

EPC support of ProSe communication over WLAN

Possible architecture and required functionality

Intel, III, T-Mobile, Cisco Systems, Broadcom Corporation,
Radisys, ETRI, Sony Mobile

S2-130324

Outline

- **Introduction**
- **Some WiFi Direct basics**
- **EPC-assisted ProSe communication over WLAN**
 - **Basic use case description**
 - **Possible architecture**
 - **Expected functionality and call flows**
 - **Splitting ProSe Server functionalities (ProSe server proper vs 3rd party App Server)**
- **Service continuity**
 - **Use case description**
 - **Possible architecture and call flow**
- **Tentative conclusions**

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Introduction (1/2)

- The ProSe WID (S2-120395) has three broad objectives:
 - ProSe Discovery over E-UTRA
 - ProSe Communication over E-UTRA
 - ***EPC support of ProSe Communication over WLAN***
- The main focus of this presentation is on the latter
 - Although also addressed are certain general requirements like those related to the Network ProSe Discovery use case (see backup)
- S2-120395 also states that service requirements for ProSe Discovery and ProSe Communication will address:
 - Continuous network operator control
 - Presence, group communication, broadcast services and relay
- WiFi Direct (specified by Wi-Fi Alliance in the “Wi-Fi Peer-to-Peer (P2P) Technical Specification”) is the natural technology of choice for ProSe communication over WLAN
 - Operates in “dual radio” mode (i.e. in parallel with 3GPP access)
 - Has native device-to-device discovery procedure
 - Allows for p2p, multicast and broadcast communications
 - Supported in many smartphones

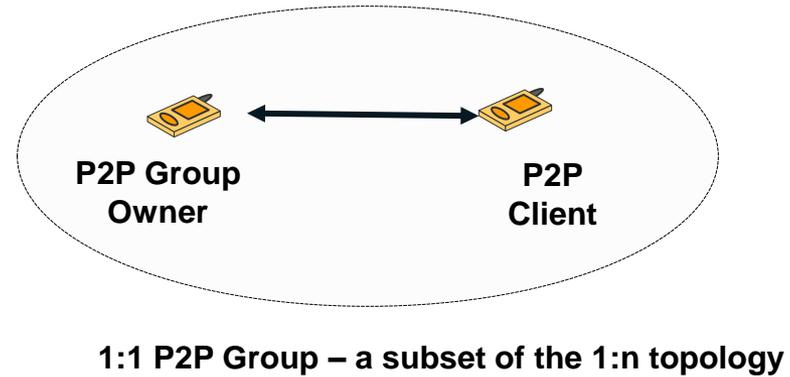
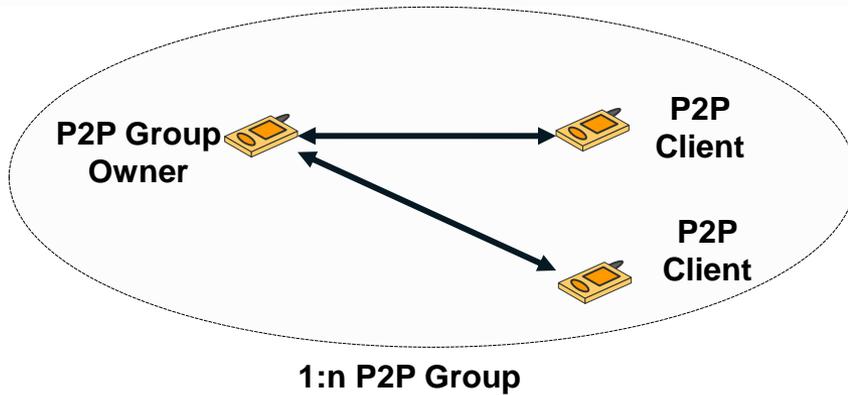
Introduction (2/2)

- The objective of this presentation is to:
 - Review certain WiFi Direct aspects in order to identify the information contents required for enabling EPC support of ProSe communication over WLAN
 - Discuss a possible architecture, required functionality and call flows for the basic use case (ProSe-assisted WLAN direct communication)
 - Discuss a possible architecture, required functionality and call flows for the service continuity use case

Outline

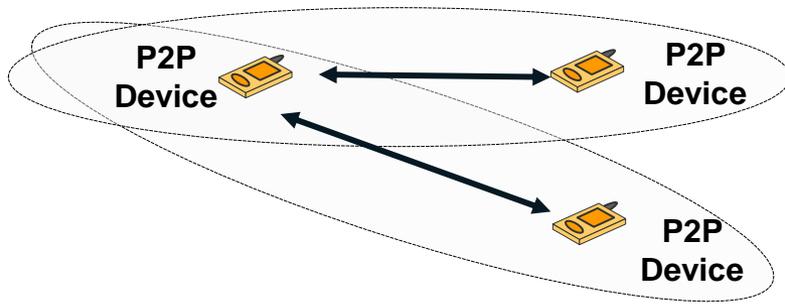
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Some WiFi Direct basics (1/3): Peer-to-Peer Group

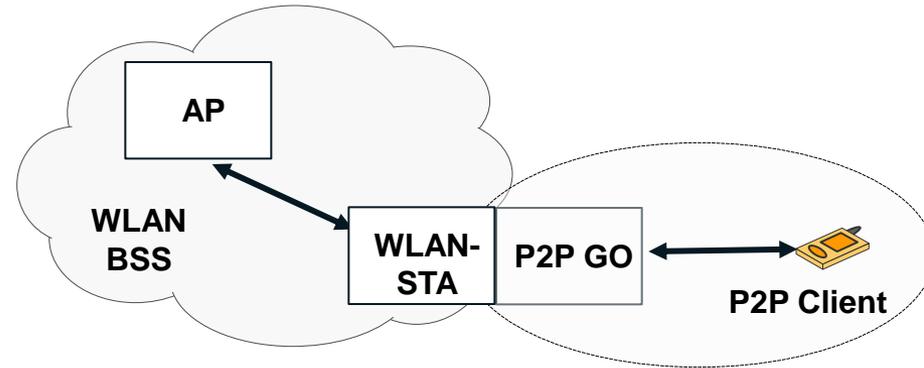


- **P2P Device:** WFA P2P certified device that is capable of acting as both a P2P Group Owner (P2P GO) and a P2P Client
- **P2P Group:** a set of devices consisting of one P2P GO and zero or more P2P Clients
- The P2P Device:
 - Negotiates the P2P Group Owner or P2P Client role
 - Supports the P2P Discovery mechanism
- The P2P GO:
 - Acts like an Access Point (AP) that provides 802.11 BSS functionality
 - Includes authenticator functionality
 - Includes DHCP server functionality; provides IP address to all connected P2P Clients
- The P2P Client: Implements non-AP STAtion (STA) functionality

Some WiFi Direct basics (2/3)



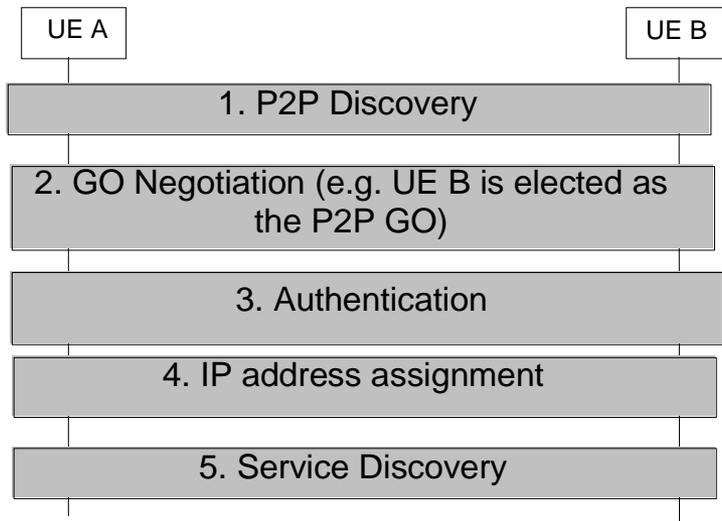
Multiple P2P Groups



Cross-connection

- Multiple P2P groups:
 - A P2P Device may operate as a member of more than one P2P Group simultaneously (not necessarily in P2P GO role on both groups)
- Cross-connection
 - A P2P Device in the role of GO may provide infrastructure access to other devices in the group; such a device is referred to as a *P2P Concurrent device*
- In either case the P2P Device has dual MAC functionality e.g. multiple virtual MAC entities over one PHY entity or multiple PHY entities
- NOTE: support for multiple P2P groups and Cross-connect is optional, whereas support for P2P Client and P2P GO roles is mandatory

Some WiFi Direct basics (3/3): high-level flow



- 1) P2P Discovery
 - UE A and UE B engage in P2P discovery process by scanning specific 802.11 channels
 - P2P Device Address is used as the device identifier: each UE sends probes with its own P2P Device Address and listens to probes from other UEs
 - Following the discovery process proper, the UE may present a list of neighbouring devices to the user and the user may select a specific P2P Device Address to which to establish a connection
- 2) GO negotiation
 - The two UEs negotiate the role of Group Owner
 - After the group is formed, the P2P GO may send invitations to other devices to join
- 3) Authentication
 - UE A (in the role of P2P Client) initiates 802.1x authentication with the P2P GO (i.e. UE B); assuming that the P2P GO has UE A's pre-shared secret (i.e. it acts as an 802.1x Authentication Server for user A), the authentication can be completed without involving any external entity; the Pairwise Master Key (PMK) is derived in the process
- 4) IP address assignment
 - P2P GO (acting as a DHCP Server) assigns an IP address to the P2P Client
 - At MAC level each device uses a P2P Interface Address (different from the P2P Device Address)
 - If two P2P Clients are connected to the same P2P GO, the data they exchange travels via the P2P GO
- 5) Service Discovery
 - Higher layer applications advertise their services via UPnP, Bonjour, etc.

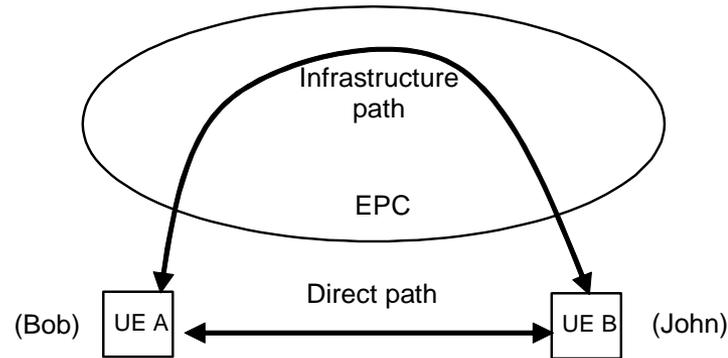
Assistance information

- The previous slide highlights the information contents required for enabling EPC support of ProSe communication over WLAN
 - 802.11 radio channel(s) on which to perform the discovery procedure; this may help in speeding up the discovery process
 - P2P Device Address so that the UE knows which UE it is looking for, without having to ask the user to select from a list of candidate devices
 - Designated Group Owner, so that the UEs don't have to engage in negotiation over the WiFi Direct link
 - A common pre-shared secret so that the UEs can mutually authenticate each other
- Other parameters (such as the IP address or P2P Interface Address) are dynamically assigned over the WiFi Direct link and need not be provided by the network

Outline

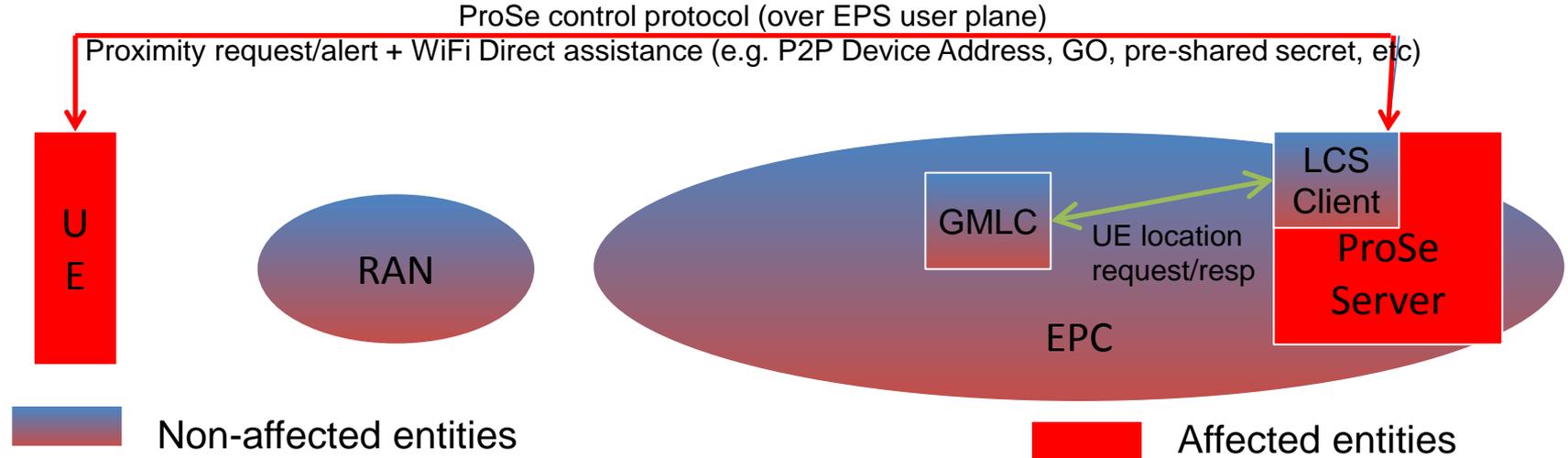
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Basic scenario for "ProSe-assisted WLAN Direct communication"



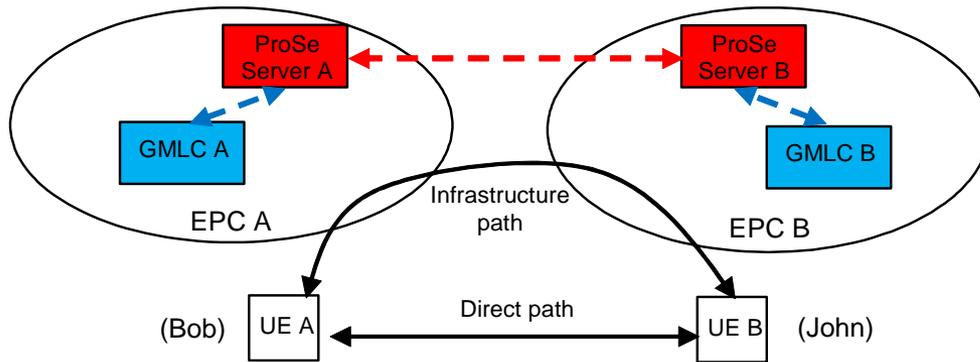
- Use case 5.1.9 in TR 22.803 (also PR.45, PR.100, PR.102):
 - Bob and John use ProSe-enabled applications on their UEs;
 - The 3GPP network has the capability to provide WLAN configuration information to ProSe-enabled UEs
 - Bob has clicked the ProSe-enabled UE to send an HD video to John
 - The 3GPP EPC determines proximity of Bob's and John's UEs and provides them with WLAN configuration information to assist with WLAN direct connection establishment
 - Bob's and John's UEs use the configuration information to verify feasibility of the WLAN direct connection and establish ProSe-assisted WLAN direct communications
 - The ProSe-enabled application on Bob's UE streams the HD video to the ProSe-enabled application on John's UE using the established WLAN connection

Possible architecture



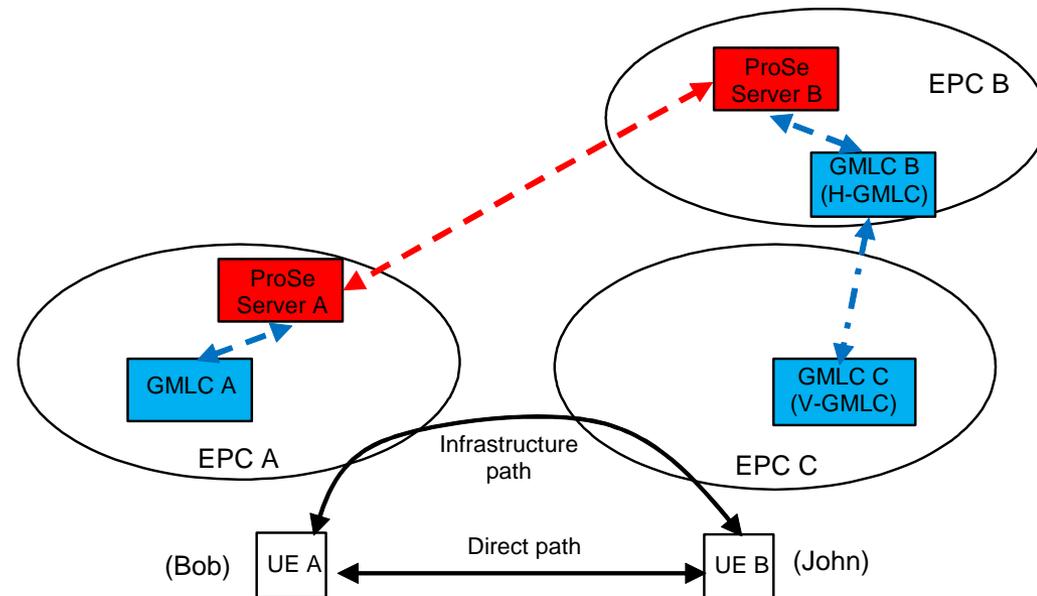
- ProSe Server – new functional entity residing in the EPC
 - stores user's profile for the ProSe service (e.g. user's discovery settings, a list of buddies, including the MNOs to which those buddies are subscribed, etc); alternatively, can fetch this information from the HSS
 - some functions can actually be hosted by a 3rd party App Server (see further below)
 - acts as a location services client (LCS client) and is able to look up the current location of its ProSe subscribers
 - communicates with ProSe server peers in other PLMNs to support cross-PLMN ProSe discovery and roaming scenarios
 - handles assistance info (e.g. P2P Device Address, Group Ownership, pre-shared secret)
 - may have interfaces towards the charging architecture

Architecture for cross-PLMN and roaming scenarios

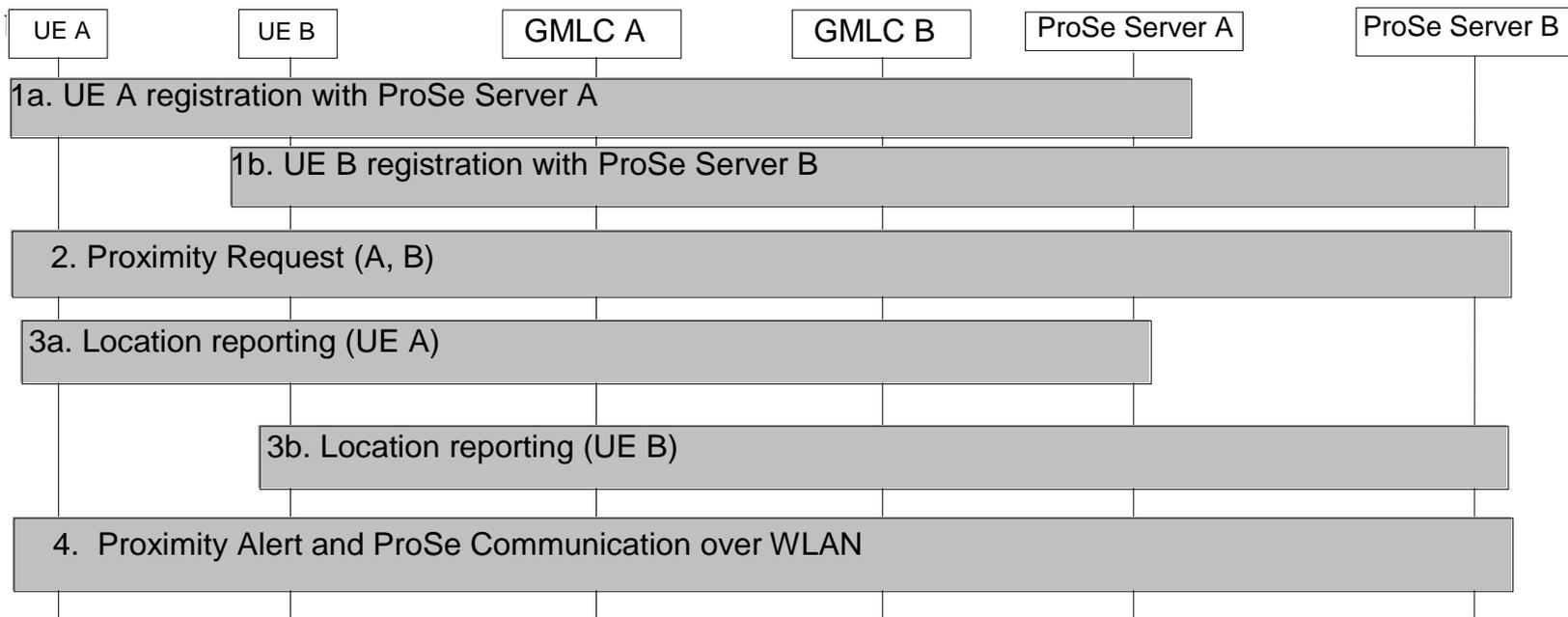


- Cross-PLMN scenario
 - User A and user B are subscribers of PLMN A and PLMN B, respectively
 - Each PLMN hosts its own ProSe server acting as LCS client wrt to the GMLC residing in the same PLMN

- Roaming scenario
 - In this scenario, user B, a subscriber of PLMN B, is currently roaming in PLMN C
 - The ProSe server for user B resides in his home network i.e. in EPC B
 - ProSe Server B subscribes as LCS client to the GMLC B, residing in the same network

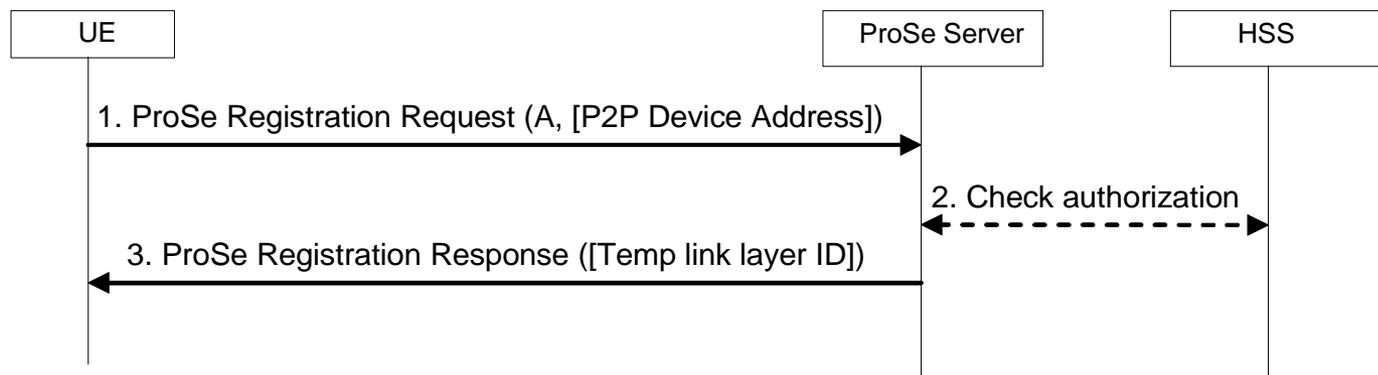


High-level call flow for EPC-assisted ProSe comm. over WLAN



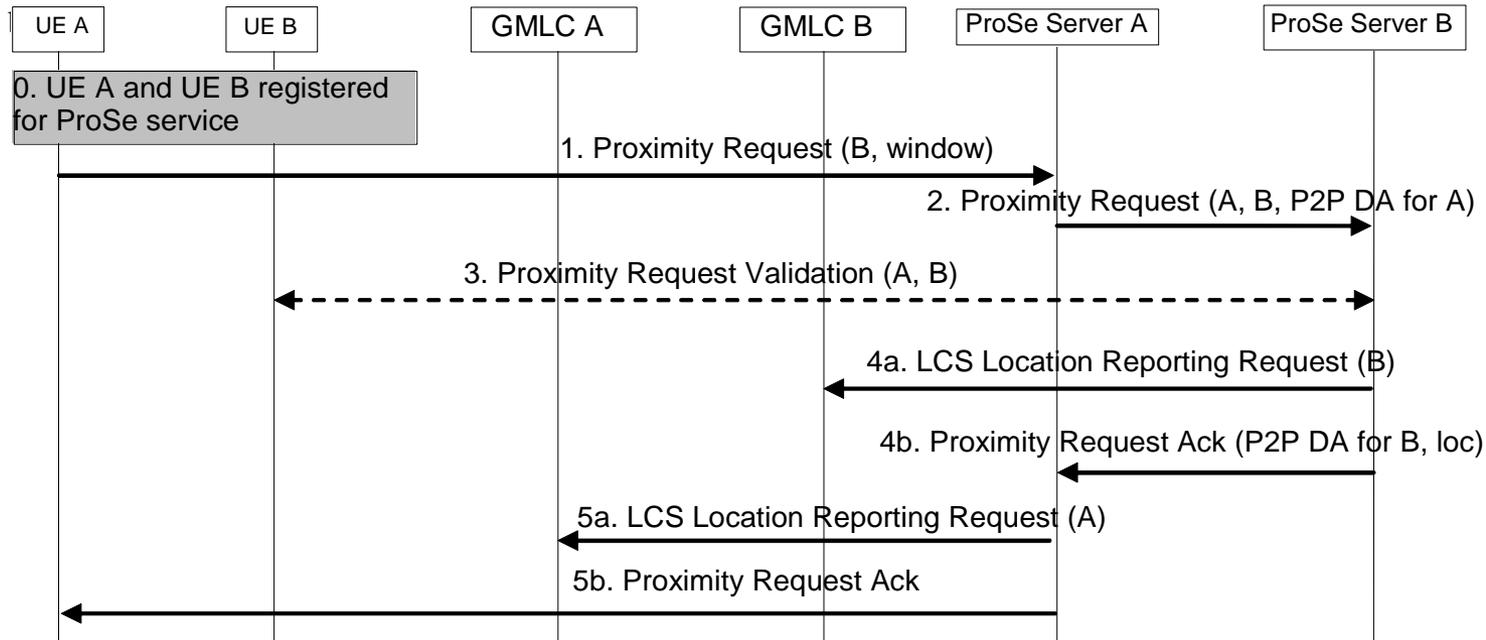
1. UEs register for ProSe service with the ProSe Server residing in their Home PLMN
2. UE A makes a proximity request i.e. requests that it be alerted for proximity with UE B (possibly indicating a window of time during which the assistance request is valid)
3. UE location is reported to the ProSe Servers intermittently
 - this need not imply any signalling on the radio e.g. if knowing UE location with cell-level granularity is deemed sufficient
4. When a ProSe Server detects that the UEs are in proximity, the network alerts the UEs and provides assistance information for establishment of ProSe communication over WLAN

1. UE registration with ProSe Server



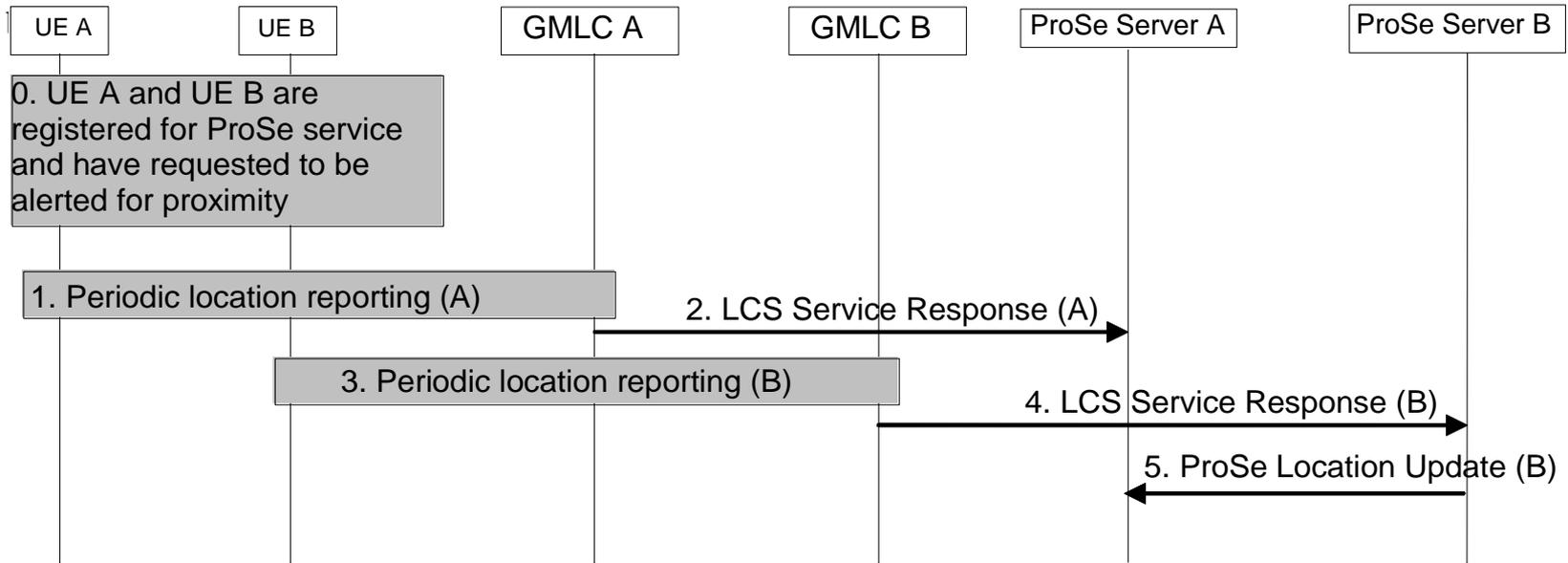
1. UE sends a ProSe Registration Request, including an application-layer user identifier (“A”) and possibly its P2P Device Address. Alternatively, it may obtain a temporary link-layer identifier in step 3
 - NOTE: other ProSe parameters (e.g. discovery permissions, group permissions, etc.) may also be included in the ProSe Registration Request
2. The ProSe server may interact with the HSS in order to authenticate the request and check whether the UE is authorised for this service. Alternatively, all user setting related to application-layer authentication and ProSe service authorisation may be configured locally in the ProSe server, in which case the interaction with the HSS is not needed
3. The ProSe server indicates to UE that the registration was successful. The ProSe Server may assign a temporary link-layer device identifier to be used as P2P Device Address

2. UE A makes a Proximity Request



1. UE A requests to be alerted for proximity with UE B (possibly within certain time window)
 - In the general case the proximity request can be made for a group of UEs (B, C, D, etc.)
2. ProSe Server A propagates the request to ProSe Server B, indicating A's P2P Device Address
3. Based on user B's ProSe profile, UE B may be asked to confirm permission for UE A's proximity request
4. ProSe Server B configures GMLC B for location reporting on user B and ack's the proximity request to ProSe Server A including B's P2P Device Address and B's current location (if known)
5. ProSe Server A configures GMLC A for location reporting on user A and acknowledges the proximity request to user A

3. Location reporting

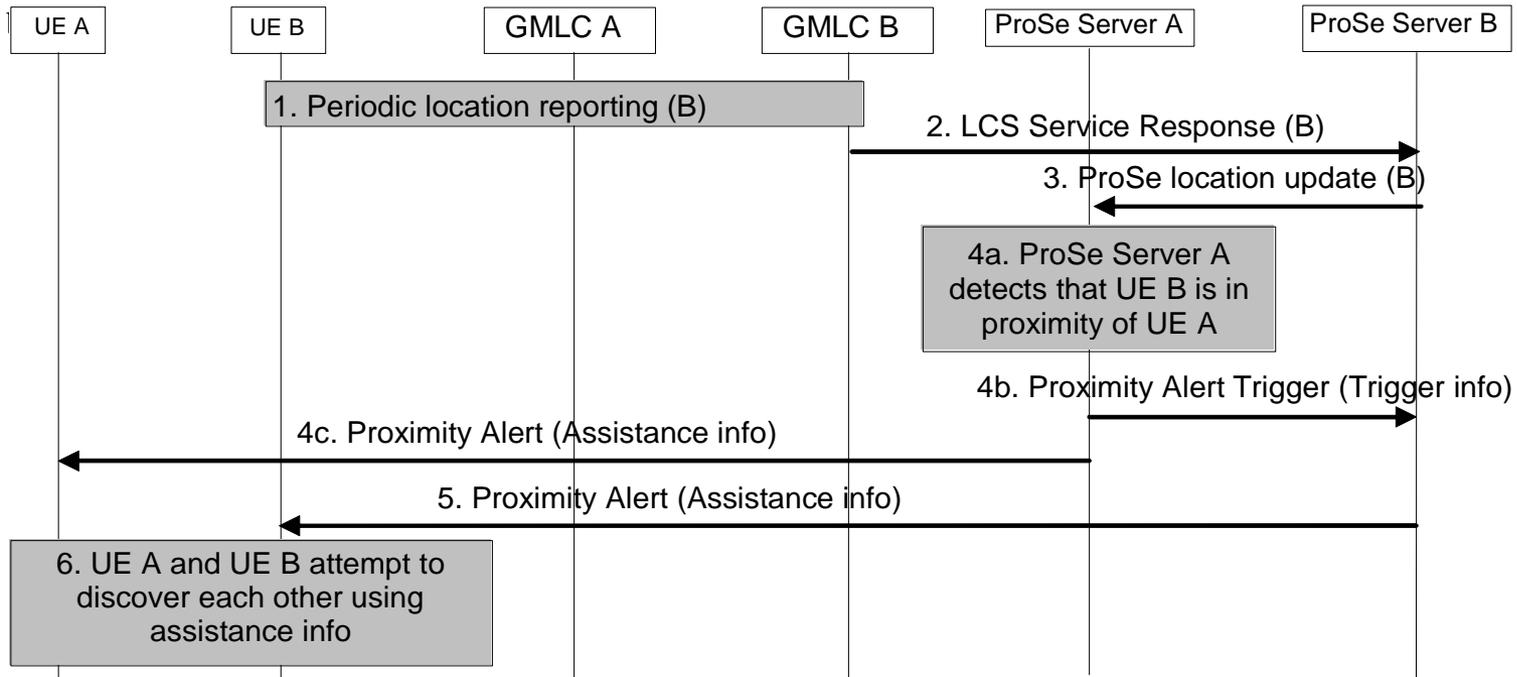


1.-4. The locations of UE A and UE B are reported to their corresponding Prose Servers intermittently

- NOTE: this reporting does not imply any signalling on the radio e.g. if knowing UE location with cell-level granularity is deemed sufficient; the reporting granularity can be fine-tuned progressively (e.g. when the UEs enter the same cell)

5. Assuming that ProSe Server A is in charge of determining proximity, UE B's location is forwarded to ProSe Server A

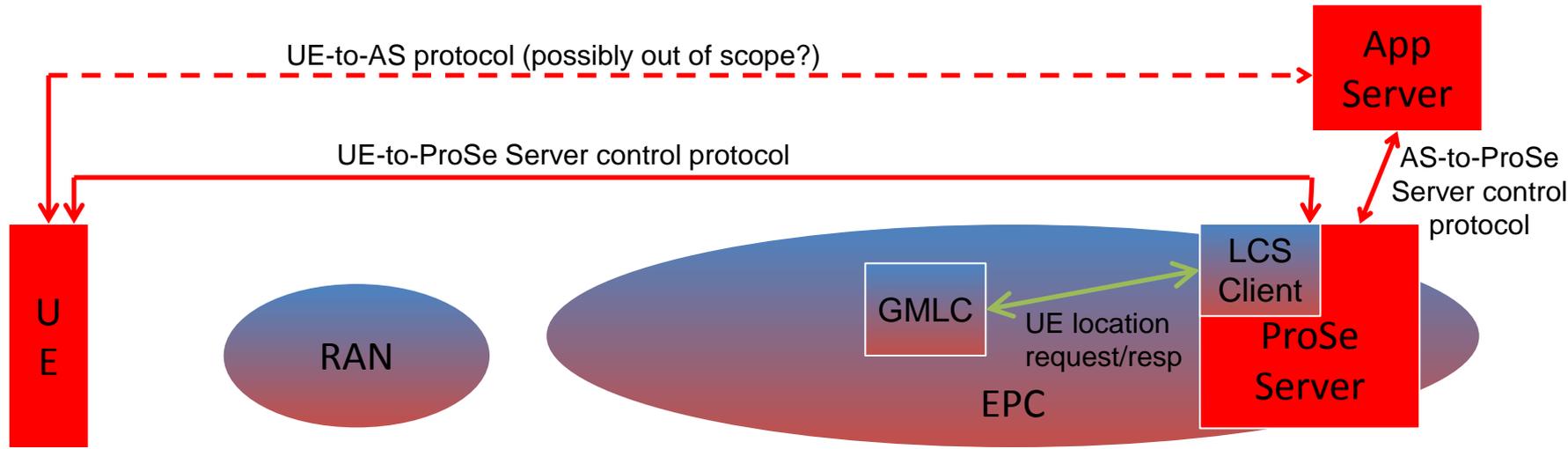
4. Proximity Alert and ProSe communication over WLAN



- 1.-3. The location of UE B is reported to ProSe Server B, which forwards it to ProSe Server A
4. ProSe Server A detects that the two UEs are in proximity; it generates the missing assistance information (e.g. designates Group Owner, generates a pre-shared key, etc), and alerts both ProSe Server B and UE A
5. ProSe Server B alerts UE B
6. The two UEs engage in WiFi Direct discovery using the parameters provided in the assistance info
 - NOTE 1: the WiFi interface in the UE is turned on in step 6 only (if not already on)
 - NOTE 2: with proximity requests sent to a group of users, any ProSe communication at WiFi level can be established either as multiple 1:1 P2P groups (see slide #8) or with a single 1:N P2P group (see slide #7)

Splitting ProSe Server functionalities (1/2):

ProSe server proper vs 3rd party App Server



- App Server
 - stores user's profile for applications relying on ProSe service (e.g. authentication credentials, user's discovery settings, a list of buddies, etc.)
 - interacts with both UE (possibly out of scope) and ProSe Server (in scope)
- ProSe Server
 - acts as a location services client (LCS client)
 - tracks and compares UE locations
 - communicates with ProSe server peers in other PLMNs to support cross-PLMN ProSe discovery and roaming scenarios
 - handles assistance info (e.g. P2P Device Address, Group Ownership, pre-shared secret)
 - interfaces the charging architecture

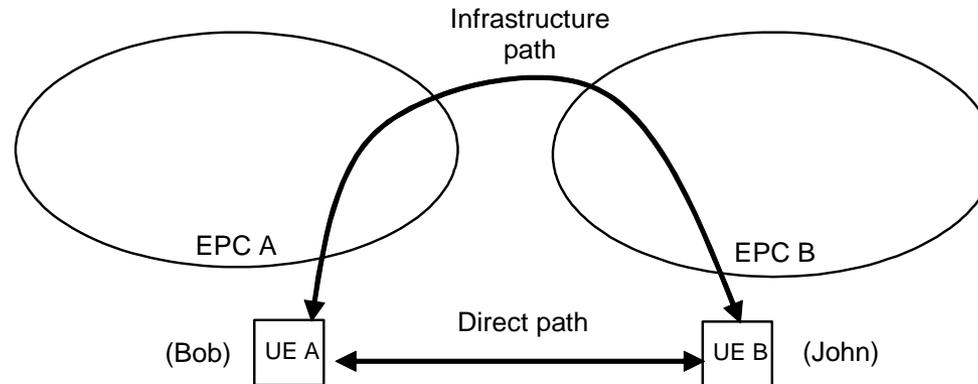
Splitting ProSe Server functionalities (2/2): *Impact on call flows*

- Overall, the call flows remain largely non-impacted, with the following notes:
 - UE may need to register with App Server in addition to registering with ProSe Server (this App Server registration is likely to be out of standardisation scope)
 - The Proximity Requests may need to be sent to ProSe Server via the App Server
 - The Proximity Request Validation may be performed directly between App Server and the B party (hence, may be out of scope)

Outline

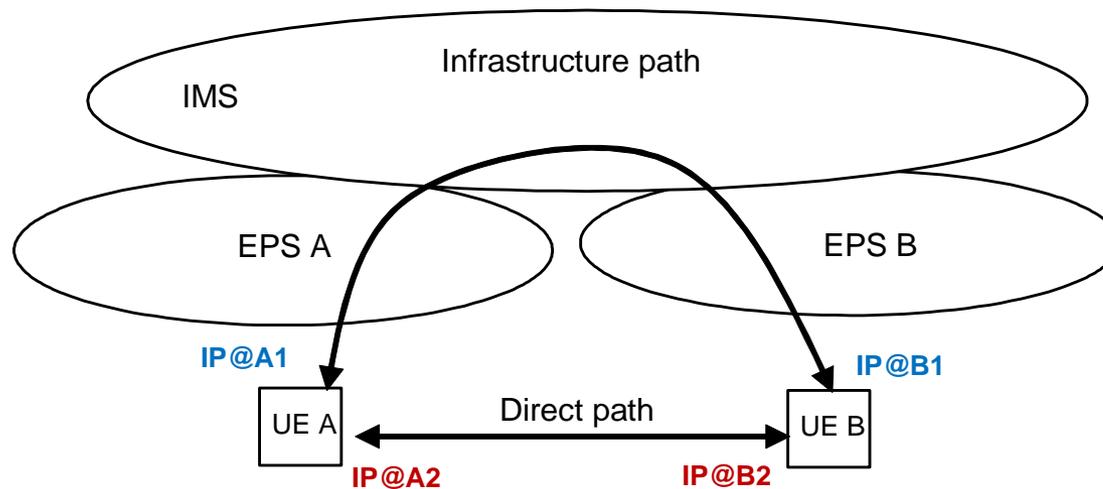
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Service continuity use case in TR 22.803



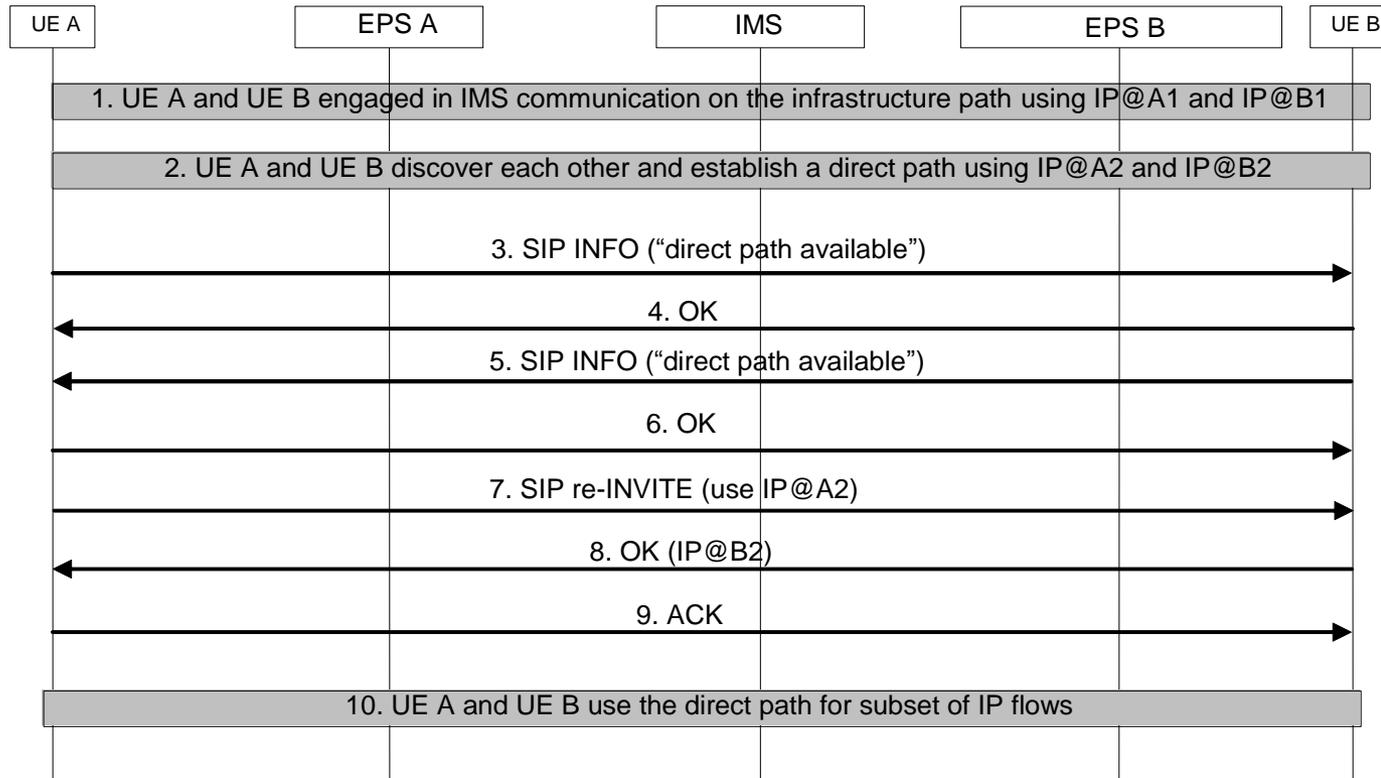
- Use case 5.1.10 in TR 22.803 (also PR.47-48, PR.105-107):
 - Bob and John are engaged in a data session (including one or more flows) that is being routed over the MNO's core network infrastructure
 - When Bob and John move within WLAN communication range, the 3GPP System switches their data session to the WLAN ProSe communication path
 - Later, when Bob and/or John move out of WLAN communication range, the 3GPP System switches their data session back to the MNO's infrastructure path

IMS-based service continuity



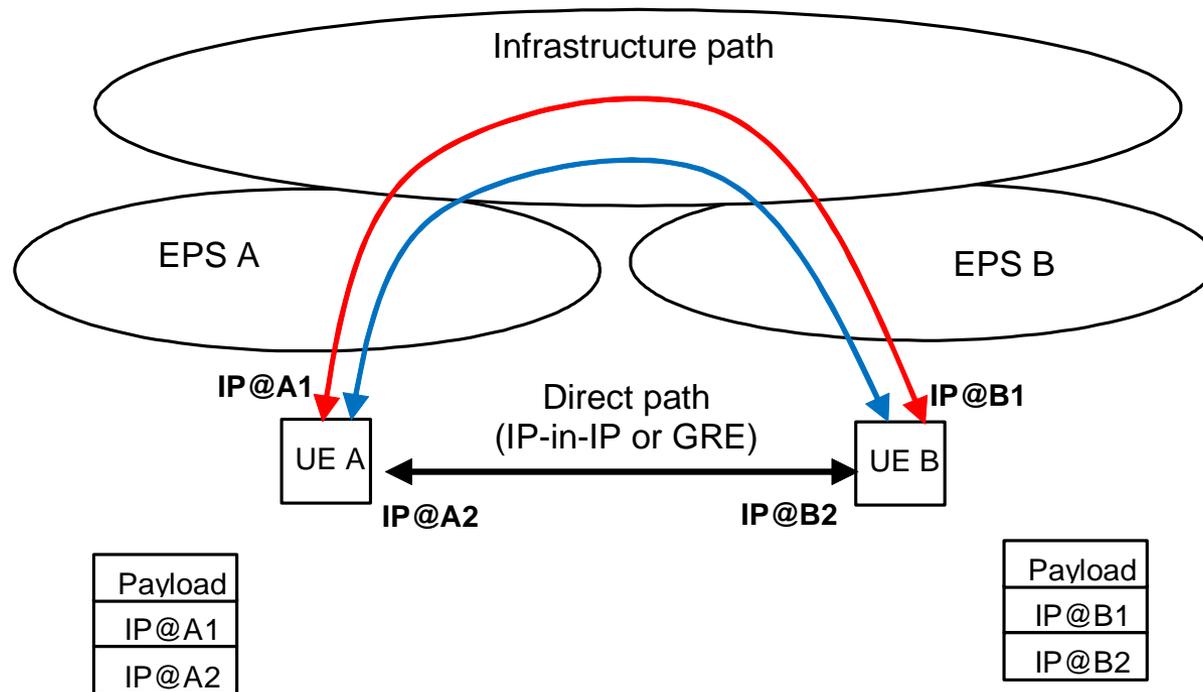
- The IP subnet on the direct path is a private network and completely disjoint from the IP network(s) on the infrastructure path
- A session control protocol is needed to perform the path switch in controlled way
- For IMS sessions existing IMS mechanisms for Dual Radio service continuity can be used with some enhancements:
 - Using existing IMS Service Continuity procedures (23.327) it is possible for user A to tell user B to use a new IP address (i.e. to switch from IP@A1 to IP@A2) for a selected subset of IP flows, so that user B can subsequently send all media packets for the concerned flows to the new IP address
 - For ProSe there is a need to switch both ends simultaneously; this may require minor enhancement to the IMS (e.g. see next chart for possible call flow)

Possible call flow for IMS service continuity



1. The two UEs are engaged in IMS communication over the infrastructure path
2. The two UEs discover that they are in proximity and establish a direct communication path
- 3.-6. The IMS client in each UE informs the remote party about the availability of a direct path
- 7.-9. Either of the two UEs initiates the path switch by sending a re-INVITE message

Service continuity for non-IMS sessions



- IP-in-IP (or GRE) encapsulation used for IP flows transferred on the direct path
- Further study required on the following (also applies to E-UTRA direct communication path):
 - handling of NAT traversal on the infrastructure path;
 - UE needs to cope with the same IP address (IP@A1 for UE A) on two different interfaces

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Tentative conclusions

- Functionality needed for the basic use case:
 - ProSe Server description (refer to slide #13, #20)
 - Procedures for ProSe service registration, proximity request, location update, proximity alert (UE-to-Server; Server-to-Server)
- Functionality needed for Service Continuity use case:
 - Minor enhancements to IMS procedures for Dual Radio service continuity in order to support service continuity for IMS sessions

Thanks!
Questions?

Backup

WLAN related requirements in 22.803 (1/2)

- [PR.44] Subject to operator policy and user consent, a ProSe-enabled UE with WLAN capability shall be able to establish ProSe-assisted WLAN direct communications with another ProSe-enabled UE when in WiFi Direct communications range, based on ProSe Discovery and WLAN configuration information from the 3GPP EPC.
- [PR.45] The 3GPP EPC shall be able to provide configuration information to ProSe-enabled UEs for the purpose of establishing ProSe-assisted WLAN direct communications.
- [PR.100] The EPC shall be able to provide configuration information that enables confidentiality and integrity on the ProSe-assisted WLAN direct communications link.
- [PR.101] The HPLMN operator shall be able to authorize ProSe-assisted WLAN direct communications for a ProSe-enabled UE, separately for use in the HPLMN and when roaming in VPLMNs.
- [PR.102] The HPLMN operator shall be able to authorize a ProSe-enabled UE to engage in ProSe-assisted WLAN direct communications with a ProSe-enabled UE being served by a different PLMN.
- [PR.103] The VPLMN operator shall be able to turn on or off ProSe-assisted WLAN direct communications for inbound roamers.
- [PR.104] Both the HPLMN and VPLMN operators shall be able to charge for ProSe-assisted WLAN direct communications.

WLAN related requirements in 22.803 (2/2)

- [PR.47] Subject to operator policy and user consent the EPC and a ProSe-enabled UE shall be capable of negotiating the move of a traffic flow between the infrastructure path and the ProSe-assisted WLAN direct path.
- [PR.48] There shall be no RAN impact due to the service continuity between the infrastructure communication path and WLAN direct path.
- [PR.105] The infrastructure network shall be able to determine whether two ProSe-enabled UEs are within WLAN direct communications range and whether the WLAN direct link can provide the necessary QoS to support the end user application.
- [PR.106] The infrastructure network shall ensure service continuity for ProSe-assisted WLAN direct communications flows and be capable of considering QoS requirements of all data flows when negotiating a communications path switch for a given end user application.
- [PR.107] The system shall be capable of establishing a new user traffic session for a ProSe-assisted WLAN direct communications path.
- [PR.108] Subject to operator policy and user consent the EPS shall be capable of maintaining existing E-UTRAN infrastructure communications while ProSe WLAN communication is established by a given ProSe-enabled UE.
- [PR.109] Subject to operator policy and user consent the EPS shall be capable of establishing new E-UTRAN infrastructure communications while ProSe WLAN communication is on-going for a given ProSe-enabled UE.
- [PR.110] The EPC shall be able to request the UE to perform a path switch between the infrastructure path and WLAN direct path for some or all of UE's sessions based on load in 3GPP networks.

Network ProSe Discovery use case in TR 22.803

5.1.5 Network ProSe Discovery Use Case

5.1.5.1 Description

In this use case, the 3GPP network provides ProSe Discovery for ProSe-enabled UEs.

5.1.5.2 Pre-Conditions

- Mary and Peter use ProSe-enabled UEs, subscribe to the same MNO, and currently reside on the HPLMN.
- The MNO network supports ProSe Discovery and Communication.

5.1.5.3 Service Flow

- Mary uses an application on her UE to connect with Peter, causing her UE to request ProSe Discovery from the MNO network.
- The MNO network verifies that Mary's UE has permission to discover Peter's UE and is in proximity of Peter's UE.
- The network informs Mary's and Peter's UEs that they are in proximity.

5.1.5.4 Post-Conditions

Mary's and Peter's UEs have discovered each other.

5.1.5.5 Potential Requirements

[PR.26] An application on a ProSe-enabled UE shall be able to request the network to determine the proximity of another ProSe-enabled UE; the network shall be able to determine proximity of two ProSe-enabled UEs and inform them of their proximity.

[PR.91] The operator shall be able to charge for network ProSe Discovery.