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Technical Report

3rd Generation Partnership Project;

Technical Specification Group Services and System Aspects;

enhanced Relays for Energy Efficiency and Extensive Coverage;

Stage 1

(Release 17)

** 

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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The present document examines several use cases with respective KPIs in different domains (e.g. inHome, SmartCities, SmartFarming, SmartFactories, Smart Energy, Public Safety, Logistics) and identifies new potential requirements for relays for energy efficiency and extensive coverage.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

<ACRONYM> <Explanation>

# 4 Overview

# 5 Use cases

## 5.1 Use case for enhancing coverage in industrial environments

### 5.1.1 Description

Acme Chemicals Corp. owns a large factory where precursor chemicals are converted into other chemicals to be used in highly specialized industries such as pharmaceutics, plastics, cosmetics etc. Many of the chemicals are dangerous in that they are flammable, toxic to humans or both and are often corrosive.

To avoid hazard to workers as much as possible, the company uses remote controlled and semi-autonomous robots for much of the movement, storage and inspection of drums (containers of chemicals) between various warehouses and the production floor itself. These robots have articulated arms and a trained operator wearing special Augmented Reality goggles can use them to manipulate objects and tools remotely using e.g. 3-D vision. The (human) operators of the robots may sit in a control room or in sealed vehicles which may be used to bring them closer to the work site.

In addition to the above, all containers of chemicals as well as hazmat suites are equipped with communications devices which can transmit critical information such as temperature, humidity and the possible presence of certain chemicals in the air.

Much of the work is done inside metal enclosures which can seal off potential chemical leaks. The enclosure walls as well as the drums, also metallic, acts as EM shields which make signal propagation difficult and unpredictable.

Rather than deploying multiple gNBs Acme has chosen to use UEs capable of multi-hop relay operation to relay messages between remote UEs and gNBs. While not all UEs may be used as relays, the large number of UEs of different types (mounted on vehicles, handheld, on drums) ensures sufficient coverage for all.

### 5.2.2 Pre-conditions

The factory uses a potentially large number of sensors, control panels (incl. e.g. AR goggles) and actuators, all of them equipped with UEs. We do not assume that all UEs have the same capabilities. Rather, different UEs are capable of e.g. different data rates, latencies etc. We do assume however that enough of the UEs (though not all) are capable of acting as relays for other UEs and those can act in a multi-hop relay environment. All UEs are capable of being relayed (i.e. being the remote UE).

We assume that at least one of the multi-hop relaying UEs is under coverage of at least one gNB though for better communication availability it is better if multiple gNB are in range of multiple UEs. Where are these gNB deployed (i.e. inside the factory or not) and how do they communicate with the external world are not the subject of this use case.

A factory App has been enabled by the MNO to indicate to the MN a permission to relay and or be relayed. The factory App interfaces to the MN and receives current accessibility status of all its UEs..

### 5.3.3 Service Flows

The owner of UEs which are capable to be used as relays has indicated to the MNO whether they may be used as such and the UEs whose traffic may be relayed. The MNO has authorized relay operation of UEs.

As each of the UEs is deployed it seeks to attach to an available network. A UE which has not successfully attached to a network tries to attach via an appropriate relaying UE. A UE which has successfully, either directly or via another UE, attached to a network makes itself available to relay to and from other UEs and the gNB and becomes a relaying UE.

An appropriate relaying UE has the capability of supporting the expected traffic characteristics required by the remote UE and has the permission and authorization to do so.

### 5.4.4 Post-conditions

Chains of relays are used to relay appropriate traffic to and from end UEs and ultimately a gNB. Different relays may be used depending on UE mobility and traffic requirements but service continuity is maintained as long as a relay path exists.

A remote UE is reachable and accessible if there exist a route from any gNB to the UE populated with appropriately authorized and QoS capable relay UEs.

The factory safety monitoring department receives updates regarding accessibility of UEs and can take corrective action when UEs become inaccessible.

### 5.5.5 Existing features partly or fully covering the use case functionality

### 5.6.6 Potential New Requirements needed to support the use case

General

The 5G system shall support the relaying of traffic between remote UEs and a gNB using a chain of UEs which have the capability of doing so.

The 5G system shall support an arbitrary number of hops.

The 5G system shall enable the MNO to limit the number of hops supported in the network.

Relay selection

The 5G system shall support the relaying of UE traffic through a chain of UEs which can support its intended traffic characteristics.

The 5G system shall support the relaying of UE traffic through a chain of UEs in a manner that minimizes the impact of the relaying on system performance.

Editor’s Note: System performance includes relays usage of resources, battery consumption, etc. and is FFS.

Permission and authorization

The 5G system shall enable the MNO to authorize UEs to be relayed by a chain of UEs.

The 5G system shall enable the MNO to authorize UEs to relay traffic in a chain of UEs to / from other UEs.

The 5G system shall support a mechanism to verify that the user of a UE has given permission to its being used as a relay in a relay chain.

Provisioning of remote UEs

The 5G system shall support the provisioning of remote UEs via an arbitrary number of relay hops.

Service

The 5G system shall maintain service continuity when remote UE traffic is relayed through a different chain of relays than the original.

The 5G system shall maintain service continuity when remote UE traffic is relayed to a different gNB.

Editor’s Note: The last requirement refers to the handover of the last relay in a chain of UE relays to a different gNB and may require further clarification.

Exposure

The 5G system shall provide a suitable API by which an authorized 3’rd party shall be able to provide the network with permission information of UEs.

The 5G system shall provide a suitable API by which an authorized 3’rd party shall be able to receive from the network information regarding the accessibility of UEs.

# 6 Traffic Scenarios

## 6.X Traffic Scenario Tittle

### 6.X.1 Description

### 6.X.2 Assumptions

### 6.X.3 Potential Key Performance Requirements

# 7 Considerations

## 7.1 Considerations on security.

## 7.2 Considerations on charging.

# 8 Consolidated requirements

## 8.1 Functional requirements

## 8.2 Performance requirements

# 9 Conclusions and recommendations

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| **11/2018** | **SA1#84** | **S1-183287** |  |  |  | * **- Added Scope** * **- Added new use case”** **Use case for enhancing coverage in industrial environments”** * **- Added Annex B “Use of Multihop Relay in Smart City and Community Services”** | **0.1.0** |

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Annex B:   
Use of Multihop Relay in Smart City and Community Services

With the development of smart phones, mobile payment, internet of things, and artificial intelligence in recent years, the new Internet is rapidly moving toward Internet of Everything (IoE). With the 3GPP progress toward 5G wireless systems, the next generation Internet of Everything shall seamlessly connect people (smart phones and wearables), smart vehicles, and smart wireless sensors in an enclosed community setup, and smart cities at large.

Smart city and community has been a hot topic for municipalities world-wide, however many issues still exist. Traditional city and community services have been based either on pure virtual community on Internet, or offline entity services in the real-world. Online to offline cannot make community services smart, unified, or integrated.

The future smart city and community are to connect every people, transportation/vehicles, retailers, and various infrastructures, through real-time sensor networks and edge computing. Through a comprehensive city and community-sensing system based on massive IoE and real-time information processing, it can integrate all data and intelligent services of smart city and community, and provide real-time visualization. At the same time, it can deliver a variety of IoE services to both consumers and municipalities.

Although individual segments including eMBB, mMTC (IoT), V2X, URLLC, etc. have been well studied in 3GPP, e.g., in the SMARTER, eV2X, and CAV, etc., IoE based smart city and community services shall provide an upgraded USER EXPERIENCE over any current IoT and eMBB applications. Therefore, it requires an interconnection and real-time processing of the individual segments to enable new services, where the use cases and related requirements have not been analyzed in 3GPP.

For example, in IoE based smart community, consumers shall be provided with intelligent services based on the real-time processing of IoE information from the sensors (things), vehicles, retailers and people, an integrated virtual scene environment that seamlessly combines the physical and virtual world.

Micro-environment services: by massive sensor networks covering the community areas, micro-environment data can be acquired in real-time. Localized and accurate environment data analysis and tracking can be provided to neighbouring users and interested consumers of the community.

Parking and transporting services: the IoE based smart community shall provide fully automatic vehicle parking and transportation, which will largely increase the space and time efficiency especially in dense urban living areas.

Elders and children services: the IoE based smart community shall provide services to elders and children who may not be used to modern smart phones and computers, such services shall help to maintain the safety and wellness of the particular population and provide any emergency alarm to caretakers.

Retailer services: the IoE based smart community shall provide consumers with an online-merge-offline experience of neighbourhood retailers, so that the real-time sight images, environment, merchant discounts are synchronized in the virtual scene, where consumers can also have enhanced shopping experience by the provide social media of real-time mixed reality.

In IoE based smart city, massive data representing real-time city IoE elements can be efficiently processed and merged to a virtual scene with accurate synchronization, which not only provides city management with intelligent real-time analysis and automatic controlling, but also an immersive on-site management experience.

Urban infrastructure management: urban infrastructure including electricity and water supply, street lights, garbage bins, etc., plays an important role in providing citizens with civilized living. Authorities shall provide effective monitoring and maintenance of such urban infrastructure facilities.

Environment and traffic management: environment and traffic conditions change dynamically in urban areas. Intelligent management closely monitors the real-time microscopic environment and traffic patterns, so as to identify any potential problems such as condensed pollution and major traffic jams. Traffic lighting, v2x services, and other environmental controlling mechanism can be trigger by the system, per authority policies.

Industrial park management: most industrial parks have problems such as difficulties in finding parking lots, and difficulties in visiting specific hosts. Intelligent management of industrial parks creates a mixed reality platform for smart vehicle parking, visitor guidance, and host hospitality.

Community management: in the urban community management, safety issues incur most concerns, crowd behaviour data shall be analysed in real-time through efficient edge computing and privacy control. Position tracking is provided to VIPs and any emergency or accidents shall be reported to any authorized recipients.

Tourism management: smart tourism management provides a real-time mixed reality platform for tourists to interact with real-world people, things, and merchants. It also provides authority with a real-time data view and intelligent analysis of the interested areas and attractions to the tourists.

For the future smart cities and communities, convenient, accurate, and high-quality services will be the key features for developing the standards of future city and community operation. Smart city management presents a potential killer application to government and business for 3GPP systems with IoE, and smart community presents a potential killer application to consumers. New business opportunities can be expected, where network operators could charge based on the QoS and number of connections instead of pure bandwidth. In particular, use cases of smart community shall provide an upgraded IoE user experience over any current mobile Internet (eMBB) services. And use cases of smart city shall be focused on the city’s concrete needs and provide enhanced management efficiency over any current IoT (mMTC) based solutions.

In most such use cases, an UE (e.g., a mobile phone or computing device, an IoT device, a servicing robot or autonomous vehicle, etc.) that presents either a smart city operator or controller, or a smart community consumer, shall be able to perform real-time information exchanging and distributed computing with any and all types of neighbouring UEs in close or large proximity, where the specific QoS granularity, traffic patterns, and proximity coverage range depend on individual use cases.

Multihop UE-to-UE and UE-to-Network communications can potentially become a straightforward way to support such traffics and applications. By studying the related use cases or traffic scenarios, new features of 5GS may be provided and quantified according to different levels of target user experience. Such new features may include any combination of the following features and functions: high density, real-time edge computing (network-controlled sidelinks), high data-rate, low latency, high reliability, high mobility, low power, high-precision positioning; where more detailed requirements on the multi-hop wireless in future 3GPP releases can be drawn based on it.

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