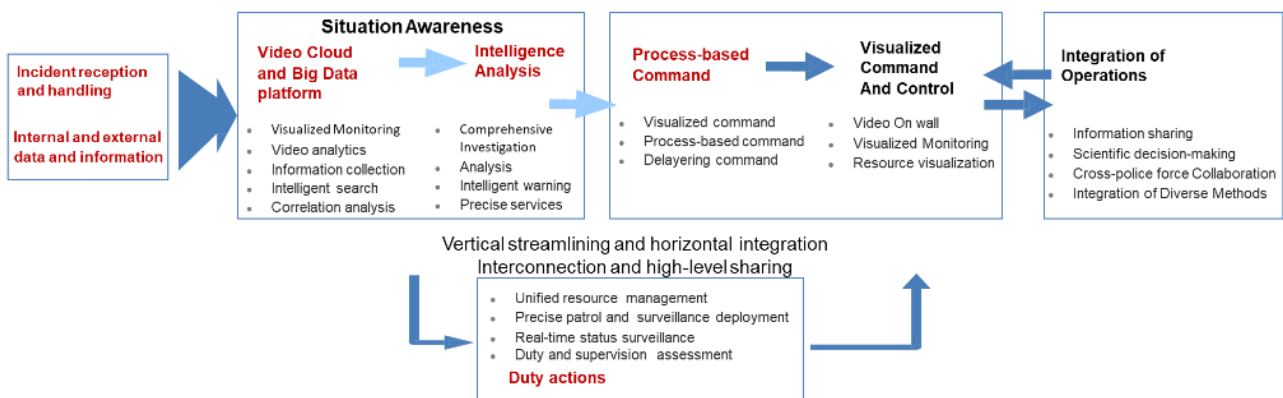


Figure 1: Example of Services Flow

2.1.1 | TRANSPARENT SITUATIONAL AWARENESS

Multi-dimensional surveillance, real-time information sensing, intuitive and visualised situational information, and unilateral, transparent on-site information for command and control centres mean that we're more able to deploy resources strategically. Time and cost are reduced by implementing the following features:

- Comprehensive investigation:

Use IoT sensing technologies to comprehensively investigate and monitor on-site situations with diverse methods from different dimensions, implementing multi-dimensional surveillance and real-time information sensing. The typical scenarios are for early warning, such as natural disasters, public events, critical infrastructure protection, etc. The whole view of these scenarios is as following:

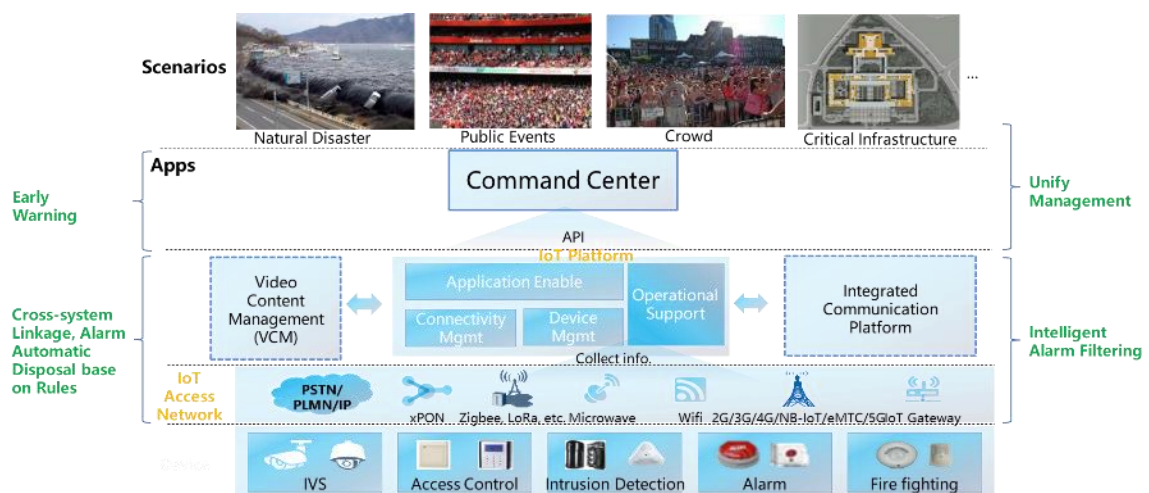


Figure 2 : Example of Transparent Situation Awareness



- Intelligence integration:

Various converged databases are built to integrate video, vehicle, facial image, and mobile phone data to conduct data comparison. Based on the multidimensional data analysis model, this implements strong internal correlation for the data, and archives data by space (S), message (M), and time (T) to form dedicated databases. Uses include automatic number plate recognition (ANPR) and facial recognition (FR) systems.

- Visualised monitoring:

Use the practical command system with the unified architecture and standard to connect systems at different levels and rapidly send comprehensive on-site situations and intelligence to diverse users, including personnel in provincial command centres, branch offices, on-site command centres and first responders.

One of the dashboard applications is multi-agency collaborative sharing and unified display of situations. E.g. abnormal crowd detection and pre-warning, remote dispatching of on-site videos, viewing emergency services' resources distribution, etc.

2.1.2 | COLLABORATION OF OPERATIONS

Integration of diverse emergency organisations' forces, systems, and methods is critical in finally forming practical command capabilities. Such as:

- Multi-system integration:

Based on a unified system architecture, insist on flexible integration of the operations service application system, auxiliary technology system, application support platform, smart equipment, network platforms, and policing cloud platforms, improving the command system's response speed and command accuracy.

- Integration of diverse emergency services organisations (if needed):

Integrate diverse agencies to jointly conduct such work as emergency processing and security governance, based on categories and levels under a unified command.

- Integration of diverse methods:

Insist on flexible integration of information, service, and command flows. Ensure seamless integration of diverse parts such as situation warning, command and processing.



2.1.3 | HYPER CONVERGED

As the demands on urban management, public safety, ICT-based disaster prevention, and emergency response increase, governments and enterprises expect to collaborate between departments more efficiently and obtain frontline information as soon as possible. To meet these requirements, they need to interconnect their emergency command systems with the internet, GIS map system, mission critical communication system (LTE and Tetra/P25), video conference (VC) system, telecommunications system, and intelligent video surveillance (IVS) system.

Command centres tend to conduct service convergence. CAD services, video surveillance services, and big data services will transform to be centralised and converged. The PSAP will provide a portfolio of open interfaces, through which incident reporting services, call taking services, GIS map services, big data services, and video surveillance services are all integrated into the CAD service software.

The PSAP will leverage GIS mapping, CAD, VA (video analytics) or IVS (intelligent video system), VMS (video management system), and big data to build up a converged solution, visualising emergency response resources and incident scene conditions for real-time command and processing. This will generate unprecedented insight into daily emergency communication centre operations, illuminating problems that can impact services before they get out of hand. It breaks down the barriers of bringing together, analysing and acting on operational, phone, radio, CAD and quality metrics – empowering PSAPs with a single view of the reality.

Implementing the above features will be carried out by the following methods:

- Intelligence integration for command agencies: Integrate information from diverse emergency services organisations improving network-based dynamic management and visualised command capabilities.
- Rapid, flexible coordination methods: Relying on network-based command and visualised control, implement transformation from pre-incident contingency plan deployment to during-incident unplanned coordination with the principle of achieving targets through delegation at different levels. Transform from focusing on plans to movements, which improves command coordination efficiency.
- Sensitive information control and response: Improve information collection accuracy and implement broadband-based data transmission and real-time, smart intelligence processing through the digital transformation of the command systems.

The PSAP can visually display conditions and resources of emergency response units on a GIS map, implementing one-stop dispatching. When receiving an incident, the dispatcher first queries available emergency response units and then selects a unit to handle the incident on-site. *Figure 3* shows an example of how resources could be visualised.

The display provides a real-time, tactical display of active emergency calls and automatic vehicle location (AVL) positions and statuses. The intuitive interface presents a variety of metrics showing fleet load and distribution of activity by zone, combined with real-time data such as traffic, weather warnings/radar, department of transportation (DOT) information, and traffic camera access. Leveraging GIS data in conjunction with maps and a variety of real-time data feeds, the operations monitor helps decision-makers by integrating all these data into one holistic display.



Figure 3: Unified command on the same GIS map

The CAD system can also display incident trends by level or emergency response unit and can report incident trends at a daily, weekly, or monthly interval. Command centres can observe incident trends for accurate commanding and view pre-set, custom, or periodic task reports to find key data among scattered data for easier decision-making. Metrics can be selected and visualised by choosing from a menu of charts, reports and performance indicators to keep track of trends and the current status.

2.2 | PSAP VISUAL COMMAND AND CONTROL FUNCTION

To better cope with complicated national and international safety situations, the PSAP could combine technologies such as multimedia telecommunications, mobile broadband telecommunications, a cloud data centre, and artificial intelligence with the Computer Aided Dispatch (CAD) application to support the full-process visualised command and control.

2.2.1 | PSAP VISUAL COMMAND AND CONTROL ARCHITECTURE OVERVIEW

PSAPs will benefit from several new capabilities that will provide greater insight into the nature of each caller's emergency and will help guide tele-communicators on the most effective response that should be dispatched.

Using an open and flexible architecture, the PSAP would support interaction with multiple, traditionally independently-operated or inter-related, safety systems such as access control, video surveillance, big data systems, fire alarm systems, etc. Their consolidation into one platform provides a hub for the analysis and dissemination of data and information collected from various sources including government agencies, private organisations and individual citizens, as well as specialised equipment such as sensors and cameras. Command and control operators with an enhanced situational awareness will streamline operations and provide faster, more effective response coordination to service outages, streamlined law enforcement operations and real-time management of crisis situations.



The following figure shows an overview of the full environment of public safety with related modules:

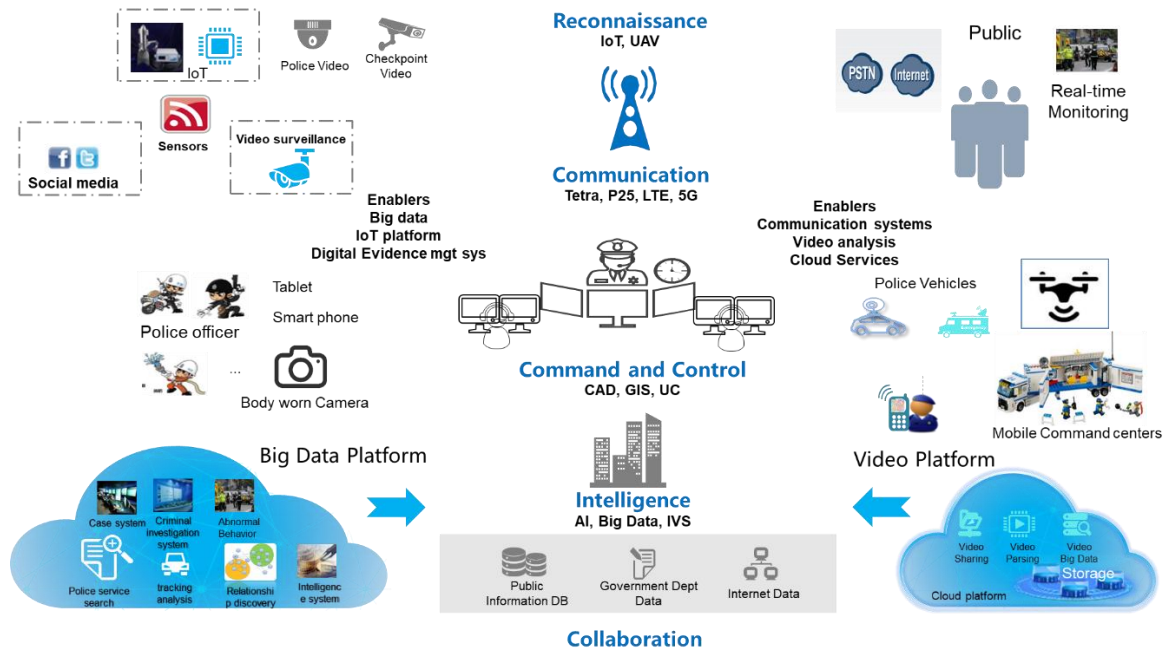


Figure 4: Full environment of public safety

Depending on the situation's priority, the module or function could be deployed selectively for visual command and control deployment.

For example, first introduce the broadband mission critical service (MCX) for visual command and control without big data analysis (communication part). The following figure shows the corresponding functionality.

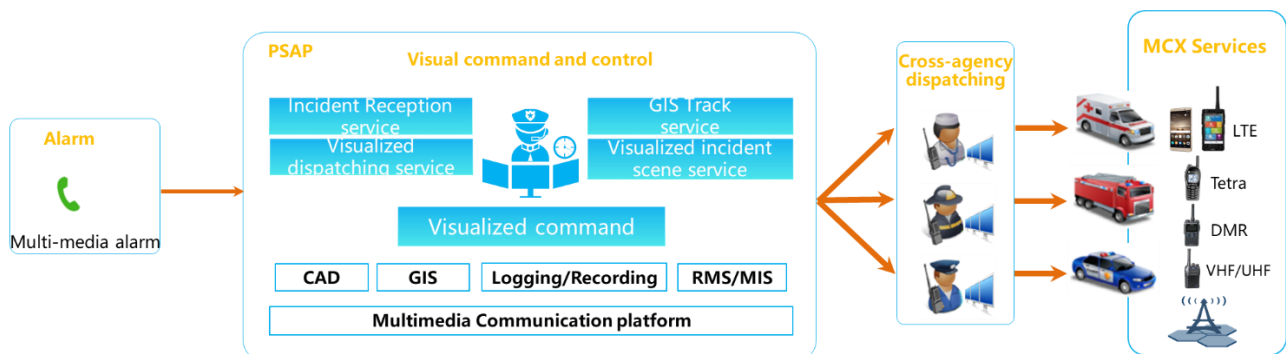


Figure 5: PSAP Infrastructure with broadband MCX service introduced

The second stage will integrate with the video system (CCTV or surveillance system, etc.) and the data enabler module (e.g. big data system), which can be deployed in national intelligence centres. The following figure shows the corresponding architecture:

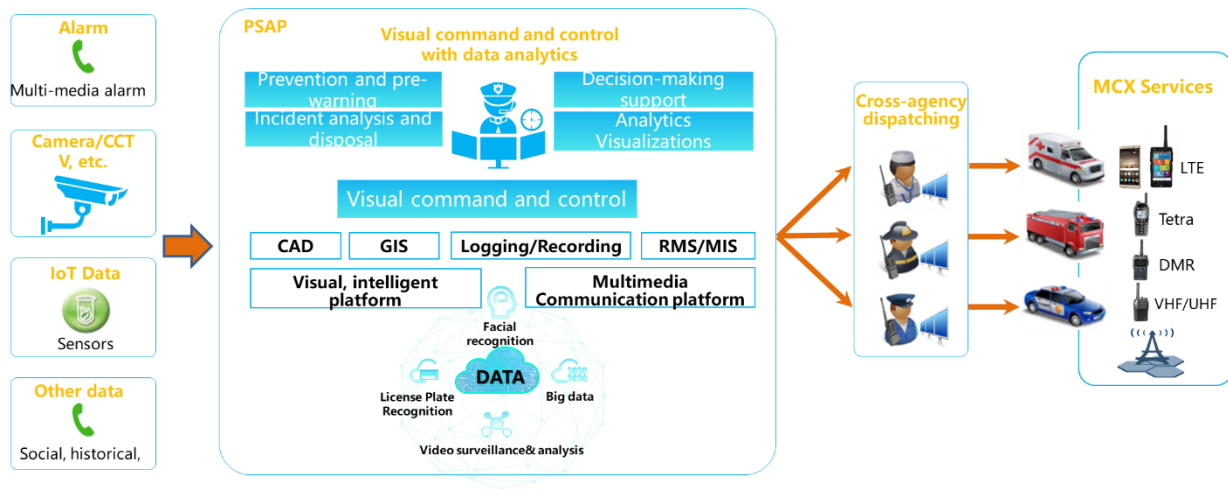


Figure 6: PSAP Infrastructure full view

The PSAP infrastructure elements, many of which carry-over, as expected, from legacy PSAP operations, may include (but are not limited to) the following:

- Infrastructure: Cloud based infrastructure or promised infrastructure.
- Platform: including visual, intelligent platform and multimedia communication platform, CAD, GIS, etc. All of the above modules can be deployed selectively.
- Applications: The application is the software the user sees and interacts with and where they enter the needed information.

To make the application simpler and more lightweight, a service support can give the flexibility to carry out the core capabilities. This can provide unified data access, exchange and analysis. It can also act as a go-between for the data tier and the user, passing on the user's different actions to the service tier.



This part combines intelligent automation, advanced analytics and data visualisation provided by a Platform as a service (PaaS) layer with the contemporary user experience of consumer home and mobile electronics. The applications provide the service applications, such as call taking, dispatching, etc.:²

- Prevention and pre-warning (e.g. Internet of Things-based)
 - Video services: video management, surveillance and media analytics (video, audio)
 - Visualised prevention and control
 - Alarm push
 - Personal/vehicle big data
 - Multi-dimensional prevention and control
 - Group incident prevention and control
 -
- Visual command and control
 - Multi-channel call taking (voice, text, data, images, video, real-time communication)
 - Incident reception
 - Situational awareness/incident status monitoring
 - Management Information System (MIS) and analytics
 - Incident recording (multimedia - voice, text, data, images, video)
 - Emergency Medical Dispatch (EMD)
 - Video wall with flexible video source selection
 -
- Decision-making support
 - Incident analysis and disposal
 - Information display: analytics visualisations
 - Criminal justice information match
 - Social media mining and external communications
 - Data analytics (descriptive, predictive, prescriptive): IoT, video, etc.
 -
- Others
 - Geographic Information Systems (GIS)
 - Records Management Systems (RMS)
 - Data retention/records maintenance
 - Identification (ALI) services
 -

In short, with this architecture, we can adopt new technologies and add more components without having to rewrite the entire application or redesigning a whole new software, thus making it easier to scale or maintain.

2.2.2 VIDEO SERVICE INTRODUCTION

The PSAP will allow for full integration of video and recording systems deployed in the country, as well as any other third-party systems required by the customer. This ensures that the officer has the highest level of protection and control, and the best tools and virtual backup possible.

The video service flow mainly consists of video management, video parsing, and video big data³ as shown in *Figure 7*.

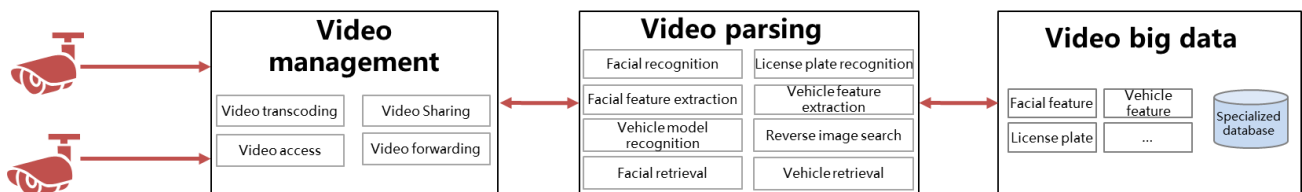


Figure 7: Overall video service flow

VIDEO MANAGEMENT AND VIDEO PARSING

This layer refers to a service-oriented platform that provides a wide array of capabilities such as video and image sharing and parsing, and video big data. The platform provides a video networking and sharing service, a facial analysis service, a vehicle analysis service, and a data collection service. The video networking and sharing service supports access to public safety and checkpoint video resources, real-time streaming, video playback, video download, and video quality diagnosis. The facial analysis service implements facial recognition analysis and stores and retrieves facial images. The vehicle analysis service implements vehicle recognition and stores and retrieves vehicle images. The valuable information generated by facial/vehicle image structuring is stored in the upper-layer big data platform, and images are stored in the underlying cloud storage platform.

VIDEO BIG DATA

The data mid-tier layer uses the video big data technology to construct basic resource libraries or valuable resource libraries for videos, images, people, vehicles, scenarios, and cases. It also enables the Platform as a service (PaaS) and Software as a service (SaaS) layers to provide services such as quick search, path restoration, relationship analysis, multi-dimensional association analysis, and person/vehicle alert deployment. This supports practical services before, during, and after incidents by implementing an aggregation of various valuable video and image data.



2.2.3 | BIG DATA SERVICE INTRODUCTION

The uptake of digital recording, evidence management and statistical reporting from control rooms has resulted in an increase in the deployment of 'predictive crime centres'. Although examples are isolated, rollouts in many countries are, in the long term, hoping to use data to curb crime rates.

Big data will play an important role in the future of the safe city. Video surveillance, mobile devices, and social media will generate vast amounts of data that command and control centres will need to interpret, analyse and action in conjunction with incident histories and response policies. The control room is where this data will converge.

This trend will change the way dispatchers and operators manage emergencies and dispatch assistance and will result in more statistical output from the control room. It will be essential to design CAD platforms to facilitate the flow of information from both the caller and first responder. In response, there has already been an increase in the number of CAD tenders including a wide range of analytical capabilities and smart applications. This is evidenced by suppliers looking towards solutions which will stream inputs from body-worn cameras straight through to the control room.

Policing big data platforms are usually deployed with a video cloud centre to provide more reliable and flexible predictive results.

Various resources can be integrated, such as video data, Internet of Things (IoT) data, internet data, and political and legal service data, to form a public safety big data centre. This consolidates structured and unstructured data from multiple sources – voice interactions, computer-aided dispatch (CAD), identification (ID), screen captures, automatic number identification (ANI) and automatic location identifier (ALI) data, geographic information system (GIS) data, text messages, video, and more – and structures it into a single synchronised event with a corresponding timeline.

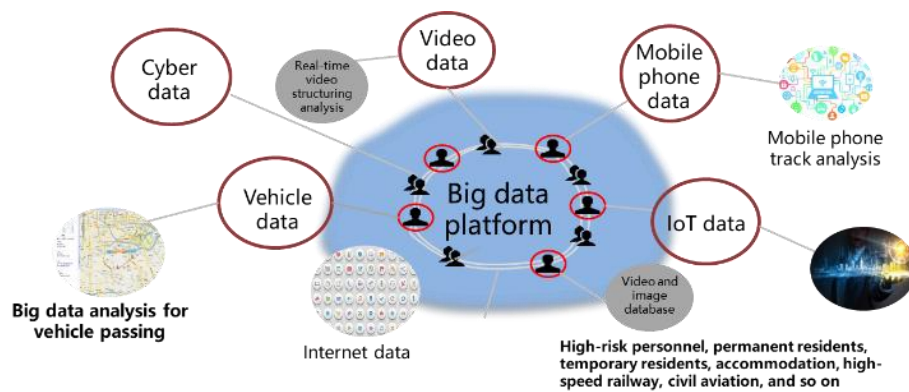


Figure 8: Policing Big Data mining

2.2.4 | SECURITY

The limited means of entry into the traditional 911/112 network significantly limited potential attack vectors, and what little cyber risk existed could be easily managed. NG112/NG911's interconnections enable new response capabilities, which also represent new vectors for attack that can disrupt or disable PSAP operations. This broadens the concerns of – and complicates the mitigation and management of – cyber risks across all levels of government.

Except for the existing NG911/NG112 security specifications, with the rise in demand for interoperability and the expanding Internet of Things, today's world demands cooperation and collaboration. Standards bodies are already working together.

There are some standards for video surveillance security developed by the Open Network Video Interface Forum (ONVIF) ^[4], including the standard for IP-based video surveillance systems. The standards have been extended to include Electronic Access Control, as well as the newest access control specification from ONVIF. For more details, refer to the ONVIF White Paper: Best Practices Security for Video Surveillance Systems. ⁴

The Task Force on Optimal PSAP Architecture (TFOPA) ² also believes that a lack of cybersecurity poses a clear and present danger to the PSAP and emergency communications system(s) in the United States of America. Creation of some core services, which provide single points of contact, direct reporting, awareness, data sharing, and real-time response to cyber-attacks at multiple levels of government is essential to the success of the efforts to defend next generation networks

and systems. The actors, vectors, and outcomes for cyber-attacks against public safety vary widely, and therefore, our approach to defending against these attacks must be focused.

The above security posture is about the devices, equipment, network infrastructure and connections, data, applications and services, which can be measured or checked through industry or general standards.

Given the dynamic nature of technology and the evolving cyber risk landscape, organisations should adopt a risk management process.

For example, in the United States of America, the Department of Homeland Security (DHS) strongly recommends implementing the NIST Cybersecurity Framework, which is a flexible, risk-based approach to improving the security of critical infrastructure.⁵

NIST uses three NIST Special Publication subseries to publish computer/cyber/information security and guidelines, recommendations and reference materials.⁶

The Core Functions of the Cybersecurity Framework are five areas on which organisations can focus their attention in order to develop a strategic view of its cybersecurity posture. By providing a high-level structure for organising information, the functions enable more informed risk management decisions. The five functions are:

- Identify - Systems, assets, data, capabilities, and other foundational elements that are critical to the organization. The activities in the *Identify* function lay the foundation for effective framework use.
- Protect - Develop and identify appropriate safeguards to ensure delivery of critical infrastructure services.
- Detect - Identify and implement the tools to identify the occurrence of cybersecurity incidents.
- Respond - The tools and activities to support the containment of a cybersecurity event.
- Recover - Bolster resilience and restore any capabilities or services impaired by the cybersecurity event.

Collaboratively developed between government and the private sector, the framework is designed to complement an existing risk management process or to develop a credible program if one does not exist. More information, including informative reference for addressing each aspect can be found in the framework.

APCO also released a [security guide for PSAPs](#). The primary goal of this document is to inform PSAP supervisors and above how to identify, prevent and minimise exposure to cybersecurity risks and vulnerabilities ^[7]. For NG112 security, EENA has also published a document about cybersecurity: [Security and Privacy Issues in NG112](#).⁸

3 | VISUAL COMMAND AND CONTROL SERVICE PROCESS

A major precondition for quickly reacting to emergencies is the effective planning and coordination of all remedial or preventive procedures. To be able to take the correct decisions in dangerous situations where critical infrastructures are concerned, a complete overview of the current situation and the available emergency personnel is essential. Structured operational sequences also ensure the fastest possible implementation of the deployments.

Command and control room systems are at the heart of any PSAP. A PSAP integrates all security-related information into a consolidated IT platform. This platform may be an advanced video-management software (VMS) solution, physical security information management (PSIM) software solution, or command and control software.

3.1 | VISUAL INTELLIGENCE BASED ON GIS

Command and control systems will provide the following visual intelligence by combining the above-mentioned technologies:

1. Visual on-site conditions and reachable instructions:
 - On-site video clips shot by fixed cameras or handheld public safety LTE (PS-LTE) terminals with the photo-taking function displayed at the command centre in real time.
 - The command centre invokes cameras to automatically trace incident locations, and enables users to watch incident-related video when necessary.
 - The command centre enables the command hall, mobile command vehicles, and handheld trunking terminals to assign tasks and report on-site conditions through voice and video services. When incidents are critical, the command centre can hold video conferences for decision makers to know up-to-the-minute on-site conditions and make efficient and accurate decisions.
 - The convergence of video conferencing and video surveillance systems enables users to watch and share live on-site surveillance video clips during video conferences, and backhaul video clips from trunking terminals to the conference sites. Such convergence greatly enhances decision accuracy and validity.

2. Visual resources

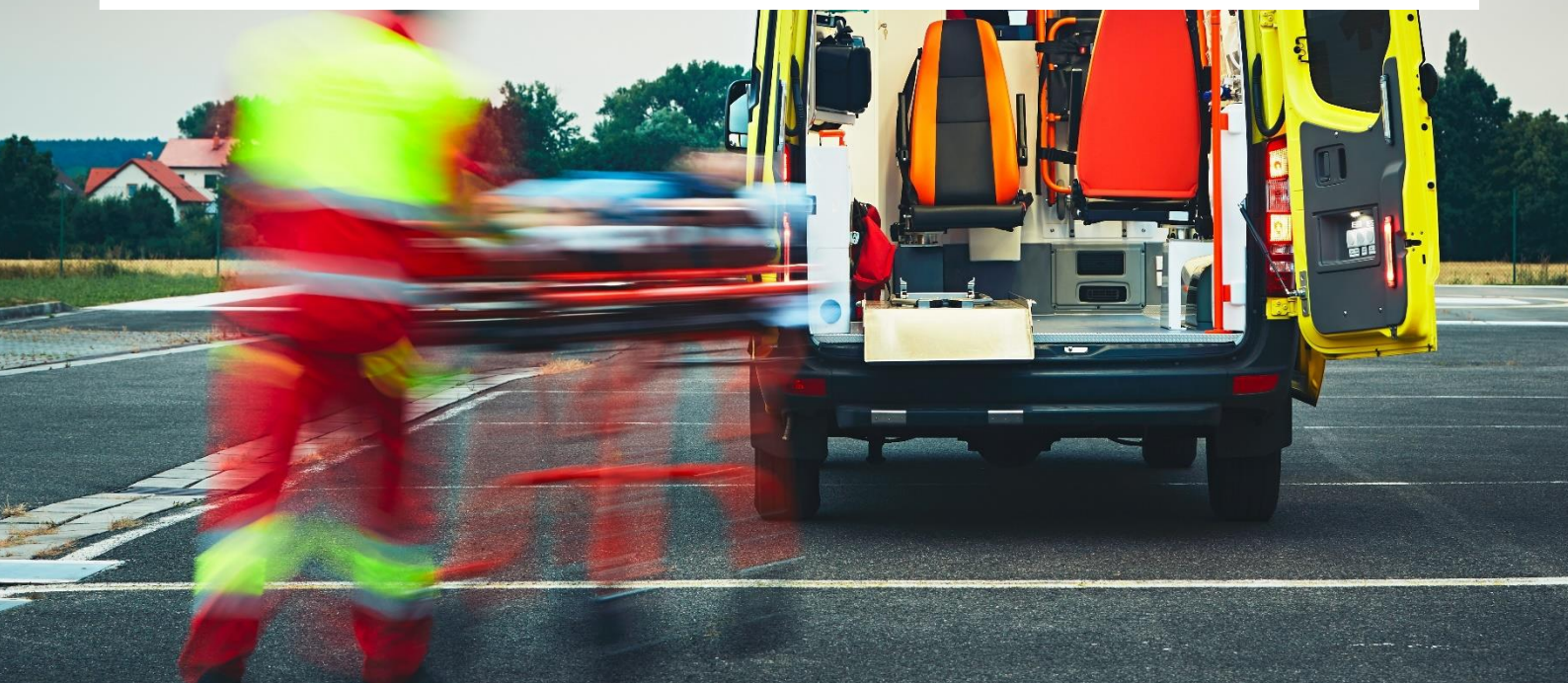
The command centre provides surveillance resource management, incident management, personnel dispatch, and incident analysis based on geographic information to implement visual command and dispatch so that users can intuitively understand on-site conditions by simple operations. The command centre uses the GIS platform to display on-site conditions, emergency services resources distribution, vehicles, and surveillance video clips shot by social units and PS-LTE terminals. This facilitates resource dispatch, providing decision-making reference for dispatching and optimised resource deployment.

In addition, there are clear safety benefits for personnel from being better informed when they arrive at a scene. For example, if they are attending a routine emergency call at a house they will be able to get information about who lives there, any criminal records linked with them or the property, or any potential dangers at that property, such as animals or health issues. Whilst this can be done now through voice communication, it takes time and effort, and often resources are too strained to provide all the required information.

3.2 | COMMANDING AND DECISION-MAKING SUPPORTED BY VISUAL INTELLIGENCE

If correct decisions can be made quickly when an emergency occurs, the emergency can be properly controlled and the loss can be minimised.

Accurate judgment of commanding and decision-making personnel depends on real-time information, as well as a good command of such information. Policing issues, such as public security management, commanding and dispatching, and safekeeping, have significant spatial features. Commanding and decision-making personnel need to master the security status in an all-round manner under a large span of geographical space. In this way, they can monitor spatial distribution of cases and emergency services.





3.3 | INCIDENT HANDLING PROCESS

By introducing visual command and controls, the visual PSAP incident handling process consists of the following stages: pre-incident prevention, efficient in-incident handling, and post-incident handling. Based on methods such as video analysis, incidents can be investigated, criminals can be captured, and contingency plans can be optimised.

Workflows can be initiated by system alarms and procedure steps can include operator-initiated control actions depending on the needs of the incident.

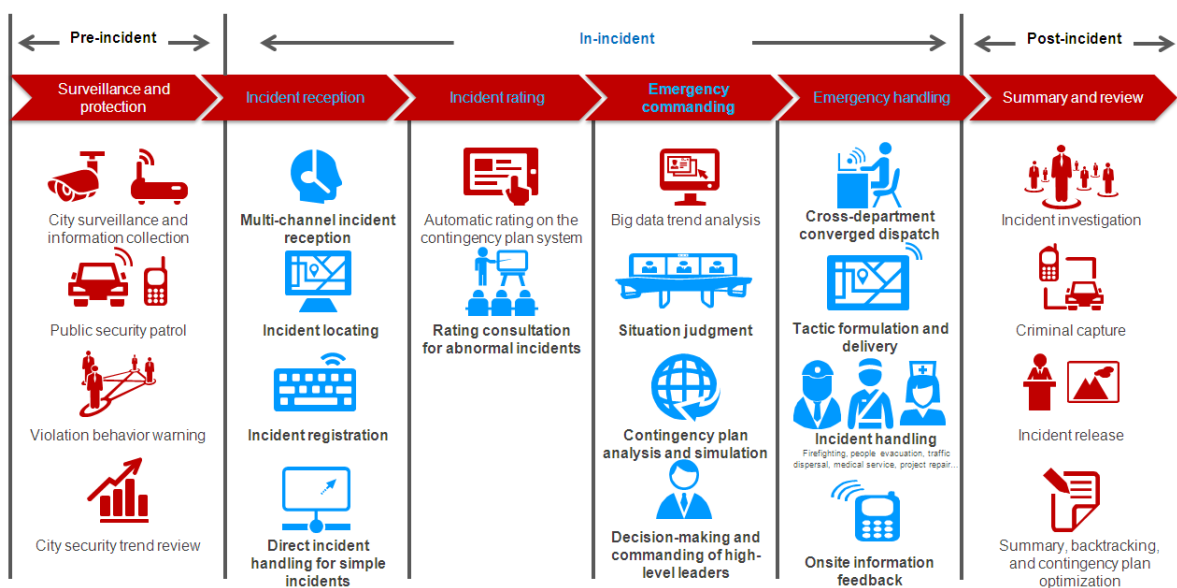


Figure 9: Incident handling process

3.4 | PRE-INCIDENT: SURVEILLANCE AND PREVENTION

The command centre will support the access of alarms from sensors (such as intelligent alarm devices, access control systems, and different types of detectors) and other sources. It will generate incident tickets automatically based on alarms, locate the incidents on the map, and play live video. This closely connects security systems to maximise the value.

The video surveillance system must support intelligent analysis of potential emergency situations. In addition, physical security systems must be linked to the warning platform so that incidents can be reported to the CAD in real time to take effective measures to prevent potential emergency situations in time.

4 | IN-INCIDENT HANDLING: RECEPTION, COMMANDING, DISPATCHING

4.1 | INCIDENT RECEPTION: MULTI-CHANNEL INCIDENT RECEPTION AND UNIFIED MANAGEMENT

The PSAP will support unified incident reception and handling and give priority to special incidents. The unified incident reception and handling system provides automatic location of incident scenes, unified dispatch of diverse terminals, and collaboration across departments. *Figure 10* shows how unified incident reception and handling is implemented.

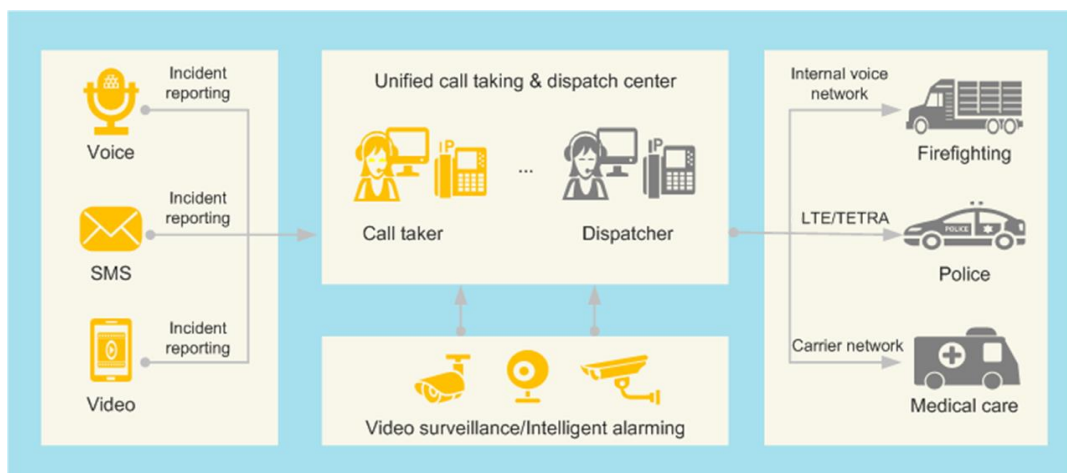


Figure 10: Unified incident reception and handling

The command centre supports multiple alarm reporting methods, including voice communications, text message, email, and social media, mitigating service congestion.

The command centre will support video-based incident reporting, meeting high definition (HD) video-based incident reporting requirements in the future. An incident reporter can use mobile apps to report incidents in video so that call takers can view key information directly. Web Real-Time Communications (WebRTC) can also be used.¹⁰

Unified reception and queuing are performed on the incidents reported through various channels to improve the incident reception efficiency. Incidents are received through call centres. Call takers can understand the incidents quickly and record key information, including locations, incident description, and mobile numbers.

4.2 | EMERGENCY COMMANDING AND HANDLING

When an emergency or a major incident occurs, police officers, firefighters, and doctors from various departments collaborate with each other. The visual dispatch system can invoke historical surveillance video clips, call on-site technical specialists, send on-site video clips to the command centre, and hold multimedia conferences to seek incident handling suggestions, report the incident progress to leaders, and send incident handling materials to various departments and terminals. All of this facilitates decision-making and incident handling.

4.3 | MULTIDIMENSIONAL DATA CORRELATION ANALYSIS

Various converged databases are built to integrate video, vehicle, facial image, and mobile phone data to conduct data comparison. These functions enhance public safety protection capabilities.

4.4 | VISUAL COMMAND AND VISUAL DISPATCH

The visual PSAP implements visualised accurate command by providing:

- Video-based consultation and decision-making: Incident scenes and emergency response units are all visualised by video of various sources such as video shot by surveillance devices and handheld terminals, video of consultation at the command centre, and video of remote experts, facilitating decision-making.

- Visualised command: Incident information, and emergency resources are all visualised and can be centrally dispatched on the GIS map, dramatically improving emergency response efficiency.
- Video display on the video wall: Video from surveillance devices, video conference, trunking terminals, and service systems can be pushed to the video wall in a unified manner.
- Mobile solutions empower the field: Mobile applications provide detailed tactical information, during operations that help the officers take the necessary decisions and communicate the same to the response teams in the field.

4.5 | VIDEO-BASED CONSULTATION AND DECISION-MAKING

The PSAP supports video-based consultation and decision-making to achieve video convergence, as shown in *Figure 11*.

The video exchange platform integrates all kinds of video streams and multimedia data in the LTE, surveillance devices, and video conferencing systems. Dispatchers at the command centre, emergency services officers at the incident scene, leaders and experts in their own offices, and other agencies can all access this platform to view video and data, achieve quick, accurate consultation and decision-making. Emergency services officers at the incident scene can directly participate in decision-making and consult experts about incident handling in real time.

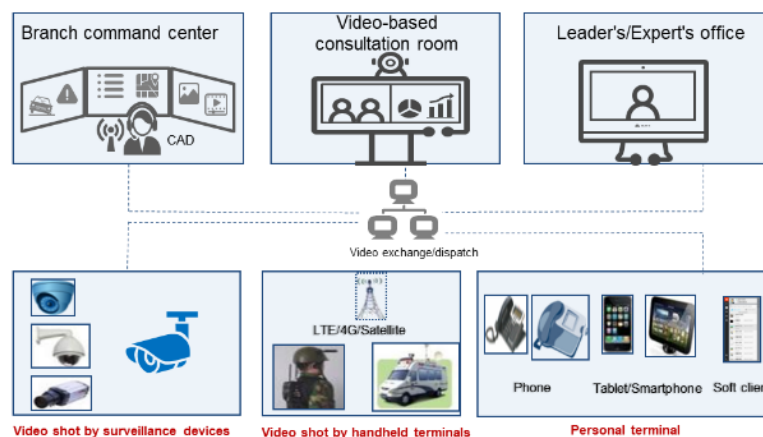


Figure 11: Video-based consultation and decision making

VISUALISED COMMAND

Visualised command is implemented through mission-critical information backhaul and video-based command, as shown in *Figure 12*.

The CAD platform is able to display all surveillance cameras at their geographical locations on one Geographic Information System (GIS) map. Operators can click to watch the live surveillance video. The large-screen system at the command centre also displays relevant information such as emergency resources, real-time traffic conditions, analysis, intelligence and on-site video sent back by broadband terminals held by field officers.

This will allow all the information relevant to the on-going incident to be displayed promptly. The information convergence greatly reduces the amount of time needed to obtain useful information, helping dispatchers or executives perform quick decision-making. For example, based on the alarm-generating location on the GIS map, the command personnel can check the surveillance video recorded by nearby cameras, find the nearest resource, and obtain more details about the on-site situation through the broadband video backhaul function. With the help of contingency plans stored in the database, and by considering the real-time traffic conditions and available emergency services resources, the decision-makers can quickly produce an emergency plan for a precise interception or rescue. The incident is thereby concluded with the least cost of operation, saving as many lives and property as possible.

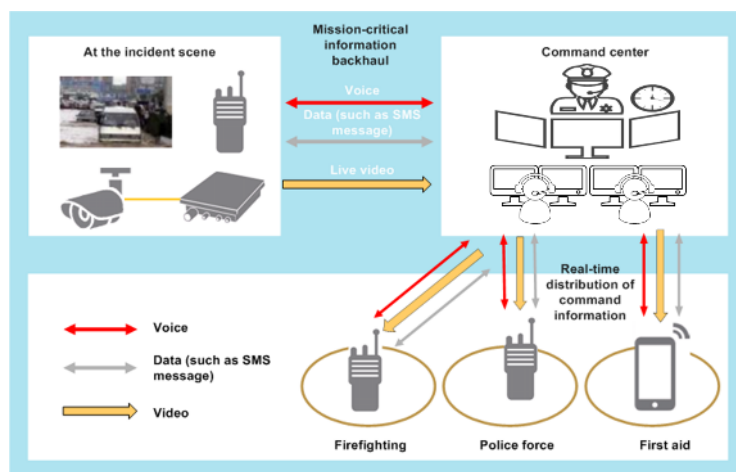


Figure 12: Visualised command

a) Mission-critical information backhaul

Video shot by surveillance devices and handheld terminals is exchanged and shared in real time. Dispatchers can transmit the video to the converged command & control centre by voice, SMS, or video. The transmission request can be initiated by dispatchers or coordinators. Dispatchers at the incident scene can perform the following tasks:

- Report mission-critical information to the converged command & control centre by voice call.
- Transmit video shot by handheld terminals back to the converged command & control centre through the LTE network.
- Transmit the incident information to converged command & control centre by SMS message.
- Transmit video shot by surveillance devices back to the converged command & control centre.

b) Video-based command

Coordinators make decisions on incident handling based on mission-critical information received from emergency services at the incident scene and deliver the decisions to one or more dispatchers by voice, SMS, or video.

Emergency services at the incident scene can have the CAD system installed on their handheld terminals, laptops, desktop computers, or tablets. In this way, they can receive incident information from the command centre anytime, anywhere and view the incident location automatically displayed on the GIS map.

Coordinators at the incident scene can view live video of the incident scene to know the incident handling process and flexibly adjust the handling method.

The command centre should enable decision-makers to see overall and detailed images of the accident spot; to hear reports of the real-time situation and related actions; to inquire about supporting information; and to pass decisions down to field personnel and other emergency management authorities.

Being an information hub, the command centre acquires information from the accident spot and lower-level command system but stands beyond both. It is therefore able to transmit data, audio and video, and initiate a plenary session or inter-functional video conferences with surveillance video:

- Video convergence: directly joins surveillance images to the videoconferencing system.
- Real-time viewing: obtains on-site surveillance information in real time in the conference room.
- Quick sharing: quickly shares surveillance images to participants including field experts.

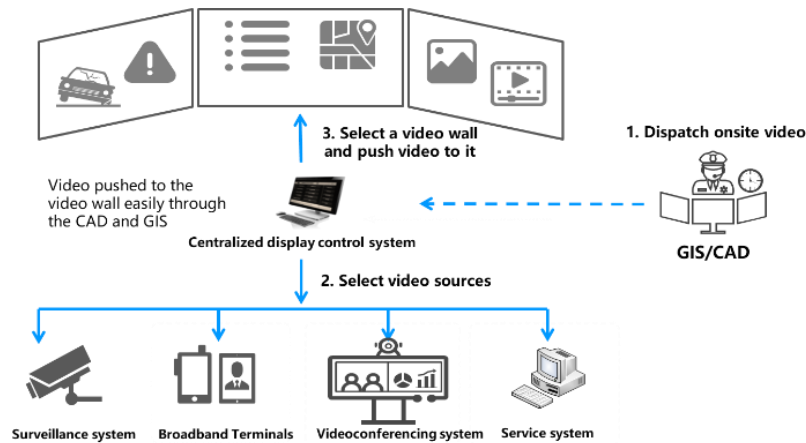


Figure 13: Quick sharing function

c) Visual Dispatch Console

The visual dispatch console is a unified interface to control over the videoconference system and surveillance system. It's an easy-to-use touch panel allowing operator to dispatch video recourse rapidly.

The console can support:

- One-touch to launch emergency pre-plan
- Unified management and control over conference and surveillance videos
- Conference and surveillance videos preview
- Support displaying conference site list and scheduling multipoint conference
- Support for conference control such as muting and broadcasting
- PTZ(pan-tilt-zoom) control over surveillance cameras
- Support sharing surveillance videos to each site
- Support surveillance sites list and preview
- Touch control, ease of use

Through the visual dispatch console, the command centre can promptly dispatch videos and audios from each municipal and county-level authority to support emergency command, enhancing the emergency response and capability for the municipal and county-level emergency administration authorities. Meanwhile, the system manages all video resources from each command centre and accident scene centrally to facilitate video resources dispatch, image tracking and recording.

The visual dispatch console offers graphic user interface (GUI) for easy image dispatch and conference control.

4.6 | POST-INCIDENT: SUMMARY AND REVIEW

Incident investigation is necessary after incident handling. Based on worldwide experience, HD video records contribute the most to incident investigation. Emergency services organisations can find many valuable data from the video records, helping them to handle various major incidents. In addition, the system records the entire incident handling process for future backtracking. Users can also optimise incident handling processes accordingly.

Thanks to the video surveillance introduction, service-oriented video investigation aims to find clues using big data intelligent analysis technologies as soon as possible.

The following chart shows, as an example, a typical post-incident flow done by the police forces. After the analysis, a Sustained Optimise Pre-plan and SOP (Standard Operating Procedure) can be optimised. This can include prompting an emergency pre-plan, improving accuracy and adding one-button dispatching in the SOP workflow.

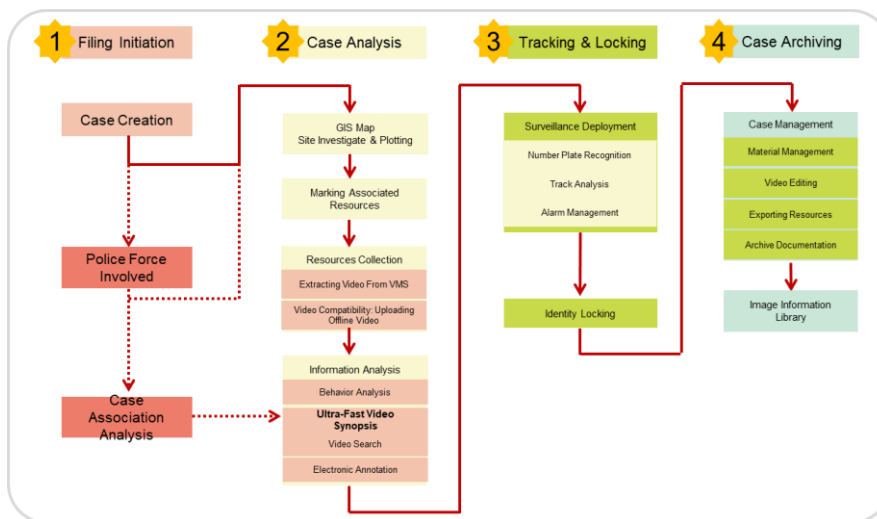


Figure 13: Post-incident process example - Police

5 | VISUAL COMMAND REQUIREMENTS REFERENCE

5.1 | 2014 G20 SUMMIT CASE⁹

The safety requirements of the 2014 G20 Summit in Cairns, Australia reflected the gravitas of the event. Although the event was held in a secured location for political leaders and their entourages, media personnel and events staff, many 'public' safety measures had to be taken.

Law enforcement agencies were allocated greater powers to stop and search members of the public in two Australian cities. Known offenders were banned from entering certain locations. Citizens were temporarily prohibited from carrying items such as cans, jars, eggs and placards.

Restrictions were placed on car usage.

By integrating hundreds of CCTV cameras with alarm prioritisation software, patrol guard communication devices and facial recognition software, public events organisers are able to oversee vast public spaces and identify potential risks in a busy setting.

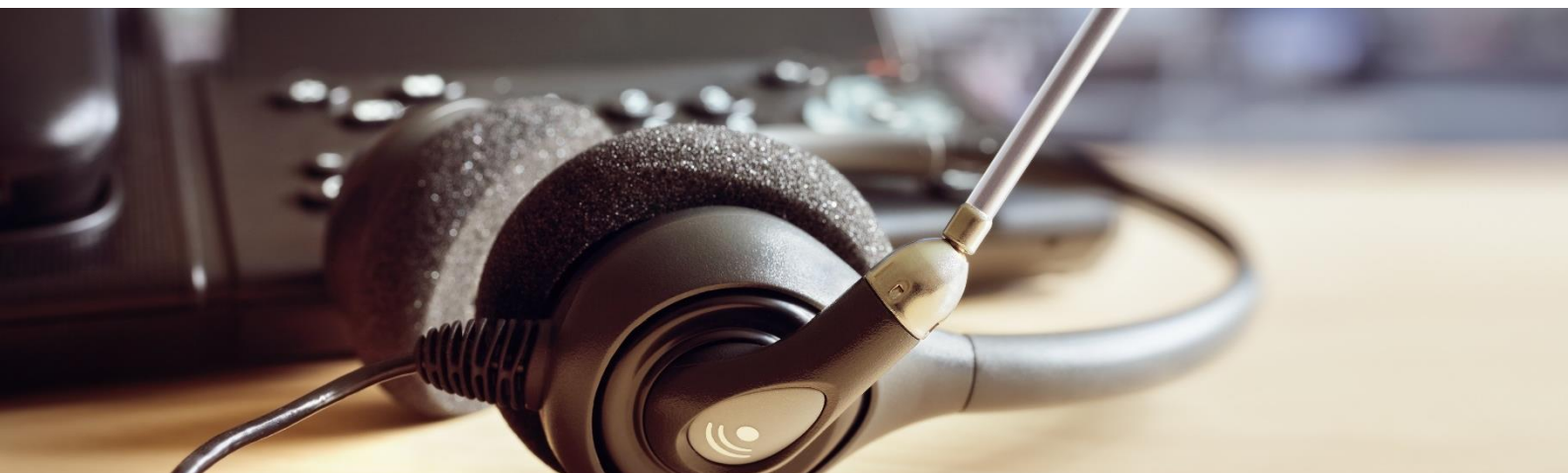
5.2 | SAFE CITY IN LATIN AMERICA

Salta (north province in Argentina with 155 488 km²) and its localities have deployed an all-round public safety protection system. The system is based on the full analysis on the video construction achievements in Salta, public safety management requirements of the city, and advanced technologies such as cloud computing and big data. The public security video-sharing platform is designed to consolidate diverse video information resources for sharing and for the support of public safety protection and control, city management, and livelihood services. The aim is to improving public safety service effectiveness and safeguard Salta.

The Salta video surveillance platform for public safety includes capital-level and city-level video surveillance network platforms, including:

1. Normal video surveillance capability distributed in 6 sites.
2. Facial recognition system only deployed in Salta site. Meanwhile analytics related to people can also be implemented in the localities' sites.
3. License plate recognition and vehicle analytics solution distributed in the 6 sites.
4. Mobile camera system handled by Salta site.

The new video surveillance system is used for the emergency 911 system. To improve efficiency, a video solution was integrated with current CAD and GIS.



6 | CONCLUSION

We all know that public organisations all over Europe have seen more and more budget constraints over the past years. This results in cost cutting, which leads to staff reduction on the one hand and reluctance to invest in new technologies on the other hand. But the market continues to move forward and is at a critical point where certain pressures and the current environment will force change. Much of the technology has been proven in other industries and has reduced costs. In addition, if organisations do not change, current operating procedures will no longer be fit for purpose as the digital transformation across society creates a new world and new threats.

The future of public safety will rely increasingly on digital intelligence, visual command and the use of data analytics to drive the trend towards incident prevention and safer societies. This can be done against the backdrop of providing a more efficient and cost-effective service to the public with investment in technology to improve everyday operations through better planning and streamlined processes.

The key to the future of public safety is investing in the right technologies that not only provide operational benefits but are also able to deal with future issues. All governments are facing a number of challenges, and in many cases the only viable answer to improve public safety is to invest in technologies to help achieve these core objectives, whilst filling capability gaps and providing clear public benefits.

7 | ABBREVIATIONS

Abbreviation	Short Description
ALI	Automatic Location Identifier
ANI	Automatic Number Identification
ANPR	Automatic Number Plate Recognition
APCO	Association of Public-Safety Communications Officials
AVL	Automatic Vehicle Location
BB-PPDR	Broadband Public Protection and Disaster Relief
CAD	Computer aided dispatch
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosives
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FR	Facial recognition
HD	High Definition
ICT	Information Communications Technology
IoT	Internet of Things
IP	Internet Protocol
ITU	International Telecommunication Union
IVS	Intelligent Video System
LTE	Long Term Evolution
NIST	National Institute of Standards and Technology
MCX	Mission critical services
P25	Project 25
PMR	Professional Mobile Radio
PPDR	Public Protection and Disaster Relief

PSIM	Physical Security Information Management
PS-LTE	Public Safety LTE
SOP	Standard Operating Procedure
TCCA	TETRA Critical Communications Association
TETRA	Terrestrial Trunked Radio
UC	Unified Communication
UAV	Unmanned Aerial Vehicle
VC	Video Conference
VA	Video Analytics
VoLTE	Voice over LTE
VMS	Video Management System
Web-RTC	Web Real-Time Communications

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