This is good

3GPP SA WG1 Meeting #98e S1-221107r5

Electronic Meeting, 9 - 19 May 2022 (revision of S1-220199)

**Source: China Telecom, ZTE, CEPRI, Xiaomi**

**Title: New SID on Multi-hop Multi-path Relay**

**Document for: Approval**

**Agenda Item: 4**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

Title: Study of Multi-hop Multi-path Relay

Acronym: FS\_MultiRelay

Unique identifier: xxxxx

Potential target Release: Rel-19

# 1 Impacts

{For Normative work, identify the anticipated impacts. For a Study, identify the scope of the study}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Affects: | UICC apps | ME | AN | CN | Others (specify) |
| Yes |  | X | X | X |  |
| No | X |  |  |  | X |
| Don't know |  |  |  |  |  |

# 2 Classification of the Work Item and linked work items

## 2.1 Primary classification

### This work item is a …

|  |  |
| --- | --- |
|  | Feature |
|  | Building Block |
|  | Work Task |
| X | Study Item |

## 2.2 Parent Work Item

For a brand-new topic, use “N/A” in the table below. Otherwise indicate the parent Work Item.

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| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
| N/A | N/A | N/A | N/A |

### 2.3 Other related Work Items and dependencies

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| --- |
| Other related Work /Study Items (if any) |
| Unique ID | Title | Nature of relationship |
| 720005 | New Services and Markets Technology Enablers (SMARTER) | Previous normative work includes one-hop relay |
| 840034 | Enhanced Relays for Energy Efficiency and Extensive Coverage (REFEC) | Pervious normative work includes multi-hops relay |
| 800007 | Service requirements for cyber-physical control applications in vertical domains (cyberCAV) | Previous normative work includes one-hop relay |

Dependency on non-3GPP (draft) specification:

None

# 3 Justification

Relay UEs are beneficial for extending communication range. It could be used for eMBB scenarios and vertical industry scenarios. It can not only work for indirect network connection, but also for direct device connection.

1. In the case of indirect network connection: Indirect network connection has been introduced in the earlier releases for IoT devices, vertical scenarios, and public safety use cases. Indirect network connection could be further enhanced for eMBB scenarios under operator’s control.

Additional use cases are proposed to study for multi-hop multi-path indirect network connection:

* Device transmits same data over different hops via different paths: When the same traffic is transmitted via different paths, there are redundant paths available if the relay of one of the paths is down or out of coverage.
* Network-assisted indirect network connection path management: considering that there may be many relays that are available, indirect network connection under operator’s control is introduced for communication performance optimization. Two examples are shown as below:
1. stationary relay UE could be placed at some shops for further coverage extension, when selecting paths, based on the operator’s policy, prioritization could be placed to the stationary relay UE, and different charging rate could be applied to the stationary relay UE,
2. if there is congestion of one of the paths, remote UE switches to a different path or dynamically schedules the packets among different paths based on the information provided by the network.
* Enhancement of mobility and energy efficiency for Remote UE: Since both the remote UE and the relay UE may move freely, in such case, relay reselection and relay handover may happen frequently, leading to poor user experience in service continuity and battery life.
* Enhancement of load control for Relay UE: Nowadays, UE has upper bound limitation of Uu capability as specified in RAN. Keeping this limitation in mind, when the UE acts as a Relay UE relaying traffic for multiple remote UEs, the experience of the remote UE may be decreased due to the massive remote UE access.
* It is noted that in TS 22.261, service requirements for multi-hop relaying and different traffic flows of a remote UE to be relayed via different indirect paths are specified. However, the existing requirements does not cover the cases for same traffic flows of a remote UE through different paths, the service requirements for multi-hop multi-path network-assisted indirect network connection path management are not covered. Moreover, mobility and load control enhancement could be further studied.
1. In the case of direct device connection: It has been studied for cloud gaming, future factory, asset tracking etc. Considering further vertical scenarios e.g. smart mine, a lot of diverse mine equipment need to be connected and exchange information in the underground long mine tunnel, it is proposed to study multi-hop and multi-path relay UE for direct device connection. These relay UEs could enable direct device connection to extend communication distance and improve reliability whether in coverage and out of coverage. The typical use cases examples are:
* To extend communication distance for vertical applications. For example, in smart mine scenario, the communication between the mining vehicle underground and its operating equipment on site spans long-distance. With the assistance of multi-hop relay UEs, the long distance direct communication can be provided. And with the relay UEs based multi-path traffic forwarding, it may provide higher reliability for the direct device connection compared with single path forwarding. The multi-hop and multi-path relay UE for the direct device connection can be used for the out of coverage and poor coverage scenario. Even for the in coverage scenario, it has the benefit of fast networking and deployment cost.
* For the multi-hop and multi-path relay UE enabled direct device connection serving for vertical applications, it can be provided only to the specific set of UEs according to Operators and Industry demand. It means that the multi-hop and multi-path direct device connection needs to be authorized and managed by the network. For UEs not belonging the group, this kind of communication service is not applied. In this way, the data traffic can be confined in the industrial park/factory area with enhanced security.
* When multiple traffic forwarding paths across multiple relay UEs applied for a given UE pair, the QoS assurance need to be considered.
* The routing path for the direct traffic between two UEs may be switched with the mobility of UE pairs. When one of the path failure or system fault happens, the connection can be dynamically switched to other data path to minimize service interruption. Taking the UE mobility and potential link failure into account, the routing path reconfiguration should be considered for service continuity.

Among existing functionalities and requirements, some partially address the direct device connection related use cases for cyber-physical control applications, V2X services and mission critical services. The multi-hop and multi-path direct device connection has not yet been studied.

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So, it is proposed to investigate the use cases and potential requirements to support the multi-hop and multi-path relay UE for indirect network connection and direct device connection.

# 4 Objective

The objectives of this study are to study use cases and identify potential new requirements, including:

* Relay UE for indirect network connection:
	+ Network-assisted multi-hop multi-path indirect network connection path management, including same traffic flows of a remote UE to be relayed via different indirect network connections paths;
	+ Further investigation on mobility and energy efficiency for Remote UE and on load control for Relay UE in presence of limited Uu capability;
	+ Identify the KPI on multi-path indirect network connection;
* Relay UE for direct device connection:
	+ Network managed multi-hop and multi-path scenarios, including management and configuration for UE groups and QoS assurance and service continuity;
* Other aspects, including charging and security;
* Gap analysis between the identified requirements and the existing requirements.

NOTE: Multi-hop and multi-path direct device communication needs to be authorized and managed by the network.

NOTE: The study should avoid overlaps with stage-2/3 work ongoing in Rel-18.

# 5 Expected Output and Time scale

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| New specifications {One line per specification. Create/delete lines as needed} |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Rapporteur |
| Internal TR | 22.XXX | Study of Multi-hop Multi-path Relay | TSG#98 (Dec 2022) | TSG#99 (Mar 2023) | Yuying Zhang, China Telecom, zhangyy45@chinatelecom.cn |

|  |
| --- |
| Impacted existing TS/TR {One line per specification. Create/delete lines as needed} |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
| N/A | N/A | N/A | N/A |

# 6 Work item Rapporteur(s)

Yuying Zhang, China Telecom, zhangyy45@chinatelecom.cn, Primary Rapporteur

Chen Lin, ZTE, chen.lin23@zte.com.cn, Secondary Rapporteur is responsible for the objectives related with direct device connection

# 7 Work item leadership

SA1

# 8 Aspects that involve other WGs

# 9 Supporting Individual Members

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| --- |
| Supporting IM name |
| China Telecom |
| CATT |
| ZTE |
| AT&T |
| China Electric Power Research Institute |
| CALTTA |
| OPPO |
| Tencent |
| Tencent Cloud |
| Xiaomi |