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317959
Mobile Opportunistic Traffic Offloading

D6.2.2– Standardization and communication activity report (release b) (public)

SEVENTH FRAMEWORK PROGRAMME

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Executive Summary

This document details the standardization activities carried out in the MOTO project.

Along the document, an introduction, where the importance of standardization is exposed, is provided. Afterwards, the standardization strategy followed by the MOTO project is showed. An iterative process was followed, encompassing: standardization potential contributions gathering and subsequent guidance was defined as key enabler to maximize the results of the standardization efforts.

The document then describes the main contribution of the project to standardization. The ProSe standard of 3GPP is described and the contribution of the MOTO achievements to moulding the future standard is exposed.

After this, the document outlines the main standards used during the project to shape the developments and the reasons why these standards have been useful. The main standards used are related to the integration of different communication technologies, the provisioning of vehicular communications and security features.

Finally, the overall standardization activities are analysed in the shape of conclusions, where the standardization activities of MOTO are defended as a success.

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1 OVERVIEW

1.1 Introduction

One of the main issues when coming to introduce a development into industry is its compatibility and interoperability. Proprietary developments usually cannot be adopted by other vendors, sometimes because of property rights, and other times because most of the big players in the industry have their own interests and opinion about how things should be done. Therefore, in MOTO, standardization is a driving force for a future adoption of the results of the project by both, operators and users, of mobile communication technologies.

In this sense, the main goal of standardization is to overcome the compatibility and interoperability problems that may arise among devices made by different providers with the same general function. For example, standardization can help with eventual issues derived from the use of different vendor's mobile devices in order to access MOTO services.

Standardization is an activity based on the consecution of a consensus between all the interested parties. Its foundations are the openness and transparency of their procedures and the involvement of independent organizations, with the objective of achieving the voluntary adoption of, and compliance with, the standards developed. The Openness of standardization means that MOTO partners are able to participate in standardization initiatives (some are already involved in some of them) and this way help in future MOTO adoption by stakeholders.

Apart from industrial adoption of standard defined technologies, standardization activities go beyond the industry range, as many times its effect can be directly visible in areas of public concern, as competiveness of industry, or indirectly in job generation, new training or knowledge requirements for entrepreneurs and workers, etc. Thus, MOTO standardization activities can help with the industrial adoption of project results and have a significant effect in a wider audience.

Additionally, standardization can have an effect at the removal of commercial barriers through harmonization, which is also interesting for MOTO partners.

This is why, when public entities define regulatory policies, standardization is taken into consideration.

There are three main groups of stakeholders that will be targeted with MOTO standardization activities as they can be considered as the primary beneficiaries of standardization processes: industry, consumers and governments.

Related to MOTO dissemination efforts, standardization may strongly facilitate the dissemination and upgrading of project results, and will provide MOTO the access to a large pool of external expertise. In this sense, MOTO partner's involvement in standardization initiatives could foster higher international recognition and future chances for collaboration to the project partners.

This document, corresponds to the final release of the deliverable D6.2.1 – Standardization and communication activity report (release b), over which the activities done related to standardization by the MOTO project are exposed.

2 MOTO's Strategy for Standardization

Throughout the next sections, a detailed description of the MOTO standardization roadmap is provided. This description will encompass the detail of the strategy that has been accomplished, and all the necessary steps that have been followed in order to assure that the efforts made to contribute to the developments of standards based on the achievements of the project are maximized.

2.1 Objectives

Task T6.2 has the following objective:

Collecting and selecting the material that the project partners could contribute to the various standardization forums

Accordingly to this objective, the MOTO standardization strategy objective has been to **assure that partners efforts made to achieve the contribution to a standard are effective**.

Consequently, task 6.2 has the following additional sub-objectives:

- Draw an updated picture of the current standardization scheme, including: standardizations bodies, active working groups, how the creation of the different standards is achieved and the methods available to participate, as a guide to facilitate potential standardization targets **(already covered in D6.2.1)**
- Keep track of the MOTO project achievements and developments.
- Identify the most interesting standardization targets for the MOTO achievements/developments, in accordance with the MOTO partner's interests.
- Assist MOTO partners in the process of contributing to a standard.

2.2 Overall Strategy

In order to achieve the objectives outlined in the previous section, an iterative strategy was defined for the MOTO standardization strategy. The process carried out consisted of the following phases:

1. Analysis of current standardization scheme, identifying the most interesting active working groups and preparing a summarized guide to help partners in their standardization contributions attempts.
2. Recollect the achievements and developments of the different partners, using effective tools and a well-defined schedule.
3. Analysis of received information about the achievements/developments made by the partners and identification of those suitable to contribute to standardization.
4. Coordination and supporting the partners in their contribution to the standards selected.

Innovalia as the task coordinator, assumed the overall coordination of the contribution of the partners, and was responsible for the analysis of the project achievements respecting the contribution to standards and the needed support.

Bellow, a visual description of the proposed strategy is given:

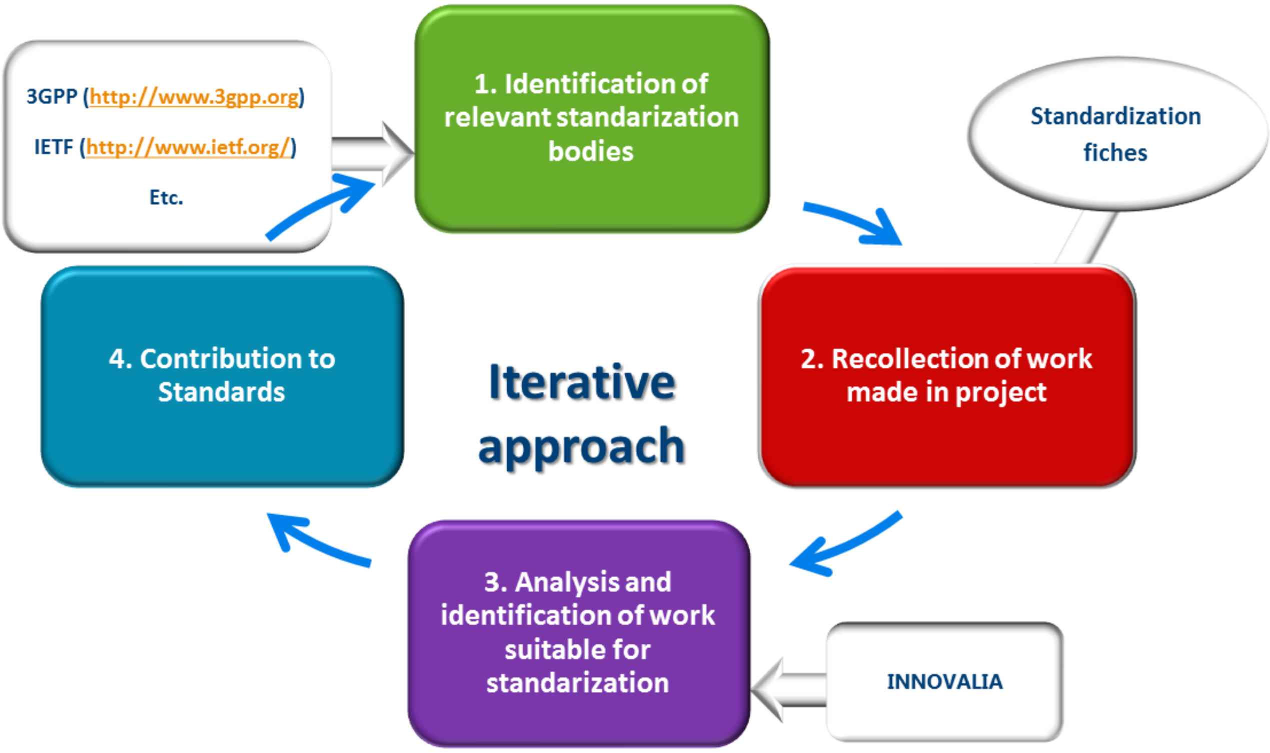


Figure 1. MOTO's standardization strategy

2.2.1 Work definition

In order to achieve the defined objectives, several sub-steps were defined for each of the phases in the breakdown of the overall strategy. These sub-steps were:

1. **Identification of relevant organization bodies:**
    - Use of websites of the different standardization bodies, such as: 3GPP (www.3gpp.org), IETF (www.ietf.org), ITU (https://www.itu.int/), etc. and other available resources to identify the most interesting standardization initiatives for MOTO. The idea was not to target all of the identified standardizations initiatives, but to have a basic catalogue that served to find possible synergies between the work being developed in the project and the running standardization work.
    - Analysis of methods to participate and contribute. This step aimed to facilitate the process for the partners once identified a particular standardization initiative they can contribute to. The work done in this sub-step, facilitated partner's rapprochement to the standardization working groups, avoiding the need to search for the methods to contribute by themselves.
    - Monitoring of advancements and progress made by identified working groups. The standardization ecosystem is continuously evolving and initiatives are being created, dropped or finalized, therefore, the interesting working groups for MOTO were subject to changes based on the direction of the work they take. This sub-step aimed to keep up to date the list of interesting standardization targets.
2. **Recollection of the work made in project**
    - Definition of unified fiches for recollection of progress made by partners. In order to effectively collect the achievements/developments made by the project partners, this step

encompassed the definition of a fiche that serves to homogenize the information received by the partners.

- Schedule of reception dates. This sub-step is aimed to define the schedule of all he process for the delivery and the subsequent reception of the standardization fiches.

3. **Analysis and identification of work suitable for standardization**

   - This sub-step is aimed to take out the analysis of the achievements made by the project members, and discuss whether they are suitable or not for standardization contribution. This sub-step will also encompass the interview of the partner who has sent the information if there is any doubt about the explanation given in the standardization fiche.

4. **Contribution to standards**

   - Development of a methodology to participate in selected working groups. Once a project achievement/development is identified as suitable to contribute to standardization, a methodology to attempt the actual contribution will be made. This will include the definition of the steps to be taken, the identification of the key persons in the standardization working group, the detailed analysis of the work process followed by the working group, etc.
   - Monitoring the participation of partners in the selected working groups. This sub-step is aimed to follow-up the involvement of the partners to the standardization, their assistance to conference, their active participation in discussions, etc.
   - Collection of the achievements and contributions made by partners in the standards. In this sub-step, the achievements and contributions made by the partners will be collected in a centralized database, in order to facilitate an updated picture of the standardizations achievements at any time.

In the next section (2.2.2), the schedule of the MOTO's standardization approach is given.

2.2.2 Standardization evolvement Monitoring

In order to keep track of the progress made by individual partners and also to provide support in their standardization attempts, the following schedule was defined. Attending to the iterative strategy approach set by the overall strategy for MOTO (section 2.2), several releases of the standardization fiches were done, after which a reception period was set. After the reception of all the fiches from the project partners, before the stated deadlines, an analysis and identification of work suitable for standardization was performed.

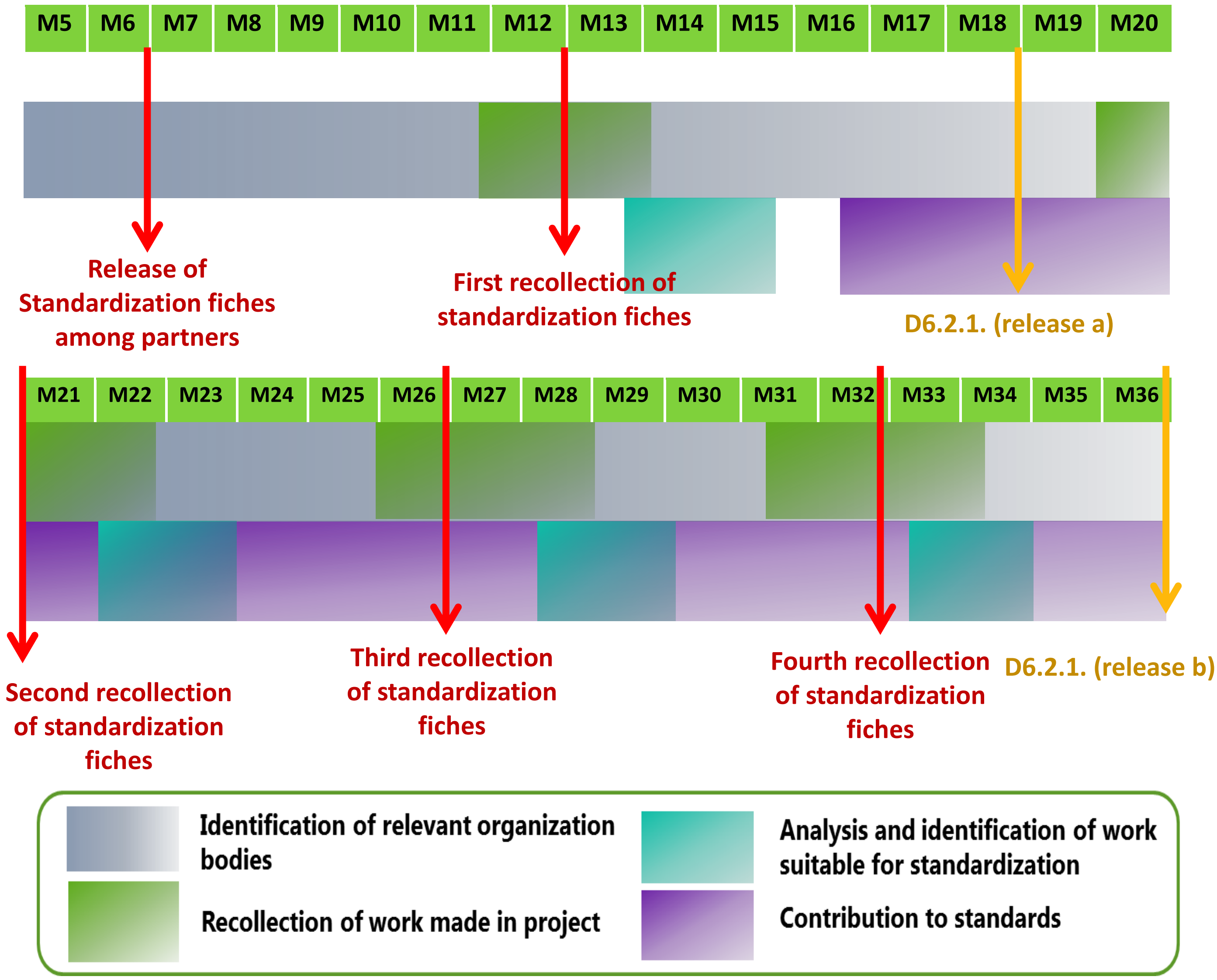


Figure 2. Standardization activities schedule

3 MOTO & ProSe

LTE ProSe represents a fundamentally new concept in cellular communications that lies in strict relationship with the MOTO project. For the first time, the 3GPP considered to allow devices in close proximity to discover each other and to communicate directly. Similarly to the proposal at the base of MOTO, considering direct communications between neighboring users is expected to improve spectrum utilization, overall throughput, and energy consumption, while enabling new peer-to-peer and location-based applications and services. ProSe-enabled devices are also expected to become the de-facto standard for public safety networks, having the ability to function even when cellular networks are unavailable.

ProSe focuses on a set of use cases, meeting the needs of both commercial and public safety mobile networks. ProSe identifies the following as key features*: discovery*, *one-to-one communication* and *one-to-many communication*. Discovery allows users to "discover" other ProSe enabled devices in their neighbourhood. One-to-one communications support the usual data communication service between two users. Finally, one-to-many communications support group data services among users in close locations (especially needed in case of public safety networks). Communications flow on a direct radio link between devices instead of being routed through the cellular infrastructure. Nevertheless, everything is under the network control, either on-line (e.g., by making use of cellular links) or off-line (e.g., through pre-provisioning).

3.1 Overview of the 3GPP standardization process

3.1.1 Overall organization of 3GPP

The highest decision making group in 3GPP is the Project Coordination Group (PCG) that is responsible for the final adoption of 3GPP Work Items (WIs), the election results and the resources commitment. Four Technical Specification Groups (TSGs), which carry out the technical specification, lie below the PCG:

- GERAN (GSM EDGE Radio Access Networks), responsible for the radio access specification of GSM/EDGE.
- RAN (Radio Access Networks), responsible for the definition of the functions, requirements and interfaces of UTRA/E-UTRA network.
- CT (Core Network & Terminals) responsible for specifying terminal interfaces (logical and physical), terminal capabilities (such as execution environments) and the core network part of 3GPP systems.
- SA (Service & Systems Aspects), responsible for the overall architecture and service capabilities of systems based on 3GPP specifications.

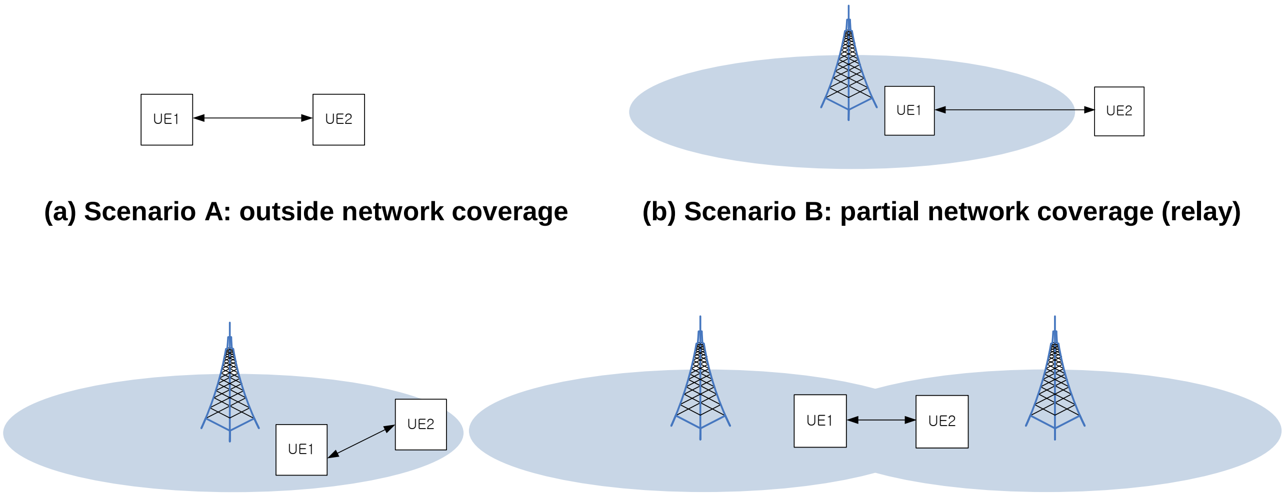
Each TSG is structured in different working groups (WG) with a particular area of expertise.

3.1.2 ProSe Standardization work

Starting in 2011, the initial set of capabilities has been defined for 3GPP Rel-12 for ProSe (frozen in March 2015). However, expected features for Release 13 (expected release in March 2016) propose significant enhancements for both commercial and Public Safety use.
At the time of writing, the work in SA WG1 (service requirements) gave birth to the feasibility study TR 22.803 [1], ended in Rel-12, and to the ongoing specification on service requirements for the EPS (TS 22.278 [2]). The work in SA WG2 (system architecture) ended the feasibility stage in Rel-12 with TR 23.703 [3] compiling all proposed enhancements for system architecture. Protocol analysis is ongoing (TR 23.713 [4]), as well the normative work on architecture (TS 23.303 [5]). SA WG3 is addressing security and privacy for ProSe in the ongoing TS 33.303 [6]. SA6, which is dedicated to mission critical applications, is in charge of

the ongoing studies on the architecture for push-to-talk over LTE (TR 23.779 [7]) and the resulting functional architecture (TS 23.179 [8]).
At radio layer, the work in RAN WG1 (Radio Layer1) ended the feasibility stage in rel-12, proposing physical layer solutions and evaluation models (channel, traffic, mobility) in TR 36.843 [9]. The work in RAN4 (Radio performance and protocol aspects) considered the radio requirements of ProSe terminals in TR 36.877 [10] (frozen in Rel-12). The work in CT WG1 (Non-Access Stratum protocols) is ongoing and considers the protocol aspects (TS 24.334 [11]) and provisioning (TS 24.333 [12]) of terminals.

3.2 ProSe Scenarios



(a) Scenario A: outside network coverage **(b) Scenario B: partial network coverage (relay)**

(c) Scenario C: in network coverage (intra-cell) **(d) Scenario D: in network coverage (intra-cell)**

Figure 3. ProSe D2D Scenarios (from (3GPP, March 2014)).

Figure 3, shows scenarios for D2D ProSe where UE1 and UE2 are out-of-coverage/in-coverage of a cell. Scenarios A and B are exclusive for the public safety scenario, while scenarios C and D (in-coverage) are shared between commercial and public safety. ProSe will consist of two main phases that will be analysed in detail later on. The first phase consists of a discovery of UEs in close proximity to each other. Only then, the direct communication between these UEs can happen with, or without, network supervision.

3.3 PHY and MAC

For 3GPP, the direct over-the-air exchanges between devices can be either based on a new air interface (in-band), or based on existing WLAN air interface (out-of-band). For the in-band air interface, 3GPP agreed on using uplink resources shared with with existing cellular UE devices in either FDD or TDD LTE networks. The motivation behind this choice is that uplink resources are less utilized than downlink resources. In addition, it is easier to fight against uplink interference at the eNodeB, rather than against downlink interference at UEs.

It follows that the waveform used for in-band ProSe transmission is SC-FDMA (single-carrier frequency-division multiple access), already employed in today's LTE uplink transmissions. This choice requires equipping UEs with new SC-FDMA receivers. Compared to an OFDMA transmitter, implementing an SC-FDMA receiver is more complex because single carrier transmission requires complex equalization at the receiver side. On the other hand, an SC-FDMA transmitter has low peak-to-average power ratio (PAPR). ProSe transmissions (from now on called **Sidelink**) will use the same frame structure defined for uplink and downlink when UEs are in network coverage; however, Sidelink transmissions are restricted to a sub-set of the uplink resources in time and frequency domain. Consequently, new logical, transport and physical channels were introduced (Figure 4).

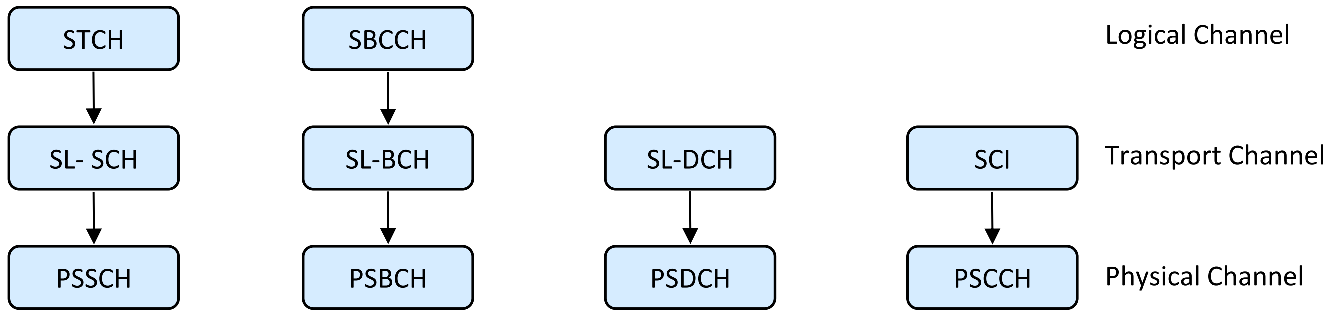


Figure 4: New logical, transport and physical introduced for Sidelink.

The physical channels dedicated to ProSe are:

- **Physical sidelink shared channel (PSSCH)**: carries data from a UE for ProSe Direct Communication
- **Physical sidelink broadcast channel (PSBCH)**: carries system and synchronization related information, transmitted from the UE.
- **Physical sidelink discovery channel (PSDCH)**: carries ProSe discovery message from the UE.
- **Physical sidelink control channel (PSCCH)**: carries control information from a UE for ProSe communication. A transmitting UE sends over the PSCCH a *Sidelink Control Information* block (SCI) that contains control information. UEs interested in receiving ProSe communication scan the whole PSCCH pool to search if an SCI Format 0 matching their group identifier can be detected.

Transport channels are:

- **Sidelink shared channel (SL-SCH)**.
- **Sidelink broadcast channel (SL-BCH)**.
- **Sidelink discovery channel (SL-DCH)**.

Logical Channels are:

- **Sidelink Traffic Channel (STCH)**: a point-to-multipoint channel, for transfer of user information from one UE to other UEs.
- **Sidelink Broadcast Control Channel (SBCCH)**: broadcasts Sidelink system information from one UE to other UE(s).

3.4 Reference Architecture

Figure 5 offers a high-level view of the non-roaming architecture for ProSe when both UEs connect to the same service provider network. 3GPP defined seven new reference points (interfaces) for ProSe. The most important among them are the interface between UEs and the ProSe Function (named PC3) and the interface between the two UEs (named PC5, aka Sidelink), used for control and data planes.

3.4.1 ProSe Function

The ProSe Function is the logical function employed for discovery and communications. The ProSe Function consists of three main sub-functions:

- **Direct Provisioning Function** (DPF), used to provision the UE with all required parameters to use ProSe in the specific network, or with parameters that are needed in case of out-of-coverage service (for Public Safety networks only).
- **Direct Discovery Name Management Function** used to allocate and maps the Application IDs and Application Codes used in direct discovery. It communicates also with HSS for authorisation of each discovery request.

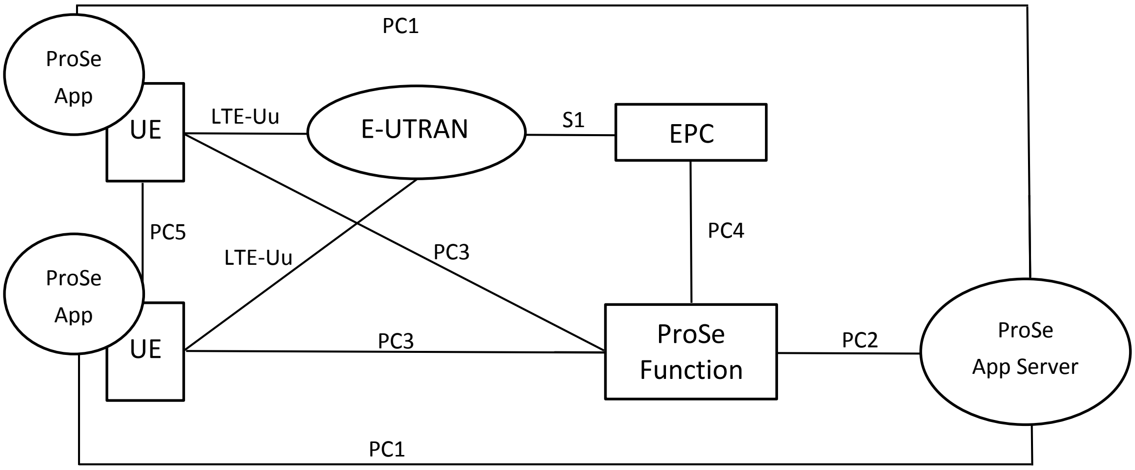


Figure 5: Reference Architecture for ProSe (non-roaming).

- **EPC-level Discovery Function** acts as a location service client (SLP agent) to enable EPC-level discovery and provides the UE with information to assist WLAN discovery and communications. Additionally, it exchanges signalling with external Application servers over the PC2 reference point for discovery.

3.4.2 ProSe Application Server

The ProSe Application Server supports the following capabilities:

- Storage of EPC ProSe User IDs: ProSe Function IDs, ProSe Discovery UE ID and metadata.
- Mapping of Application Layer User IDs and EPC ProSe User IDs.
- Mapping of RPAUID and PDUID for restricted discovery.
- Maintaining permission information for restricted discovery.

3.4.3 UEs

Any ProSe enabled UE supports the following capabilities:

- Exchange of control information with the ProSe Function over PC3 reference point.
- Procedures for open and restricted ProSe Direct Discovery of other ProSe-enabled UEs over PC5 reference point.
- (Public Safety only) Procedures for one-to-many ProSe Direct Communication over PC5 reference point.
- (Public Safety only) Procedures to act as a ProSe UE-to-Network Relay. An out-of-coverage UE communicates with the relay over PC5 interface. The relay UE uses layer-3 packet forwarding.
- Exchange of control information between ProSe UEs over PC5 reference point.
- Exchange of control information between another ProSe-enabled UE and the ProSe Function over PC3 reference point.
- Configuration of parameters (e.g. including IP addresses, ProSe Layer-2 Group IDs, Group security material, radio resource parameters). Parameters can be pre-configured in the UE, or, if in coverage, provisioned by signalling over the PC3 reference point to the ProSe Function in the network.

3.5 Discovery

Device discovery envisioned for ProSe may be broadly categorized into two types: **direct discovery** and **EPC-level discovery**. Direct discovery works for both *in-coverage* and *out-of-coverage* scenarios and does not preclude network assistance when available. In EPC-level discovery, the EPC is in charge of determining the proximity of UEs, and informing a UE to start the discovery procedure. This scheme works only if the UEs are under the coverage of the network, because it requires the network to track UE's location.

3.5.1 Direct Discovery

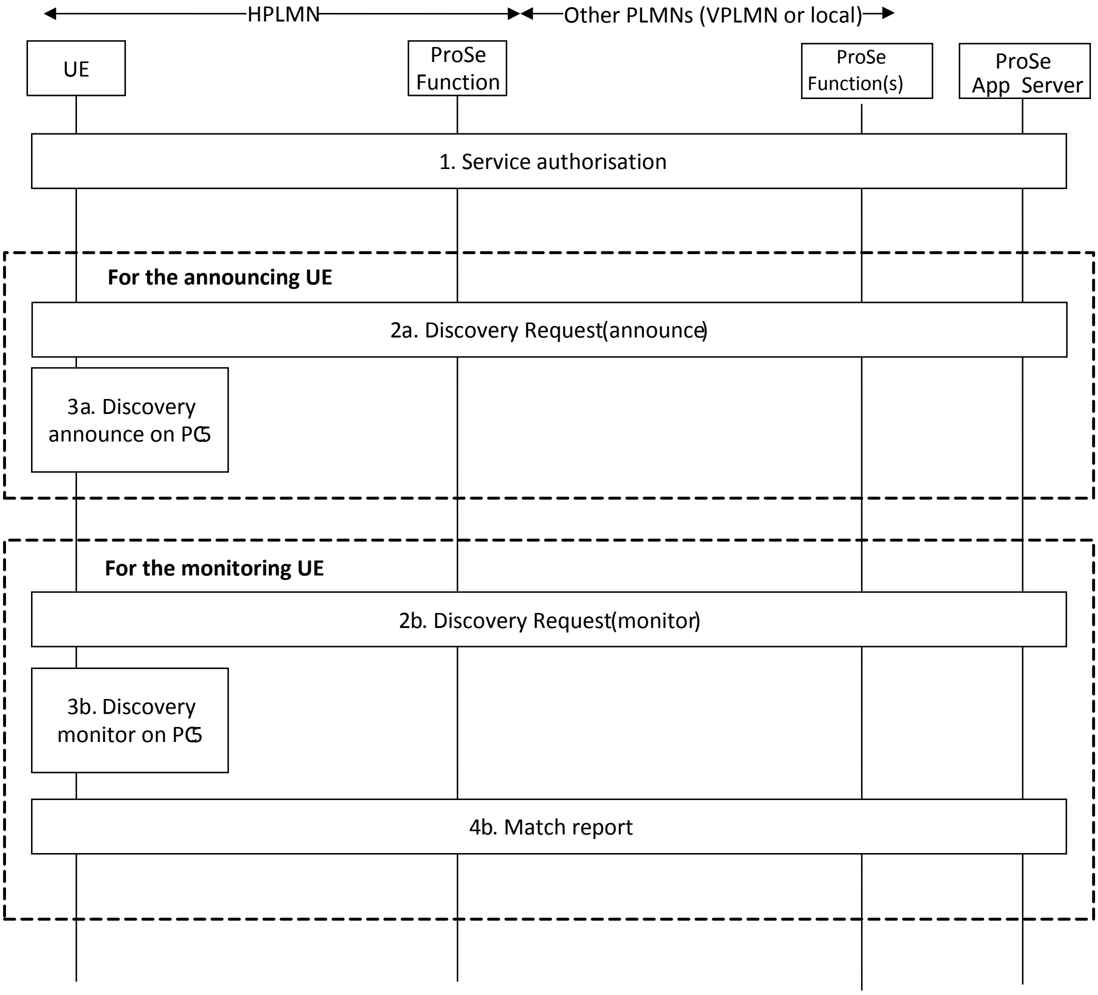


Figure 6: ProSe Direct Discovery procedure for Model-A and *in-coverage* scenario (from [5]).

In the case of network coverage, after being authorized by the network, an UE would search for nearby UE devices autonomously. After a successful discovery request exchange with the ProSe Function on PC3 interface, demanding UE can transmit/receive periodically discovery beacons using direct radio signals on PC5 interface (Sidelink). In the case of network unavailability (e.g., for Public Safety needs), there is no grant from the network, and the UEs start the discovery process using some parameters that are already stored on the device or on the USIM.

Regardless of the coverage scenario, two types of discovery are defined in [5] for direct discovery: *open* and *restricted*. In open discovery, no explicit permission is needed from the UE being discovered to match it. On the other hand, restricted discovery only takes place with the explicit permission from the discovered UE.

Apart from this distinction, 3GPP defined also two possible direct discovery modes:

- **Model A ("I am here"):** where the announcing UE broadcasts certain information that could be used by monitoring UEs in proximity with permission to discover. In *model A*, the announcing UE broadcasts discovery messages at pre-defined intervals and the monitoring UEs that are interested in these messages can read them and process them (Figure 6).

- **Model B ("Who is there? Are you there?"):** where the discoverer UE transmits a request containing certain information about what it is interested to discover. The discovered UE receiving the request message can respond with some information related to the discoverer's request (Figure 7).

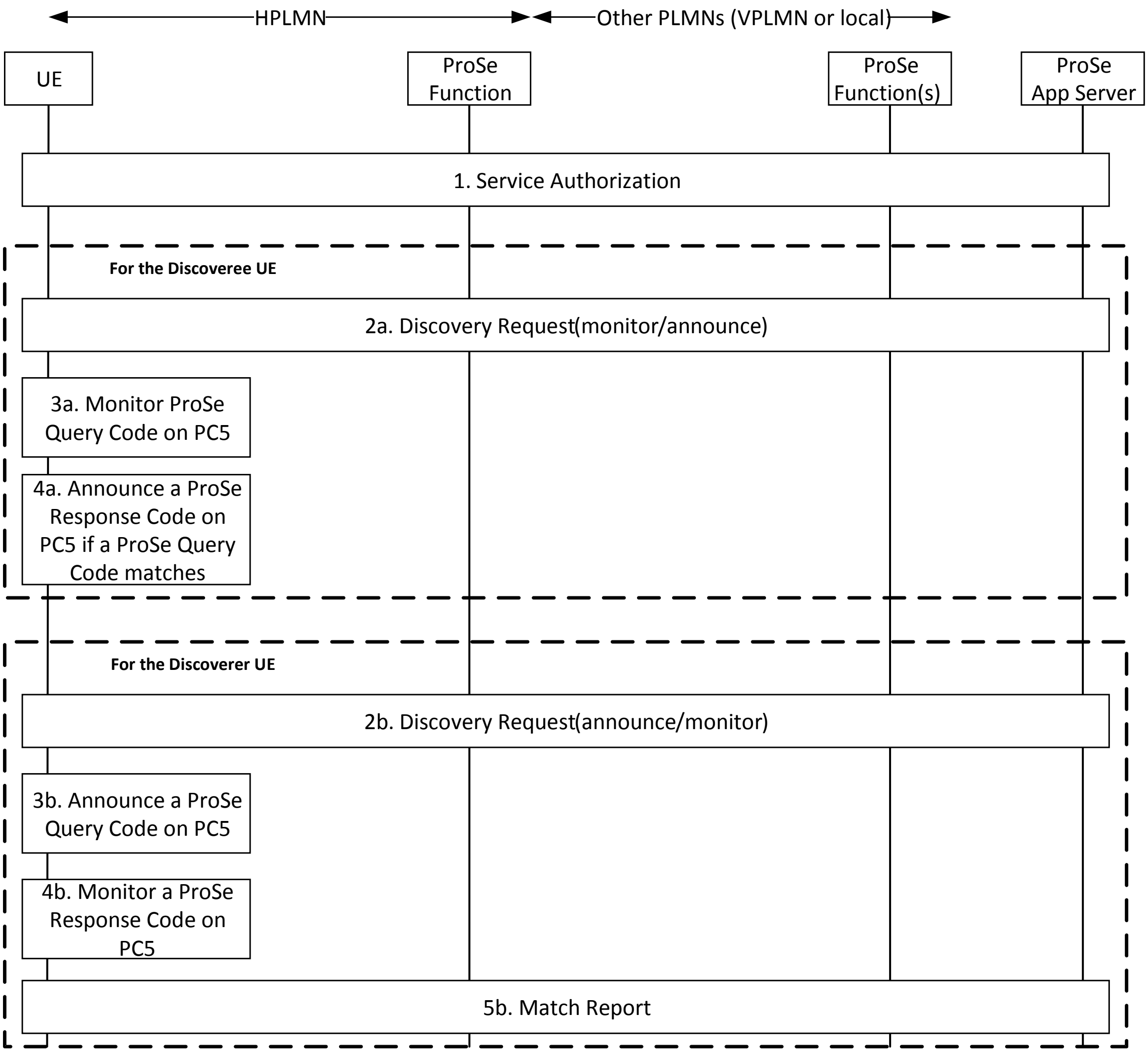


Figure 7: ProSe Direct Discovery procedure for Model-B and the *in-coverage* scenario (from [5])

3.5.2 EPC-level Discovery

In the case of EPC-level discovery, the 3GPP network acts as a trusted intermediary, helping the UEs in the discovery process. The proximity between UEs is inferred from periodic location updates.

In this case, a device (e.g., UE A) interested in detecting proximity has to make an explicit *proximity request* to be alerted for proximity of another UE (e.g., UE B) via a communication with ProSe Function on the PC3 interface. In response, the ProSe Function requests location updates for UE A and UE B. *Location reports* can be periodic, based on a trigger, or a combination of both. The EPC determines the proximity of the two UEs based on the received reports and informs the requesting devices of their proximity, by triggering a *proximity alert* procedure on the interface PC3, offering also the assistance for setting up the communication channel (eventually using a WLAN out-of-band channel).

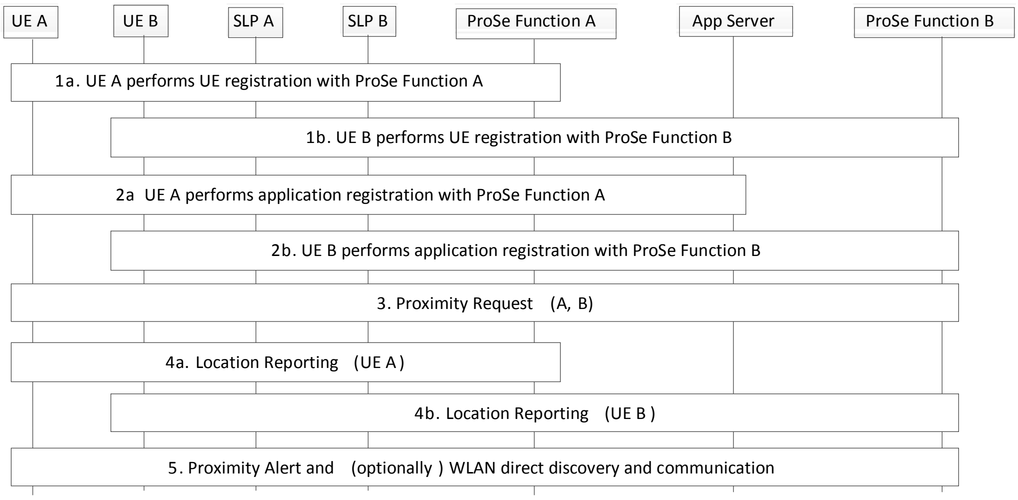


Figure 8: Call flow for EPC-level ProSe Discovery (from [5]).

3.6 Communication

3.6.1 Provisioning

Direct Communication between two UEs in proximity is defined for both the *in-coverage* and the *out-of-coverage* scenarios (for public safety only). In the in-coverage scenario, it is assumed that the device camps on a carrier supporting ProSe communications. Otherwise, the UE needs to perform a cell handover toward a ProSe carrier. In the out-of-coverage scenario, the UE employs predetermined values (stored in the device or on the USIM). All devices wanting to participate in one-to-one or one-to-many communications need to be provisioned with network information. For the in-coverage scenario, the network can perform the provision. Instead, in the out-of-coverage scenario a device could be pre-provisioned with the information stored either in the device or on the USIM.

The following list of parameters is necessary for UE provisioning (either network performed or pre-provisioned):

- PLMN(s) the device is allowed to perform direct communication in when *in-coverage*.
- Information if UE is authorized to perform ProSe communication when *out-of-coverage*.
- ProSe Layer-2 Group ID,
- ProSe Group IP multicast address,
- Indication if the device shall use IPv4 or IPv6 for that group,
- Security parameter for group communication,
- Radio parameters to use when UE is *out-of-coverage*.

3.6.2 Resource Allocation

The radio resources to use for one-to-one or one-to-many communication can be scheduled either by the network (for the *in-coverage* scenario), or autonomously by the device (for the *out-of-coverage* scenario).

In the *in-coverage* scenario, the UE needs to be RRC_CONNECTED in order to transmit data. If the device has acquired System Information Block (SIB) Type 18, which provides information for transmission of Sidelink control and data (PSCCH, PSSCH), then it would use the radio resource from the resource pool indicated by SIB Type 18. Similarly, SIB Type 19 provides information on the radio resource allocation to perform and retrieve discovery messages. Whenever SIB Type 18 provides no valid resource, the UE initiates a RRC connection, and sends a *SidelinkUEInformation* message to the network announcing its wish to use ProSe communication functionalities.
Whenever the UE requests ProSe transmission resources from the eNodeB, it is assigned an identifier SL-RNTI (Sidelink Radio Network Temporary Identifier) that will be used by the network to schedule future

ProSe transmission. When the UE has some data to transmit using the ProSe service, it transmits a BSR (Buffer Status Report) to the network announcing the amount of data to transmit. Based on this information, the network grants the UE with an allocation on both PSCCH (control) and PSSCH (data) for ProSe transmission. The allocation information is broadcasted over the PDCCH using a Downlink Control Information (DCI) Format 5 (specified in TS 36.212). The UE will then use the provided resource to transmit the SCI format 0 over the PSCCH and the corresponding data over the PSSCH. An example of the resource allocation procedure for the *in-coverage* case is provided in Figure 9.

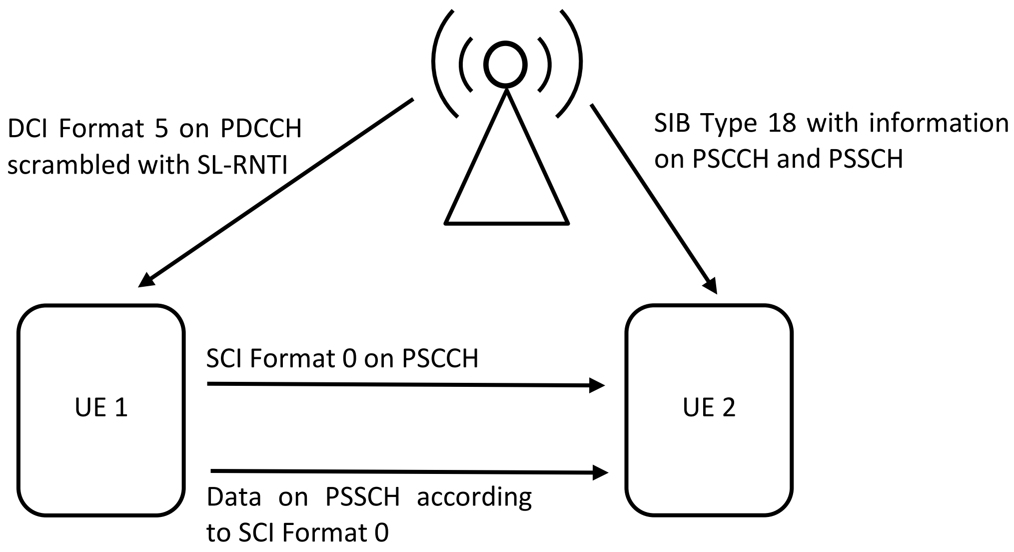


Figure 9: Resource allocation for the in-coverage scenario.

When the UE is in the *out-of-coverage* scenario, it can select on its own from the resource pools the resources to transmit control and data on the Sidelink. If the UE can locate itself in a geographical area and it is provisioned with radio parameters for this geographical area, then the UE shall select the radio parameters associated with that geographical area. In all the other cases, the UE shall not initiate ProSe communication. Before initiating ProSe communication, the UE shall always check whether the selected radio parameters do not cause interference to other cells.

The UE performs ProSe communication on subframes defined over the duration of a Sidelink Control period. The Sidelink Control period is the period over which resources allocated in a cell for Sidelink Control and Sidelink Data transmissions occur. Within the Sidelink Control period, the UE sends a SCI Format 0 message followed by data. Sidelink Control indicates a Layer 1 ID and the characteristics of the transmissions (e.g., MCS, location of the resource(s) over the duration of Sidelink Control period, timing alignment).

In case of multiple communications taking place concurrently, the UE performs transmission and reception on Uu and PC5 interfaces in the following decreasing priority order:

1. Uu transmission/reception (highest priority);
2. PC5 ProSe Communication transmission/reception;
3. PC5 ProSe Discovery transmission/reception (lowest priority).

3.6.3 Synchronization

Sidelink Synchronization Signals (SLSS) and Sidelink Broadcast Channel (PSBCH) carry the essential information needed to receive other ProSe channels and signals. Both SLSS and PSBCH are transmitted periodically each 40ms. When the UE is *in-coverage*, the contents of PSBCH are derived from the parameters signalled by the eNodeB. When the UE is *out-of-coverage*, the UE can select another UE as a synchronization reference, in that case, the content of PSBCH is derived from the received SBCCH; otherwise, the UE employs pre-provisioned parameters. One subframe each 40ms is used for synchronisation and PSBCH transmission for *in-coverage* operation. In this case, SIB Type 18 provides the resource information for synchronisation signal and PSBCH transmission. In the *out-of-coverage* scenario, instead two pre-configured subframes are sent every 40m.

3.7 Focus on MOTO actions toward ProSe standardization

The following are the 3GPP work items in Rel-12 and Rel-13 related to ProSe to whom TCS contributed and co-signed as a supporting member.

- **Proximity-based Services** (ProSe) *UID_580059*: the Study on Proximity-based Services [1] has identified services that could be provided by the 3GPP system based on UEs being in proximity to each other. The identified services provide support for Public Safety and non-Public Safety services that would be of interest to operators and users. Proximity-based applications and services represent an emerging social-technological trend. The introduction of a Proximity Services (ProSe) capability in LTE would allow the 3GPP industry to serve this developing market. ProSe capabilities will also serve the urgent needs of several Public Safety communities that are jointly committed to LTE, e.g. see SP-120456 (MoU between TETRA & Critical Communications Association (TCCA) & the National Public Safety Telecommunications Council), and S1-121247 (TCCA). ProSe normative specification are also requested to enable economy of scale advantages, i.e. the requirements should ensure that the resulting system can be used for both Public Safety and non-Public Safety services, where possible. Work Item leadership: SA1, SA2.
- **Enhanced LTE Device to Device Proximity Services** (LTE_eD2D_Prox) *UID_660074*: the objective of this work item is to enhance LTE device to device, both for discovery and for communication. This work item also aims to enhance the support for D2D in presence of multiple carriers and PLMNs. For example, currently D2D transmissions by a UE are limited to its camped cell. This can force UEs that are engaged in D2D signalling among themselves to be on the same cell, which in turn can cause load imbalance among carriers of a deployment. Allowing UEs to transmit on non-serving carrier can alleviate this issue. Work Item leadership: RAN2, RAN1, RAN3, and RAN4.
- **Mission Critical Push To Talk over LTE** (MCPTT) *UID_620064*: Mission Critical Push To Talk is an essential functionality of public safety communication systems. Service requirements for Group Communication System Enablers for LTE [13] and Proximity Services [2] were approved in June 2013. While these service requirements provide essential LTE enablers for communications independent of any particular type of media, specific service/system/EPS/application requirements are needed for development of network and application architectures, security, RAN aspects, and network and application protocols to support Mission Critical Push To Talk over LTE (MCPTT). Work item leadership: SA1, SA2, SA4, and SA6.

In particular, at least two people from the standardization team of TCS attended the SA6 meetings during the MOTO project lifetime, in order to propose studies, requirements or contributions in order to help the definition of the related work items. Those studies and contributions are the results of various EU-funded projects including MOTO. In particular, MOTO results related to were exploited in order to propose the standard.

4 Further Standardization activities in MOTO

In this section, a brief description of the main standards being applied or taken into consideration by the MOTO partners in the work they have carried out in MOTO is given.

The main standards used to perform the work of the MOTO project are:

Table 1. 3GPP TS 23.402 standard use in Taks 4.1 (Wi-Fi and mobile communications integration)

WP4	
Task 4.1	
Partner:	FON
Standard used:	TS 23402 "Technical Specification Group Services and System Aspects; Architecture enhancements for non-3GPP accesses"
Description of the standard	Service description for providing IP connectivity using non-3GPP accesses to the Evolved 3GPP Packet Switched domain. In addition, for E-UTRAN and non-3GPP accesses, the specification describes the Evolved 3GPP PS Domain where the protocols between its Core Network elements are IETF-based.
Brief Description of the work performed	
Analysis of the specification to understand what are the existing protocols and mechanisms for Wi-Fi and mobile networks integration. These are crucial for traditional offloading applications. We are assessing whether this specification can be evolved to cope with MOTO services or what aspects we can reuse for MOTO.	
Why is this standard interesting to the work performed	
This specification will allow the understanding of which are the current standard mechanisms and protocols for the integration of Wi-Fi and mobile networks and how they can be reused to integrate MOTO into LTE core network. In the multi-operator setup used for experimental validations (see D5.3), authentication methods (EAP) for Wi-Fi networks covered by this specification were used. In any case, full integration between FON and AVEA networks was not required for the testing. There was also intended to prove that operators can be connected to the same MOTO platform without having any commercial relationship or integration.	

Table 2. 3GPP 24.302 use in task 4.1 (Preferred access networks)

WP4	
Task 4.1	
Partner:	FON
Standard used:	TS 24302 "Technical Specification Group Core Network and Terminals; Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks"
Description of the standard	Discovery and network selection procedures for access to 3GPP Evolved Packet Core (EPC) via non-3GPP access networks and includes Authentication and Access Authorization using Authentication, Authorization and Accounting (AAA) procedures used for the interworking of the 3GPP EPC and the non-3GPP access networks.

Brief Description of the work performed
ANDSF is a cellular standardized function which allows an operator to provide a list of preferred access networks with policies for their use up to the granularity of a single IP flow or all traffic for a given PDN network (APN). As an example, discovery information may be sent by the ANDSF server and allows the mobile device to map from its current location to a list of alternative access networks that may also be available. For example, a list of Wi-Fi access networks within the current 3G cell or at the current mobile device geographical location can be provided by the ANDSF server. This type of function is quite interesting to understand what mechanisms may be applicable for similar functions needed in MOTO.
Why is this standard interesting to the work performed
Particular focus on ANDSF "Access Network Discovery and Selection Function" may allow understanding currently existing discovery and selection functions for Wi-Fi and mobile networks and policies that may be applied by the operator. Both MOTO and ANDSF rely on centralised architectures where network side servers manage where the content is to be retrieved from by the users or which access network is to be connected to, respectively. The original purpose was not to use ANDSF but to understand well how this function works to mimic some of its mechanisms for MOTO.

Table 3. ITU-TX.509 - ISO/IEC 9594-8 use in task 4.3

WP4	
Task 4.3	
Partner:	INNOVALIA
Standard used:	Recommendation ITU-T X.509 | ISO/IEC 9594-8
Description of the standard	The public-key certificate framework is the base specification for public-key certificates, for the different components going into a public-key infrastructure (PKI) for validation procedures and for public-key certificate revocation, etc. The attribute certificate framework is the base specification for attribute certificates and the different components going into the Privilege Management Infrastructure (PMI). These frameworks may be used by standards bodies to profile their application to PKIs and PMIs.
Brief Description of work performed	
For the security scheme proposed in MOTO, one of the main requirements to be fulfilled is the correct authentication of the users, and the availability of their trust level to other users. The use of certificates will enable the consecution of these two requirements; however, trust level is a field that has to be added to the certificate, as it's not normally included. Several certificates currently in use have been analysed in order to select the most suitable one for the MMOTO security necessities.	
Why is this standard interesting to the work performed	
X.509 v3 certificates provide much more flexibility than the traditional certificates by allowing the introduction of new fields, which would be really useful in MOTO, for instance for the incorporation of users' trust level.	

Table 4. IETF RFC5019 use in task 4.3

WP4	
Task 4.3	
Partner:	INNOVALIA
Standard used:	IETF RFC5019: Lightweight Online Certificate Status Protocol (OCSP) Profile for High-Volume Environments
Description of the standard	The lightweight Online Certificate Status Protocol (OCSP) addresses the scalability issues inherent when using OCSP in large scale (high volume) Public Key Infrastructure (PKI) environments and/or in PKI environments that require a lightweight solution to minimize communication bandwidth and client-side processing.
Brief Description of work performed	
For the security scheme proposed in MOTO, one of the main requirements to be fulfilled is the correct authentication of the users, and the availability of their trust level to other users. The use of certificates will enable the consecution of these two requirements; however, the revocation of these certificates imposes severe restrictions on bandwidth usage and client-side processing, due to the limited processing power and batteries of the UE. The work done encompasses the analysis of methods to verify the revocation status of these certificates.	
Why is this standard interesting to the work performed	
MOTO users need real-time verification of the revocation status of other user's certificates. However, the previously used Certificate Revocation Lists (CRLs) that were delivered by the Central Authority (CA) who issued the certificate are inapplicable in MOTO, due to the large files they can become, the limited bandwidth available and the limited processing power of the UEs. Therefore, a protocol that permits MOTO users to perform a query to the MOTO platform in order to request the current status of a given protocol is the best option. This protocol needs to be adapted to the mobile environment set in the MOTO proposed communication strategy. In this sense, the Lightweight Online Certificate Status Protocol (OCSP) Profile for High-Volume Environments is perfectly suitable.	

Table 5. ETSI ITS G5 use in tasks 5.1 and 5.2

WP5	
Task 5.1 and task 5.2	
Partner:	CRF
Standard used:	ETSI ITS G5
Description of the standard	The ETSI ITS G5 standard is an evolution of the IEEE 802.11a standard including communication functions required to operate in rapidly varying vehicular environments and exchange messages with short connection establishment delays. It can be seen as a profile standard of IEEE 802.11p, adapting it to the European spectrum.
Brief Description of work performed	
The development of the MOTO simulation tool environment will be based on the iTETRIS platform for the vehicular related functionalities. iTETRIS is an open source simulation platform aimed at implementing and evaluating cooperative ITS applications. It already includes a standard compliant implementation of the ETSI ITS G5 (mainly oriented to ITS G5A operation mode) which will be used as a starting point for	

implementing the new MOTO-related features.
Why is this standard interesting to the work performed
ETSI ITS G5 (being strictly related to IEEE 802.11p) is considered as the reference standard for vehicular Ad Hoc networks implementation. It has been used for implementing the communication among vehicles in the simulation platforms developed into the task 5.2. The obtained results have been then tested through the intensive simulation campaign conducted under task 5.2. The implemented models give the possibility to set all the parameters which characterize the communication protocol. In this way, it is possible to test the developed MOTO architecture under different conditions for the vehicular scenarios.

4.1.1 MOTO contribution to Standardization

MOTO partners have been focused on identifying what parts being developed in MOTO project are subject to be presented at standard bodies. Some partners have approached interesting working groups and other partners are keeping close track of the work being done by some identified as interesting working groups. Worth mentioning the following partner's approaches related standardization activities and plans:

- Innovalia has joined **the Cloud security alliance Software Defined Perimeter working group** and has been keeping track of the research lines and initiatives taken, as well as the work achieved by this working group and its suitability to the MOTO security approach. Although some of the concepts and focus of the activities of the working group deal with aspects related to MOTO, the overall picture of the working group does not align with the requirements and needs stated for the security research undertaken in the project.
- AVEA has identified working groups of their interest for the MOTO developments and is already following some of them:
  - → **ETSI:** STQ, RRS, ATTM, NTECH, SmartM2M
  - → **ITU-T:** SG-11 ; SG-12; SG-13; SG-15; SG-16 and SG-17
- Thales has actively contributed to the definition of 3GPP TR 22.803 (ProSe): people from the standardization team of TCS attended the SA6 meetings during the MOTO project lifetime, in order to propose studies, requirements or contributions in order to help the definition of the related work items. Those studies and contributions are the results of various EU-funded projects including MOTO. In particular, MOTO results related to were exploited in order to propose the standard.
- Some of the project partners already are members of standardization bodies and other interesting related entities, and have commitment to take advantage of this fact for MOTO achievements. Other partners like the UPMC and Innovalia although are not currently members of standardization bodies, follow activities from several working groups of relevant standardization initiatives, such as Cloud Security Alliance, IETF, IEEE and 3GPP. The following table, is a summary of the involvement of the project partner's in the different standardization initiatives:

Table 6. MOTO member's membership in standardization initiatives

	INTECS	FON	TCS
ETSI World Class Standards	X		
ITU International Telecommunication Union			X
CSA cloud security alliance			X
Wi-Fi Alliance		X	

5 Conclusions

At the beginning of the project, when the project proposal was written, the standards framework and targets for MOTO were clear. MOTO had the ETSI forum and the European-led 3GPP specification context as targets. The MOTO partners were already active in the relevant standardisation bodies (AVEA and INTECS in the ETSI TC on M2M and in the ETSI 3GPP TSG, Innovalia in the ETSI SA3 and TISPAN), and the project was going to pursue standardisation activities according to the plan presented in the related deliverables of WP6. MOTO aimed to make an impact in future standards for Future Internet technologies.

To do so, at the beginning of the standardization activities a solid and good structured strategy was defined which would assure the consecution of the expected impact by the MOTO activities in the standardization initiatives. This relationship was however not a unidirectional lane, as MOTO developments and activities highly relay in standards to assure its compatibility with real world implementations.

Making a final assessment of the achievements of MOTO regarding standardization, all the activities held and the results achieved are considered positive. MOTO activities have definitively contributed to the outcome of future demanded standards, mainly in the provisioning of Proximity-based Services as a 3GPP standard. In this sense, MOTO consortium members have proposed studies and requirements, and have made contributions in order to help the definition of the related work items. Those studies and contributions are the results of various EU-funded projects including MOTO. In particular, MOTO results related to were exploited in order to propose the standard.

6 References

[1] 3GPP, TR 22.803 Feasibility study for Proximity Services (ProSe) V12.2.0, September 2014.

[2] 3GPP, TS 22.278 Service requirements for the Evolved Packet System (EPS) V13.2.0, December 2014.

[3] 3GPP, TR 23.703 Study on architecture enhancements to support Proximity-based Services (ProSe) V12.0.0, October 2014.

[4] 3GPP, TR 23.713 Study on extended architecture support for proximity-based services V13.0.0, September 2015.

[5] 3GPP, TS 23.303 Proximity-based services (ProSe); Stage 2 V13.1.1, September 2015.

[6] 3GPP, TS 33.303 Proximity-based Services (ProSe); Security aspects V13.1.0, September 2015.

[7] 3GPP, TR 23.779 Study on application architecture to support Mission Critical Push To Talk over LTE (MCPTT) services V1.0.0, September 2015.

[8] 3GPP, TS 23.719 Functional architecture and information flows to support mission critical communication V1.1.0, October 2015.

[9] 3GPP, TR 36.843 Study on LTE device to device proximity services; Radio aspects V12.0.1, March 2014.

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[11] 3GPP, TS 24.334 Proximity-services (ProSe) User Equipment (UE) to ProSe function protocol aspects; Stage 3 V13.1.0, September 2015.

[12] 3GPP, TS 24.333 Proximity-services (ProSe) Management Objects (MO) V13.0.0, September 2015.

[13] 3GPP, TS 22.468 Group Communication System Enablers for LTE (GCSE_LTE) V13.0.0, December 2014.

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[15] TS 23402: Technical Specification Group Services and System Aspects; Architecture enhancements for non

[16] 3GPP accesses, September 2015 - http://www.3gpp.org/ftp/Specs/archive/23_series/23.402/23402-d30.zip

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[19] Intelligent Transport Systems (ITS); European profile standard for the physical and medium access control layer of Intelligent Transport Systems operating in the 5 GHz frequency band, 2007 - http://www.etsi.org/deliver/etsi_es/202600_202699/202663/01.01.00_50/es_202663v010100m.pdf

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