# ISITEP
# D5.1.2 - TERMINAL OPEN ARCHITECTURE AND FUNCTIONS PUBLIC SPECIFICATIONS

| | | | |
|---|---|---|---|
| **Document Manager:** | Marco Carli | RM3 | Editor |

| | |
|---|---|
| **Programme:** | Inter System Interoperability for Tetra-TetraPol Networks |
| **Project Acronym:** | ISITEP |
| **Contract Number:** | 312484 |
| **Project Coordinator:** | FINMECCANICA - LEONARDO |
| **SP Leader:** | RM3 |

| | | | |
|---|---|---|---|
| **Document ID N°:** | ISITEP_D5.1.2_20161005_V1.3 | **Version:** | V1.3 |
| **Deliverable:** | D5.1.2 | **Date:** | 05/10/2016 |
| | | **Status:** | Approved |

| | |
|---|---|
| **Document classification** | **PUblic** |

| Approval Status | |
|---|---|
| **Prepared by:** | Claudia Olivieri (FNM-LDO) |
| **Approved by (WP Leader):** | Alessandro Neri (RM3) |
| **Approved by (SP Leader):** | Alessandro Neri (RM3) |
| **Approved by (Coordinator)** | Paolo Di Michele (FNM-LDO) |
| **Security Approval (Advisory Board Coordinator)** | Etienne Lezaack (BFP) |

## CONTRIBUTING PARTNERS

| Name | Company / Organization | Role / Title |
|---|---|---|
| Federico Frosali | FNM-LDO | Contributor |
| Claudia Olivieri | FNM-LDO | Contributor |
| Federica Battisti | RM3 | Contributor |
| Ramon Ferrus | UPC | Contributor |
| Jaakko Saijonmaa | ADS FI | Contributor |
| Serge Delmas | ADS FR | Contributor |

## DISTRIBUTION LIST

| Name | Company / Organization | Role / Title |
|---|---|---|
| All Company Project Managers | All involved companies | Members of the Steering Committee |
| Elina MANOVA | EC DG REA | EC Programme Officer |
| General Public | NA | NA |

## REVISION TABLE

| Version | Date | Modified Pages | Modified Sections | Comments |
|---|---|---|---|---|
| V0.2 | 15/05/2015 | All | All | First draft |
| V.0.4 | 16/07/2015 | All | All | Added: details on vehicular solution and HW deployments.<br>Added HW key integration on Hand Held ISITEP App renamed Communication Manager App<br>Removed details on Control If Removed Communication Manager SW components requirements |

| | | | | |
|---|---|---|---|---|
| V 0.5 | 07/06/2016 | All | All | Updated SW Architecture in order to be coherent with sub-systems design description. Removed those parts already detailed in subsystem Design Description. |
| V 0.6 | 08/06/2016 | All | All | Revised version |
| V 1.0 | 30/08/2016 | All | All | Revised version |
| V1.2 | 30/09/2016 | All | All | Updated TETRAPOL related Sections |
| V1.3 | 05/10/2016 | All | All | Updated TETRA section |

## Publishable extended abstract

This deliverable (D5.1.2) is the deliverable issued by WP5.1.

WP 5.1 is in charge to define open architecture of the ISITEP enhanced terminal defining from the HW and SW point of view.

Document D.5.1.2 reports on the advances in Task 5.1.2 until M30.

In particular, the following points are covered:

- Definition and Design of the HW architecture.
- Definition and Design of the SW open architecture.
- Definition of an adaptation service layer integrating TETRA and TETRAPOL
- Definition of the interfaces provided by the enhanced ISITEP terminal toward PPDR added value functions and PPDR cloud added value functions.

## CONTENTS

# 1 INTRODUCTION

The ISITEP enhanced terminal has the scope to integrate the TETRA and the TETRAPOL technology and to improve PPDR forces interoperability during joint international operations overcoming language barriers and supporting procedure execution.

The optimal solution for a bi-technology terminal would be having a single terminal capable of realizing both TETRA and TETRAPOL waveform, but in order to provide such kind of terminal the Software Defined Radio (SDR) technology will be used.

Budget and duration of the ISITEP project does not allow the use of SDR technology therefore such kind of bi-technology terminal is not achievable inside the ISITEP project.

As a proof-of-concept the ISITEP project addresses a prototype of bi-technology terminal realized using already available TETRA and TETRAPOL modems integrated through a programmable device.

The ISITEP project addresses both the Hand-Held and the Vehicular solution.

Currently TETRA-TETRAPOL interoperability is realized using back-to-back devices that allow extending the TETRAPOL coverage inside the TETRA network and vice versa extending the TETRA coverage in the TETRAPOL network, in this way near the border, the TETRA users are able to use their TETRA terminal and the TETRAPOL users are able to use their TETRAPOL terminals.

Current solution is not scalable, up to one group allowed, and it works just near the border, in the other case the only way to cooperate is that TETRA users are also equipped with TETRAPOL terminals and TETRAPOL users are equipped with TETRA terminals.

Therefore, end-users are already accustomed to using two terminals, especially those end-users who have to go several kilometers across the border.

# 2 DEFINITIONS AND ABBREVIATIONS

## 2.1 Definitions

This section is intended to capture the definitions of some key terms used in the document for the purpose of increased consistency. Most of the definitions are obtained from official 3GPP and ETSI documents:

**Access control**: the prevention of unauthorized use of resources, including the use of a resource in an unauthorized manner.

**Authentication**: the act of positively verifying that the identity of an entity (network, user) is the same as the claimed identity.

**Confidentiality**: the property that information may not be available or disclosed to unauthorized individuals, entities or processes.

**Data integrity**: the property that data has not been altered or destroyed in an unauthorized manner.

**Encryption**: the conversion of plaintext to ciphertext.

**Key**: a sequence of symbols that controls the operations of encipherment and decipherment.

**Key management**: the generation, selection, storage, distribution, deletion, archiving and application of keys in accordance with a security policy.

**Migration**: act of changing to a location area in another network (either with different Mobile Network Code and/or Mobile Country Code) where the user does not have subscription (e.g. ITSI in TETRA) for that network. In this document, migration is used as a synonym of roaming.

**Profile**: the capability of a particular equipment. This is defined separately for individual subscriber terminals and individual infrastructures.

**Roaming**: utilization of a mobile terminal in a network other than the one where the mobile is subscribed but on which the mobile can still be located and operated by agreement between the respective network operators.

## 2.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

| Acronym | Definition |
|---|---|
| ACM | Adaptation and Communication Manager |
| AuC | Authentication Center |
| App | Application |
| BL | Business Logic |
| BT | BlueTooth |
| DTAP | Data Transmission Applicative Protocol |
| GPS | Global Position System |
| GUI | Graphic User Interface |
| HMI | Human Machine Interface |
| IF | InterFace |
| IP | Internet Protocol |
| LAN | Local Area Network |
| MOCH | Multi-Site Open Channel |

| | |
|---|---|
| MPAP | Mobile PC Asynchronous Protocol |
| PDA | Personal Digital Assistant |
| PEI | Peripheral Equipment Interface |
| PPDR | Public Protection and Disaster Relief |
| PTT | Push To Talk |
| SDR | Software Defined Radio |
| SDS | Short Data Service |
| TETRA | TErrestrial Trunked Radio |
| TPOL | Tetrapol |
| UI | User Interface |
| USB | Universal Serial Bus |

# 3 SURVEY OF EXISTING TERMINAL

## 3.1 TETRA

In this paragraph are described legacy TETRA Hand-Held and TETRA vehicular considering the most commonly used TETRA features that are available in almost every TETRA radio available in the TETRA market. We will not enter into detail of the Man Machine Interface of the TETRA radio because this is the aspect that mainly differentiates the various TETRA radio manufacturers.

The TETRA radio description takes advantage of the FINM and Airbus FI experience as TETRA radio manufacturers present on the market for many years.

### 3.1.1 Hand Held

TETRA hand-helds are designed for Public Protection and Disaster Relief end-users, they are specifically designed to fulfil the operational needs of mission critical users working in severe operational conditions. They offer hard resistant metal case, a large well-spaced keypad for use with gloves, graphical display with excellent visibility in all lighting conditions and a high audio power for use in noisy environments.

This kind of radio provides the typical TETRA communication services like group speech calls, individual speech calls, short data services, GPS localization etc. and the top TETRA functionalities to guarantee the highest performance levels in terms of security, authentication, air interface encryption and end-to-end encryption.

Often TETRA hand-helds offer the man down switch facility with automatic alarm sending and embedded GPS receiver with automatic location positioning service.

### 3.1.2 Vehicular

The TETRA vehicular solution mainly provide the same TETRA functionalities of the hand-held solution, except that the vehicular solution is more powerful being supplied by a car and sometimes providing also more physical interfaces like LAN and WiFi.

The TETRA vehicular solution usually is able to provide four-slot data connectivity providing larger bandwidth to data application.

## 3.2 TETRAPOL

The next two paragraphs are given high level view on existing Tetrapol Handled and vehicular configuration.

### 3.2.1 Hand Held

Current Tetrapol Handleds are designed to facilitate users' mission critical in their everyday job. Tetrapol Handled are design to easily fir in user's hand and user interface have been designed for instinctive usage. Tetrapol Handled have compact design and comfortable grip. Battery autonomy is a key feature for a Tetrapol user, all Tetrapol Handleds are designed to have best battery life possible and fast swap battery.

Radio has been design for enabling Direct mode, trunk mode. Radio can be used in an encrypted or clear mode. Short message service is also available.

Tetrapol Handleds have some key features as a large Push to Talk button, emergency button, large display and Keypad and dedicated keys for adjusting the volume. A set of Handled accessories is available as micro loud speaker, BT earpiece, charger and so on.

### 3.2.2 Vehicular

The equipment used for vehicular configuration is exactly the same as the handheld one. The end user keeps his terminal when he is outside or inside the car to keep on the communications he is involved in. He has the possibility to plug the terminal in a specific dock to supply power from car battery.

# 4 HARDWARE DESIGN DESCRIPTION

## 4.1 Architecture

The ISITEP enhanced terminal is composed by a programmable device, a TETRA modem and a TETRAPOL modem. The programmable device is exploited to integrate TETRA and TETRAPOL technologies and to improve PPDR forces interoperability during joint international operations.

The ISITEP project address both the hand-held and the vehicular solution, the two solutions are physically different because of the different needs that an hand-portable radio shall satisfy with respect from those ones that shall be satisfied by a vehicular radio.

### 4.1.1 Hand Held deployment

In the following figure it has been represented the HW deployment of the Hand Held version of the ISITEP enhanced terminal. Currently during PPDR operation the end-user is equipped with a TETRA and a TETRAPOL terminal, in order to avoid worsening of the current end-user status it is necessary to be able to introduce the programmable device without introducing a third terminal.

Therefore, in the Hand-Held prototype of the enhanced ISITEP terminal the TETRA modem is embedded in a Customized Smart Device, while the TETRAPOL modem is connected to the smart device using a USB cable.

Audio devices are independent: the TETRAPOL modem exploits its own audio devices while the TETRA modem exploits the audio devices of the smart device.

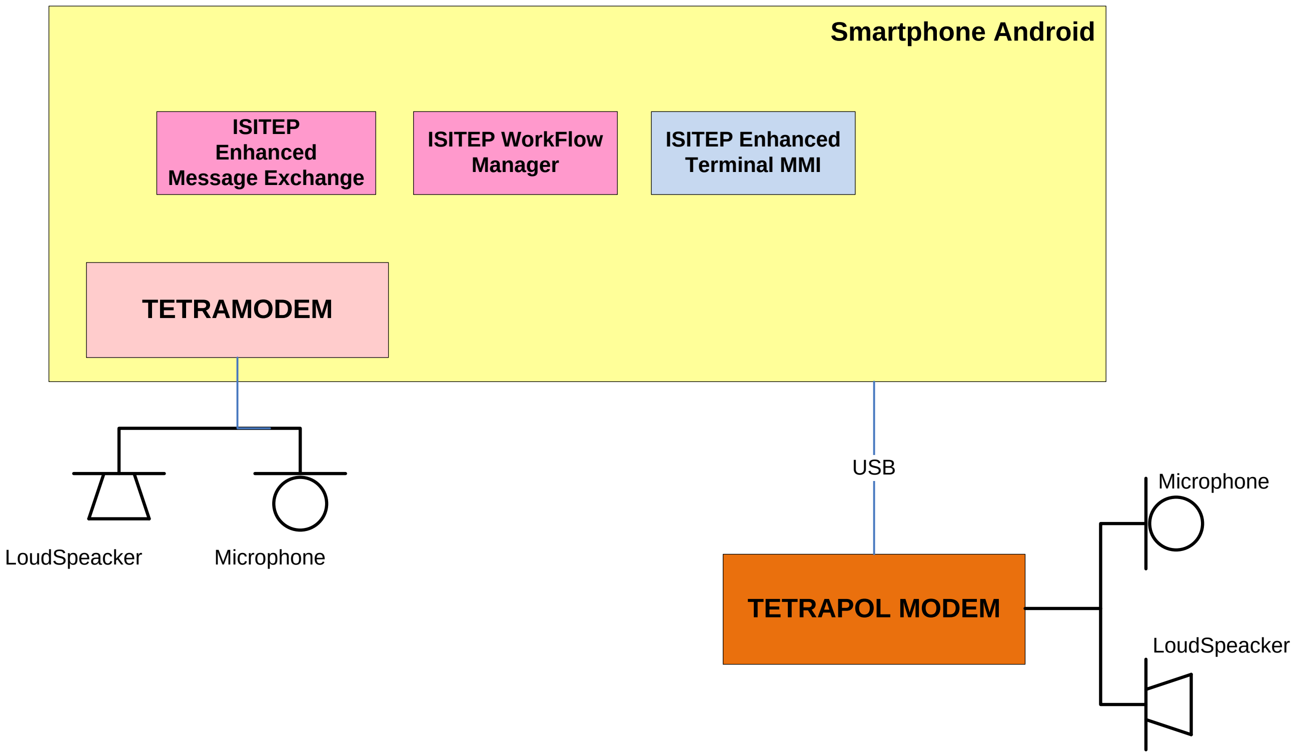


**Figure 1: ISITEP enhanced hand-held terminal**

#### 4.1.1.1 TETRA modem

FNM-LDO has realized a new TETRA Hand-Held where a TETRA modem is embedded in an Android Device. The new FNM-LDO Hand Held prototype provides touch interface to the Android Device and has the same physical usability provided by a typical professional radio:

- there is a knob to change and select the group
- there is the red button for the emergency
- there is the PTT button
- there is a button to make speech calls
- there is a button to close speech calls
- there are also other customizable functional buttons that can be used to callback other TETRA functions like the Short Data Service, or to run an external application selected by the user.


**Figure 2 FNM TETRA radio with embedded Android device.**

The TETRA modem provides all the TETRA features described in par. 3.1.

The Android platform provides the possibility to deploy additional added value services, for the ISITEP project in the Android Platform will be deployed the following functions:

- Workflow Manager, this function is detailed in WP 5.4 deliverables.
- Semantic And Syntactic Translator, this function is detailed in WP 5.5 deliverables.
- Enhanced Message Exchange, this function is detailed in WP 6.4 and WP 6.5 deliverables.
- Location dependent addressing, this function is detailed in WP 6.4 and WP 6.5 deliverables.
- Dynamic Functional Number, this function is detailed in WP 6.4 and WP 6.5 deliverables.

The Android release used is greater than 4.3.

#### 4.1.1.2 TETRAPOL modem

The TETRAPOL modem is the TETRAPOL Hand Held TPH 900 provided by Airbus.

### 4.1.2 Vehicular deployment

In the vehicular solution, the TETRA and the TETRAPOL terminals are deployed inside a car and the requirement of having up to two terminals is not mandatory. Inside a car, the vehicular terminals are fixed and the physical integration is facilitated because more space is available.

Therefore in the Vehicular solution both TETRA and TETRAPOL modem are external to the smart device (tablet).

The TETRA modem is connected via WiFi to the tablet and the TETRAPOL modem is connected to the tablet using USB.

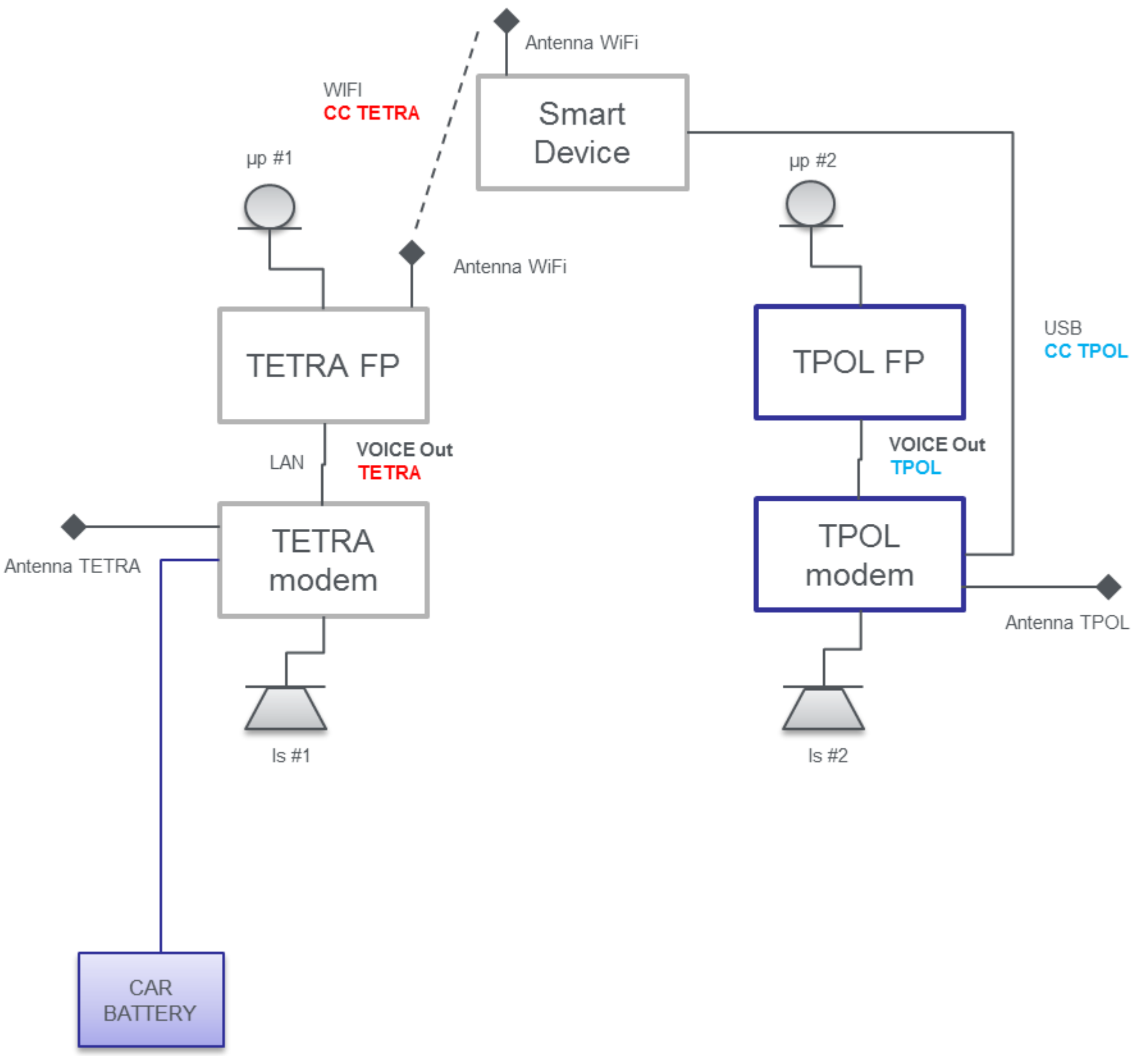


Figure 3 ISITEP enhanced vehicular terminal

Smart device: Commercial Samsung Smartphone Galaxy S4 with Android release is greater or equal than 4.3

TETRA Modem: FNM-LDO TETRA Vehicular VS4000

TETRA FP: FINM TETRA Vehicular Front Panel FPG3+, this is an audio device that provides the connectivity to the Smart Device (WiFi) and to the TETRA audio accessories: microphone and HW PTT.

TPOL Modem: Airbus FR TETRAPOL vehicular TPH900

TPOL FP: Airbus FR TETRAPOL Front Pant, this is an audio device that provides the connectivity to the TETRAPOL audio accessories: microphone and HW PTT.

Each modem uses its own audio accessories. The TETRA modem is connected to the battery of the car while the TETRAPOL modem uses its own battery.

In order to reduce interferences between TETRA and TETRAPOL two antennas will be deployed on the car.

#### 4.1.2.1 Future evolutions

A future evolution could be the possibility to share the microphone and the HW PTT between the TETRA and the TETRAPOL radio.

This could be realized implementing an audio matrix inside the FINM Audio Device FPG3+.

The ACM App is aware of the status of the TETRA and of TETRAPOL Apps and could command the proper configuration of the Audio Matrix in order to automatically move the microphone from TETRA to TETRAPOL and vice-versa.

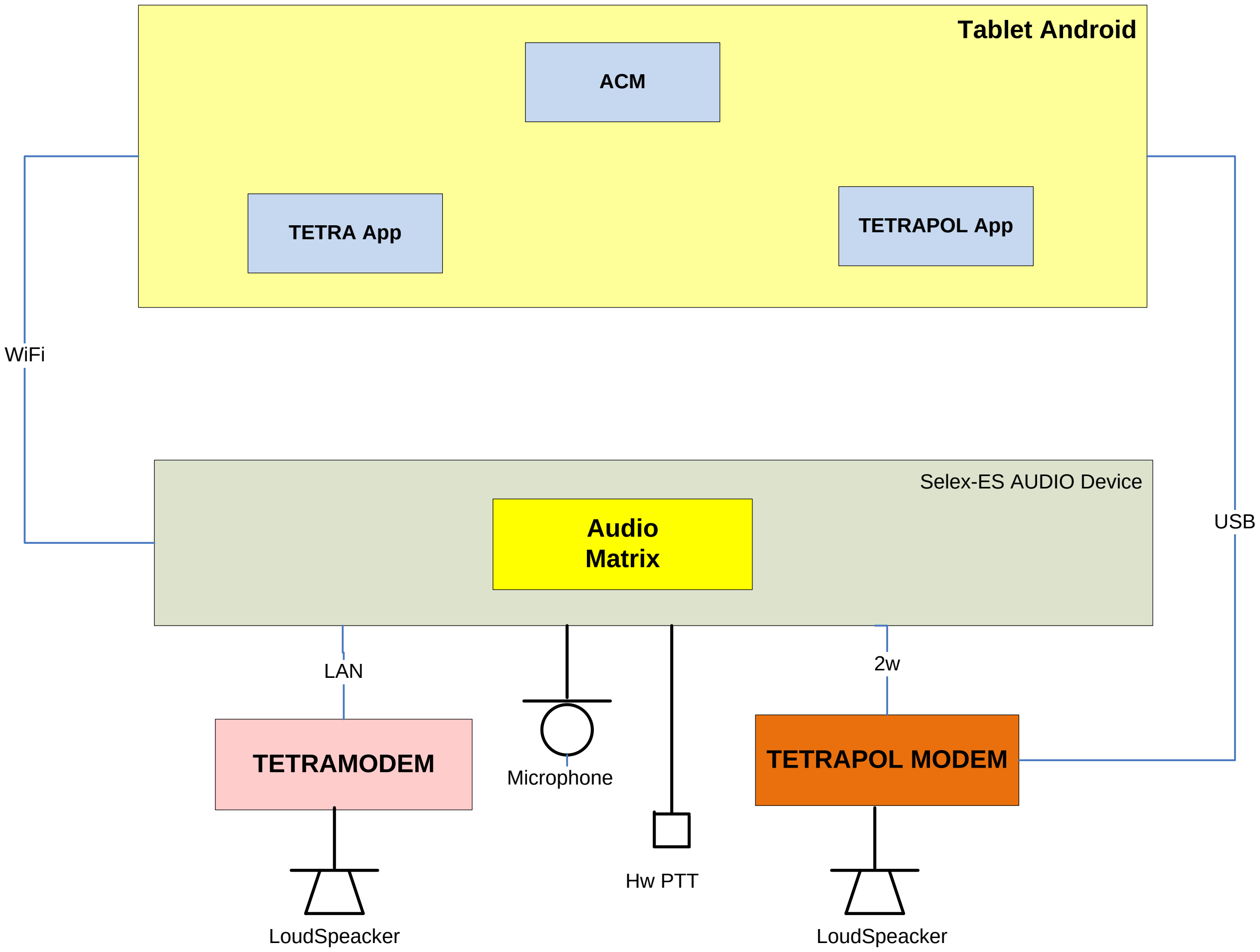


**Figure 4 ISITEP enhanced vehicular terminal – future evolution**

#### 4.1.2.2 TETRA vehicular

The TETRA vehicular provided by FNM-LDO for the ISITEP enhanced terminal is the VS4000. The VS4000 is a vehicular TETRA radio unit that can be combined with a user-friendly front panel FPG3+, that allow to control audio devices and extend the VS4000 physical interfaces

FNM-LDO VS4000 key characteristics for the ISITEP project are:

- TETRA air interface
- Authentication
- Air Interface Encryption
- Embedded GPS positioning and TETRA standard LIP protocol support
- PEI over LAN
- WiFi interface (in FPG3+)

The WiFi interface provided by the FPG3+ is used to remote the VS4000 HMI on the Samsung Smartphone S4.

In the following figure it has been represented the VS4000 with its accessories:


#### 4.1.2.3 TETRAPOL vehicular

The Tetrapol vehicular configuration solution proposed for the ISITEP project is based on the Tetrapol Handled.

Solution is:

- to connect the Tetrapol Handled to Leonardo Company Audio device thanks to a dedicated cable
- to connect the Tetrapol Handled to the Android device through USB cable

The Leonardo Company Audio device in the future will enable to have one Push to talk and microphone for both TETRA and TETRAPOL device. For the ISITEP project the PTT and microphone for the TETRAPOL device will be realized through a dedicated audio kit.

All features available in the ISITEP Handled configuration could also be available in vehicular configuration.

# 5 SOFTWARE DESIGN DESCRIPTION

In the current chapter it is described the software architecture realized on the Android device to realize the goals of the ISITEP enhanced terminals; as explained in the introduction the TETRA and TETRAPOL modems are black box with a set of features, therefore no details on SW architecture of modems is provided.

The SW architecture of the Android device is the same both for the Hand-Held and for the Vehicular solution.

Two options have been evaluated for the SW architecture of the ISITEP enhanced terminal:

The first option considered was the classical PC-oriented structure on the bottom of this SW architecture there is the adaptation and communication manager that interfaces the TETRA and the TETRAPOL modems and on the top of this SW architecture there is the HMI. This is a SW architecture that requires a tight integration between the involved SW components without the possibility of reusing what have been already experienced by FNM-LDO and by Airbus in the past years.

This option requires an ad hoc development of each PPDR feature exported by the enhanced ISITEP terminal exposing the enhanced ISITEP terminal to the risk of a reduced functional coverage for the final ISITEP demonstrations.

The second option takes more advantages of the innovative technology offered by Android platform, the different SW components deployed inside the ISITEP enhanced terminal independent Android Application allowing a high level integration of the different SW components. Each Android App can be independently developed and the integration between them is guided by the Android framework.

The first option provides the advantage of having a unique HMI for PPDR services on the Android device, but only a small subset of PPDR services could be provided in time to ISITEP project deadlines. On the contrary with the second option the TETRA and the TETRAPOL HMI coexist and provide the full set of TETRA services under the TETRA coverage and the full set of TETRAPOL services under the TETRAPOL coverage; in the ISITEP enhanced hand-held version it is also possible to configure the same use of HW buttons (i.e. knob, emergency, PTT etc.) in both TETRA and TETRAPOL case.

The main observation that led us to choose the second option is that a general professional radio has for the 90% the same kind of usage: group calls, PTT, group/channel selection (via knob), emergency button, therefore even if on the Android device there are two different HMI this could not be perceived in the 90% of cases by the end-user if the two HMI use in the same way the HW buttons (i.e. knob, emergency, PTT etc.) provided by the ISITEP enhanced hand-held.

Moreover the second option is less risky because:

- FNM-LDO and Airbus are able to fully exploit their experience in PPDR terminals development.
- A soft integration is required between the different SW components deployed inside the enhanced ISITEP terminal and joint development is not required.

In the following paragraph it will be described only the selected SW architecture.

## 5.1 Software Architecture

The SW architecture has been re-designed considering FNM-LDO and Airbus expertise and considering the capability of the Android technology of decoupling SW components through the Android Framework realized for the Applications.

FNM-LDO provides a TETRA Application that is able to interface the TETRA modem using TETRA PEI interface. Airbus provides a TETRAPOL Application that is able to interface the TETRAPOL modem terminating the MPAP and DTAP protocols. TETRA App and TETRAPOL App provides a different Graphic User Interface on the touch screen, but the same physical interaction with the enhanced ISITEP terminal could be realized on the Hand Held for the main PPDR functions: group selection and PTT.

The TETRA App is able to provide all the TETRA services in the TETRA network and TETRAPOL App is able to provide all TETRAPOL services in the TETRAPOL network.

The interoperability applications (Work Flow Manager and Semantic and Syntactic Translator) and the cloud added value applications (Dynamic Functional Number, Location Dependent Addressing and Enhanced Message Exchange), briefly, ISITEP Added-Value Apps in the following, exchange data with the remote servers using SDS offered by TETRA and TETRAPOL networks.

Communication Manager that manages the access to the TETRA/TETRAPOL App solving concurrency issues due to TETRA and TETRAPOL coverage overlapping. Moreover, it offers an HMI that allows the end-user to set the Manual or Automatic handover.

The TETRA App and the TETRAPOL App are able to export on the Android Broadcast BUS a common intent interface SDS App IF to send message across the TETRA or the TETRAPOL air interface, SDS App IF abstracts the radio interfaces (TETRA and the TETRAPOL) toward the ISITEP Added-Value applications.

The same SW architecture is used on the ISITEP Hand-Held and on Vehicular prototypes. In the following figure it has been represented the SW architecture of the ISITEP enhanced terminal.

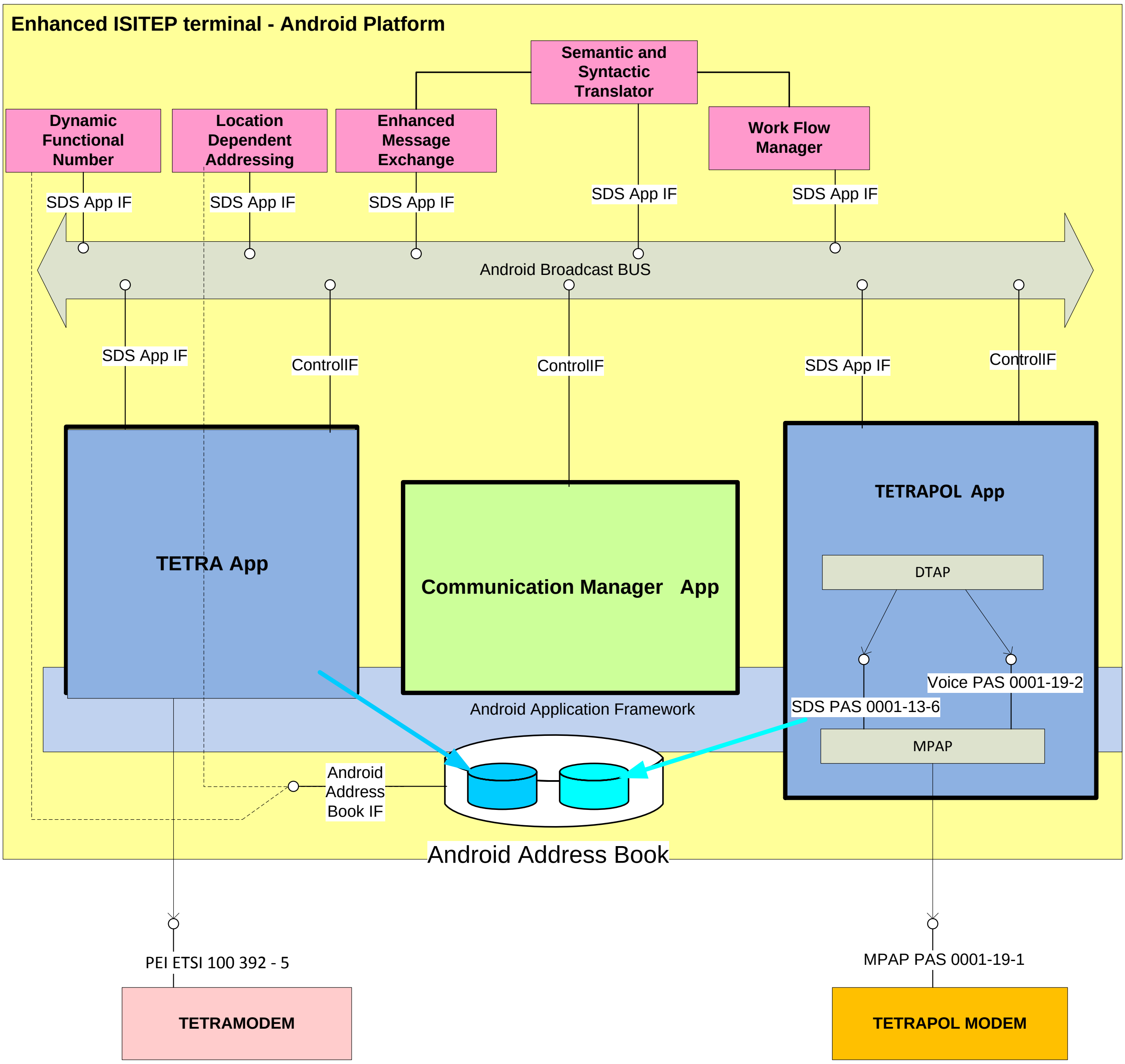


**Figure 5 ISITEP enhanced terminal SW architecture second option – Vehicular solution**

In order to realize such architecture it is necessary

- Developing the Communication Manager App in order to integrate the TETRA and the TETRAPOL App in the same platform.
- Adapting the existing TETRA App and the TETRAPOL App in order to enable these applications to be managed by the Communication Manager App and to provide SDS App IF toward the ISITEP Added-Value Apps.
- Developing ISITEP Added-Value Apps

The second option provides two different Graphic User Interfaces (presentation logic) to the end-user the TETRA GUI and the TETRAPOL GUI. Anyway this option is open to provide the same HW HMI to the end-user indeed the Android Platform of the ISITEP enhanced terminal could provide to the end-user the same PTT button and the same rotary knob to select the group..

The main advantage of this option is that all the TETRA and TETRAPOL services are available in TETRA and in TETRAPOL network and just a high level integration between the different applications is required. Therefore, efforts and developments are decoupled reducing the risks in the product finalization.

### 5.1.1 SW components

In the enhanced terminal, the following software components are implemented:

- The TETRA App, is able to provide all the TETRA services in the TETRA network, defined in
- The TETRAPOL App is able to provide all TETRAPOL services in the TETRAPOL network.
- The Work Flow Manager App, that allows the communication between the user on the field and the Control Room. It uses the TETRA and TETRAPOL communication channels to exchange messages. It has been defined in D5.4.2[5]
- The Communication Manager App for managing the access to the TETRA/ TETRAPOL App solving concurrency issues due to TETRA and TETRAPOL coverage overlapping, defined in D5.2.2[3]
- The User Interface and BL Manager for managing the device logic, for acting as an interface among Applications/Services, Workflow Manager, Security Manager and the Semantic/Syntactic Translator and for adapting the user interface between TETRA and TETRAPOL systems.
- The Semantic and Syntactic Translator for semantically and syntactically translating messages, as defined in D 5.5.3[6]
- The Dynamic Functional Numbering for allowing the communication with PPDR resources in charge in a specific operational area, as defined in D 6.4.2[8]
- The Location assisted numbering for allowing the call of PPDR resources of a specific type in a specific area, as defined in D 6.4.2[8]
- The Enhanced message exchange application for allowing the exchange of orders through short messages, as defined in D 6.4.2[8]

### 5.1.2 Interfaces

In the open architecture the following interface are involved:

1. The ControlIF: This interface supports Communication Manager App managing the infrastructures (TETRA and TETRAPOL) availability. This interface is detailed described in the ISITEP D 5.2.2 [3].
2. The SDS App IF: This interface supports ISITEP Added-Value applications providing an un-reliable data transport layer based on short data service provided by the TETRA and by the TETRAPOL modem. This interface is detailed the ISITEP document D5.6.2 [7].

3. Android Address Book If: interface exported by Android Address Book. This interface is described in details in the deliverable D6.4.2 [8].

The description of the interface exported by the TETRA modem is provided in document PEI ETSI 100 392-5, and the description of the interface exported by the TETRAPOL modem is provided in the following documents PAS 0001-19-1, PAS 0001-19-2, PAS 0001-13-6.

## 5.2 Security

Both TETRA and TETRAPOL standard provides security mechanism to provide verification of identities, confidentiality and integrity. Security features like Authentication, Air Interface Encryption, End to End Encryption, Enable and Disable have been fully described in deliverable D2.2.3 [2].

Authentication and Encryption are addressed by each modem, for security reason no external access to these security mechanisms is provided.

The ISITEP enhanced terminal addresses security of the Android smart device, see par. 6.2 of the current document.

# 6 ANDROID PLATFORM

As described in the previous chapters, the SW components deployed inside the enhanced terminal are Android App. Android Operating System provides a framework enabling Apps to coexist and to communicate each other using a broadcast mechanism. Furthermore, the Android framework allows high-level integration between Apps are completely decoupled from each other.

## 6.1 Android Framework

### 6.1.1 Android App

All the ISITEP applications are Android App. In the Android App, there are the following components:

- An *Activity* represents a single screen with a user interface
- A *Service* is a component that runs in the background to perform long-running operations or to perform work for remote processes.
- A *Broadcast Receiver* is a component that responds to system-wide broadcast announcements.

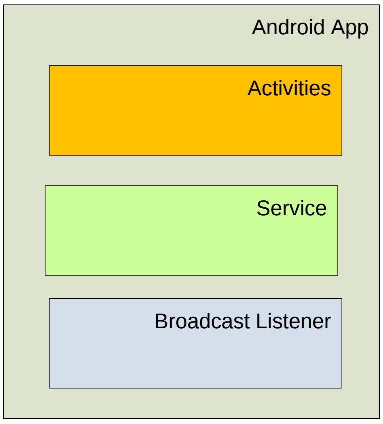


**Figure** Errore. Nel documento non esiste testo dello stile specificato.**6: Android App structure**

The interaction between ISITEP App follows the usual Android App interaction scheme.

It is possible to use one App a time. Different mechanisms are available for the user for switching among Apps:

- By using the Home button the user puts the current App in “background” and is able to activate another App clicking on the related icon.
- An external and uncontrolled event (i.e. incoming call) recall the TETRA or TETRAPOL App, the current App is put in “background” and the new App is started in “foreground”. When the call ends the user is able to recall from the android toolbar the App he was working on previously.

It is the Android framework that helps the application to save their status, data when they go in “background”.

### 6.1.2 Content Provider

A content provider manages access to a central repository of data. A provider is part of an Android application, which provides its own UI for working with the data [16].

### 6.1.3 Broadcast Intent

An Intent is a messaging object you can use to request an action from another app component.

With Intents is possible to:

- to start an activity;
- to start a service;
- to deliver a broadcast.

"A broadcast is a message that any app can receive. The system delivers various broadcasts for system events, such as when the system boots up or the device starts charging. You can deliver a broadcast to other apps by passing an Intent to sendBroadcast()".

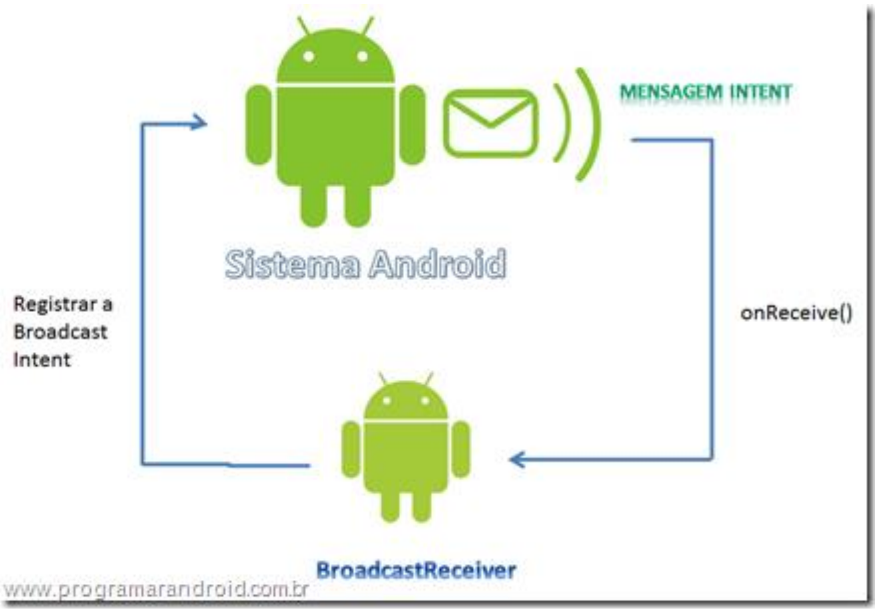


**Figure 7 Android broadcast**

### 6.1.4 Event Listeners

An event listener is an interface in the View class that contains a single callback method. The Android framework will call these methods when the View to which the listener has been registered is triggered by user interaction with the item in the UI [15].

## 6.2 Android Security

A detailed analysis of the security aspects of an Android based device is reported in D5.3.2. In the following, for sake of clarity, the main features are reported.

Once installed on a device, each Android app lives in its own security sandbox:

- The Android operating system is a modified version of the multi-user Linux system in which each app is a different user.
- Linux makes use of a discretionary access control model, based on permissions. Each user, identified by a user ID, is the owner of his resources and can therefore grant privileges. Furthermore, the user can be member of groups used for mapping organization layers in the system access-control mechanism. These groups are identified by means of a group ID.
- To enforce isolation, the system assigns each App a unique Linux user ID (the ID is used only by the system and is unknown to the app). The system sets permissions for all the files in an app so that only the user ID assigned to that app can access them. In this way, it is possible to deal with applications as if they are users, denying access to files and resources that are not within its authorization level.
- Each process has its own virtual machine (VM), so an app's code runs in isolation from other apps.
- By default, every app runs in its own Linux process. Android starts the process when any of the app's components need to be executed, then shuts down the process when it is no longer needed or when the system must recover memory for other apps.

In this way, the Android system implements the principle of “least privilege”. That is, each app, by default, has access only to the components that it requires to do its work and no more. This creates a very secure environment in which an app cannot access parts of the system for which permission is denied.

Permissions in Android grant the access to high-level device functionalities, such as Internet access or camera usage. The fabric set of permissions can be modified and/or extended by manufacturers and application developers.

Permissions are organized in four classes, according to the security impact of the capability requested. The four classes are: *normal permissions* (considered harmless for the system, therefore granted without further controls), *dangerous permissions* (requiring user approval to be granted), *signature permissions* (granted only if the requesting application has the same), and *SignatureOrSystem permissions* (granted only to applications in the Android system or signed with the same certificate as the application declaring the permission).

Permissions must be accepted when the application is installed. Permission denial requires uninstalling the application.

The permission system together with application isolation are the core of the Android sandboxing.

The device administration framework can be useful to enforce security measures on the system, although it is not directly part of the system. The framework is composed by a set of API and programming facilities that allow the definition of system administrators, that are entities used to enforce high level policies to the user.

ISITEP Apps are designed to exploit as much as possible the native security mechanisms of Android, implementing further mechanisms for improving the security of the framework as described in [4]

# 7 REFERENCES

[1] D 5.1.1 Enhanced Terminal Requirements
[2] D 2.2.3 Final Security Requirements
[3] D 5.2.2 Adaptation / Communication Manager Design Description
[4] D 5.3.2 Security Manager Design Description
[5] D 5.4.2 Workflow Manager Design Description
[6] D 5.5.3 Semantic/syntactic translator engine design description
[7] D 5.6.2 User Interface and Business Logic Manager Design Description
[8] D 6.4.2 PPDR Terminal Application Design Description
[9] ETSI-TS 300 392-5 V2.2.1 - TETRA – Voice Plus Data (V+D) and Direct Mode Operation (DMO) – Part 5: Peripheral Equipment Interface (PEI).
[10] ETSI-EN 300 392-2 V3.4.1 – TETRA – Voice Plus Data (V+D) and Direct Mode Operation (DMO) – Part 2: Air Interface (AI)
[11] PAS 0001-13-6 V1.1.5 – TETRAPOL Specifications – Part 13: UDT and ST interface – Part 6: UDT-ST open interface for “type 2” UDT
[12] PAS 0001-19-1 V1.0.6 – TETRAPOL Specifications – Part 19: Stand Alone Dispatch Position Interface – Part1: Stand Alone Dispatch Position Interface
[13] PAS 0001-19-2 V2.0.0 – TETRAPOL Specifications - Part 19: Stand Alone Dispatch Position Interface – Part2: System Terminal Control Protocol.
[14] http://developer.android.com/guide/components/fundamentals.html
[15] http://developer.android.com/guide/topics/ui/ui-events.html
[16] https://developer.android.com/guide/topics/providers/content-providers.html