EENA Operations Document

Recording for PSAPs
Future Technology

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1 Executive Summary

This paper reviews the current PSAP recording technology and introduces the changes happening in PSAPs that affect recording.

Today recording in PSAPs is mostly limited to voice recording, often with analogue or ISDN telephone systems. Future recording will be based on IP networks and include communication types other than voice such as text and video.

2 Introduction

2.1 Changing Environment

Currently most PSAPs in Europe make recordings of all requests for assistance from the members of the public. In some jurisdictions this is a legal obligation. Today nearly all such requests for assistance are delivered through voice telephone calls to 112, or other local numbers.

Historically members of the public have been accustomed to communicating with other people, companies and public bodies using the telephone service. However more recently the internet and smart phones have opened up a myriad of different ways for people to communicate. There is an increasing expectation from members of the public that they will be able to communicate with PSAPs using these new methods. Some PSAPs are already responding to this expectation by supporting services such as eCall and Text to 112.

Additional change is driven by telephone service providers who are increasing moving their telephone services from legacy ISDN/PSTN Trunks to VoIP/SIP trunks and the accompanying trend in commercial telephone systems to make use of standards based IP technologies such as SIP. PSAPs can often benefit from reduced costs and increased flexibility by moving to IP based technologies.

For the longer term view EENA has developed a new architectural model for PSAP communication which incorporates new communication types and the move to VoIP, known as Next Generation 112 (NG112). Industry is working with EENA to offer solutions compliant with NG 112 to PSAPs. This will provide a consistent and interoperable solution for 112 as these requirements become more prevalent in the future.

Just as the public are using new communication methods so are the emergency services that the PSAP dispatches. Emergency Services are making use of both commercial data networks and national data networks dedicated to Public Safety. Already Mobile Data terminals in emergency services vehicles are commonly used to provide dispatch information.

2.2 Record keeping

As with any organisation PSAPs need to keep records of interactions with the public and emergency services. Today the majority of the interactions between public and PSAPs are through telephone calls or radio transmissions, and most PSAPs keep audio recordings of these interactions which serve as a record of the interaction. In addition these recordings can be used for quality assurance and process improvement.

As PSAPs adopt other communication methods, additional record keeping techniques need to be deployed and where possible integrated with existing records.

Alternative data communications with the Emergency Services usually include features to record the messages sent in CAD or RMS.

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2.3 Definitions

Term	Definition
NG 112	**Next Generation 112 – IP based 112 communications**
PSAP	Public Safety Answering Point
eCall	An EU system for providing an automatic call to 112 from a vehicle in the event of an accident.
Text to 112	A text service delivering SMS text messages sent to the number 112 to a PSAP
CAD	Computer Aided Dispatch – A system to assist dispatchers in allocating first responders to incidents.
SIP	Session Initiation Protocol – A IP protocol for connecting telephone calls or other communication links
SMS	Short Message Service – The text service provided on commercial mobile phone systems
VoIP	Voice over Internet Protocol – Any voice system using IP as a transport layer.
IETF	Internet *Engineering* Task Force – An organisation creating technical guidelines for the internet.
SIPREC	SIP Recording – A protocol for connecting SIP based communication systems to recorders.
RMS	Record Management System – A system used within a law enforcement agency to centrally record about the activities of the agency. For example each incident an agency responds to will have a record and associated to this record will be records of officers associated with the incident, cisitizens of interest to the case, and any legal actions taken.
SPAN	Switched Port Analyzer – Proprietary term used by Cisco for a mirror port on a network switch. A mirror port receives a copy of every packet transiting the switch even if that packet is not addressed to a device connected to the mirror port.

3 Why Record in a PSAP?

The most obvious reason to record what happens in a PSAP is that in some localities local laws demand that communications are recorded. But there are many good reasons for recording that mean it should be considered at all PSAPs even where local laws do not require it.

Keeping a record of PSAP communications provides material for:

a) Resolving complaints about service to the public or first responders
b) Coaching operators on best practice
c) Improving PSAP processes
d) Responding to evidence requests from external investigators.

For complaint resolution every dispatch action in a PSAP is logged in the CAD system and the CAD event history shows what happened in each incident so why should a PSAP keep any other records? The CAD events are just a history of what happened. They tell us the outcome of the decisions made at the time but don't contain any information on the back ground to why those decisions were made or how they were conveyed to others.

To see this information we need to know what communications were made in and out of the PSAP at the time. This sets the decisions in context and allows an investigator to understand why a particular path was taken. It may be that un-clear information was given to the operator or that conflicting priorities meant one case being handled before another.

Well run organizations constantly seek to improve themselves and their staff. Reviewing a recording of an incident with the operator handling it allows managers to coach operators and following the PSAP processes. In addition these reviews give the operators and management the opportunity to reflect on how changes to the PSAPs processes might have improved the outcomes.

The communication records are a key item in defending PSAPs actions against complaints in this way.

PSAPs pay critical poles in many cases which are subsequently investigated by Police or other organisations outside the PSAP. Often these investigations require records of the PSAPs actions that may subsequently be presented to a court of law. Recordings of PSAP communications are frequently requested as part of these investigations so PSAPs need to provide copies of recordings and other material such as CAD records. For these records to be useable in a court of law there must be clear processes in the PSAP for ensuring that the records are correct and not tampered with.

In some jurisdictions there is a legal requirement for a PSAP to keep communication records and provide them to investigators on request.

4 Recording today

4.1 Conventional recording – PSTN / ISDN

Currently most PSAPs have recording to cover emergency telephone calls and radio communications.

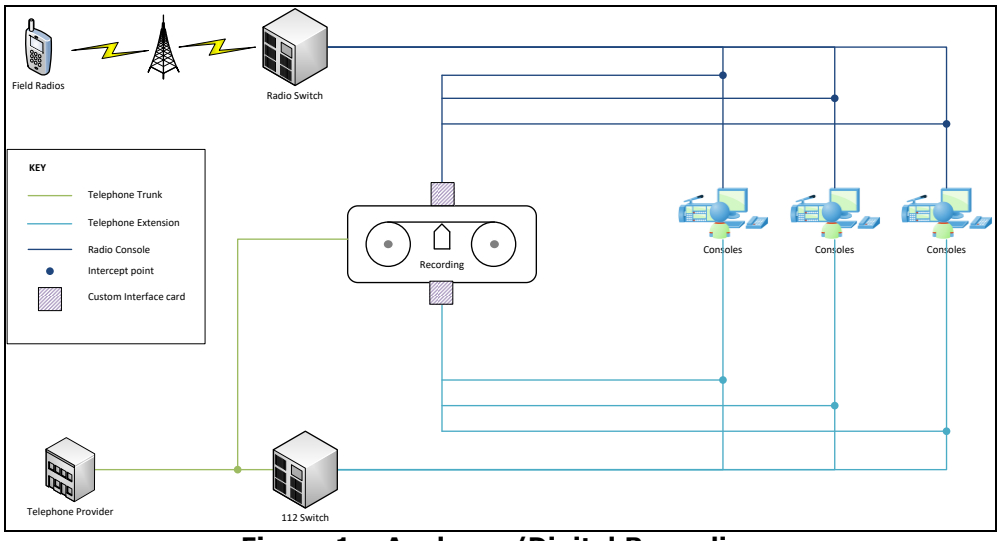

Figure 1 – Analogue/Digital Recording

Telephone calls can be recorded from 2 interface points in the PSAP, each has its advantages:

1) Record the trunk lines coming into the PSAP from the public telephone network. Recording the trunk lines gives a complete and continuous recording of each 112 call, regardless of holds and transfers. It may be difficult to determine who handled the call within the PSAP as there is no relationship between the trunk line and the extensions used by the operators.

   The main advantage of trunks line recording is that any sound happening at the caller's phone is captured even while the call is on hold and gives a complete picture of the call from the caller perspective. There have been occasions where a caller made a comment while they thought no one was listening that become relevant in a subsequent investigation.

2) Record the lines going to each operator extension. Recording the extensions gives a separate recording for each operator. When a call is transferred the recording will resume on a different extension.

   The main advantage of extension recording is that it makes operator coaching and assessment much easier as each recording relates to a single operator.

These recording systems capture the analogue or digital communication links within the PSAP to listen in to telephone calls and radio transmissions. The speech from analogue links is digitised, and the digital data from the digital links transformed into a standard format before it is compressed for storage.

4.2 Data Storage

Until recently compressed speech data has been stored on hard disk drives initially and transferred to DVDs or backup tapes for long term archiving. After speech is archived it will continue to be available from the hard disk drives for a few months after recording. Eventually it will be deleted from the hard disk drive to make space for new recordings. Playing back calls that are no longer on the hard disk drive requires that the relevant data is manually extracted from the DVD or tape archives.

The benefits or archiving to DVD or tape are that the on-line hard disks drive system capacity is kept small and the DVD or tapes can be stored in secure fireproof locations. But managing the archive DVDs or tapes is a time consuming activity that many agencies would like to avoid and the DVD and tape media are becoming more expensive as cloud services take over many of the uses of these items.

There are a number of ways to reduce the time taken managing these at the expense of higher initial costs:

1) Robotic media libraries that store the DVDs or tapes and automatically insert them into a drive unit to access them. The initial cost of these robotic libraries is high and so is the on-going maintenance. Also the disks or tapes storage is usually not fireproof. This type of system is no longer advised for new installations unless 10 or more years of data is expected to be kept.

2) Large hard disk stores that allow the entire archive to be kept locally on line. The falling cost of hard disk storage has made it viable for many organisations to keep their entire recording archive on-line. The initial cost of this is no longer prohibitive and the on-going maintenance cost is low.

   The individual disks in the storage system will fail over time and the whole storage system could be destroyed by fire or similar catastrophic event.
   - RAID disk arrays are used to mitigate against the failure of individual disks.
   - Sending data to a second disk store at another location so there is a duplicate of all the speech at another location is used to mitigate against fire and other disasters.

3) Cloud data storage providers can be used as an alternative to local storage. An organisation rents storage space at the cloud providers' locations as needed. The cloud providers handle the issues of disk RAID and storage in 2 physical locations. Many governments are promoting the use of cloud providers for public services so although a new option this expected to become popular in the near future.

Historically the recording system has been engineered as a complete unit dedicated to the task with internal archive drives and front panel controls to configure and operate the system. There has been a move to designing recording systems that are based on commercial computer server systems with separate workstations used to access the system via an application or web site.

The connection to the analogue or digital communications link requires specially designed interface cards even in systems based on commercial computer servers. There are many variants of these interface cards each one designed for a particular telephone or radio system. The need for these cards is reducing as systems move to VoIP.

4.3 VoIP Recording

Current telephone systems have moved away from PSTN and ISDN communications links to VoIP links based on computer networking technology. This has removed the need for dedicated hardware interfaces in telephone systems and replaced them with the same network interfaces already used for computer networks.

The impact of this trend in recording has been to remove the need for specialist interface cards in recording systems with a subsequent reduction in hardware costs. VoIP recording systems are based entirely on commercial computer servers with no need for specialist interface cards. It is still sometimes possible to re-use existing analogue recording equipment to record the headsets of VoIP telephone systems to separate the upgrade of the telephone and recording systems but in the longer term the benefits of moving to VoIP are compelling.

In addition the interception point for recording lines has changed. Instead of physically connecting to each extension and trunk a single network monitor point can extract all the voice calls at one point simplifying the associated cabling.
VoIP recording can be divided into 2 techniques:

a) Passive Recording
b) Active Recording

4.3.1 Passive VoIP recording

Passive VoIP recording is similar to conventional analogue/digital recording, instead of monitoring PSTN or ISDN lines the IP communications are monitored. This is described as passive recording as the system being recorded is not affected by the recording system.

The technology to perform the monitoring is built-in to most existing network switches. The monitoring technology is referred to as a SPAN or Mirror port.

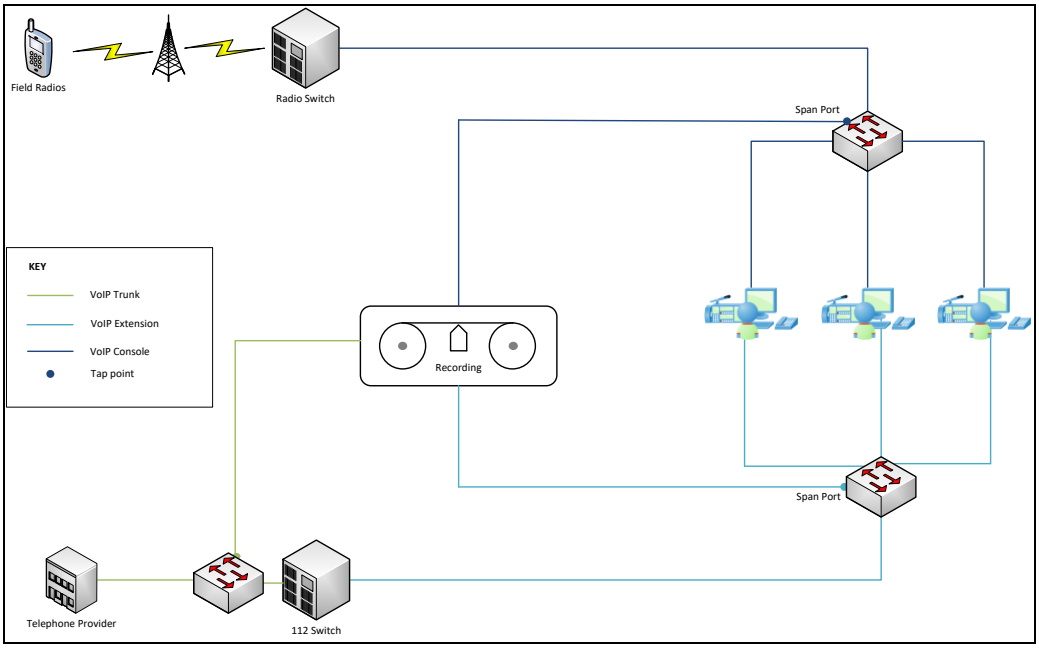

Figure 2 – Passive VoIP Recording

VoIP recording reduces the physical complexity of cabling and removes the need for specialist interface cards. However careful attention does need to be applied to the configuration of the SPAN or Mirror ports. This configuration is as important to recording as the integrity of the cables in a conventional system but is now hidden within the network configuration and not available for physical inspections.

As the security of communications becomes more important some organisations are encrypting their VoIP communications. The purpose of the encryption is to prevent any external system maliciously listening to the communications, this also hides the communications from passive VoIP recording. This drawback is overcome by using Active recording.

4.3.2 Active recording

Some communications systems can be recorded by creating conference calls for each call and conferencing in a recording system to the call. This form of recording requires that the communications system participates in the recording process and is referred to as active recording.

The IETF is progressing a standard for active recording using VoIP. This standard is known as SIPREC (RFC 6341). This standard is incorporated into the EENA NG112 architecture.

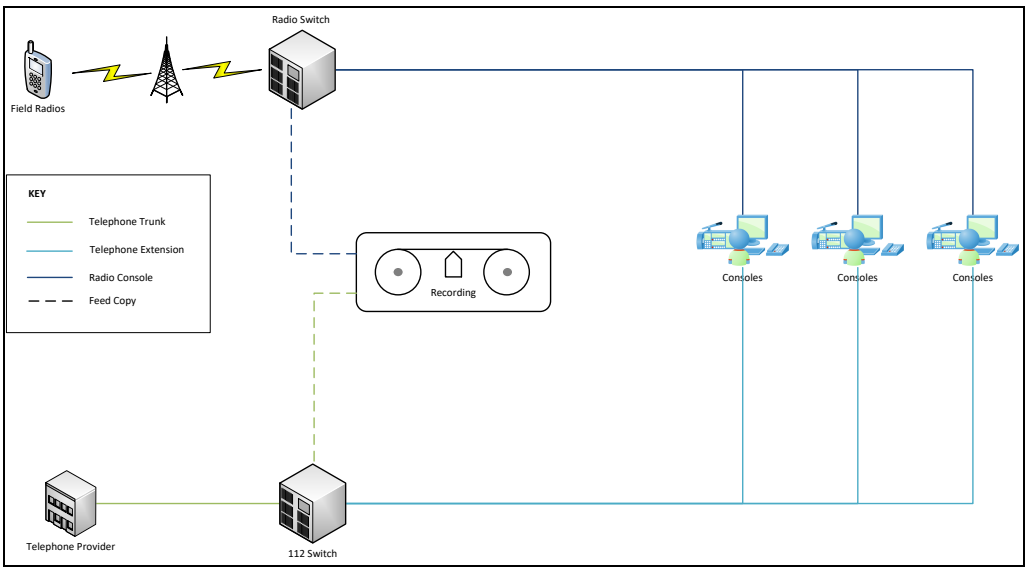

Figure 3 - Active recording

Broadly speaking there are two classes of active recording for PSAPs.

1) The communication system automatically conferences in a recording system to every call.
2) The recording system watches for calls being made and makes a conference request for every call it sees.

A 112 call which is answered by one operator and transferred to another may be described a multi-segment call. Active recording typically creates separate recordings for each segment of a call in the same way as passively recording operator extensions. A failure of connectivity between the recording and communications system can be easily detected in an active system as the link is a defined point to point connection. A similar break in connectivity on a passive system can only be inferred by a lack of activity.

Active recording usually a licensed option on a communications system so may cost more to install than the equivalent passive recording system.

4.4 Meta Data

In order to be able to find recordings a system needs to label calls with some descriptive information known as meta data. Depending on the recording system design this data may be obtained in different ways.

In all cases the recording system needs to keep track of the time at which recordings were made. Time stamping the recordings requires that the recording system clock is synchronised to the main PSAP time standard to ensure the recording timestamps are in line with other time stamped records for instance CAD records).

Where operator extensions are recorded passively the physical wiring layout can be used to infer the operator extension. This makes passive operator extension recording simple to configure.

VoIP recording systems extract meta data from the VoIP control information (SIP). The scope of meta data available in the SIP varies from system to system from just caller number and answering position, to a full record including the subscriber name and calling location. A recording system typically supports extracting information from popular communication systems via this method but some systems may require customisation to extract the data.

For analogue and digital trunk or active recording there is often no meta data embedded in the communication path. Most communication systems also provide a proprietary call information feed with that send out the required meta data for each call. Recording systems typically support a number of these feeds but may require customisation for some types.

4.5 Current best practice

A well specified PSAP recording solution for today should include as a minimum:

1) Recording of all telephone extensions at operator positions taking 112 including timestamp and answering extension meta data.
2) Recording of all recording communications with dispatched field resources.
3) Storage of calls on local hard disk for a minimum of 1 month for easy access.
4) Archiving of calls to geo-redundant media as soon as possible after recording either hard disk arrays or cloud storage.
5) Synchronisation of internal clocks to the master PSAP clock.

Preferably

a) Additional call meta data describing caller number, caller location, telephone subscriber name and answering operator identity should be recorded for each call.
b) Telephone extension recording should be performed using the active VoIP method.
c) Incoming 112 trunk lines should be recorded.
d) All non-112 telephone extensions used for supporting incidents should be recorded. (for instance – Translation services, requests to adjacent PSAPs)
e) Options to record or log SMS messaging where this is in use.

5 Future PSAP recording needs

5.1 Public connection to PSAPs

Current trends in public communications suggest that in the foreseeable future communications are centring round IP based systems. This move to IP based communications has been accompanied by an increase in the range of communications types to include a variety of voice, text and video based options.

Not all of the new communications types are successful. Some launch and fade into disuse and others become embedded in popular culture more permanently. Voice telephony was the dominant way to remotely communicate throughout the 20th century and remains popular today. In comparison social networks became popular in the early 21st century and many of the initial networks are already falling in popularity to be replaced with newer systems. PSAPs need to balance following current trends with demonstrating effective investment of public money in the long term. Typically PSAPs can only invest in communications platforms that have a track record in a wide range of demographics.

As well as the general expectation that PSAPs will support new communications methods a number of these new communication types are of particular interest to people with communications related disabilities[1]. Text and video messaging provide better services than voice for some members of the community with speech or hearing impairments. The needs of these members of the community also drive the move to incorporate new communications types into the PSAP.

[1] See REACH112 – https://eena.org/our-work/eu-projects/reach-112/

5.2 PSAP connection to First Responders

PSAPs serve 2 customers, member of the public requesting emergency help and first responders needing detailed dispatch information to get the right help to the right location.

First responders are increasing investing in new communication types to supplement the voice communications they have traditionally used. Text based dispatch systems that send incident information direct to the driver and video systems that send pictures of incidents back to control posts are frequently deployed.

As with public communications all these are enabled over IP networks in this case based on radio rather than fixed links.

5.3 Future Recording

As PSAPs become ready to handle these new message types they will need to keep records of them so the recording systems will need to adapt. The arrival rate of new communications types is increasing so the flexibility of systems to change is a key feature. It is unlikely to be economic to invest in dedicated recording systems for each new communication type. Nor will it be useful to create separate information silos around different communication types. Incidents will often involve a mixture of communication types.

Lastly PSAPs need to be ready to help themselves. Their recording systems can be expanded to cover screen recording at operator positions which gives supervisors a virtual view over the shoulder of operators. So coaching sessions can reflect not just of what was said but how the CAD and other systems were used. In addition to personnel improvement this allows studies to be made on the efficiency of the CAD screen layouts.

EENA is working to create an open architecture called NG 112 for PSAPs of the future. A number of suppliers are committed to supporting the NG 112 architecture when it is completed. Systems complying with NG 112 will be inter-operable and have less need for customisation for each PSAP.

To cope with this acceleration of change most VoIP based recording systems are designed to be expandable to handle these new message types as they become prevalent. VoIP recording systems are typically designed as software systems running on commercial computer server systems so new capabilities can be offered by updating the software rather than replacing the entire system.

6 Preparing for change

Today's world is always changing and there are many more trends than a PSAP can practically follow. It's important to identify some key changes that a PSAP can make to impact efficiency today and prepare for future changes.

- Replace removable media archive systems (tape, DVD, etc.) with on-line or cloud solutions. This reduces the need to manage physical media. Media types do go obsolete and there is considerable cost in moving old archives to new media types. Migration of on-line or cloud archives is more automatable and so cheaper.
- Match moves to IP communication systems with a planned move to IP recording systems.
- Assess recording systems implemented in software that can run on commercial computer servers and on virtual servers to reduce investment in hardware.
- Consider suppliers that are committed to long term support of the EENA NG112 architecture.

7 EENA recommendations

Stakeholders	Actions
European Authorities	Invest in research and innovation activities related to new recording technologies.
Emergency services	To create plans for introducing modern recording technologies and to record all types of communications with citizens. To adopt IP based communication networks and corresponding recording systems.
National telecommunication regulator Network operators	To ensure all new 112 communications will be delivered over IP networks.

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