# ISITEP
# D7.6.1&2&3 - JOINT INTERNAL ASSESSMENT REPORT, (FIRST VERSION & FINAL & PUBLIC VERSION)

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## Publishable extended abstract

This document describes an overall assessment of the design, technical set-up and evaluation results for the five demonstrations across the ISITEP cross border use cases.

TETRA related demonstrations (WP7.1, WP7.2, WP7.5)verified the TETRA-TETRA ISI functionality in real operative use by end users to fulfil the key cross border communications requirements of end users. As part of these demo also operative procedures definied within ISITEP were successfully validated.

Migration of TETRA terminals was not a development item in ISITEP but the TETRA terminals, used in these ISITEP demonstrations, showed fast migration in a few seconds, both automatic and manual..

TETRAPOL related demonstrations (WP7.3, WP7.4) were manufacturer provided proof of concept- and laboratory demonstrations. Those two demonstrations lacked the operational procedures and hence related end user scenarios were not perform. Nonetheless the two demos demonstrated technical capabilities for TETRAPOL-TETRAPOL and TETRA-TETRAPOL interconnection of great interest for the operational needs of the ends-users.

The dual radio TETRA-TETRAPOL IET terminal demonstrated TETRA-TETRAPOL migration as a proof of concept in WP7.5 (and partially in WP7.3 and WP7.4). raising the end-user interest from the operational standpoint.

ISITEP tools were presented the context of four ISITEP demonstrations related workshops (WP7.2, WP7.3, WP7.4, WP7.5) receiving positive feedback. In particular, Terminal Training and Operation Training Tool, and Infrastructure Dimensioning Tool are innovative in the PPDR field, and can effectively support help filed officers improving quality of cross border operations.

Concerning the legal framework generic guidelines for mutual cross-border contracts were produced in ISITEP and verified by the signing of the first cross-nation ISI contract between Norway and Sweden in the context of Norway-Sweden ISITEP demonstration (WP7.1). Hence the contractual conditions for TETRA ISI connections between European countries are now in place.

This report gives an overview of the performed end user demonstrations main results and collected feedbacks.

## CONTENTS

# 1. INTRODUCTION

## 1.1 Introduction

Currently, first responders across Europe use different and incompatible communication systems, complicating cross-border activities. Interoperability is at an elementary level, based on back-to back ad-hoc solutions. To establish the added value of the newly developed infrastructure in ISITEP, a series of demonstration runs, following the different scenarios have been carried out. This document describes the joint assessment results of the five cross border ISITEP demonstrations, covering the main use cases of operational interoperability of first responders of different European nations.

## 1.2 Objectives WP 7.6

As stated in ISITEP DoW, the main goal of ISITEP is to facilitate the cross-border communication of first responders. To evaluate the added value of ISITEP, it is therefore essential to test the frameworks in a set of scenarios across national borders.

WP7.6 is to join together the main assessments of the five ISITEP demonstrations of WP7.1-WP7.5, that are described in more detail in the deliverables D7.1.4,), D7.2.4, D7.3.4, D7.4.4 and D7.5.4&5.

Input to this WP is the assessments and final reports of the WP7 demonstrations, including final assessment on end user experiences, challenges, barriers, enablers, procedures, technologies and tools, used in the demonstrations.

In ISITEP DoW the overall value added of the border line PMR interconnection and public safety communications interoperability capabilities is targeted to be evaluated against the cost of implementation and operation. As the cost of ISI implementation is subject of commercial ISI GW and user licenses terms, it has been outside the scope of ISITEP. The cost of connection (E1 or IP) to support ISI connections is available from commercial operators but is a minor cost issue compared to the overall costs and is thus not basis for economic evaluation.

ISITEP has been one means to lower the cost of introduction of ISI in Europe by defining the required ISI services, processes, tools and regulations. With ISITEP also the industry has been able to develop and verify the ISI interoperability between different implementations of the manufacturers.

## 1.3 This deliverable D7.6.1

This deliverable D7.6.1 reports the results of tasks 7.6.1-.7.6.4 as stated in the ISITEP DoW:

Task 7.6.1 - PMR networks and services assessment:

Task 7.6.2 - PMR terminals technical and usability assessments:

Task 7.6.3 - Operative and procedural assessments:

Task 7.6.4 - Regulative assessment

Task 7.6.5 - Security assessment

The structure of this deliverable is thus based on the assessments of topics of these five tasks. This is also the final version D7.6.2 as the first version could not be published before the final one due to delay of the demonstrations.

# 2. PMR NETWORKS AND SERVICES ASSESSMENT (TASK 7.6.1)

## 2.1 Practical objectives and approach

The conducted five demonstrations cover the most important cross-border ISI use cases:

1. Police, rescue and ambulance collaboration during a major accident cross-border between two nations (WP 7.1 Norway-Sweden multi-agency demo). This was a real field exercise of the end users on 16.Nov 2016, using Norway and Sweden operational TETRA networks, terminals, control rooms and real end users capabilities (fire trucks, police cars, ambulances, helicopters with full set of rescue equipment). The added value of TETRA ISI was tested in a real major accident scenario.

2. Police forces joint chasing of a suspected vehicle across three nations (WP 7.2 B-NL-Ge Hot Pursuit demo). This was also a field demonstration with TETRA laboratory networks in Helsinki, Copenhagen and Genova, manufacturer provided TETRA base stations, control room dispatchers and terminals, run by operational field police dispatcher end users. The added value of TETRA ISI was tested against the existing back-to-back GW solutions, used in the border area between Belgium, Netherlands and Germany.

3. TETRAPOL-TETRAPOL Swi-Fr cross-border interoperability in a major airplane accident at the Swiss and France border. This was a manufacturer demonstration, where double TETRAPOL networks coverage (France and Switzerland) was available for the rescue operation (WP 7.3 Airplane disaster in Geneve Swi-Fr border demo). Demonstration included also back-to-back TETRA-TETRAPOL GW solution to connect CERN own rescue TETRA network. No ´story board´ or fleet-map of the operational use of neither radio communications, nor end user personnel was included.

4. VIP delegates protection personnel migrating to Belgian TETRA network with their home country TETRA terminals to safeguard own country delegates and to interoperate with the Belgian local police forces and control centers in a top level EU meeting in Brussels (WP 7.5 Be-Dk-Fi-Lux-NL-Fr VIP protection demo). This demonstration used three operational networks: Acropol, C2000 and ASTRID, Acropol and C2000 being interconnected with ASTRID via gateways (respectively a WP 4.5 GW and a BIM-gateway, the latter outside of ISITEP GW´s). And also the ASTRID TETRA test network that was ISI connected to Dk/FI/Lux laboratory networks (Motorola and Airbus). In parallel with this, a deployable DMO TETRA-TETRAPOL mobile (back to back) Gateway was also used in Paris to connect TETRAPOL and TETRA terminals.

5. TETRAPOL-TETRAPOL Portugal-Spain cross-border interoperability supporting joint patrolling and mobile controls consisting of agents and officials of both parties. The WP 7.4 Demo was a Lab demo, hosted at LDO premises in Genoa and involving remote connection with ARIBUS FR Lab in Paris, with the main objective of validating technological capabilities of the ISITEP framework for improving TETRA-TETRAPOL interoperability.

ISITEP value added applications and tools were presented in the demonstration. No ´story board´ or fleet-map of the operational use of neither radio communications, nor end user personnel was included. Hence there is not an end user assessment or service assessment alike in Demos 7.1, 7.2 and 7.5.

The services of the TETRA-TETRA demonstrations were based on TETRA ISI TCCA ph3 functionality as tested and verified in WP4.7 (D4.7.4) between Motorola, Airbus Finland, Leonardo

and Airbus Fr. The common service objectives in the 7.1, 7.2 and 7.5 demo runs were based on the requirements, set in WP2.3 and on the joint fleet maps, based on the end-user scenarios, in a major way based on TETRA ISI group linking capabilities.

The deployed TETRA ISI network functionalities, common in the demonstrations, were:

- Provisioning of visiting users migrating TETRA terminals with the needed rights to communications services in visited networks
- Migration and home authentication key support for terminals, migrating between TETRA networks. Verification of both automatic and manual migration.
- Migrated TETRA terminal continued connection and use with home 112-center, emergency room/ NCP, while migrated into foreign network
- Migrated TETRA terminal communication in joint international groups with foreign terminals in foreign and home TETRA network as well as with other home terminals in home and foreign TETRA network
- Migrated TETRA terminal communication in foreign local groups in the visited network
- Emergency communications cross border, emergency alert over ISI
- Control centers cross border and national NCP´s to communicate in joint multinational groups and with operational users in the field

The network objectives of the TETRA demonstrations were based on TCCA IOP ph3 ISI functionalities between TETRA networks. Verification of the functionalities between the TETRA manufacturers was reported in SP4 in D4.7.4. Most of the services, as defined in ISITEP WP2.3 user requirements, have been demonstrated in at least one of the demonstrations.

Figure 1 shows the ISI architectures of the three TETRA-TETRA demonstrations. Those cover major cases of implementing TETRA ISI between two, three as well as four (or more) countries.

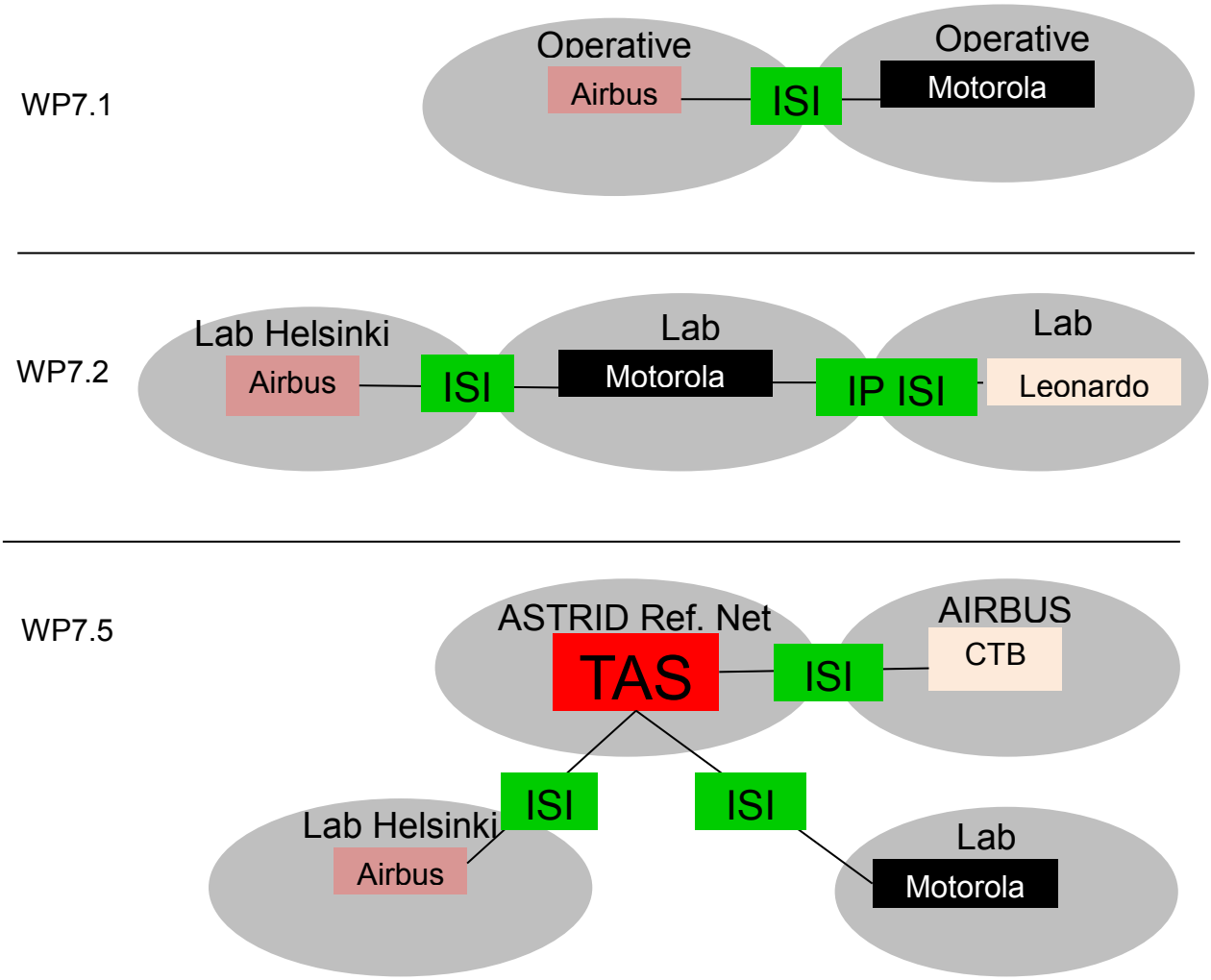



**Figure 1**

Each demonstration developed a fleet map (schema of linked groups), communication scheme of TETRA terminals (home and migrated), dispatchers and control centers, to use international (ISI linked) as well as home groups. Fleet maps covered:

- Group calls between two (demo 7.1), three (demo 7.2) and four (demo 7.5) TETRA networks. Those were implemented between the three ISITEP TETRA infrastructure manufacturers (ADSFi, Motorola and Leonardo), using the two versions of TETRA ISI interface (IP ISI, E1 ISI)
- TETRA ISI (EI ISI and IP ISI) connections were mostly implemented over the international Internet in the demonstrations. In the Norway-Sweden exercise, an E1 connection was used. In the demonstration 7.2 (NL-B-Ge) also TETRA base station and dispatcher connections were implemented over the international Internet.

TETRA ISI, as standardised in ETSI is a point-to-point connection, whether based on E1 or IP. Also for security reasons, a direct link between the communicating organisations cross-border is needed.

Hence for any terminal, migrating from home to visited network, there must be a direct ISI link between those two networks. In the demonstrations a full mesh of ISI was not implemented, but only those ISI connections needed in the use case. In particular, the extended VIP protection demonstration, consisted of 4 ISI connected TETRA networks in a star configuration (not full mesh) as the visited network for all migrated terminals was ASTRID reference network in Brussels.

The service objective in the 7.4 demo was limited to a subset of the requirements expressed in WP2.3 and specifically on static linking of groups across TRETRA and TETRAPOL networks enabling group calls over ISI..

Figure 2 shows the ISI architectures of the three TETRAPOL-TETRA demonstration in WP7.4

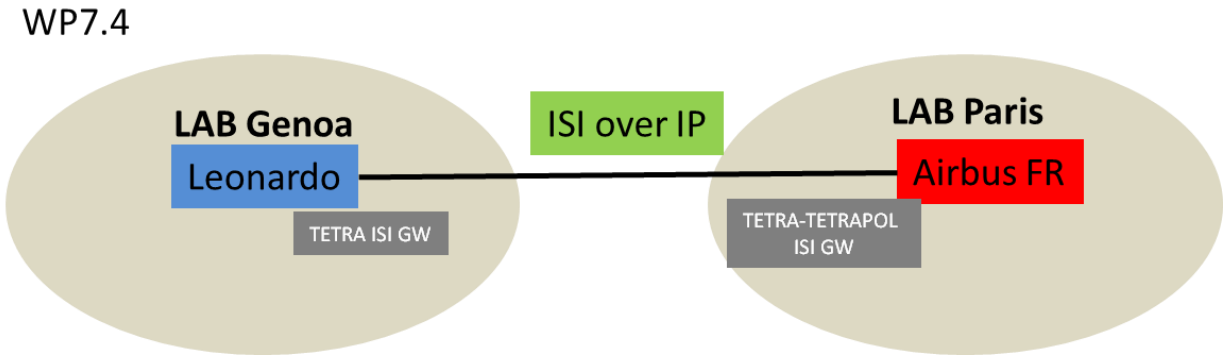



**Figure 2: ISI architectures demonstrated in WP 7.4**

A fleet map (schema of linked groups) was defined covering group calls between a TETRAPOL and a TETRA network. Those were implemented between Leonardo (TETRA infrastructure manufacturer) and ADS Fr (TETRAPOL infrastructure manufacturer) using TETRA ISI over IP, implemented over the international Internet

In WP7.3 TETRAPOL related demonstrations, the TETRA ISI test cases, as documented in WP4.8 were not used. TETRA-TETRAPOL group was linked via back-to-back terminals GW as developed in WP4.5.

Security requirements, architecture and solution for IP ISI were developed in WP2.2. In the demonstrations these were not deployed as they based on 3rd party products and solution. Manufacturers used their own VPN solutions over IP, as they found feasible. In the context of the hot pursuit 7.2 demonstration, a paper assessment of the security solution was performed, not part of the operative demonstration. In real operative implementation the ISI connection needs to fulfil the requirements of the connected nations TETRA security rules that may vary case by case.

## 2.2 Networks assessment of conducted ISITEP demonstrations

### Demonstration 7.1 (Norway-Sweden cross border)

TETRA ISI architecture in the WP7.1 Norway-Sweden cross border collaboration exercise is the basic ISI case of connecting two networks, as shown in figure 3.

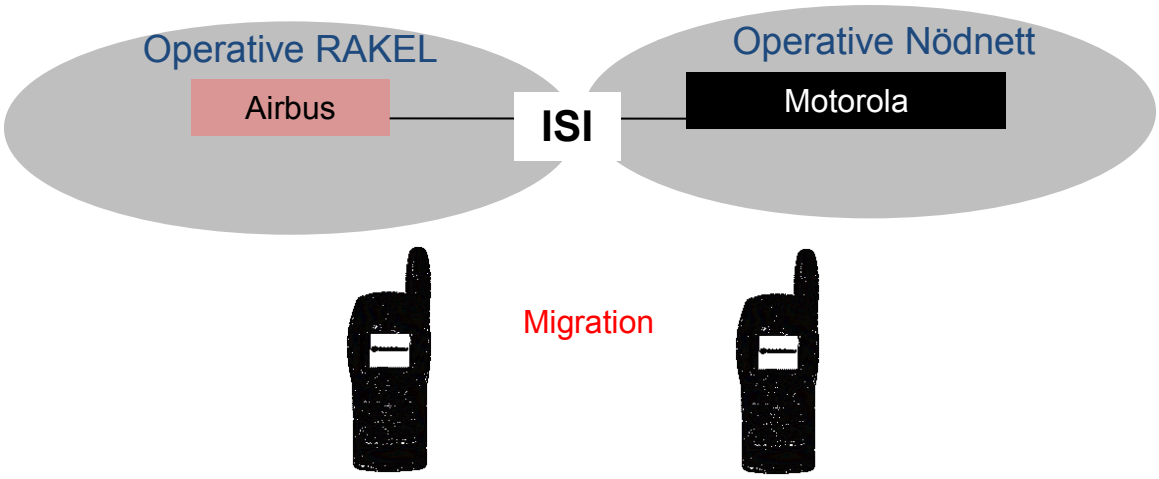



**Figure 3: ISI connecting Norway and Sweden networks.**

The ISI requirements of the Norwegian and Sweden users were extensively studied during ISITEP project 2013-15, matching the functionalities and way of use of RAKEL and Nødnett in Sweden and Norway respectively. Consequently a specification for the interoperability was agreed between the two operators and two manufacturers. Solution was implemented, tested and verified in scope of WP4.2. An official IOP session with ISCOM was conducted in November 2016 between Airbus and Motorola, also as part of WP4.8.

As a consequence of extensive preparations, including also DNK and MSB and end-user testing between reference and operative TETRA systems, the exercise fulfilled the cross-border operative interoperability needs of Police, Border Control, Rescue and Ambulance in Norway and Sweden.

- The five control rooms operated by Police, rescue (+112 SOS alarm) and health services during the exercise fulfilled the operational needs with ISI functionality.
- TETRA terminal ISI migration worked across Norway and Sweden entire countries.
- Outside the ISITEP scope, but mandatory to the exercise, the used TETRA terminals fulfilled the ISI compliancy, as required by DNK and MSB.

- The exercise supported, in addition to the other demonstrations, TCCA ISI ph3 functions (as in below table), implemented by Motorola and Airbus TETRA networks and over ISI.
- Both Sweden and Norway TETRA networks are configured to support up to 500 simultaneously migrated terminals. 124 Swedish and 94 Norwegian TETRA terminals were active in NOSE talk groups during the exercise on Nov. 16 (Motorola, Airbus and Sepura terminals).
- A total of 2361 calls were made between the two networks during the day of the exercise. 1667 calls originated in Nødnett/Norway and 642 calls originated in Rakel/Sweden. In the busiest hour of the exercise call-time amounted to 7 600 seconds (> 2 hrs) in 8 linked (NOSE) talk groups.
- One E1 for ISI interface was implemented for the exercise. 8 linked groups were in use simultaneously (8 voice channels over ISI). Target capacity for operative use will be 4 x E1 (120 channels to support all the more than 60 linked groups in the fleet map)
- No ISI redundancy was in place in the exercise, but 1+1 ISI GW redundancy is being tested between Motorola and Airbus, to be implemented for operative use.

The ISI interface worked smoothly without any disruption over the duration of the exercises. Also the entire Motorola (Nödnett) and Airbus (RAKEL) networks worked smoothly and radio coverage was good in the area of the exercise.

All the migrated TETRA terminals of the exercise worked as planned: Handheld terminals, ambulance, fire and police vehicle terminals. Helicopter terminals suffered from the high noise as is the case within home network use also. Voice quality in the linked groups over ISI was good: no degradation of voice quality over ISI, compared to that in either home network was notified.

The main exercise scenario took place in Norway side of the border and many Sweden (RAKEL) TETRA terminals migrated to Norway (Nødnett). Some Norway TETRA terminals migrated to Sweden (Rakel) for a search and rescue operation. Terminal migration to/from the other country was smooth and fast. Manual migration is defined to be the default concept to go to the neighbor country. Automatic migration may, however also be used, when it takes place at the right time. This depends on the TETRA coverage planning of both networks in the border areas. In the linked groups the same GSSI was used in both networks, so that no terminal manipulation was needed, when crossing the border. This is due to the current fact, that TETRA terminals do not re-configure automatically to the linked-groups, when migrating.

Group call set-up times in the linked groups (over ISI) was fast. No difference from that in the home networks was notified. Queuing of voice is available in RAKEL but it is not used in the linked groups, as it is not used in Nødnett. This is found to be a minor issue currently.

The control centers worked as planned. Control centers participated actively in the NOSE talk groups. Norwegian dispatchers could easily see on their PC screen the migrated RAKEL terminals in Nödnett. A study of the communication statistics (who speaks to who, when and how much) was performed during the exercise. There is a separate research report on that.

The feedback on the ISI technical functionality from all the end users was very positive and they are waiting now to get ISI into their operational use as fast as possible (release date of the service is scheduled to be 17. March 2017).

| IOP function | Use case between Norway and Sweden |
|---|---|
| Migration | Terminal migration to/from foreign SwMI |
| Individual Call | Individual call<br>• between any terminal located in any SwMI |
| Telephone Call | Inbound telephone interconnect for visiting foreign terminals<br>Outbound telephone call handled locally by visited SwMI |
| Individual Short Data | Send SDS from terminal to terminal/fixed host:<br>• from any terminal located in any SwMI |
| Group Short Data | Send SDS from terminal to local linked group (with limitations) |
| (Individual Status) | Show rejection of Individual status messages |
| Group Status | Send Status from any terminal to local linked group |
| Group Call | Group call<br>• between any terminal located in any SwMI |
| Group Combining | Patching of homed talkgroups to linked talkgroups |
| Emergency Call | Emergency Group Call<br>• between terminals and dispatchers in any network |

| | |
|---|---|
| Authentication | Authentication of visiting terminals |
| Encryption | Delivering key material for Air Interface Encryption |

**Table 1: List of Norway-Sweden ISI functionality**

**Demonstration 7.2 (Belgium-Netherlands-Germany Hot Pursuit)**

TETRA ISI architecture in the WP7.2 three-country Belgium-Netherlands-Germany cross border hot pursuit demonstration is shown in figure 3.

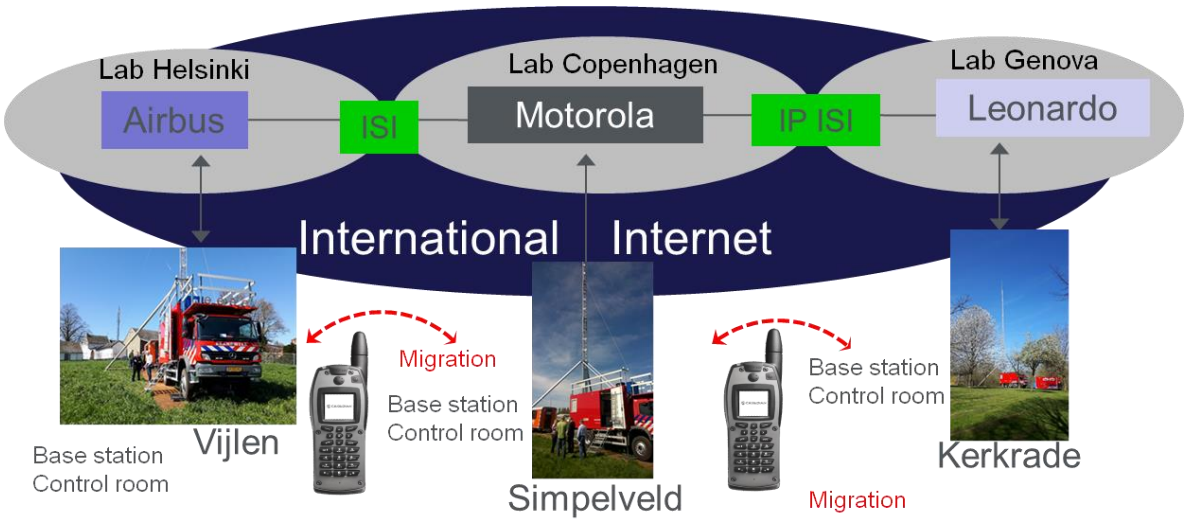



**Figure 3**

Demonstration 7.2 connected three TETRA laboratory networks of the three TETRA manufacturers of ISITEP, implementing E1 ISI between Airbus and Motorola as well as IP ISI between Motorola and Leonardo, as no ISI capable TETRA infrastructure was available in NL for the demonstration. The manufacturers TETRA networks of the demonstration were at their home sites in Italy, Denmark and Finland and ISI interconnections were implemented over the Internet. NL police provided deployable sites, one per network, which were used to place the TETRA base station and dispatchers of the three TETRA manufacturers in the demonstration area. These sites had a mast and TETRA antennas for the base stations to enable manufacturers to implement the needed coverage in the three countries over the hot pursuit route. The base stations of the three networks and dispatchers in the Netherlands Limburg Hot pursuit demonstration area were all connected to the home network also via Internet. Vijlen (Belgium) base station connection used ´last mile´ over KPN 3/4G and the two others in Simpelveld and Kerkrade used fixed ADSL connections.

All the three networks and their interconnections over Internet were tested prior to the two end user test runs, April 26 and May 27, 2016. Migrating terminals were provisioned and preparatory test runs were done to ensure the coverage along the hot pursuit route. In this way the ISI functionalities, dispatchers and terminals behaviour were verified for the demonstrations before the real demonstrations with Be, NL and Ge police end users on above dates. ISI interoperability was verified between the manufacturers beforehand in the ISITEP WP4.7 manufacturer testing and has been reported in D4.7.4.

International Internet provides extensive capacities, but do not guarantee any QoS, as all traffic is ´best effort´. This means that overload in Internet may disturb the QoS of ISI connection and as a

consequence calls may fail, voice spurts may be missing and voice quality may be degraded. Especially for E1 ISI links, emulated over the Internet, communication is vulnerable to jitter in Internet. To tackle Internet jitter, jitter buffers are needed at both ends of the ISI. These caused an additional delay in call setup time (some 240 msec) and delay (60msec) of the audio. The instability of the best effort Internet connections was seen during the testing and also the demonstration and this influenced to some degree to the overall picture of the capability of the E1 ISI inter-system communication.

As the IP ISI and dispatchers were laboratory installation, some malfunctions and disturbances of the VPN of the IP connections also showed occasional ´demo effects´ of missing voice.

In general, open Internet should not be used in mission critical operational deployment of ISI. Dedicated QoS IP connections and E1 lines are a necessity. The technical issues and conclusions on them are handled in more detail in D7.2.4.

The demonstration was based on the end users defined fleet maps: structure of linked and local groups for the field operators and dispatchers to manage the hot pursuit chase. As a summary, the demonstrations on April 26 and May 27 worked reasonably well, the intended functionality requirements were filled and the service was good enough to be evaluated against the criteria of ISI added value and easy to use, also to compare to the deployable back-to-back GW based CBC solution that is in use. It was found that TETRA ISI adds significant value to the demonstrated hot pursuit use case and the real benefit of ISI is the nationwide coverage of the service, not only the narrow border area of extended coverage. As in the Norway-Sweden case, fast migration, being manual or automatic is a necessity in this case of critical use case. Terminal manipulation at migration has to be fully automatic or kept at minimum. To achieve that, the same GSSI of linked groups was used in all countries to avoid manual change of talk group after each migration.

**Demonstration 7.3 (Airplane disaster in Geneve)**

This demonstration showed TETRAPOL-TETRAPOL as well as TETRA-TETRAPOL connection. As there is no migration in TETRAPOL, terminals do not migrate between TETRAPOL networks, the limitation was circumvented in the demonstration by dual TETRAPOL coverage in the demonstration area. A special TETRAPOL base station, integrating a base station of both two networks into one rack in the show area, was used. This enables for both countries first responders to use their home network in the neighbour country. As CERN is in the border area of Switzerland and France, the double coverage concept for the airplane accident use case place was found feasible. For TETRA-TETRAPOL interoperation, a TETRA group was back-to-back bridged to a TETRAPOL group with a deployable TETRA-TETRAPOL GW. Demonstration 7.3 used TETRA infrastructure and terminals, without migration or ISI support, from a 3rd party (Sepura).

In Geneve Demo Exprivia showed, all the functionalities adopted with ISITEP enhanced terminal, focalizing in particular to a new PPDR terminal composed of a smart device (android programmable) connected with a TETRA modem and with a TETRAPOL modem. IET functionality is described in Chapter 3 in the terminals assessment of Demonstration 7.5, where it was connected to both TETRA and TETRAPOL networks.

**Demonstration 7.4 (Joint police surveillance patrol)**

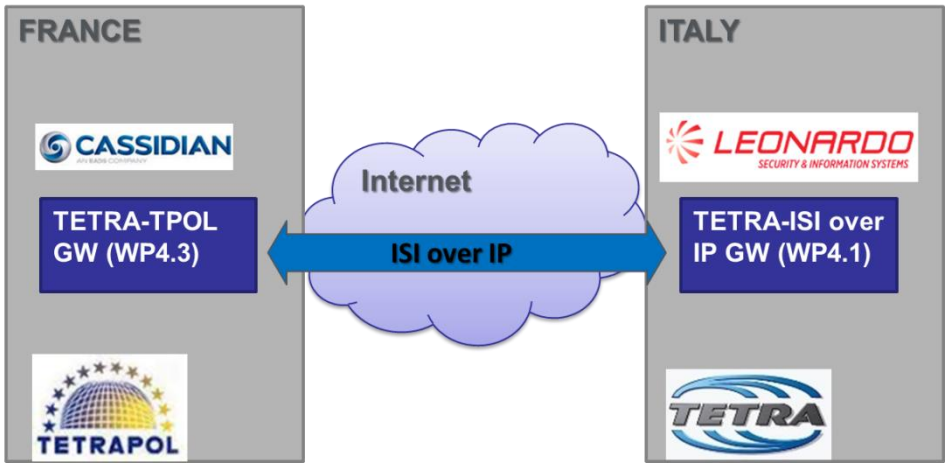



**Figure 4**

Demonstration 7.4 connected a TETRA laboratory network at Leonardo premises in Genoa with a TETRAPOL laboratory network at ADS Fr premises in Paris implementing ISI over IP, shown in figure 4. ISI interconnection was implemented over the Internet and secured by an IPSEC VPN solution. The interconnection over Internet was tested prior to the two end user test runs, in September 2016. TETRA dispatchers and terminals behaviour were verified as part of the TETRA-TETRAPOL ISI interoperability tests performed by Leonardo and ADS Fr as part of WP4.7 in November. No specific QoS profile was implemented during the tests and the demo runs, but this didn't impact the results at all. Despite that in general, open Internet should not be used in mission critical operational deployment of ISI, dedicated QoS IP connections are a necessity. As the IP ISI, ISI Gateways and dispatchers were laboratory installation, some malfunctions due to instability of the software provided caused minor demo effects of missing voice.

| IOP function | Use case |
|---|---|
| Group Call | Group call<br>• between any terminal located in each home network SwMI |

**Table 2: List of WP7.4 "Joint police surveillance patrol" ISI functionality**

**Demonstration 7.5**

TETRA ISI architecture in the WP7.5 VIP protection demonstration is shown in figure 4.

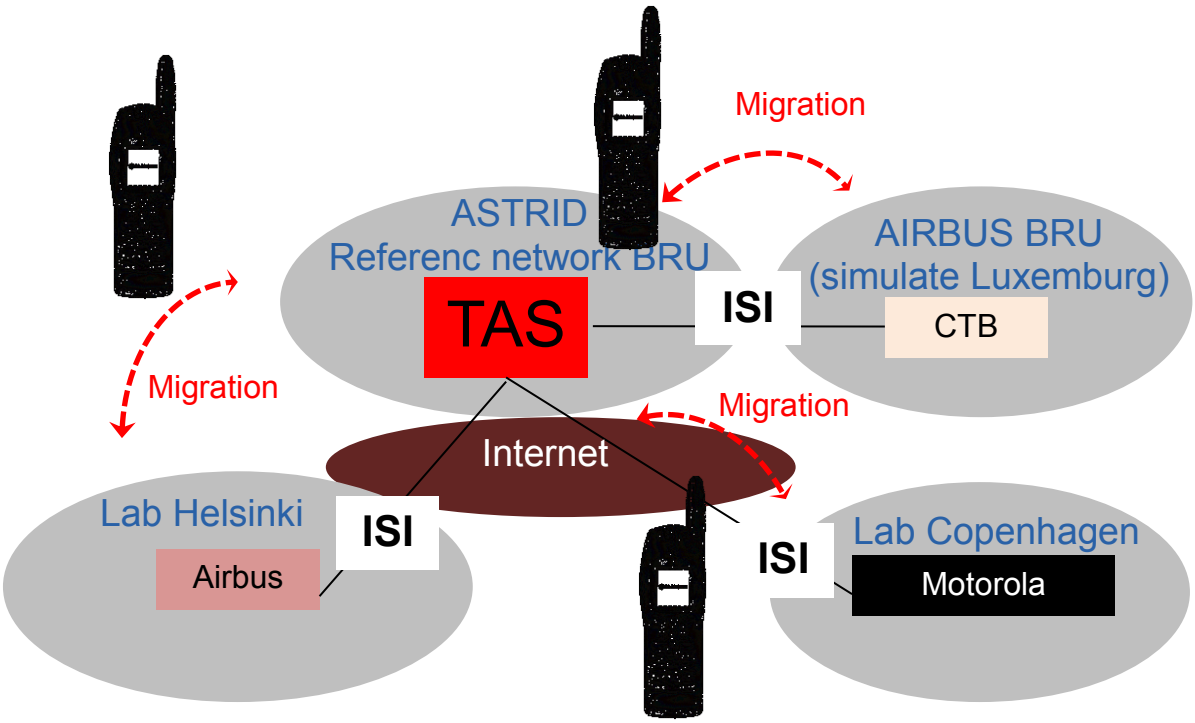



**Figure 4**

TETRA ISI use case in the 7.5 ´extended´ demonstration was supporting VIP protection personnel migrating TETRA terminals from three other European countries TETRA networks to ASTRID TETRA reference network (TAS) in Brussels. Those three networks were (star) connected to ASTRID reference network by TETRA ISI interface: two over Internet (from Dk and Fi) and one over E1 line (from Airbus Belgian reference TETRA network in Brussels, emulating Luxemburg).

The ISI connections, configurations and parametrisations of the four connected TETRA networks, VIP protection persons TETRA terminal migration to ASTRID reference network as well as group communications in the fleet map of the use case: linked groups between those four TETRA networks, including the national NCP´s and Belgian control canters, were all tested to work correctly before the actual demonstration days.

Airbus and Motorola provided their migrating TETRA terminals (two from each) of the laboratory networks as well as dispatchers in their laboratories to play the role of NCP´s outside Belgium.

The extended demo did technically run as planned and technical objectives of the demonstrated ISI GW´s and connections were fulfilled. Internet was used for ISI, but less than in the 7.2 demo. Some Internet QoS issues of missing voice did occur also in this demonstration. The technical issues are handled in more detail in deliverable D7.5.4&5.

The demonstration used also ASTRID operational network and ASTRID provisioned operative terminals, but with no technical additions compared to normal in-country operations. ISI was not implemented in the operational ASTRID network. NL VIP delegation used bi-national terminals provisioned in both ASTRID and C2000 databases. Moreover, there was a BIM-gateway (see D2.1.3, section 3.4.3) to interconnect the group selected by the VIP delegation with their home C2000 TETRA network. This enabled the implementation of the end user demonstration also with NL delegates' participation as described in the ´story board´.

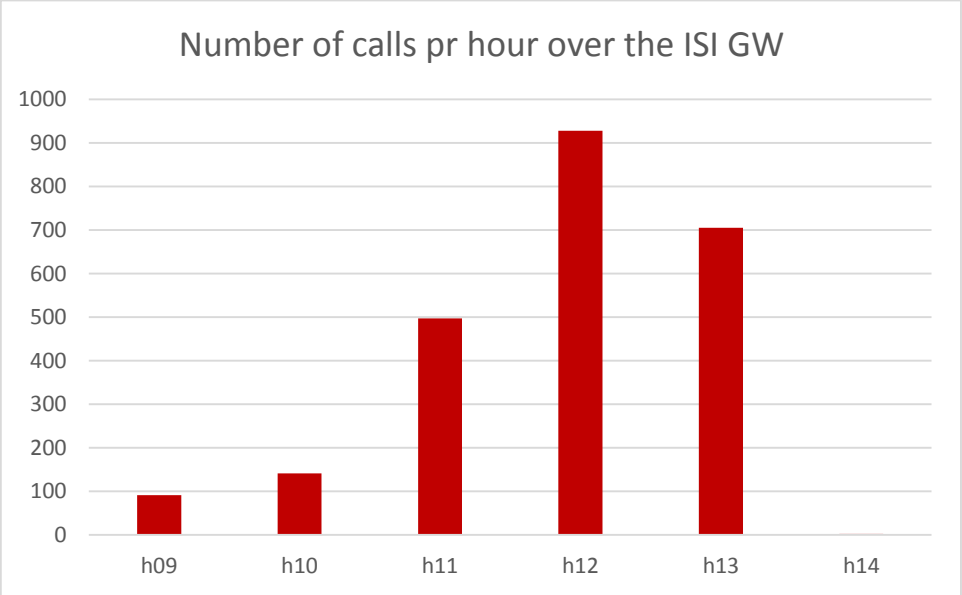
The deployable WP 4.5 TETRA-TETRAPOL GW was used in Lille to connect French VIP protection persons TETRAPOL terminals (network Acropol) to ASTRID operational network. An ASTRID operative TETRA terminal, provided by BFP was connected to the GW via its audio interface. The IET terminal was connected to both TETRA and TETRAPOL networks in Lille, where both networks coverage was in place. Its migration from using TETRAPOL connection to using TETRA connection is described in Chapter 3.

## 2.3 Services assessment of conducted ISITEP demonstrations

### Demonstration 7.1

There was extensive planning of the use of ISI services between the end-user organisations in Sweden and Norway. The planning produced nationwide definition of joint TETRA groups for the various public safety organisations in Norway and Sweden (WP3.2 and WP3.3). The exercise was to verify and demonstrate that work in real.

The use of TETRA in the traffic accident scenario was based on use of 8 Norway-Sweden (NOSE) linked talk groups: common emergency group for all actors, three joint police groups, two health/ambulance specific groups, two joint rescue and one joint coordination group (used by exercise management). During the most busy hour (hrs 12-13), over 900 calls were made altogether over ISI over those groups. The most active being health/ambulance (3700 call seconds) followed by the police groups (2800 call seconds). 124 RAKEL TETRA radios and 93 Nødnett TETRA radios as well as five control rooms participated.




There was an extensive training program prior to the use of ISI services by Police, Health, Rescue and Border control between Norway and Sweden in the exercise. Specific sessions were conducted for trainers and also sessions to produce training materials (based on deliverables in SP3). The use of ISI during the exercise was backed by this training effort. The end users used their normal TETRA terminals, which was very beneficial.

Based on 86 end user respondents to the query of the exercise, the cross border functionality in the exercise was evaluated as very important, voice quality was excellent and migrations worked well. The end users on both sides of the border are waiting to get the ISI service into normal operative use early 2017.

**Demonstration 7.2**

Service assessment summary.

The use of ISI services in the demonstration was developed by NL police in collaboration with Belgian police, MSB and DNK, the TETRA end user partners of ISITEP. The Be-NL-Ge hot pursuit demonstration was based on a joint international fleet map: use of two Be-NL-Ge internationally linked voice groups for the field operational people and for the control rooms. Harmonised GSSI TETRA addresses of these groups helped the migration so that the talk group number did not need to be changed after migration. Both the control room dispatchers and terminals were not those of the end users, but provided by the manufacturers. As end user training of those TETRA terminals use was limited to a short session just before the demonstration, the terminal use was designed to be as simple as possible w/o use of any more advanced TETRA terminal functions. Consequently, 90% of end users found the learning to use the ISI service to be easy. The linked voice groups were programmed to the terminals and majority of the end users stated that change of voice groups

between those was quick. This was important as the hot pursuit case did not offer the operational users time to terminal manipulation during the intensive chase drive. Audio quality was generally assessed good, but some degradations occurred due to the use of open Internet w/o QoS.

After the demonstration, the end users evaluated the use of ISI service and the terminals.

90% of the respondents (23 responses in total) evaluate the demonstrated ISI service to help to conduct the task (hot pursuit). 90% also evaluated the benefits to be clear. 70% evaluated that ISI service covered all the communication needs. One issue here was the right time to migrate to the neighbour country to minimise the break in communication. Best way was found to be the control room to command that, based on vehicle position (automatic position updates to control room), shown on their map.

There was variance in the perceived speed of call set-up time. Belgian end users, who use call setup queuing, are trained to wait a moment (for the acknowledgement beep) before speaking, while NL users tend to speak immediately and may start speaking before channel is granted over ISI. There was a longer set-up time delay over ISI than in inland group communications.

**Demonstration 7.3**

There was no ´story board´ of the airplane disaster and no end user play to assess feasibility of the service to the defined use case.

**Demonstration 7.4**

The 7.4 was a laboratory demo with the main objective of validating technological capabilities of the ISITEP framework for improving TETRA-TETRAPOL interoperability. Despite the absence of a specific story board, the end users involved, members of the Spanish Civil Guard & National Police, and the Portuguese Republican National Guard, were requested to assess the potential benefits of using ISI services to connect TETRA and TETRAPOL networks.

The feedback was largely positive: the integration of TETRAPOL and TETRA networks based on use of an ISI over IP digital interface addresses a real problem, can help cross border operations improving quality of group communications and making them easier. The real benefits of ISI among TETRA and TETRAPOL networks are the potential nationwide coverage of the service provided (patching of TETRAPOL and TETRA talk groups), greater flexibility (no limitation due to the number of radios available, possibility to dynamically change and patch different user groups) reduced end-to-end delay and increased voice quality

The main remark raised by the end users is the limited number of services developed on the TETRAPOL side compared to those available over ISI on the TETRA side, SDS and emergency call in particular.

IET terminal and its functionality was shown to the end user observers of the demonstration 7.4. Its assessment by BFP as part of demonstration 7.5 is presented in chapter 3.

**Demonstration 7.5**

This was the most extended set of user scenarios along the VIP protection operation of an EU top level meeting in Brussels. The demonstration consisted of eight different scenes of management of police field operations 1) NL VIP crossing the Be-NL border, 2) Belgian rail police coordination with BFP control room and with Fr VIP escort from Paris Nord station, 3) unrest in train Amsterdam-Paris, 4) French VIP escort crossing the Fr-Be border in Lille, 5) Luxemburg VIP escort crossing Be border on E40 motor way 6) Finland and Denmark VIP arrivals in Brussels national airport 7) Brussels, Be and NL control rooms co-operation and 8) Finland and Denmark VIP embarkment from Copenhagen and Helsinki.

In the field demonstration police forces participated from 6 different Belgian police units, 4 Dutch police/control room units, French border police, Luxemburg motorway police force (played by CIK BRU), Finland body guards and NCP (played by Airbus Fi) and Denmark body guards and NCP (played by Motorola),

The eight communication scenes covered the entire scope of the police operation in relation to the VIP protection and they used both current existing technical means: ASTRID terminals and operational ASTRID network (Scenes1,2,3) as well as ISITEP developed new methods: four ISI connected TETRA test networks, migrating TETRA terminals, TETRAPOL-TETRA network and DMO GWs and also the ISITEP developed IET dual radio terminal (scenes 4,5,6,7,8). The enhanced dual radio TETRA-TETRAPOL terminal (IET) of scene 4 was demonstrated in Lille afterwards, see chapter 3, Terminals assessment, Demonstration 7.5.

The demonstration aimed to visualize to the ISITEP audience the field operations of all these 8 different scenes that took place, using real time Skype videos from scenes, visualising pictures and an on-line didactic interpretation in the showroom. The central element of the show was the Be-NL-Lux-Fr-Dk-Fi joint radio scheme, showing all the involved entities and the use of the various voice groups.

In a separate workshop after the field demonstration, 5 original plain scenarios were run, showing TETRA terminal migration via TETRA-TETRA ISI between the ASTRID and the Airbus.be test platforms in Brussels (“TAS” and “CTB”), as well as the use of Coordination groups, Euro visit groups, Alert groups (see International Fleet map Proof Of Concept, D23.3, appendix 3), combining of linked groups and emergency call. These scenarios demonstrated the added value of ISITEP created new technical capabilities, that were used in the field exercise.

An end user evaluation of the demonstration was done after the demonstration run. The end user feedback on terminal and control room work station manipulation was good. Manipulation of terminals was minimised by either automatic migration or manual migration with change of network. GSSI harmonisation enabled terminals to continue in same linked group, as TETRA terminals do not support automatic change of group profile after migration. Using group linking in the control room,

also home groups can be enabled to visited network w/o terminal user manipulation. Showing of the network code or name on the TETRA terminal UI is essential, as was the case in all newer or test dedicated TETRA terminals. Feasibility of the radio procedures, developed for the VIP protection, was verified by end users. End user training of the use of linked and local groups is essential, As VIP protection is a planned case, nearly no manipulation was requested from the end-users. Unexpected network and talk group changes were more developed during the Workshop scenarios. Easiness of control operations by control rooms was also found good. General interest to use the demonstrated new features, enabled by TETRA ISI was high.

# 3. PMR TERMINALS TECHNICAL AND USABILITY ASSESSMENTS (TASK 7.6.2)

The basic deployment of TETRA ISI requires migration capable TETRA terminals of which only few are currently commercially available. For the use of ISITEP TETRA-TETRA demonstrations, the needed TETRA terminals were developed by the manufacturers, but outside of ISITEP scope. For WP7.1 a list of TETRA terminals requirements, beyond migration capability were issued by DNK and MSB[1]. To fulfil those needed extra development effort of TETRA terminals beyond ISITEP.

In the demonstration WP7.2 (Hot pursuit) Motorola, Leonardo and Airbus FI migration capable TETRA terminals were used. Leonardo and Motorola provided prototype terminals, while Airbus terminals were from laboratory, but similar as used in ASTRID network normal operations (same SW).

Demonstration 7.5 (VIP protection) used the operational ASTRID network and terminals as well as Airbus Fi and Motorola migrating TETRA terminals for the Fi, Dk and Lux delegations to migrate to ASTRID reference network in the WP7.5 extended demonstration. In addition to migration support, no special usability requirements to those terminals were stated, as they were outside the development scope of ISITEP. As the case in the other demos, the same GSSI in linked groups were used to minimise terminal manipulation at migration. Also automatic migration was tested in a separate test run in a motorway in Brussels.

ISITEP enhanced TETRA-TETRAPOL terminal (IET) is a dual radio terminal concept, integrating TETRA and TETRAPOL modems in a single terminal installation: Android terminal with separate or in-built TETRA modem and an externally connected TETRAPOL hand-held phone to work as a TETRAPOL modem. IET was presented in context of the operational demonstration 7.5 (VIP protection) in the France-Belgium border (Lille). It was verified after the end user demonstration in a separate test session, as its integration was delayed and it did not work properly in the demonstration day. The challenge of the IET was to automatically change from using TETRAPOL modem to use TETRA modem due to vanishing TETRAPOL coverage and emergence of TETRA coverage.

Demonstration 7.4 (Joint police surveillance patrol) intended to showcase the ISITEP enhanced TETRA-TETRAPOL terminal (IET) in the context of a joint cross- border operation to keeping audio connection with the Control Rooms while migrating between the two coverages. Due to the impossibility of ADS Fr to make its terminals available for the demo, due to overlapping commitments, it was not possible to showcase the full solution and the demonstration of the operational part was based on videos, filmed during the 7.5 demonstration.

Nonetheless the feedback on the TETRA-TETRAPOL voice migration technological capability demonstrated was positive: the use of the Enhanced Terminal addresses a real problem and can help end-users in their field operations even if the operational advantage is not completely demonstrated.

Demonstration 7.3 did not use TETRA terminals from ISITEP partners and no migration was in use. TETRAPOL terminals of the two TETRAPOL networks, simulating Switzerland and France, were from Airbus France. They worked in normal way in their home networks as no migration is possible and there were no ISI linked groups as no international fleet map had been developed for the airplane disaster use case due to lack of the operative scenario (story board). Also the IET was showcased as

[1] See Radio Terminal Requirements for ISI
https://www.msb.se/Upload/Produkter_tjanster/Rakel/Nyheter_och_kalender/ISI/Radio_Terminal_Requirements_for_ISI_2014

part of WP7.3, but only as a technical capability. The most relevant comments collected were that: a complete integration in a unique terminal would be the most practical solution, the terminal should take into account present and future solutions integrating TETRA-TETRAPOL-Commercial 4G networks, the terminal shall be able to run TETRA and TETRAPOL at the same time, the USB cable to connect the two radios should be replaced by a more flexible wireless connection, the capability to control remotely a PMR modem is quite interesting and shall be adapted to iOS as well, the vehicular deployment is the most relevant from the operational point of view even but the solution demonstrated is experimental and that can't be used in the field

### 3.1 Required ISI support

Basis for ISITEP demonstrations 7.1, 7.2 and 7.5 was migrating TETRA terminals, which the ISITEP manufacturers provided to the demonstrations, outside the scope of ISITEP terminal development in SP5.

The basic required ISI support in TETRA terminals is migration signalling, enabling migration to a visited network, receive authentication keys from the home network and inform home network from the visited network so that incoming calls can be routed over ISI to the visiting terminal.

Authentication secures the use of the TETRA terminal in the visited network, provided that its operator relies on the authenticity of the keys, delivered from the home network. As visiting terminals must be provisioned also in the visited network, no ´blind´ TETRA terminals are allowed to register and authenticate, but only those who have been beforehand intended to do it. This issue has been under discussion in ISITEP and there is an initiative in TCCA to allow also ´blind migration´.

No migration between TETRA and TETRAPOL or between two TETRAPOL networks was implemented. The ISITEP WP5 IET was thus required to enable to manually or automatically select the network, TETRA or TETRAPOL, that had feasible coverage, but services of those networks stayed separate. IET based on separate independent TETRA and TETRAPOL subscriptions and services were not interconnected. TETRA migration was not implemented in IET as there was no ISI use case scenario to be demonstrated.

The demonstrations relied on the security of authentication, based on using home authentication keys. AIE TEA2 is used in the demonstrations 7.1 and 7.5, where the visited TETRA networks are TETRA operator (ASTRID, DnK, MSB) owned. Astrid reference TETRA network supported both TEA2 AIE and clear voice (no authentication).

Visiting TETRA terminals in ASTRID reference network in demonstration 7.2 did run on clear voice, as TEA2 was not available in the ISITEP manufacturer provided TETRA terminals..

### 3.2 Terminal usability

Assessment of the usability of the TETRA terminals for the ISITEP demonstration use cases has been evaluated. In addition to migration from and authentication by the home network, TETRA

terminals needs to provide visibility and allow the users to use the TETRA terminal in a convenient and ergonomic way, while migrated.

There is need to use full ITSI addresses, incl. country and network codes in the communications. TETRA terminal phone book must to enable easy international calling and group communication in visited network.

Terminal needs to display the current network code (MNI) or mnemonic on the screen. The speaking partner (Talking Party Identification –TPI) needs to be shown with full address (or mnemonic) on the screen.

Radio terminal suppliers2 provided (beta) software with Air Interface Migration (AIM) capabilities for the WP 7.1 (and WP 7.5) demo. ISI/AIM will be a standard feature in 2016/2017 software releases from these suppliers. Radio terminals are tested and are in in line with the ISI radio terminal requirements described above and comply with requirements compiled by DNK and MSB.

To avoid having to manually change talk group after migration, the GSSI group addresses of the linked TETRA groups in both networks were defined to be the same and thus the terminal could continue to communicate in “the same” linked talk group (use the same GSSI of the home network) while migrated. In normal cross border situations there should be available joint address space for the linked groups GSSI´s to be coordinated between two or more countries. This arrangement could be relaxed, if terminals would be enabled to automatically change active group settings after migration: change active group to the migrated network new GSSI.

Assessment of the usability of the ISITEP Enhanced Terminal (IET) was evaluated in the 7.5 demonstration.

The main collected feedbacks of terminal usability are:

- Terminal needs to display the current network (TETRA or TETRAPOL) and MNI or mnemonic on the screen.
- After migration it should be easy (automatic) to switch to the right linked and local groups, available for the visiting user in the visited network.
- Migration needs to be as easy as possible requesting minimal user interaction (see 3.3)

2 Airbus, Motorola and Sepura

### 3.2 Automatic vs Manual migration

Migration needs to be as easy as possible. For the end users, an automatic migration would be optimal, but the terminal should not migrate ´by accident´, when terminal is in shadow of own network and neighbour network coverage is in place. Migration may also take several seconds and thus the terminal should not migrate, while being in critical use. Hence many operative use cases prefer manual migration at user control, but with minimal additional user interaction.

Prior to the WP 7.1 demo the end-users decided to use manual migration only. The radio terminal will always prefer the network it is registered on even in cases with overlapping coverage until it drops out of coverage due to network parameter settings. Automatic migration will only happen when you lose contact with your home network. In places with overlapping coverage from two networks, manual migration provides the end-user with more control because the radio is maybe on the home network but the incident is handled in a talk group controlled by the other network.

Analysis of automatic vs. manual migration has been provided by BFP (see D75.5, 3.2.2.17).

Automatic migration was tested in context of 7.5 pre-demonstration early 2016 in Brussels by BFP. Automatic migration was found to be the preferred option, but if it cannot be done reliably at the right moment, manual migration is to be used, but with minimal end user intervention. Automatic migration may take place too late or by accident, when there neighbour network coverage and own network coverage has a gap. In the demonstrations TETRA-TETRA both manual and automatic migration was fast and manual change of the network was evaluated to be easy.

### 3.4 Terminals assessments of conducted ISITEP demonstrations

Summary or the assessments of terminals in demonstrations 7.1, 7.2, 7.3 and 7.5….(to be added).

Demonstration of WP7.1

The demonstration used 200 migration capable terminals from Airbus Fi, Motorola and Sepura. (ISITEP IET terminal was not used, as that was out of scope of the TETRA-TETRA use case). The terminals functionality to support cross-border collaboration of WP7.1 was defined by MSB and DNK, as published in their terminal requirement document3. Airbus, Motorola and Sepura provided TETRA terminals, with updated SW to support the functionalities. RAKEL existing operative Airbus Fi TETRA terminals were compliant to the use case of the demonstration and were used in the WP7.1 demonstration, part of the from Sweden to Norway migrated terminals. In addition to AIM TIP specifications, a set of requirements for the usability of the terminal (UI), when migrated, were defined. Certain functions, not supported over ISI, are defined to be de-activated in the terminal during migration. Certain functions, incl. emergency, that work differently in the visited network, need also to be supported by the terminal, when migrated. Manual migration was defined by the Norway and Sweden end users as the way to migrate. Also automatic migration was shown in the demonstration.

3 Radio terminal requirements for ISI. Document developed by DNK and MSB
https://www.msb.se/Upload/Produkter_tjanster/Rakel/Nyheter_och_kalender/ISI/Radio_Terminal_Requirements_for_ISI_20140526.pdf

The Nødnett and RAKEL provisioned 200 migrating TETRA terminals in the demonstration worked as required and RAKEL terminals migrated to the incident scheme in Norway as planned, and vice versa. The end users were satisfied with the functionality. More detailed analysis of terminals in WP7.1 demonstration is described in D7.1.4.

Demonstration of WP7.2

As the demonstration was based on TETRA-TETRA ISI, ISITEP SP5 terminals were not deployed. The demonstration used laboratory TETRA terminals from Airbus Fi. Motorola and Leonardo, provisioned to their respective home network. Those fulfilled the required ISI function of the hot pursuit use case of the demonstration: participated communications in the defined cross-country linked groups of the field operatives and control rooms. In the demonstrated use case of the hot pursuit, the home command center had the best view of the right time point to migrate, based on the location of the migrating terminal and status of the command. For the user, the most easy way of migration is desirable, fully automatic at the right moment to be the best. Both manual and automatic migration was used.

As migrating TETRA terminals were outside of ISITEP DoW work, there was no separate ISITEP TETRA terminal verification, nor systematic verification of SP2 defined ISI functions of terminals, but only the SP7.2 demonstration overall technical verification and also the demonstration pre-run by the Belgian, NL and Germany police end users. No special requirements for the terminal UI or usability of the terminals were set for the operation in visited network.

Airbus Fi, Motorola and Leonardo TETRA terminals worked as verified over the demonstration final run. Terminal migrations worked well and their manipulation was found easy. Some more detailed analysis of the terminals in SP7.2 demonstration is described in D7.2.4, including also end users evaluation of terminal usage.

Demonstration of WP7.3

Normal TETRAPOL terminals from ADS Fr were used. As TETRAPOL terminals worked in their home network and there was no terminal migration, no new functions were to be assessed by end users.

The ISITEP IET terminal was demonstrated, not in an operative context, but showing only its technical capabilities. The main feedback collected were

- The vehicular deployment is the one that has a potential operative relevance even if the operational advantage is not completely demonstrated
- the USB cable to connect the TETRA and TETRAPOL radios should be replaced by a more flexible wireless connection,
- the capability to control remotely a PMR modem is quite interesting and shall be adapted to iOS as well

- The possibility to configure the Migration as automatic or manual is interesting but needs to be proven in an operational context
- The terminal should take into account present and future solutions integrating TETRA,TETRAPOL and Commercial 4G networks
- The solution demonstrated is experimental and that can't be used in the field

More detailed analysis of terminals in SP7.3 demonstration is described in D7.3.4.

Demonstration of WP7.4

Demonstration 7.4 (Joint police surveillance patrol) intended to showcase the ISITEP enhanced TETRA-TETRAPOL terminal (IET). Due to the impossibility of ADS Fr to make its terminals available for the demo, demonstration 7.4 only presented videos filmed during the 7.5 demo. Nonetheless the feedback on the TETRA-TETRAPOL dual radio technological capability demonstrated was positive: the use of the Enhanced Terminal addresses a real problem and can help end-users in their field operations even if the operational advantage is not completely demonstrated.

More detailed analysis of terminals in WP7.4 demonstration is described in D7.4.4.

Demonstration of WP7.5

The demonstration 7.5 VIP protection used Airbus Fi and Motorola migrating TETRA terminals, provisioned into the laboratory networks of Airbus and Motorola, interpreting home networks of the VIP protection delegations. ASTRID reference network home TETRA terminals worked locally in the ISI linked groups of ASTRID reference network. In addition and in parallel also operative ASTRID TETRA network was used with its home non-migrating terminals.

The 2+2 from home (Finland and Denmark) migrated Airbus Fi and Motorola terminals worked as planned in the VIP protection demonstration scenario. The TETRA terminals from Airbus Brussels ISI connected test network (interpreted Luxemburg) migrated to ASTRID, but registered there without home authentication, that was not available in that home network. TETRA terminal manipulation in and after migration was evaluated to be easy. Using own familiar terminals, minimal training for the terminal use is needed. More detailed analysis of the TETRA terminals usability in WP7.5 demonstration is described in D7.5.5.

IET terminals TETRA radio was provisioned in the ASTRID operational network as a home terminal and its TETRAPOL modem was French police provided operational TETRAPOL terminal provisioned in the Acropol operational network.

In this scenario was used an hybrid version of configurations of the ISITEP enhanced terminal: a sort of mix of vehicular and hand-held solution.

This particular configuration IET (ISITEP Enhanced Terminal) was acted by a Samsung S4 mobile (Android version 4.4.1) with installed: ACM (Exprivia SW), SmartPMR (new version of Airbus SW), PerseuPhone (Leonardo Company SW) and it was interfaced to Leonardo Company vehicular Tetra Modem by WiFi connection and to Airbus TPH900 Tetrapol modem by Bluetooth connection.

The demo execution

For IET we got the following simply configuration:

- Preferred network: TETRA
- Automatic change of modem from TETRA to TETRAPOL : enabled

Demo steps

All demo's phases was performed into Police's car on the road in Lille near the Train Station where are present both network coverage TETRA and TETRAPOL.

HW configurations demo was based on following steps:

1- ACM, SmartPMR, PerseuPhone are started in environment where both TETRA and TETRAPOL coverage are present;

2- Basing on ACM configuration IET activate TETRA modem: audio and TETRA modem gui was forwarder over android mobile;

3- A disconnection from Tetra network is triggered: (antenna was detached by Tetra modem, in order to simulate the end of coverage of TETRA network): ACM deactivate Tetra modem and activate Tetrapol Modem: audio and TETRAPOL modem GUI was forwarder over android mobile;

4- On steps 2 and 3 a voice call was executed. PTT functionality was tested and audio quality was checked;

5- A reconnection to Tetra network is triggered: (antenna was reattached to Tetra modem): ACM deactivate Tetrapol modem and reactivate Tetra modem: audio and TETRA modem GUI was forwarded again over Android mobile;

6- A voice call was executed. PTT functionality was tested and audio quality was checked.

The automatic roaming of the IET was very quick, similar to a manual roaming delay (< 1 sec). This is because, in an overlapping zone, both TETRA and TETRAPOL modems are connected and active in their home network. The IET communication manager, made that only one of both modem was audio active for the IET user, but as soon as the audio active modem has no signal anymore, the communication manager audio activates the other modem, which is fully ready to take over.

Unfortunately, like for a usual TETRA terminal, the current IET prototype automatically roams when its audio active modem loses totally its signal. It can therefore happen, when the signal received by the audio active model is poor (not sufficient for an operationally acceptable audio service) that the IET is

unusable while the other network has an excellent coverage and is perfectly received by the other modem.

As assessed by BFP, using a terminal with 2 transceivers, like the IET, increases the terminal migration performance, compared to existing solutions of TETRA-TETRAPOL (back-to-back) interoperability.

# 4. OPERATIONAL AND PROCEDURAL ASSESSMENTS (TASK 7.6.3)

In WP3.1 the PPDR Framework standard model and template agreements has been published in D3.1.1. D3.1.2 describes the Norway-Sweden agreement. In WP3.2 deliverable D3.2.1 the functional model is described and in WP3.3 Common procedures in operations in the deliverable D3.3.1 ´Handbook of operational procedures´.

WP 7.1 Norway Sweden cross-border demonstration utilised these SP3 developed results to the scope of the cross border traffic accident exercise, involving a large number of police, rescue, helicopters and ambulance personnel in cross-border cooperation's. The exercise was preceded by extensive planning, pre-rehearsals and training sessions with the end users. The extensive amount of communications over ISI in the real end user exercise was recorded and analysed thoroughly. The results were reported in ISITEP advisory board and user forum, in MSB and DNK internal documents and web pages4 and are documented in ISITEP deliverables D71.4 and D71.5. The project created the readiness of the end users to take Norway-Sweden ISI interface into operative use in 2017.

WP7.2 demonstration operational and procedural definition was developed by NL police with contributions from ISITEP Belgian police partners, where feasible. International fleet map followed the one, developed in SP3 and was implemented for the 3-country police (Hot pursuit) use case in Maastricht NL/B/Ge border area. The assessments of the involved NL, Belgian and German police end users are reported in their written feedback documents, done after the demonstration and conducted and reported by TNO & al in deliverable D7.2.4.

WP7.3 demonstration did not involve operational procedures, but was a technology demonstration. No international fleet map for the Airplane disaster case was in use. Hence there was no operational or procedural assessment.

WP7.4 demonstration was a laboratory demonstration of ISI interface between Leonardo TETRA and Airbus Fr TETRAPOL to support group voice, implementing the existing Portugal-Spain back to back based communications solution model by ISITEP technology. No international fleet map of the end users was developed and hence there was no operational or procedural assessment.

WP7.5 demonstration implemented the operational and procedural definition ISITEP WP2.3 (deliverable D2.3.2) in the use case of Belgian police to manage major Brussels EU top meeting VIP delegates safety arrangements. This definition was developed by Belgian police, extending with the ISITEP provided possibility of involving VIP protection delegations safety personnel to use their own home TETRA terminals, migrated to Belgium from their home country. The developed International Fleet map Proof of Concept was found useful and added value in the operations. It involved in addition to Belgian police internal communication models, also international linked groups, VIP delegations home control rooms, NCP´s , the migrating TETRA terminals, used also in their home country,. International alert groups and emergency communications were included as well as automatic migration. These are documented in deliverables D7.5.1-5 and the BFP VIP protection demonstration planning, implementation and training internal documents. The demonstration verified the viability of the international fleet maps in operational use by the Belgian police forces. As it was more complex than that in the other ISITEP demonstrations, end user training to its use was found

4 See the film from the WP7.1exercise here: https://vimeo.com/196720387

necessary. The demonstration summary with end user assessments is presented in ISITEP User Forum and is documented in deliverable D7.5.5.

# 5. REGULATIVE ASSESSMENTS (TASK 7.6.4)

Using existing TETRA infrastructures and migrating terminals, TETRA ISI does not require any TETRA frequency coordination/re-use agreements. When there is no terminal migration, assessment of availability of radio channels for dual coverage is needed: TETRA-TETRAPOL DMO as well as TETRAPOL-TETRAPOL dual frequencies in the border area or at occurrence of major incidents. In general, this needs to be resolved case by case, as the PPDR radio frequency planning is a national issue. The manufacturer deployed TETRA infrastructures in NL used C2000 TETRA (deployable sites) radio channels.

The WP7.1 Norway-Sweden cross-border demonstration in the Norwegian-Sweden border was associated with the Norway-Sweden ISI agreement, signed by MSB and DNK in the meeting in Meråker near the exercise place, attended by the respective ministers of Norway and Sweden. The agreement is the first realisation of the ISITEP ISI contract model, delivered by DNK and MSB in WP 3.1 (D3.1.2). The agreement provides the legal foundation for operations of the ISI solution and governance of cross-border communication between the two countries' emergency communication networks.

The other TETRA demonstrations of WP7.2 and WP7.5 did not include regulatory agreements, but were installed as an ISITEP demonstration project in one ISITEP participant country (NL in WP7.2 and Be in WP7.5), involving the end user organisations of the concerned border countries, but not involving ISI interface of national operational TETRA networks.

For TETRAPOL connection in the VIP protection demonstration, a DMO TETRAPOL frequency was used in Belgium, close to the French border to enable use of TETRAPO DMO in Belgium. This was based on an agreement in Belgium for the demonstration.

In the case of TETRAPOL-TETRAPOL demonstration (WP7.3), there had to be agreement of the deployment of dual coverage base stations (and their radio frequencies) including base station and frequency of the neighbour country.

# 6. SECURITY ASSESSENT (TASK 7.6.5)

Assessment of security gateways was analysed by TNO in D4.6.3. Several commercial off-the-self security gateway products were inspected and found to fulfil the security requirements of ISI interface via IP to the national TETRA network. In the ISITEP SP7 demonstrations external security GW´s were not used.

The WP7.1 Norway Sweden cross border demonstration used TETRA AIE with TEA2 in line with the Sweden and Norway national networks security rules. The control rooms and dispatchers were those, certified in the operative use in Rakel and Nødnett. The migrating TETRA terminals were in line with these security rules in the national RAKEL and Nødnett TETRA networks. As the ISI was implemented via E1 leased line, there was no ISI IP or Internet security related issue to tackle in the interface. In RAKEL the ISI interface is isolated from MSB and RAKEL internal secured IP infra. The ISI interconnection and migrated terminals follow the same security rules as in the internal operations of those networks.

WP7.2 demonstration was run on manufacturers TETRA infra and terminals and were not covered by the national security rules. The demonstration used heavily Internet and was not secured in the level of SP2 requirements. The manufacturers did use their own IP/VPN connections in the demonstration, providing security of the communications between their used elements, but no other security measures were implemented. No security assessment of the demonstration was done.

WP 7.3 did not involve ISI interface and was out of scope of ISITEP (SP2) security requirements scope. No security assessment was reported.

WP7.4 demonstrations was done in laboratory environment without scope to security issues. The demonstration used Internet to connect the TETRAPOL and TETRA laboratory networks provided by ADS Fr and Leonardo respectively and was not secured in the level of SP2 requirements. The manufacturers did use their own IP/VPN connections in the demonstration, providing security of the communications between their used elements, but no other security measures were implemented. No security assessment of the demonstration was done.

WP7.5 demonstration used the ASTRID operative TETRA network as well as the ASTRID separate reference network (TAS). The TAS was ISI interconnected, following a star configuration, to manufacturers (two Airbus and one Motorola) TETRA laboratory networks. The operative ASTRID network was connected to the operative TETRA C2000 network and to the operative TETRAPOL networks, using ASTRID certified TETRA terminals and hence followed the ASTRID internal security rules. The ASTRID reference network was ISI connected to manufacturer TETRA networks over the Internet, but the termination of interface to ASTRID reference network was via E1 that was isolated from the rest of ASTRID IP infrastructure. No separate security GW´s were deployed as only E1 ISI was deployed and no security assessment of the demonstration was done.

# 7. CONCLUSIONS

An extensive set of demonstrations was performed in ISITEP. All the main cross-border use cases of two, three and four interconnected TETRA-TETRA ISI interconnections were demonstrated and verified by operational end users. The added value of cross-border cooperation over ISI has been proven, not least by the decision to implement TETRA-TETRA ISI to real operational TETRA networks in Sweden and Norway.

Migration of TETRA terminals was not a development item in ISITEP but the TETRA terminals, used in these ISITEP demonstrations, showed fast migration in a few seconds, both automatic and manual. Preference of automatic vs. manual migration was found to be a case by case choice. Easy terminal manipulation, while migrating, is the most important issue. As the end user migrates his home TETRA terminal and uses it in the usual way , minimal terminal manipulation was demonstrated in the TETRA-TETRA terminal migration ISITEP demonstrations.

TETRAPOL related demonstrations (WP7.3, WP7.4) were manufacturer provided proof of concept- and laboratory demonstrations. Those two demonstrations lacked the operational procedures and hence related end user scenarios were not perform. Nonetheless the two demos demonstrated technical capabilities for TETRAPOL-TETRAPOL and TETRA-TETRAPOL interconnection of great interest for the operational needs of the ends-users.

ISITEP developed the dual radio TETRA-TETRAPOL IET terminal that, provisioned in both (TETRA and TETRAPOL) networks, demonstrated TETRA-TETRAPOL migration. The IET terminal was successfully demonstrated as a proof of concept in WP7.5 (and partially in WP7.3 and WP7.4), but, even of interest from the operational standpoint, would need further development to become a real product for operative use.

ISITEP tools were presented or shown in the context of three ISITEP demonstrations related workshops receiving positive feedback. In particular, Terminal Training and Operation Training Tool, and Infrastructure Dimensioning Tool are innovative in the PPDR field, and can effectively support help filed officers improving quality of cross border operations.

Generic guidelines for mutual cross-border contracts were produced in ISITEP and verified by the signing of the first cross-nation ISI contract between Norway and Sweden in the context of Norway-Sweden ISITEP demonstration. Hence the contractual conditions for TETRA ISI connections between European countries are now in place.

Internet was widely used in the demonstrations for practical reasons and it was verified that ISI requires mission critical IP links with ensured quality of service. When using E1 ISI over IP, the link is especially vulnerable to delay variation (jitter), that has to be controlled in the IP connection, also to keep the PTT set up time short enough not to affect end user experience.

Security is the other main issue to avoid use of open Internet. For practical reasons, ISITEP demonstrations did not involve security gateways, but these were studied off line. Commercial security gateways, which fulfil the ISITEP defined security requirements, are available in the market to secure the ISI links. They can be added to the operational ISI solution, verified by the ISITEP demonstrations.

The below table summarises the scope of the five ISITEP demonstrations.

| # | Name | Network connections | ISITEP framework component validated |
|---|---|---|---|
| 7.1 | Multi agency demo | TETRA-TETRA ISI | TETRA-TETRA ISI GWs<br>TETRA terminals<br>Procedures |
| 7.2 | Police hot pursuit | TETRA-TETRA ISI | TETRA-TETRA ISI GWs<br>TETRA terminals<br>Procedures |
| 7.3 | Airplane disaster in Geneva border | TETRA-TETRAPOL<br>TETRAPOL-TETRAPOL | TETRAPOL-TETRAPOL GWs<br>TETRA-TETRAPOL Mob. GWs<br>(IET shown)<br>(ISITEP Tools shown) |
| 7.4 | Joint police surveillance patrol | TETRA-TETRAPOL | TETRA-TETRAPOL GW<br>(IET shown)<br>(ISITEP Tools shown) |
| 7.5 | VIP protection service | TETRA-TETRA ISI<br>TETRA-TETRAPOL | TETRA-TETRA ISI GWs<br>TETRA-TETRAPOL Mob. GWs<br>TETRA terminals<br>IET demonstrated after demo day<br>(ISITEP Tools shown)<br>Procedures |