

## S2-175927: Evaluation of Layer 2 and Layer 3 relay

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# List of Layer 2 relay and Layer 3 relay features



Feature	L3 Relay	L2 Relay
1. Full identification of remote UE via relay UE	No support	Support
2. Power efficient reachability of remote UE via relay UE	No support	Support
3. Service continuity in path switch	No support	Support
4. Privacy of remote UE data	No support	Support
5. eNB control of remote UE radio resources (QoS)	No support	Support
6. Policy control and charging for remote UE	Partial support	Support
7. Unidirectional relay	No support	Support
8. Support for Non-3GPP accesses	Partial support (only WLAN)	Supports WLAN and BT
9. Support for Non-IP data delivery	No support	Support
10. Support for CP CIoT EPS optimization	No support	Support

**Note:** Above evaluation is based on

- For L2 relay: latest SA2/RAN2 agreements and potential conclusions based on proposed solutions.
- For L3 relay: solution described in clause Annex B of TR 23.733.

# 1. Full identification of remote UE via relay UE (1 of 2)



## Motivation

- Manage remote UE as regular UE to have additional connections and revenue to operators..

## L2 Relay support

- eRemote UE has its own PDN Connections handled by its NAS signalling: identification is naturally supported.
- eRemote-UE context in eNB, MME, SGW and PGW.
- Apply operator value added services to eRemote-UEs as the UE is directly visible to EPC.

## L3 Relay support

- Only partial identification of the remote UE is possible. There is no separate Remote UE context in MME, SGW or PGW: does not increase number of active UE contexts in EPC.
- Relay UE sends NAS message *Remote UE Report (remote UE ID, IP info)* to MME, who forwards it to S/PGW.
  - It's FFS how the PGW understands the remote UE ID (i.e. User info), which is out of scope of 3GPP.
- The *Remote UE Report* message shall be sent when the Remote UE disconnects from the Relay UE to inform the MME, S-GW and the P-GW that the Remote UE(s) have left.

# 1. Full identification of remote UE via relay UE (2 of 2)



## Impacts to standard

- L2 Relay
  - Minor changes on the EPS in SA/CT level, based on selected Solution 6.1.5 for Key Issue 1.
  - Impacts on RAN.
- L3 Relay
  - Currently no support for full identification. Solution is FFS.

## Evaluation

- L2 Relay supports full identification of eRemote-UE in a simple way and with limited impact.
- L3 Relay may only support partial identification (i.e., no UE context in CN) of remote UE.

## 2. Power efficient reachability of remote UE (1 of 2)



### Motivation

- Network shall be able to support sending/receiving data to an eRemote-UE after it moves to IDLE state
- Support for efficient power consumption of eRelay-UE and eRemote-UE

### L2 Relay support

- Option 2 and Option 3 of TR 36.746 allow reaching idle eRemote-UEs out-of-coverage of the eNB
- eRemote-UE supports idle mode operation to save power

### L3 Relay support

- Remote UEs out-of-coverage of the eNB can be reached only while PC5 is active.
- Every time a remote UE moves in and out of coverage of the relay UE
  - The relay UE has to inform the MME/SGW/PGW.
  - The remote UE has to update the latest IP address in application servers.

## 2. Power efficient reachability of remote UE (2 of 2)



### Impacts to standard

- L2 Relay
  - No changes to EPS at SA/CT level, if Paging Option 2 is selected. Changes to EPS needed if Option 3 is selected.
  - Impacts to RAN.
- L3 Relay
  - No impacts, with the limitation the remote UE and relay UE have to keep PC5 connection active.

### Evaluation

- L2 Relay support reaching eRemote UE in idle mode both in- and out-of-coverage for power savings, e.g. long DRX.
- L3 Relay cannot support reaching the remote UE in a power efficient way.

## 3. Service continuity during path switch (1 of 2)

### Motivation

- Provide necessary/basic user experience, i.e., IP level continuity.
- Flexible link selection based on power and/or spectrum efficiency criteria.

### L2 Relay support

- From CN perspective, eRemote-UE has its own IP address allocated by the network.
- Service continuity during path switch can be supported with selected solution for Key Issue 5.

### L3 Relay support

- VoIP with application level service continuity
  - Remote UE has to update latest IP address in application server whenever it moves in/out of coverage of Relay UE.
- Solutions have been proposed to support IP level continuity (e.g., [S2-151727](#))
  - Remote UE and Relay UE are limited to be served by the same PGW.
  - MME, S-GW and P-GW need to be enhanced.
  - Relay UE needs to update binding relationship in MME/PGW whenever remote UE (dis)connects to/from it.

## 3. Service continuity during path switch (2 of 2)

### Impacts to standard

- L2 Relay
  - Minimal changes to EPC at SA/CT level.
  - Impacts to RAN node.
- L3 Relay
  - No impacts , with the limitation that the it requires application level supports service continuity.
  - If IP level service continuity potential solution is used (e.g., [S2-151727](#)) high complexity and significant impacts to EPS.

### Evaluation

- L2 Relay provide better service continuity with minimal impact on EPS.
- L3 Relay does not provide IP level service continuity and is purely based on application level solution, which is not widely supported as of now.

## 4. Privacy of remote UE data

- 📶 Motivation
  - Enable private data transmission between Remote UE and eNB, i.e., without relay UE being able to decipher the data.
  - Application level security maybe used, but it is out-of-scope of 3GPP.
- 📶 L2 Relay Support
  - Natively supported by PDCP layer between eRemote-UE and eNB.
- 📶 L3 Relay Support
  - Does not support, since Relay UE, as an IP router, can decipher any traffic it relays.
- 📶 Impacts to standard
  - L2 Relay
    - Minor changes on the EPC at SA/CT level.
    - Impacts on RAN node.
  - L3 Relay
    - N/A (It cannot support the feature).
- 📶 Evaluation
  - L2 Relay provides data privacy protection for eRemote UE.
  - L3 Relay cannot provide privacy of remote UE data.

## 5. eNB control of remote UE radio resources (1 of 2)



### Motivation

- Guaranteed QoS service, especially for voice and video service.

### L2 Relay support

- With some enhancement, supports Uu-like QoS Framework (e.g., Semi-Permanent Scheduling; [R2-1704325](#)).

### L3 Relay support

- Best effort only, as there is no eNB scheduling.
  - For UL, Relay UE uses UL TFTs to select UL EPS bearers for relayed UL packets independently from PPPP.
    - How to update the uplink TFT is still not clear.
  - For unicast DL traffic, Relay UE maps the QCI of the EPS bearer onto a PPPP value to be applied for the DL relayed unicast packets over PC5. The mapping rules are provisioned in the Relay UE.

## 5. eNB control of remote UE radio resources (2 of 2)



### Impacts to standard

- L2 Relay
  - No impact to EPC at SA/CT level.
  - Impact to RAN node (e.g., support for Semi-Persistent Scheduling over side-link).
- L3 Relay
  - N/A (Cannot support Uu-like QoS) .

### Evaluation

- With impact limited to RAN, node L2 Relay can support end-to-end QoS management natively.
- L3 Relay cannot support end-to-end QoS (including the PC5 link) unless enhancements are introduced.

## 6. Policy Control and Charging (PCC) for remote UE

### Motivation

- Network shall be able to fully support PCC functionality for a Remote UE.

### L2 Relay support

- Natively supported as a regular UE due to per-eRemote-UE PDN connection.

### L3 Relay support

- No support for eRemote-UE specific PCC functionality.

### Impacts to standard

- L2 Relay
  - Natively supported (no additional impact on top of baseline L2 relay).
- L3 Relay
  - Impacts on MME, PCRF and PGW to map UE identities to IPv6 addresses.
  - If not, only limited support for offline charging based on Relay UE volume counting reported to the CN, which is not desirable for commercial usage (ProSe Function charging sub-function may need to be deployed, leading to additional costs).

### Evaluation

- L2 Relay is more suitable and less complex than L3 Relay.

## 7. Unidirectional relay

- 📶 Motivation
  - Allow RAN to select most suitable path (e.g., bidirectional or unidirectional) considering power savings, etc.
- 📶 L2 Relay support
  - From perspective of EPC, natively support.
- 📶 L3 Relay support
  - Not supported
- 📶 Impacts to standard
  - L2 Relay
    - Impact to RAN.
  - L3 Relay
    - N/A, it is not supported.
- 📶 Evaluation
  - L2 Relay can support unidirectional Relay with some enhancement in RAN.
  - L3 Relay cannot support unidirectional Relay without significant enhancements and inefficiencies.

## 8. Support for Non-3GPP access

- 📶 Motivation
  - Decrease cost of implementation and provide efficient power consumption, especially for IoT devices.
- 📶 L2 Relay support
  - Natively supports identifying, security and charging for WLAN and BT.
- 📶 L3 Relay support
  - Partial supports WLAN (Enhancement to WLAN/BT needed to fully support identification, security and charging).
- 📶 Impacts to standard
  - L2 Relay
    - Impacts to RAN.
  - L3 Relay:
    - Impacts to multiple non-3GPP accesses technologies over side link (out of scope of 3GPP).
- 📶 Evaluation
  - L2 Relay supports Non-3GPP access to support all above mentioned requirements.
  - L3 Relay cannot fully support Non-3GPP access, unless changes to Non-3GPP standards are applied.

## 9. Support for Non-IP Data Delivery (NIDD)

### Motivation

- Decrease device complexity and power consumption.

### Impacts to standard

- L2 Relay
  - Natively supported (no additional impact on top of baseline L2 relay).
- L3 Relay
  - Significant impacts as it requires separate PDN connections per Remote UE. Solution is FFS.
  - Needs to perform L2 relaying between Remote UE and Relay UE. Solution is FFS.

### Evaluation

- L2 Relay can natively support NIDD
- L3 Relay cannot support feature as of now. Significant impact on Remote and Relay UE needed to support it.

## 10. Support for CP CloT EPS optimization

### Motivation

- Support for IoT devices and reduce cost (no need of DRB establishment).

### Impact to current standard

- L2 Relay
  - Natively supported (no additional impact on top of baseline L2 relay).
- L3 Relay
  - Cannot support the feature. Solution is FFS.

### Evaluation

- L2 Relay can natively support CP CloT EPS optimization.
- L3 Relay cannot support CP CloT EPS optimization.

## Conclusions



- Existing L3 relay architecture supports limited set of features. To extend it to new features, impacts on RAN and CN foreseen but no solutions studied in detail.
- Existing L3 relay architecture is de-facto not deployed: currently deployed networks affected independently of the type of relay.
- L2 relay architecture allows introducing new features (eRM-UE data privacy, mobility support, Uu-like QoS, CloT, etc.).
- Changes introduced by L2 relay architecture mostly in RAN. Limited CN impact.

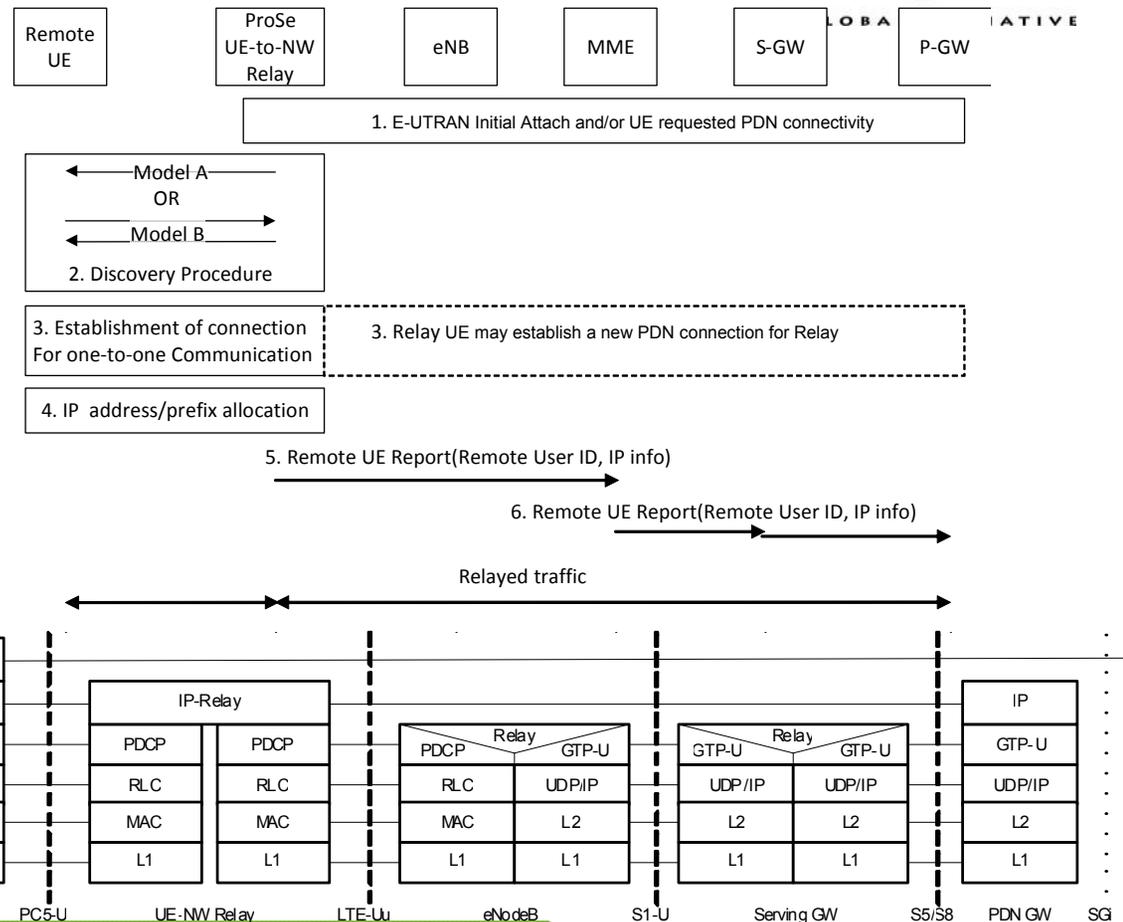


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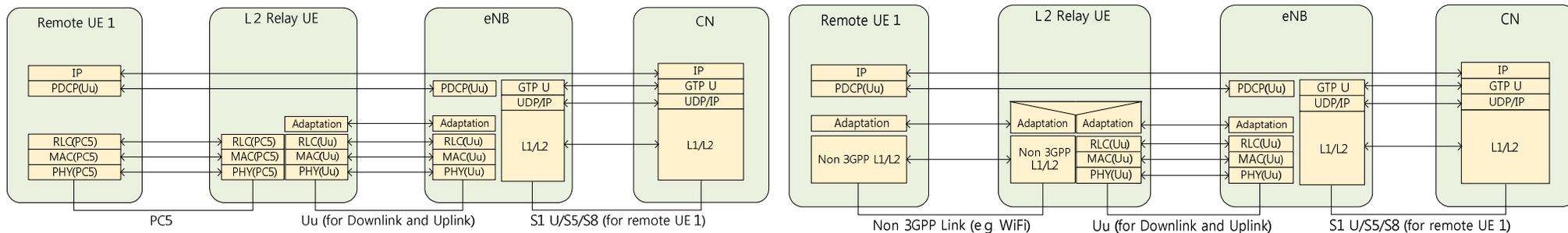
# Rel-13 D2D comm. enhancement: L3 UE-to-NW Relay



- In Rel-13, D2D communication is enhanced to support UE-NW relay via 1-to-1 communication.
  - Relay UE as a router is able to relay UL/DL unicast traffic between Remote UE and network at IP level.
- Only Relay UE is controlled by the operator when accessing the network.
  - Network authorizes whether the UE is able to act as Relay, during attach and service request.
- Remote UE IP address is allocated by Relay UE, the network becomes aware of the Remote UE by Relay UE's reports.
- It is assumed Relay UE is reliable although it can decipher the data from remote UE, i.e., Public Safety usage.



# FS\_REAR: L2 UE-to-NW Relay (eRelay)



**User plane protocol stack for PC5 based Layer 2 relay**

**User plane protocol stack for non-3GPP based Layer 2 relay**

- eRemote-UE is visible and reachable by the network.
  - eRemote-UE has its own PDN connection in the network.
  - This naturally enables authorization, charging, service continuity.
- eRelay-UE can't decipher data of eRemote-UE.
- Due to the adaptation layer, eNB is capable of distinguishing traffic between eRelay-UE and eRemote-UEs. Furthermore, eNB is able to distinguishing traffic among eRemote-UEs connected to same eRelay-UE.
  - This further enables end to end QoS support for eRemote-UE.
  - When multiple Uu DRBs are used to carry traffic of different QoS classes, eRelay-UE can support one or multiple eRemote-UEs as well.
- For non-3GPP case, an adaptation layer is used over Uu and PC5 to carry traffic from/to eRemote-UE.