教育部「5G行動寬頻人才培育跨校教學聯盟計畫」

5G行動網路協定與核網技術聯盟中心

課程:5G垂直應用網路

單元7
5G垂直應用分析

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Outline

- eMBB應用分析
  - –TR22.863 Feasibility study on new services and markets technology enablers for Enhanced Mobile Broadband; Stage 1
- URLLC應用分析
  - –TR22.862 Feasibility study on new services and markets technology enablers for Critical Communications; Stage 1
- mMTC應用分析
  - –TR22.861 Feasibility study on new services and markets technology enablers for Massive Internet of Things; Stage 1

TR22.863
Feasibility study on new SMARTER for Enhanced Mobile Broadband

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   - Higher Data Rates
   - Higher Density
   - Deployment and Coverage
   - Higher User Mobility
   - Devices with highly variable data rates
   - Fixed Mobile Convergence
   - Femtocell deployments
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1. Scope

- The present document aims
  - to identify and document the use cases and consolidated potential requirements, and
  - to capture desired system requirements and capabilities to enable 3GPP network operators to support the needs of enhanced mobile broadband
- The focus of this work is on the use cases and requirements that cannot be met with EPS

Families for eMBB Scenarios

- Higher Data Rates
  - For peak, experienced, downlink, uplink, etc. data rates can be derived, as well as associated requirements pertaining to latency when applicable with UEs relative speed to ground up to 10 km/h (pedestrian)
- Higher Density
  - For the transport of high volume of data traffic per area (traffic density) or transport of data for high number of connections (devices density or connection density) with UEs relative speed to ground up to 60 km/h (pedestrian or users moving on urban vehicle)
- Deployment and Coverage
  - Considering the deployment and coverage scenario e.g. indoor/outdoor, local area connectivity, wide area connectivity, with UEs relative speed to ground up to 120 km/h

Families for eMBB Scenarios (Cont.)

- Higher User Mobility
  - With UEs relative speed to ground up to 1000 km/h
- Devices with Highly Variable Data Rates
  - For UEs having multiple applications which exchange small amount of data and large amount of data
- Fixed Mobile Convergence
  - Enabling combined use of fixed broadband (e.g. FTTx/xDSL) access and Next Generation Radio access network
- Femtocell Deployments
  - Deliver a seamless user experience to end users accessing operator services across any access network

Higher Data Rates – Traffic Scenarios

- In an office scenario, users uses real-time video meeting and frequently upload and download data from company's servers and they are various in size
  - The productivity is dependent on the efficiency of the system response time and reliability
- Dependent on time of day (e.g. morning, evening, weekday vs. weekend etc.) and the location (e.g. shopping mall, downtown street), user expects multi-media traffic upload and download towards internet as well as D2D communications
- Enable support of broadcast transmission of scheduled linear time Audio and Audio &Video programmes, e.g. 4K UHD with 3GPP device capability
  - An additional extension to capacity consideration for the virtual meeting user scenario should also be catered for adding latency requirement
- To compete with wired offerings (e.g. cable), and to offer home offices sufficient data rates, the 3GPP system must support peak data rates of tens of Gbps and experienced data rates of up to 1 Gbps for residential users
  - To simplify network planning and deployment, it should be possible to limit the coverage for each subscription
  - Such approach is known as WLL (Wireless Local Loop), where the last mile is delivered wirelessly

Higher Data Rates – Potential Service Requirements

- [PR.5.1.3.1-001] The 3GPP system shall support the user experienced data rate up to Gbps DL and 500 Mbps UL while the user is moving slowly up to 10 km/h
- [PR.5.1.3.1-002] The 3GPP system shall support the peak data rate per user at [10] Gbps while the user is moving slowly up to 10 km/h
- [PR.5.1.3.1-003] The 3GPP system shall be able to support user experienced broadcast data rate up to [300Mbps] (e.g. video streams such as 4k UHD or 8k UHD)
- [PR.5.1.3.1-004] The 3GPP system shall be able to support at least [15] broadcast channels of [20Mbps] each simultaneously over the same carrier
- [PR.5.1.3.1-005] The 3GPP system shall be able to provide roundtrip delay including coding/decoding in the magnitude of 10-12ms and be able to provide bandwidth capable of running an 8k 3D video streaming [250Mbps] for uplink and downlink
- [PR.5.1.3.1-006] The 3GPP system shall support residential deployment with high peak [10s of Gbps] and experienced data rates [up to 1 Gbps]
- [PR.5.1.3.1-007] The 3GPP system shall support residential deployment with a latency of [10 ms]

Higher Density – Traffic Scenarios

- In an office scenario, users frequently upload and download data from company's servers and uses interactive applications e.g. real time video communications with colleagues. Users are expected to be indoor
- In a hotspot scenario with high user density, depending on time of day (e.g. morning, evening, weekday vs. weekend etc.) and the location (e.g. pedestrians in shopping mall, downtown street, stadium, users in buses in dense city centre), there could be high volume and high capacity multi-media traffic upload and download towards internet
  - Users can be either indoor or outdoor
  - Meanwhile when a user is indoors, it is either stationary or nomadic; however, when a user is outdoor it may travel slowly up to 60 km/h
- Mobile broadband scenario is to be provided even when terminals enter areas with a high traffic density

Higher Density – Potential Service Requirements

- [PR.5.2.3.1-001] The 3GPP system shall support the aggregate traffic volume in the area at least the level of Tbps/km^2 to support case of traffic
  - for pedestrians (up to 10 km/h) and users in urban vehicle (up to 60 km/h),
  - in 200-2500/km^2 connection density

- [PR.5.2.3.1-002] The 3GPP system shall provide guaranteed per user experience for mobile broadband like live video in areas with a high UE density which requires user experienced
  - data downlink rate of 300Mbps and uplink rate of 50Mbps
  - in 200-2500/km^2 connection density

- [PR.5.2.3.1-003] The 3GPP system shall provide guaranteed user experience for mobile broadband services like live video in areas with a high UE density which requires user experienced
  - data downlink rate of 120Mbps and uplink rate of 50Mbps
  - in 200-2500 /km^2 connection density
  - with user velocities in the range of 0-60 km/h

Deployment and Coverage – Traffic Scenarios

- Small Area Connectivity
  - Small area connectivity covers e.g. an office scenario where the users and their serving nodes are expected to be deployed indoors
  - In an education environment virtual presence can give a remote student real time 360° video communication with their classmates and teacher
    - The coverage area per each serving node is small
  - In office, users do real-time video meeting and frequently upload and download data from company's servers and they are various in size which could be up to terabit of data
- Wide Area Connectivity
  - As a basic scenario of mobile communications, the seamless wide-area coverage scenario aims to provide seamless service to users
  - Satellite based access is one way to complement terrestrial based networks to ensure ubiquitous, 100% geographic coverage
  - This is specifically true for geographic areas where it is extremely difficult or in some cases impossible to deploy terrestrial based access networks
    - For example, maritime services, coverage on lakes, islands and mountains or other recreational areas that can only be covered by the satellites

Deployment and Coverage – Traffic Scenarios (Cont.)

- Wireless Local Loop
  - In urban and rural areas residents are accustomed to fast wired Internet access
  - To compete with wired offerings (e.g. cable), and to offer home offices sufficient data rates, the 3GPP system must support peak data rates of tens of Gbps and experienced data rates of up to 1 Gbps for residential users
  - To simplify network planning and deployment, it should be possible to limit the coverage for each subscription
  - Such approach is known as WLL (Wireless Local Loop), where the last mile is delivered wirelessly
- Extreme Coverage in Low Density Areas
  - The provision of Broadband Access Everywhere over long distances for Low density areas (extreme rural area) including both humans and machines shall be supported
  - The key characteristics of this scenario are Macro cells with very large area coverage supporting data rates (up to [2] Mbps for stationary devices and up [384] kbps for moving devices), voice services and all necessary control channels assuming a propagation distance of [100 km] and low user density

Deployment and Coverage – Potential Requirements

- Potential Service Requirements
  - [PR.5.3.3.1-001] For wide area coverage, the system shall support a minimum experienced data rate per user for mobile broadband anytime and anywhere, e.g., 100Mbps, with the user velocity up to 120 km/h
  - [PR.5.3.3.1-002] For Extreme coverage in low population density areas, the system shall support cells with very large area coverage for a propagation distance of 100 km
- Potential Operational Requirements
  - [PR.5.3.3.2-001] The 3GPP system shall enable support up to 100% geographic area as part of wide area connectivity (one way shall be via satellite access)
    - Note that the 100% geographic area refers to the entire area allowed to be covered by the spectrum license and could be regional or global
  - [PR.5.3.3.2-002] The 3GPP system shall support residential deployment with service limited to a pre-defined geographic area

Higher User Mobility – Traffic Scenarios

- Enhanced mobile broadband in fast moving vehicles
  - Enhanced mobile broadband is enabled seamlessly to the users in fast moving road vehicles (up to 200 km/h)
    - The example user applications include in-vehicle entertainment, accessing the internet, enhanced navigation through instant and real-time information, safety and vehicle diagnostics
- Enhanced mobile broadband in fast moving trains
  - Enhanced mobile broadband is enabled seamlessly to the users in fast moving trains (up to 500 km/h) in various regions for inter-city transport
  - While travelling, passengers will use high quality mobile Internet for information, interaction, entertainment or work
    - Examples are watching a HD movie, gaming online, accessing company systems, interacting with social clouds, or having a video conference
- Enhanced connectivity services in fast moving airplanes
  - Enhanced connectivity services are enabled seamlessly to the users in fast moving aircrafts (up to 1000 km/h)
    - Typical aircraft routes are up to 12 km in altitude, while other objects like helicopters will usually fly at much lower altitudes
  - In these use cases the licensed mobile frequency bands are used between aircrafts and ground

Higher User Mobility – Example User Experience and System Performance KPI's

Traffic scenario	User Experienced Data Rate	Connection Density	Traffic Density
Mobile broadband in vehicles (cars, trains): up to 500 km/h	DL: 50 Mbps UL: 25 Mbps	2000 / km^2	DL: 100 Gbps / km^2 UL: 50 Gbps / km^2
Airplanes connectivity: up to 1000 km/h	DL: 15 Mbps per user UL: 7.5 Mbps per user	80 per plane 60 airplanes per 18,000 km^2	DL: 1.2 Gbps / plane UL: 600 Mbps / plane

Higher User Mobility – Potential Requirements

- [PR.5.4.3-001] The 3GPP system shall support mobile broadband to users in fast moving road vehicles up to 200 km/h and trains 500 km/h
  - User experienced data rate up to 50 Mbps per user at DL and 25 Mbps per user at UL
- [PR.5.4.3-002] The 3GPP system shall support mobile broadband to base stations/relays in fast moving road vehicles up to 200 km/h and trains 500 km/h
  - User experienced data rate up to 50 Mbps per user at DL and 25 Mbps per user at UL
- [PR.5.4.3-003] The 3GPP system shall support mobile broadband to users in airplanes (up to 1000 km/h)
  - User experienced data rate up to 15 Mbps per user at DL and 7.5 Mbps per user at UL
- [PR.5.4.3-004] The 3GPP system shall support enhanced connectivity services to base stations/relays in fast moving airplanes (1000 km/h) with enhanced user experience
  - User experienced data rate up to 15 Mbps per user at DL and 7.5 Mbps per user at UL
- [PR.5.4.3-005] The 3GPP system shall be able to provide the mobile broadband in fast moving road vehicles and trains
  - Traffic density of up to 100 Gbps / km2 at DL, and 50 Gbps / km2 at UL
- [PR.5.4.3-006] The 3GPP system shall be able to provide fast moving airplanes connectivity
  - Traffic density of up to 1.2 Gbps / airplane at DL and 600 Mbps / plane at UL

Devices with Highly Variable Data Rates – Traffic Scenarios

- A device sends small amounts of data
- The system is able to accept data transmission without the necessity for a lengthy and signalling intensive procedure
- As a result the system avoids both a negative impact to battery life for the device and a wasting of signalling resources
- At other times the device needs to transmit or receive a large amount of data (e.g., video) and may use an optimized procedure for the purpose

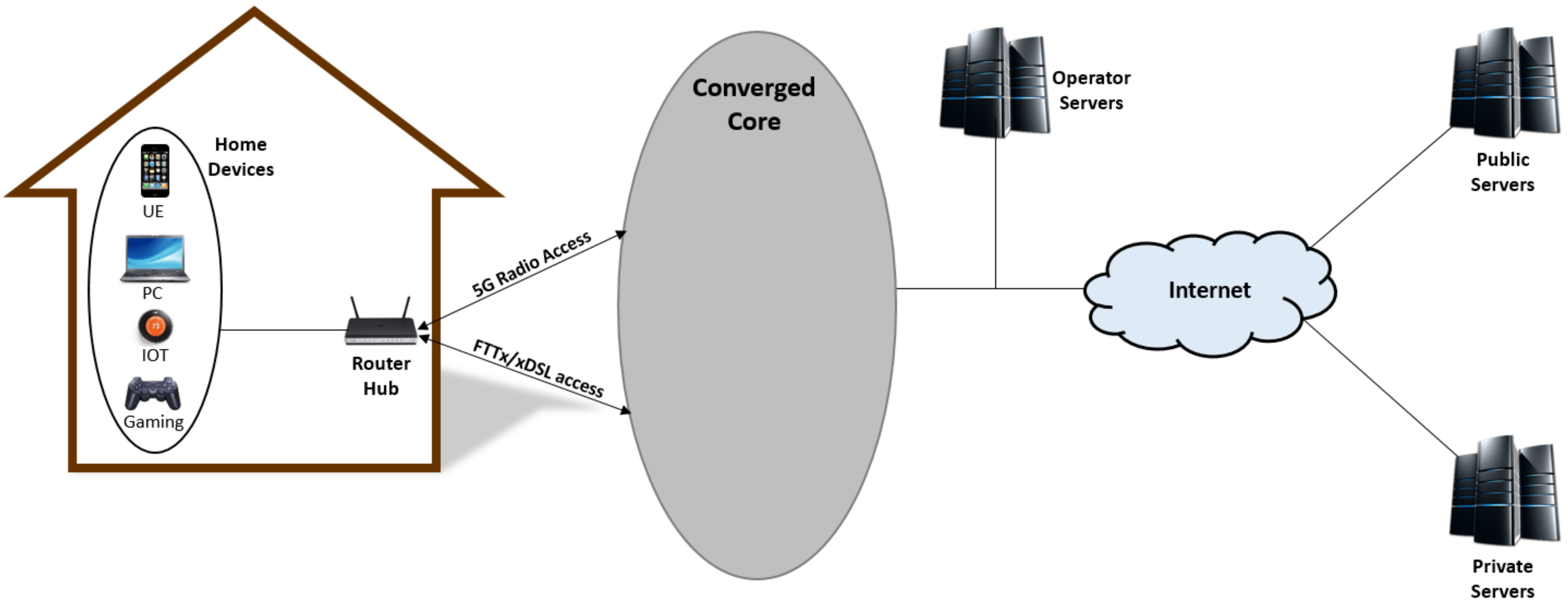
Devices with Highly Variable Data Rates – Potential Requirements

- [PR.5.5.3-001] The 3GPP System shall be efficient and flexible for transmission of both small and large amounts of data (e.g., streaming video) from the same device
- [PR.5.5.3-002] The 3GPP system shall minimize signalling overhead e.g. for security needed for transmission of small amounts of data without reducing its level of security

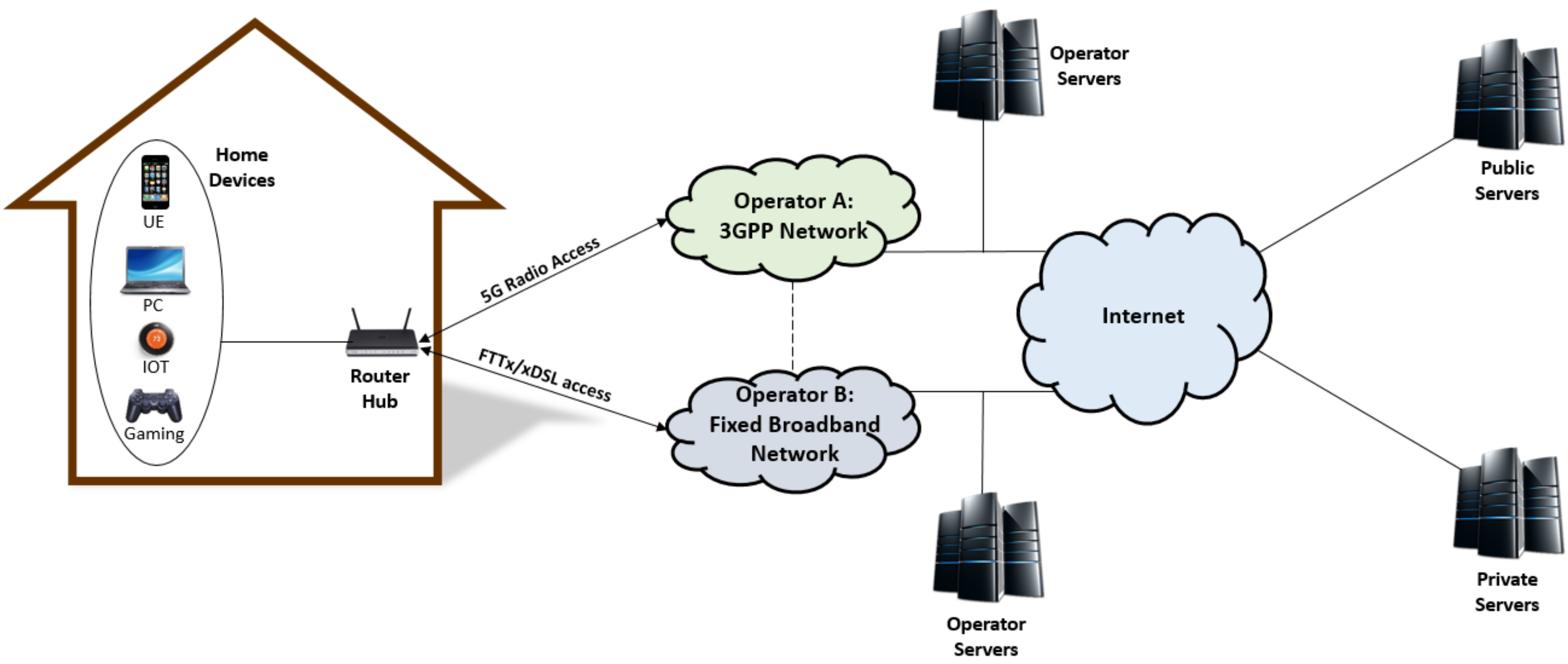
Fixed Mobile Convergence – Overview of Scenarios

- Today a large number of residential or business users rely on fixed broadband (FTTx/xDSL) technology and MBB technology for accessing public Internet and private networks for their day-to-day use
  - Users should be able to intelligently combine both fixed and mobile access in a number of ways to meet their future needs
- In the scenario where users need ultra-high data rates for future applications, traffic originated to/from their devices in the home or in the office should be able to send/receive across both fixed broadband and Next Generation Radio access either simultaneously or individually
  - It may be possible for the 3GPP system to specify network control policies to manage fixed broadband and Next Generation Radio access as primary/secondary access type and dependent on the type of applications, time-of-day, location, type of user, type of end device and state of the network
  - User traffic may be operator provided services, customer's own services (e.g. corporate) or third party services (e.g. OTT)

Converged Access – Single Operator Scenario



Converged Access –
Two Separate Operators Scenario



Fixed Mobile Convergence – Traffic Scenarios

- Scenario 1 – Simultaneous use of next generation radio and fixed broadband access
  - This traffic scenario allows constant and simultaneous use of both fixed broadband access and Next Generation Radio access in such a way that the end result data rate is close to the sum of both fixed and 5G data rates (>90%)
  - It is assumed that a common implementation of this functionality would be to only use the cellular access when it is required i.e. for traffic peaks, as a load-balancing mechanism, or as a top-up as per operator policy
- Scenario 2 – 5G access as bandwidth boost
  - This traffic scenario allows the on-demand use of Next Generation Radio access to provide bandwidth boost to fixed broadband access
  - Users can trigger the bandwidth demand according to type of applications, time of day and type of Ues
    - This allows users to control their tariffs and increase their QoE
  - For Operators it enables the ability to increase revenues by upselling dynamic and temporary on-demand bandwidth for a specific time duration
    - As a minimum, users should have the ability select on-device turbo boost purchases via a smartphone app/webpage portal

Fixed Mobile Convergence – Traffic Scenarios (Cont.)

- Scenario 3 – 5G access as failover
  - Use of Next Generation Radio access as failover mechanism in the case where fixed broadband goes out of service
- Scenario 4 – 5G access as fast provision
  - Use of Next Generation Radio access as fast provision service whilst users wait for their fixed broadband to be deployed or activated
- Scenario 5 – Symmetric bandwidth
  - This traffic scenario provides the end user with the same high data rates in the upstream direction as in the downstream direction
  - The faster uplink speeds can be used for cloud services, media and photo upload, etc.

Fixed Mobile Convergence – Potential Requirements

- [PR.5.6.3-001] The 3GPP system shall be able to deliver the aggregate throughput and speed of the FTTx/xDSL and Next Generation Radio access in both UL and DL directions to all traffic types and 3rd party applications
- [PR.5.6.3-002] The 3GPP system shall support wide area coverage (urban and rural) to enable the combined use of Next Generation Radio access and fixed broadband access
- [PR.5.6.3-003] The 3GPP system shall support very high reliability to enable the combined use of Next Generation Radio access and fixed broadband access
- [PR.5.6.3-004] The 3GPP system shall support very high availability to enable the combined use of Next Generation Radio access and fixed broadband access
- [PR.5.6.3-005] The 3GPP system shall support very high density deployment of the combined use of Next Generation Radio access and fixed broadband access
- [PR.5.6.3-006] The 3GPP system shall support the use of common user equipment (e.g. router hub at customer premises) that support Next Generation Radio and fixed broadband access

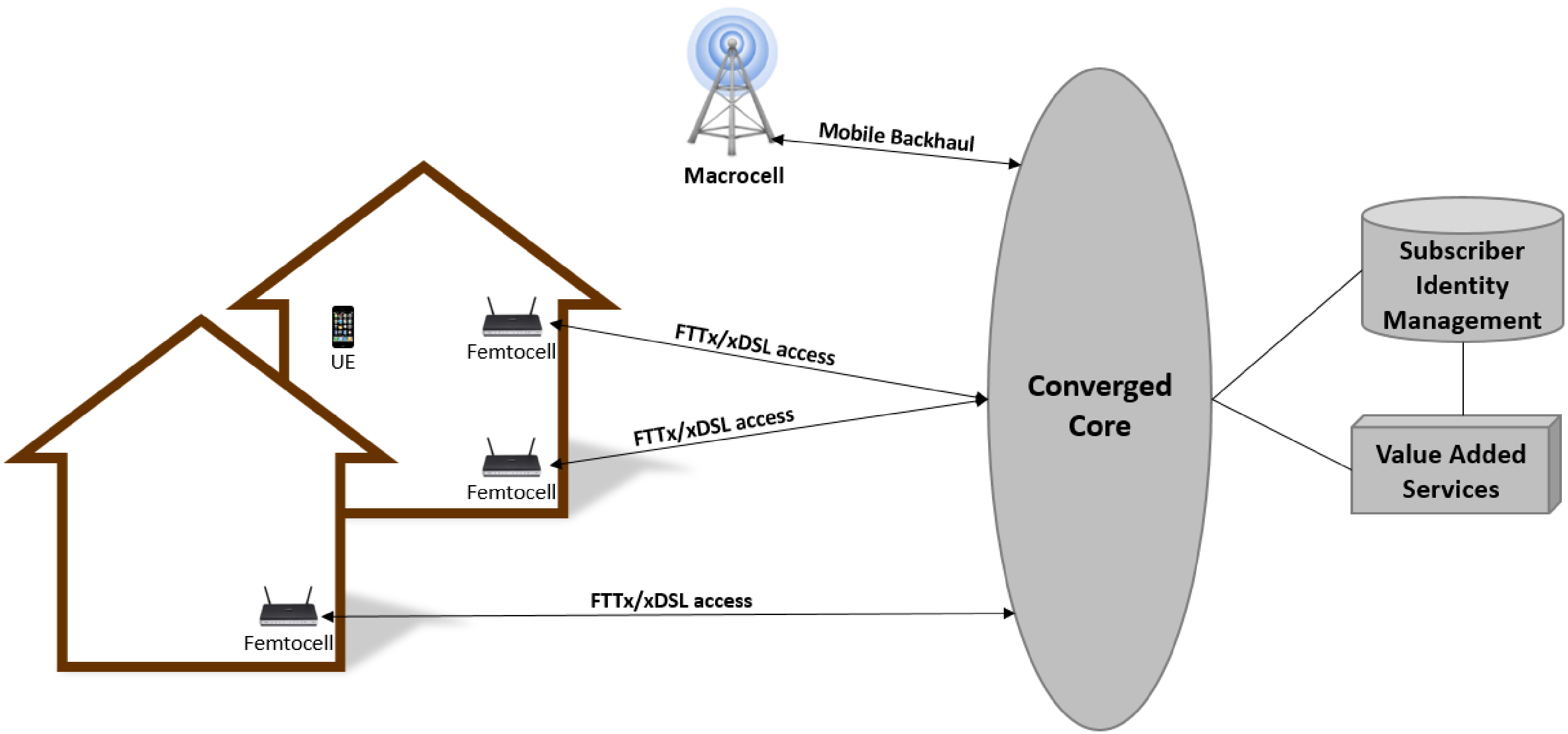
Fixed Mobile Convergence – Potential Requirements (Cont.)

- [PR.5.6.3-007] The 3GPP system shall support dynamic and static network address allocation to the common user equipment over Next Generation Radio and fixed broadband access
- [PR.5.6.3-008] The 3GPP system shall support all traffic types over the combined use of Next Generation Radio access and fixed broadband access
- [PR.5.6.3-009] The 3GPP system shall support the option for Operators to provide the same level of security over the FTTx/xDSL link as is provided over the Next Generation Radio access link
- [PR.5.6.3-010] The 3GPP system shall support legal obligations and accounting in the combined use of Next Generation Radio and fixed broadband access
- [PR.5.6.3-011] The 3GPP system shall provide a generic protocol that has a minimum overhead that can handle per packet or per flow scenarios
- [PR.5.6.3-012] The 3GPP system shall support a flexible geographical distribution of the functional elements in the converged core and the operator services platforms, allowing for the FMC scenarios described in this document to be supported on any geographical deployment

Femtocell Deployments – Overview of Scenarios

- Today a large number of residential and business users rely on fixed broadband (FTTx/xDSL) technology and MBB technology for accessing public Internet and private networks for their day-to-day use
  - The 5G ecosystem will comprise of Macrocells, Picocells and Femtocells
  - It should be possible for the 3GPP system to identify users, make decisions about access type and provide a single set of services across both fixed and mobile accesses
- It should be possible for an Operator to deploy any type of Small Cell, including Femtocells, over fixed broadband service to the customer premises, sharing traffic with e.g. public Internet or private VPN traffic
  - Fixed broadband technologies (FTTx/xDSL) will be essential for Operators to provide backhaul capabilities for Femtocell deployments
  - This should be implemented in a manner where mobile broadband and fixed broadband traffic can both be identified, anchored, policed, billed and managed in the same way from a converged core network
  - A consistent set of Value Added Services should also be applied over fixed and broadband access regardless of whether the customer is using the cellular or direct wired/wireless connectivity to the fixed broadband router
  - Access to Local Area Network services (e.g. peripherals, content servers) shall also be possible from the Small Cell deployed in the Customer Premises

Femtocell Deployments



Femtocell Deployments – Traffic Scenarios

- Scenario 1 – Unified set of identities
  - An Operator shall be able to manage a unified set of identities for a single user in order to consolidate subscriber data to allow seamless access across fixed and cellular access networks, including cellular access over fixed broadband as described in the scenarios section
- Scenario 2 – Consistent set of policies
  - An Operator may provide a consistent set of policies to a user/s across all networks (e.g. QoS and traffic management policies), including cellular access over fixed broadband as described in the scenarios section
- Scenario 3 – Access to a single set of services
  - Once an Operator has identified a user, it may then grant that user access to a single set of services (e.g. VAS, parental controls, content, content optimisation and access to local services when appropriate) when using cellular, fixed or cellular over fixed broadband access as described in the scenarios section
  - This has the advantage for the Operator to consolidate services, and for the end user with regards to consistency of service offering across all access types
- Scenario 4 – Access local area network services
  - The end user shall be able to access local area network services (e.g. peripherals, content servers etc.) when connected to the Small Cell at the Customer Premises

Femtocell Deployments – Potential Requirements

- [PR.5.7.3-001] The 3GPP system shall support
  - Use of common user equipment (e.g. Femtocell at customer premises) that supports Next Generation Radio, WiFi and fixed broadband access
- [PR.5.7.3-002] The 3GPP system shall support
  - Convergence of fixed and mobile network in such a way that the converged core shall support 3GPP access (Femtocell, Microcell & Macrocell) and other access technologies including Wifi and fixed broadband access
- [PR.5.7.3-003] The 3GPP system shall support
  - Seamless mobility and service continuity between Macrocell to Femtocell, Femtocell to Macrocell and Femtocell to Femtocell
- [PR.5.7.3-004] The 3GPP system shall support
  - Service specific QoS policies, i.e. a distinction between
    - Services which require a dedicated radio resource (e.g. LTE dedicated bearer) or
    - Services which require prioritisation over the non 3GPP access (e.g. a WMM session)

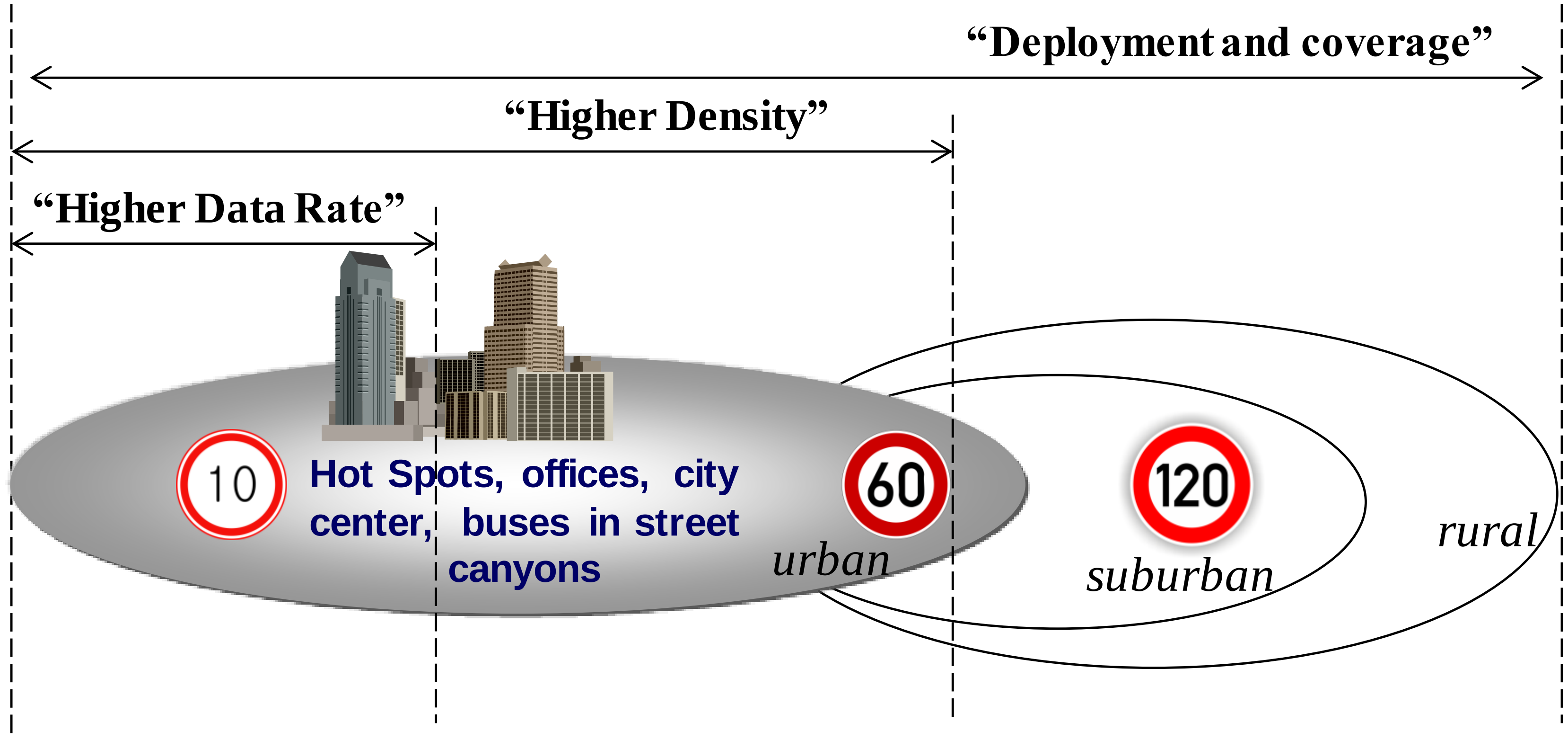
Femtocell Deployments – Potential Requirements (Cont.)

- [PR.5.7.3-005] The 3GPP system shall support
  - A unified set of identities for a single user in order to consolidate subscriber data to allow seamless access across fixed and cellular access networks, including cellular access over fixed broadband
- [PR.5.7.3-006] The 3GPP system shall provide
  - A consistent set of policies to a user/s across all networks (e.g. QoS and traffic management policies), including cellular access over fixed broadband
- [PR.5.7.3-007] The 3GPP system shall support
  - Identification of a user, the ability to grant that user access to a single set of services (e.g. VAS, parental controls, content, content optimisation and access to local services when appropriate) when using cellular, fixed or cellular over fixed broadband access
- [PR.5.7.3-008] The 3GPP system shall support
  - The end user accessing local area network services (e.g. peripherals, content servers etc.) when connected to the Small Cell at the Customer Premises

Considerations on Security

- The 3GPP system shall minimize security signalling overhead needed for transmission of small amounts of data without reducing its level of security
- The 3GPP system shall support the option for Operators to provide the same level of security over fixed broadband access link as is provided over the Next Generation Radio access link
- The 3GPP system shall support regulatory requirements in the combined use of Next Generation Radio and fixed broadband access

Comparison of Use Cases



- Use cases from eMBB families 1, 2 and 3 are in "black" text

eMBB Use Cases and NGMN Use Cases

MBB Family	Higher Data Rate		Higher Density	Deployment and Coverage
Speed	Pedestrian (upto10 km/h) in small areas: offices, stadium		Pedestrian or vehicle up to 60 km/h	Pedestrian or vehicle up to 120 km/h
Data Rate	Everywhere: minimum 100 Mbps ("DL" is missing) (NGMN: 50+ Mbps)		Everywhere: minimum 100 Mbps ("DL" is missing) (NGMN: 50+ Mbps)	Everywhere: minimum 100 Mbps ("DL" is missing) (NGMN: 50+ Mbps)
	A) Peak rate: 10 Gbps, experience rate: up to Gbps (value missing) B) Missing: experienced rate 1 Gbps DL, total 17 Tbps/km^2 (UL+DL)	Experienced rate (stadium) DL 25Mbps UL 50Mbps $\rightarrow$ missing in eMBB TR Total 12 Tbps/km^2 (UL+DL)	Guaranteed exper. rate: 300Mbps DL/50Mbps UL (same in NGMN) Total: 1 Tbps/ km^2	
Density	A) Missing : <200/km^2 connections B) 75000/km^2 connections	150000/km^2, 30000/stadium	200-2500/km^2 connections (in line in NGMN)	400 /km^2 connections (suburban) 100/km^2 connections (rural)
NGMN Category	A) Not in NGMN but in ITU-.M2083 B) Matches with #2 "Indoor Ultra-high Broadband Access"	matches with #3 "Broadband Access in a Crowd"	#1 "Broadband access in dense area"	#4 "50+ Mbps everywhere"

- New values are in "green",Use cases from NGMN are in "blue" text

Conclusion and Recommendations

A number of use cases have been identified for eMBB service support over 3GPP system

- Higher Data Rates
  - This family focuses on identifying key scenarios from which eMBB primary data rate requirements for peak, experienced, downlink, uplink, etc. data rates can be derived, as well as associated requirements pertaining to latency when applicable with UEs relative speed to ground up to 10 km/h (pedestrian)
- Higher Density
  - This family covers scenarios with system requirement for the transport of high volume of data traffic per area (traffic density) or transport of data for high number of connections (devices density or connection density) with UEs relative speed to ground up to 60 km/h (pedestrian or users moving on urban vehicle)
- Deployment and Coverage
  - This family covers scenarios with system requirement considering the deployment and coverage scenario e.g. indoor/outdoor, local area connectivity, wide area connectivity, with UEs relative speed to ground up to [120] km/h

Conclusion and Recommendations (Cont.)

- Higher User Mobility
  - This family focuses on identifying key scenarios from which eMBB mobility requirements can be derived, with UEs relative speed to ground up to 1000 km/h
- Devices with Highly Variable Data Rates
  - This family focuses on identifying key scenarios from which eMBB requirements can be derived, for UEs having multiple applications which exchange small amount of data and large amount of data
- Fixed Mobile Convergence
  - This family focuses on identifying key scenarios to enable combined use of fixed broadband (e.g. FTTx/xDSL) access and Next Generation Radio access network
- Femtocell Deployments
  - This family focuses on identifying key scenarios to enable use of fixed broadband (e.g. FTTx/xDSL) access and Next Generation Radio access network for femtocell deployments

Outline

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TR22.862
Feasibility study on new SMARTER for Critical Communications

1. Scope
2. References
3. Definitions, symbols and abbreviations
4. Overview
5. Use Case families
   - Higher reliability and lower latency
   - Higher reliability, higher availability and lower latency
   - Very low latency
   - Higher User Mobility
   - Higher accuracy positioning
   - Higher availability
   - Mission critical services
6. Considerations
7. Conclusion and Recommendations

TR 22.862 Scope

TR 22.862 - Feasibility study on new services and markets technology enablers for critical communications; Stage 1 (15.0.0)

- The present document covers Critical Communications
- The requirements of Critical Communications
  - Latency
  - Reliability
  - Availability
- These requirements can be met with
  - Improved radio interface
  - Optimised architecture
  - Dedicated core
  - Radio resources

Definitions

Availability (%)	Percentage value of the amount of time the 3GPP system is delivering services divided by the amount of time it is expected to deliver services in a specific area
Reliability (%)	The amount of sent network layer packets successfully delivered to a given node within the time constraint required by the targeted service, divided by the total number of sent network layer packets
Service continuity	The uninterrupted user experience of a service that is using an active communication when a UE undergoes an access change without, as far as possible, the user noticing the change

Overview

- The objective of this study is to develop use cases and identify potential service and operational requirements to enable 3GPP network operators to support Critical Communications

- The following use case families have been identified in 3GPP TR 22.891 in the area of Critical Communications
  - Higher reliability and lower latency
  - Higher reliability, higher availability and lower latency
  - Very low latency
  - Higher accuracy positioning
  - Higher availability
  - Mission Critical Services

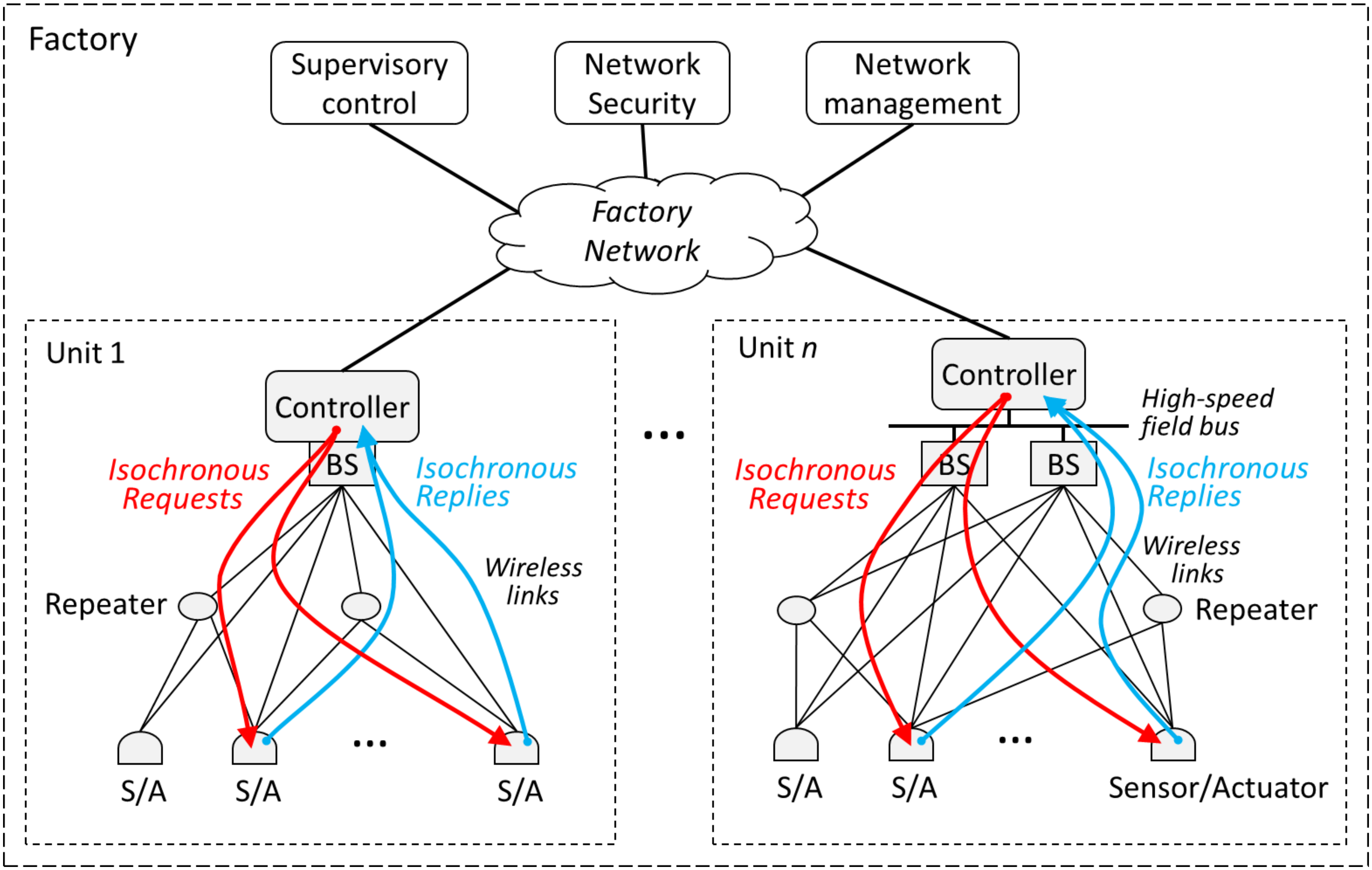
Families for uRLLC Scenarios

- Higher reliability and lower latency
- Higher reliability, higher availability and lower latency
- Very low latency
- Higher accuracy positioning
- Higher availability
- Mission Critical Services

Higher Reliability and Lower Latency – Traffic Scenarios : Industrial Factory Automation

- Industrial factory automation requires communications for closed-loop control applications
- In a closed-loop control application, the controller periodically submits instructions to a set of sensor/actuator devices, which return a response within a cycle time
- The considerations of closed-loop factory automation
  - Limitation to short-range communications
  - Use of direct device connection between the controller and actuators
  - Allocation of licensed spectrum for closed-loop control operations
  - Reservation of dedicated air-interface resources for each link
  - Combining of multiple diversity techniques to approach the high reliability target within stringent latency constraints
  - Utilizing OTA time synchronization to satisfy jitter constraints for isochronous operation
  - Network access security used in an industrial factory deployment is provided and managed by the factory owner

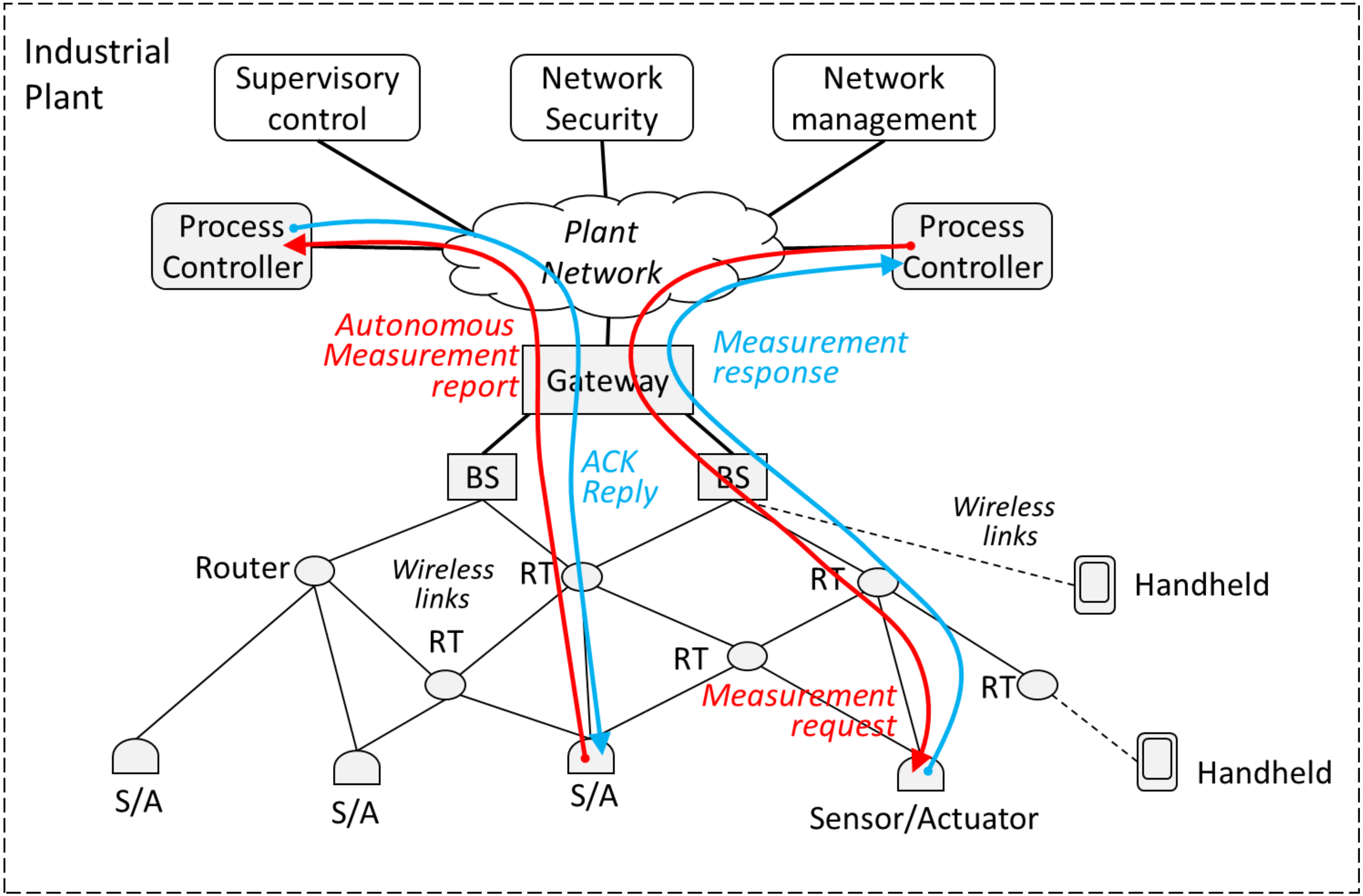
Communication Path for Isochronous Control Cycles within Factory Units



Higher Reliability and Lower Latency – Traffic Scenarios : Industrial Process Automation

- Process automation requires communications for both supervisory and open-loop control applications in industrial plant
- The large number of sensors and the high deployment complexity of wired infrastructure due to the sizable extension of the plant
- High growth rates are expected in the migration from wireline to wireless solutions for industrial process manufacturing
- The use of licensed spectrum could overcome the vulnerability to same-band interference and therefore enable higher reliability
- Multi-hop topologies can provide range extension and mesh topologies can increase reliability through path redundancy

Communication Path for Service Flows Between Process Controllers and Sensor/Actuator Devices



Higher Reliability and Lower Latency – Traffic Scenarios : Ultra-Reliable Communications

- Mission critical communication services require preferential handling compared to normal telecommunication services
- Examples of mission critical services
  - Industrial control systems
  - Mobile Health Care, remote monitoring, diagnosis and treatment
  - Real time control of vehicles, road traffic, accident prevention
  - Wide area monitoring and control systems for smart grids
  - Communication of critical information with preferential handling for public safety scenarios
  - Multimedia Priority Service (MPS) providing priority communications to authorized users for national security and emergency preparedness

Example mission critical use cases

Sample use case	Description	Critical requirements
Substation protection and control	Automates fault detection and isolation to prevent large scale power outage	• Latency: as low as 1 ms end-to-end • Packet loss rate: as low as 10^{-4} • Transmission frequency: 80 samples/cycle for protection applications. 256 samples/cycle for quality analysis and recording • Data rate: ~12.5 Mbps per MU at 256 samples/cycle • Range: provide coverage to the substation
Smart grid system with distributed sensors and management	A smart grid system aims at improving the efficiency of energy distribution and requires prompt reaction in reconfiguring the smart grid network in response to unforeseen events	Performance requirements are derived from EC FP7 project METIS Deliverable D.1.1 [4]: • Throughput: from 200 to 1521 bytes reliably (99,999 %) delivered in 8 ms • One trip time latency between any two communicating points should be less than 8 ms for event-triggered message that may occur anytime • Device density -- dense urban hundreds of UEs per km^2 -- urban around 15 UEs per km^2 -- populated rural max 1 UE per km^2
Public Safety	Operation of first responders in case of fire or other kind of emergency situation	Public Safety requires preferential handling of its traffic Requires the ability to support dynamic allocation of quality of service, priority and pre-emption parameters including: • Access Class (AC) • Quality of Service Class Identifier (QCI) • Allocation and Retention Priority (ARP) • Guaranteed Bit Rate (GBR) • Aggregate Maximum Bit Rate (AMBR) • Differentiated Services Code Point (DSCP)
Multimedia Priority Service (MPS)	Priority communications to authorized national security and emergency preparedness (NS/EP) users in times of disasters and emergency	MPS requires preferential handling, and priority treatment

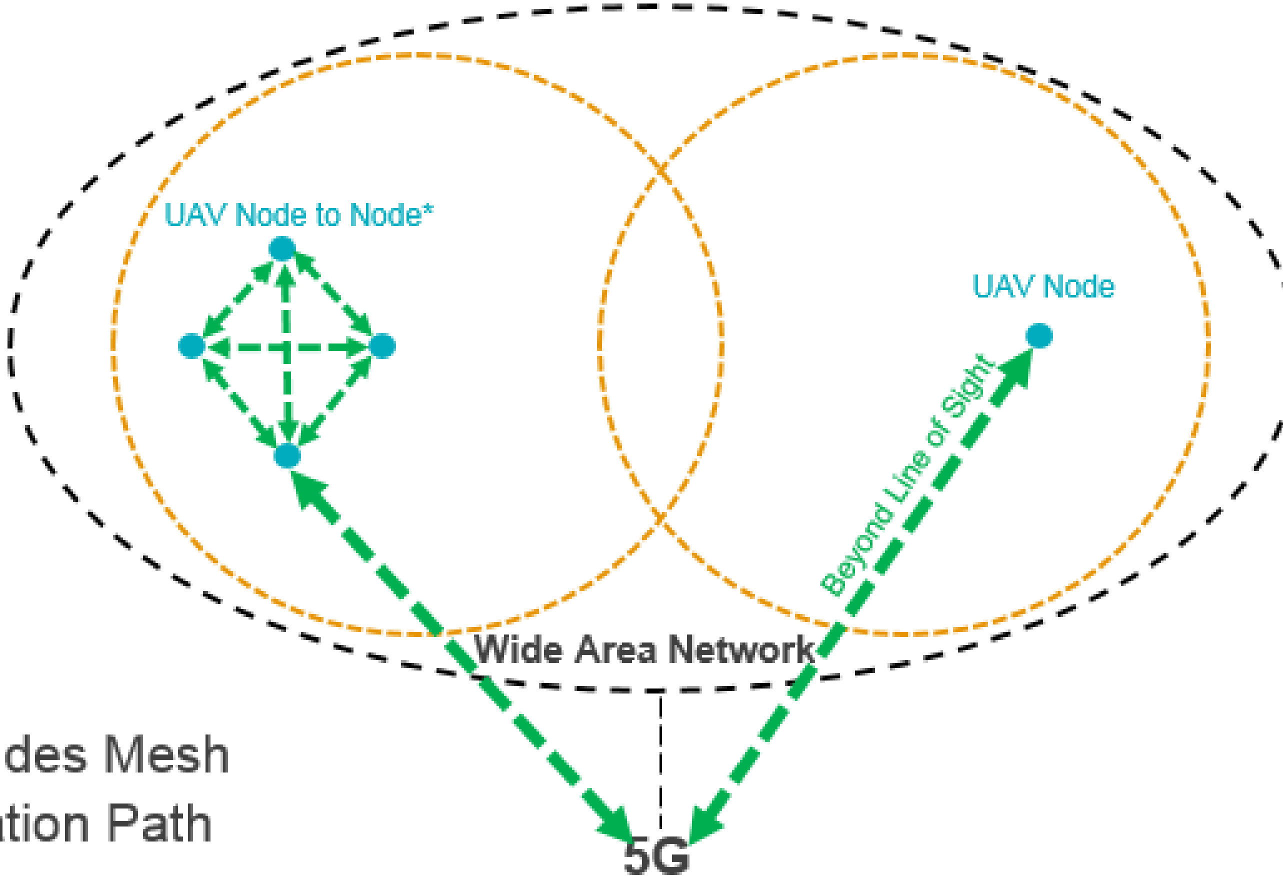
Higher Reliability and Lower Latency –Traffic Scenarios : Speech, Audio and Video in Virtual and Augmented Reality

- Voice communication is used in a highly interactive environment
- The voices of participants must be transmitted as quickly as visual information related to the environment
- The latency requirements for video including encoding and decoding are derived from human perception should be less than 10 ms
- Augmented reality, virtual reality, and three-dimensional (3D) services will be among the services which play an increasingly significant role in the 2020+ timeframe

Higher Reliability and Lower Latency – Traffic Scenarios : Local UAV Collaboration and Connectivity

- Unmanned Aerial Vehicles (UAVs) can collaborate to act as a mobile sensor and actuator network
- Examples of uses for deploying a team of UAVs
  - Searching for an intruder or suspect
  - Continual monitoring of natural disasters
  - Performing autonomous mapping
  - Collaborative manipulation of an object

Communication Path



- Node

* Node to Node includes Mesh

– Communication Path

Higher Reliability and Lower Latency – Potential Requirements

- The 3GPP system shall support industrial factory deployment
  - security
    - ID management
    - Authentication
    - Confidentiality and integrity
  - scalability
    - Large number of sensors and actuators
    - Transaction range improving
- The 3GPP system shall provide significant improvements compared to UMTS, EPS, and Wi-Fi
  - End-to-end latency
  - Ubiquity
  - Security
  - Availability
  - Reliability

Higher Reliability, Higher Availability and Lower Latency – Traffic Scenarios

- Industrial Control
  - Traditionally industrial control applications have relied on wired connections, or proprietary or tailored wireless solutions
  - A wired connection is subject to tear and wear also impacts the mechanical design of the machines to be controlled
  - Proprietary wireless solutions may suffer from the lack of globally available frequency bands
- High Reliability, High Availability, High Mobility
  - The telemedicine will increasing the survival rate of patient
  - Cloud-based services can be used to provide anytime and anywhere in order to support advanced telemedicine
  - Fast and seamless handover between different technologies is crucial since the ambulance may be dispatched to a remote location that does not have the same coverage and available RAT

Higher Reliability, Higher Availability and Lower Latency – Potential Requirements

- [PR 5.2.3-004] The 3GPP system shall support high uplink data rate (tens of Mbps per device in a dense environment)
- [PR 5.2.3-005] The 3GPP system shall support local processing of the traffic
- [PR 5.2.3-006] The 3GPP system shall support low latency and high throughput (100 Mbps) even in the high mobility scenario (e.g. up to 120 km/h)
- [PR 5.2.3-007] The 3GPP system shall support service continuity in the high mobility scenario
- [PR 5.2.3-008] The 3GPP system shall support ultra-high reliability (99,999 % or higher) [3][4] even in the high mobility scenario
- [PR 5.2.3-009] The 3GPP system shall support high availability (approximately 100 % of the time on the road) [4] even in the high mobility scenario
- [PR 5.2.3-010] The 3GPP system shall support low end-to-end latency ranging from 1 ms up to 10 ms [3] even in the high mobility scenario
- [PR 5.2.3-011] The 3GPP system shall support dynamic resource utilization in the cloud and at the network edge (compute, storage, network and radio) for a given UE

Very Low Latency – Traffic Scenarios

- Extreme real-time communications and the tactile internet
  - Truly immersive, proximal cloud driven virtual reality
  - Remote control of vehicles and robots, real-time control of flying and driving things
  - Remote health care, monitoring, diagnosis, treatment, surgery
  - Telementoring, Teleteaching, Teleteamworking
- Tactile internet
  - Tactile internet makes the cellular network an extension of our human sensory and neural system
  - The human sensory system requires a millisecond or lower latency to give the impression of immediate response
  - The connection must remain intact and secure

Very Low Latency – Potential Requirements

- [PR 5.3.3-001] The 3GPP system shall support 1 ms one-way delay between mobile devices and devices in the nearby Internet
- [PR 5.3.3-002] The 3GPP System shall support very low one-way latency on the radio layer [1 ms]
- [PR 5.3.3-003] The 3GPP System shall support very high reliability
- [PR 5.3.3-004] The 3GPP System shall support connections that are very difficult to block, modify, or hijack
- [PR 5.3.3-005] The 3GPP System shall minimize the delay that is required prior to user data transmission

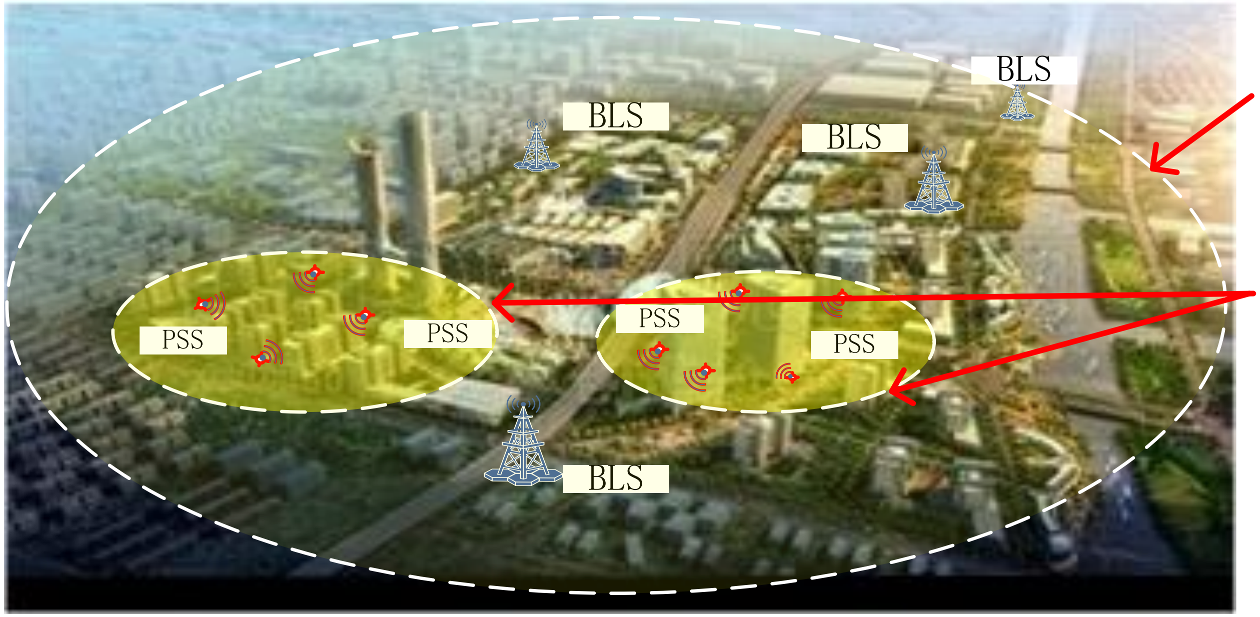
Higher Accuracy Positioning - Traffic Scenarios

- Higher accuracy positioning outdoor with high speed moving
  - The two vehicles are aware of the potential crash since the coarse location information was exchanged using V2X communication
  - the vehicles start measuring the location in 1 m accuracy at every 100 ms and exchange the information via V2V communication
  - the time to determine their position and the reaction time must be short to avoid collisions with its surroundings
- Higher accuracy positioning with low speed moving (including indoor and outdoor)
  - With a location-based service, nearby available parking places can be precisely located with the accuracy <1 m
  - get instantaneously multimedia discounts information of specific shop pushed by 3GPP network when going to shopping mall

Higher Accuracy Positioning - Traffic Scenarios(Cont.)

- Higher accuracy positioning for low altitude UAV in critical condition
  - Searching for an intruder or suspect
  - Continual monitoring of natural disasters
  - Performing autonomous mapping
  - Collaborative manipulation of an object
- Higher accuracy positioning for mIoT
  - Consider the case of a warehouse, package delivery system, supplies registry, or equipment tracker
  - The communication from each sensor would need to be reliable but not necessarily of high priority
  - The tracking devices would be low complexity, low powered, battery-powered sensors
  - The sensor should support multiple radio access technologies to ensure reachability as it crosses access coverage boundaries

Network Supporting High Accuracy Positioning



Identical communication and positioning coverage area

Enhanced positioning coverage area

BLS:positioning enhanced eNB
PSS:positioning enhancement node

Higher Accuracy Positioning - Potential Requirements

- [PR 5.4.3-001] The 3GPP system shall support higher accuracy location capability less than [3 m] at [80 %] of occasions
  - In for services requiring a lower position accuracy (e.g., deliver dense packages from a warehouse to a delivery truck then to a delivery location), the 3GPP system should support high positioning accuracy (e.g., 0.5 m) in both outdoor and indoor, along with high density of the location tracing devices up to (e.g., 1 million devices per km^2), and high mobility at minimum of 100 km/h
- [PR 5.4.3-002] The 3GPP system shall support location estimation of UE in less than [10] seconds when the information is requested by user
- [PR 5.4.3-003] The 3GPP system shall support different configuration for accuracy according to different service requirements
- [PR 5.4.3-004] Power consumption due to the continuous use of positioning service shall be minimized
- [PR 5.4.3-005] The 3GPP system shall support co-existence with legacy 3GPP positioning service and migration to higher accuracy positioning service

Higher Availability - Traffic Scenarios

- Secondary connectivity
  - Wireless access is quickly becoming the primary mode of connectivity to access services, content and information
  - In spite of increased component reliability and built-in redundancies, there are occasions when the terrestrial network fail
  - It is important to ensure that a reliable secondary wireless connection is available for the users to remain connected
- Disaster and Emergency Response
  - it is important that emergency response teams have communications capabilities to coordinate and manage the relief efforts across diverse groups and organizations
  - there are specific emergency situations/incidents that occur in areas where there is no terrestrial coverage
  - the next generation of public safety communication services are also expected to evolve to require enhanced speeds ubiquitously

Higher Availability - Potential Requirements

- [PR 5.5.3-001] The 3GPP system shall support connectivity using satellite access
- [PR 5.5.3-002] The 3GPP system shall support service continuity when the user terminal switches between satellite and terrestrial access

Mission Critical Services - Traffic Scenarios

- Prioritised communications
  - Prioritised traffic may be allowed to use simpler and faster access procedures than regular users
  - A user may need to access the network resources even when the network is congested, possibly pre-empting other users and traffic
  - A user may need to have guaranteed quality of service during the duration of the communication, possibly pre-empting other users when requiring resources is a new cell
- Isolated communications
  - Isolating prioritised users and traffic from other users and traffic makes it easier to offer a guaranteed level of service
- Protected communications
  - It is possible to tailor the protection to meet the requirements for different users and traffic when the network offers different levels of security

Mission Critical Services - Traffic Scenarios(Cont.)

- Guaranteed communications
  - More efficient error correction to reduce the error rates
  - Higher power to reduce the error rates
  - Redundant links to reduce the error rates
  - Dedicated resources to reduce the error rates
  - Alternate access technologies to increase coverage
  - Alternative access technologies to increase availability
- Optimised communications
  - Locating the services and data close to the user allows faster access to them
  - Locating the services and data in a centralised location allows efficient deployments
- Supported communications
  - A regular user may have access only to basic services
  - Surveillance cameras in street corners may have access to video streaming to provide visual information about the environment
  - A fireman may have access to all services to operate efficiently at the scene of an accident
  - A user may be allowed to access services of another network

Mission Critical Services - Potential Requirements

- [PR 5.6.3-001] The 3GPP system shall support the prioritisation of users and traffic, during connection setup and when connected
- [PR 5.6.3-002] The 3GPP system shall support optimised signalling for prioritised users and traffic
- [[PR 5.6.3-003] The 3GPP system shall support the allocation of resources dedicated to certain users
- [PR 5.6.3-004] The 3GPP system shall support the isolation of dedicated system resources from other system resources
- [PR 5.6.3-005] The 3GPP system shall support different levels of protection for users and traffic.
- [PR 5.6.3-006] The 3GPP system shall support different levels of resilience, availability, coverage, and reliability to offer different levels of guaranteed communications
- [PR 5.6.3-007] The 3GPP system shall support alternative access technologies (e.g., satellite) to increase availability and coverage
- [PR 5.6.3-007a] The 3GPP system shall support direct device connections, also for high data rates (e.g., 100 Mbps)
- [PR 5.6.3-008] The 3GPP system shall support different service architectures (e.g., locally, in the core network, and in the cloud)
- [PR 5.6.3-009] The 3GPP system shall support different sets of supported services for different user (e.g., based on the type of user)
- [PR 5.6.3-010] The 3GPP system shall support the use of services of a network without a roaming agreement

Considerations on Security

- The 3GPP system owned by a 3rd party shall support network access using identities, credentials, and authentication that is provided and managed by that 3rd party
- The 3GPP system owned by a 3rd party shall allow confidentiality and integrity protection managed by that 3rd party
- The 3GPP system shall support an authentication process that can handle alternative authentication methods with different types of credentials to allow for different deployment scenarios such as industrial factory automation
- The 3GPP system shall be able to provide means to verify whether a UE is authorized to use prioritized access for transport of data for critical service
- The 3GPP system shall support confidentiality and end-to-end integrity protection for user data
- The 3GPP system shall be able to provide at least message integrity protection

Considerations on Charging

- The traffic scenarios did not contain any charging related aspects but it can be assumed that
  - Dedicated networks may have dedicated charging solutions, or may have no charging at all
  - High priority and low latency may be chargeable

Conclusion and Recommendations

- The study on critical communications has identified several scenarios where 4G networks cannot meet all the requirements
- Some of the requirements are simple to quantify, usually related to latency, often with low data rates
- There are also requirements that are partly solved by system design and deployment, related to reliability, availability, and coverage
- Normative work should be started to support the consideration and consolidated potential requirements
- Requirements related to higher accuracy positioning have not been confirmed

Outline

- eMBB應用分析
  - –TR22.863 Feasibility study on new services and markets technology enablers for Enhanced Mobile Broadband; Stage 1
- URLLC應用分析
  - –TR22.862 Feasibility study on new services and markets technology enablers for Critical Communications; Stage 1
- mMTC應用分析
  - –TR22.861 Feasibility study on new services and markets technology enablers for Massive Internet of Things; Stage 1

TR22.861
Feasibility study on new SMARTER for Massive Internet of Things

1. Scope
2. References
3. Definitions and abbreviations
4. Overview
5. Use Case Families
6. Considerations
7. Consolidation of Potential Requirements
8. Conclusion and Recommendations

Annex A: Change history

1. Scope

- Emerging from the FS_SMARTER work, the present document aims
  - To identify and document the key families of use cases and their consolidated potential requirements, and
  - To capture desired system requirements and capabilities to support the needs of new services and markets related to massive Internet of Things
- The focus of this work is on the use cases and requirements that cannot be met with EPS

4. Overview

- Among the use cases developed in the FS_SMARTER study, there are a group of use cases with massive number of devices (e.g., sensors, wearables) with a wide range of characteristics and demands
  - This group of use cases are particularly relevant to the new vertical services, such as smart home/city, smart utilities, e-Health and smart wearables
- Three key families to consolidate the potential requirements for the massive Internet of Things application scenarios
  - Operational aspects
  - Connectivity aspects
  - Resource efficiency aspects

Overview - Application Scenarios

- This group includes different application scenarios:
  - Internet of Things
    - Large numbers of devices with non-time critical data transfer, some very simple and some very complex, are members of this family
    - Some specific aspects also need to be considered, including efficiency of security and device configuration
  - Smart wearables (Personal Area Network)
    - The use of wearables consisting of multiple types of devices and sensors becomes mainstream
    - Some common attributes can be observed in this key family of use cases, such as low complexity and high battery life, high reliability, and some may also require high data rates
  - Sensor networks
    - Smart services will become pervasive in urban areas, and usage will also grow in suburban and rural areas
    - The aggregation of all these services leads to very high density of devices with very different characteristics expected to be combined in a common communication and interworking framework
    - Depending on the specific use cases, very low complexity devices with very long battery life may be required

5. Use Case Families

Operational Aspects

- The Massive Internet of Things introduces new operational considerations to a 3GPP system
  - While some support for IoT will be provided by current systems, there is room for improvement in the operational aspects that can be designed into a 5G system whereas they are not easily retrofitted into an existing system
- This family includes the operational aspects that will apply to the wide range of devices and services anticipated in the 5G timeframe
  - These aspects are derived from the use cases included in and cover security needs for IoT as well as support for network servers/applications and devices to identify, address and reach each other

Internet of Things Security Aspects

- With the diversity of device types and access interfaces anticipated in the Internet of Things, a security mechanism needs to be designed to meet the service requirements, user and access requirements and deployment models
- The core network will need to support authentication methods appropriate to the respective access network to allow a seamless user experience across multiple access networks
  - Since smart devices are expected to support multiple radio access technologies such as 3GPP RAT and non-3GPP RAT, with both access network for 3GPP RAT and access network for non-3GPP RAT connected to the same mobile core network

Traffic Scenarios for Operational Aspects

- Traffic scenario 1: lightweight device configuration
- Traffic scenario 2: variable data size
- Traffic scenario 3: Internet of Things security
- Traffic scenario 4: farm machinery and leasing
- Traffic scenario 5: one user with multiple devices
- Traffic scenario 6: one device with multiple users
- Traffic scenario 7: connection support by service provider
- Traffic scenario 8: communication between devices with multi-vendors

Scenario 1: Lightweight Device Configuration

In the following traffic scenario, a very simple device (e.g., no IMS client) is installed and activated for service

- The device could be, for example, a smart electric meter
- It records electricity usage, provides up to the minute usage reports that allow the customer to take advantage of time of day rating, and provides a larger, complete report to the electric company once a month
- The electric company deploys a large number of these smart meters within an apartment building, one for each apartment
- The meter technician needs an efficient mechanism to quickly associate each smart meter to the correct account (e.g., apartment number) and activate the smart meter
- This mechanism should allow the technician to immediately activate transmission of electricity consumption data to enable real-time tracking and charging for electricity used

Scenario 2: Variable Data Size

In the following traffic scenario, a video recorder is installed and activated at a street corner

- The video recorder includes a camera, some on-board processing capability, as well as the ability to send information to the traffic police
- The camera records continuous video, storing the content for some period of time
- The device periodically sends a status update to the traffic police indicating that traffic is moving smoothly
- When an accident occurs at the intersection, the device begins sending high quality video to the traffic police of the accident and ensuing traffic congestion
- The network will need the flexibility to provide efficient service to the device at all times, whether a small or large amount of data is sent in a given transmission
- An efficient system could minimize any negative impact to battery life for the device and minimize use of signalling resources
- The same device will need to establish a connection when it needs to transmit a large amount of data (e.g., video)

Scenario 3: Internet of Things Security

- In the future it is expected that devices sold outside operators' channels will likely not be preconfigured with operator-specific subscription credentials
  - In the following traffic scenario an end user buys a 3GPP enabled smart band or other device, which has not been preconfigured for any operator
- Having obtained a subscription (for the device), when the device tries to connect to the 3GPP network there shall be a mechanism to get to the device appropriate subscription credentials over the 3GPP network so that the device is used in its intended way

Scenario 4: Farm Machinery and Leasing

- Farm machinery is increasingly being automated
  - Tractors, harvesting machines, and crop loaders autonomously drive through farms under close coordination, alleviating the need for a human driver
- Farm machinery can report various sensor data, such as soil condition and crop growth, so that the farmer can remotely monitor the farm condition and control machinery
  - The data gathered helps with crop predictions and planting plans
- Compared to smartphones, farm machinery have very long lifetimes (in the order of 15 years) which makes it essential to have technologies that will remain relevant or easily upgradeable over a very long time frame
- Farm machinery is often leased. Due to these factors, flexible devices that can cope with various regions and migration are desirable
  - Different renters may prefer different mobile operators for service
  - It is therefore important to provide technologies that facilitate easy switch between mobile operators

Scenario 5: One User with Multiple Devices

- When connectivity module gets cheaper, most things will include the connectivity module
  - As a result, the number of connected devices belonging to one user will also increase
- The devices one user possesses can be grouped into following two groups
  1. Group of mutually exclusive devices: at most one device can be simultaneously activated
     - Typical example of this group is a devices used for fashion item such as a smart watch or smart bracelet, etc
       - e.g., a user may possess several smart watches with different shapes and colour
     - Because the user does not wear multiple watches at the same time, only one of the watches needs connection to network
  2. Group of independent devices: each device can be connected to network independent of connection status of other devices
     - For example, a smart glass can be connected to network while a smart watch is connected to network
- The connectivity management (e.g., addition, removal, activation, deactivation, etc.) of multiple devices should be simple and straight-forward
  - From user experience point of view, it is not desirable that a user is required to make a separate subscription for each device whenever a device is bought, discarded or modified

Scenario 6: One Device with Multiple Users

- Already in the market, many businesses are based on the concept of sharing economy emerged (e.g., car rental services, where the same care is shared by many people)
- As devices can be shared among people, a new model of providing connectivity to devices is needed together with mechanism from prevention of fraudulent access by unauthorized users

Scenario 7: Connection Support by Service Provider

Control of connectivity based on authorization by the content or service provider can serve various business models

- A content or service provider may be willing to pay for the cost of any type of connectivity used for traffic delivery without requiring a user to use specific Apps
  - In one example, utility company may pay for the traffic generated for the smart meters installed in each house
  - In another example, traffic generated by a biometric sensor used to track physical activities is paid by a fitness program provider
  - In addition, the content or service provider may require the ability to provide to the MNO specific connectivity requirements (e.g., QoS)

- This traffic scenario can be further enhanced with out-of-the-box connectivity provision

- When service provider pays for the connectivity service for the devices, it is necessary to prevent fraudulent use of the provided connectivity
  - For that, the network needs to filter out traffic other than for the intended service

Scenario 8: Communication between Devices with Multi-Vendors

- Reachability and addressability should be ensured across different domains
  - There ideally should be an easy/common way to identify a particular device and then use that identifier to reach and address the device, independently from how it is connected
  - In addition, devices from different manufacturers should be able to communication with each other, without any dependency on a specific service provider, a specific IoT platform, a specific operating system or a specific application

- Efficient communication between the devices should be supported
  - The device is typically limited in capability so that it may not support IP protocol or may not be equipped with an IMS client, because more processing power is needed to handle IP/IMS stack and more protocol overhead is expected over radio interface

- When the number of devices increases and when each device can be used by different users, it should be easy and intuitive for a user to address each device

- While efficient communication between devices needs to be supported, delivery of messages from unauthorized sources should be prevented.

Potential Requirements for Operational Aspects

- Lightweight device configuration
  - The 3GPP system shall be able to support devices (e.g., smart meter) with limited communication requirements and capabilities (e.g., devices without an IMS client)
  - The 3GPP system shall minimize signalling for device configuration (i.e., service parameters)
  - The 3GPP system shall support a resource efficient mechanism to configure (e.g., service parameters) and activate multiple (e.g., all smart meters in an apartment building) devices
- Internet of Things security
  - The 3GPP system shall support a secure mechanism to remotely provision a device that has not been pre-provisioned, with its 3GPP subscription credentials
- Variable data size
  - The 3GPP system shall minimize the signalling (e.g., for security) that is required prior to user data transmission
- Device relevance
  - The 3GPP system shall provide mechanisms to change the UE subscription within the same operator and in between different operators

Potential Requirements (Cont.)

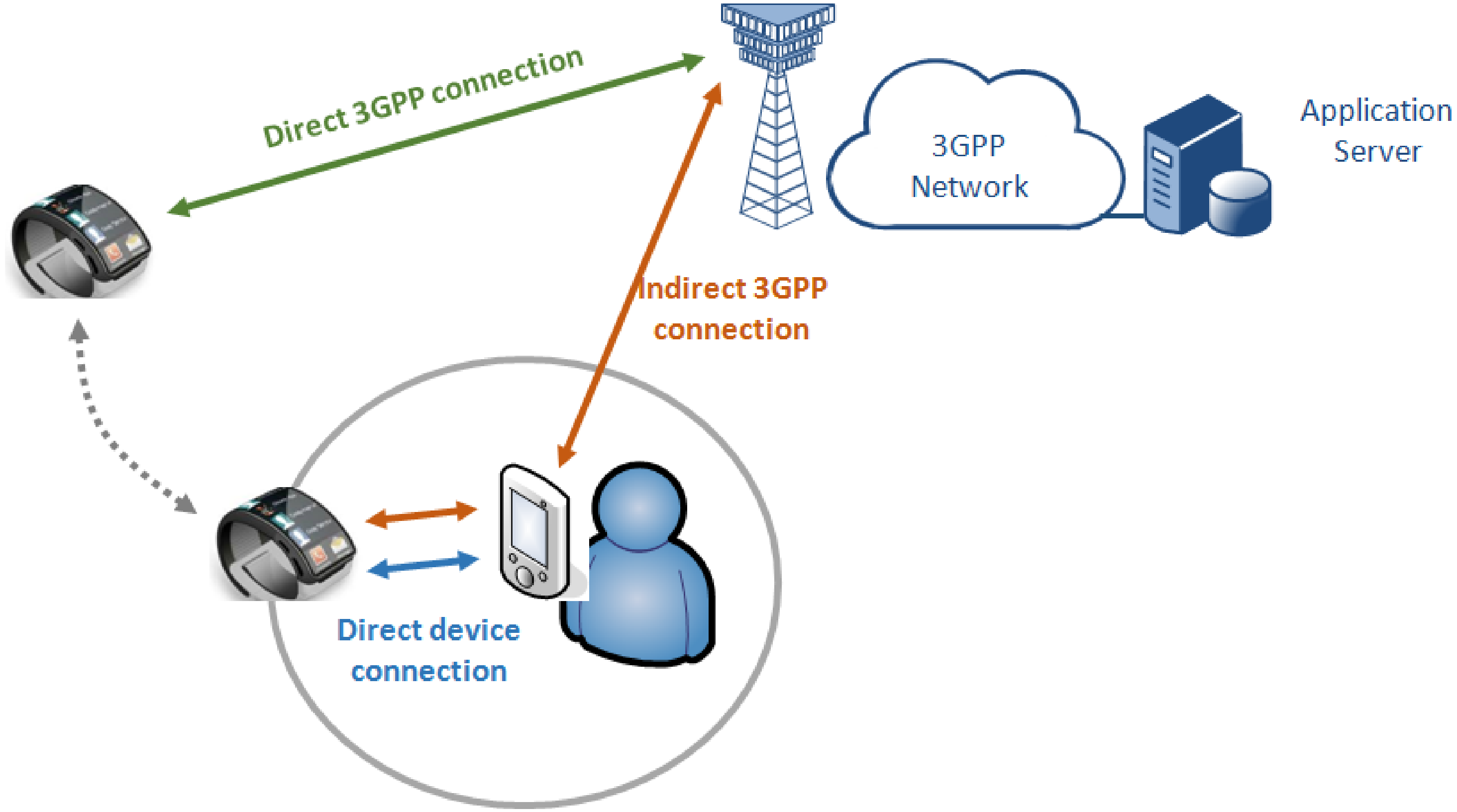
- Diverse connectivity
  - The 3GPP system shall be able to provide means to dynamically and seamlessly change the association between a subscription and a device
  - The 3GPP system shall be able to support enhanced authentication, authorization and charging mechanisms to support various types of connectivity (e.g., subscribed, OTB or content-aware connectivity), with or without the presence of operator credentials in the device
  - Enhanced authentication mechanism shall be able to provide efficient means to authenticate a user and a device (e.g., using biometric information)
  - Enhanced authorization mechanism shall be able to provide a user and a device with on-demand connectivity based on operator policy
  - Enhanced charging mechanism shall be able to collect charging-related information for enhanced authentication mechanism and enhanced authorization mechanism
- Multi-vendor communication
  - The 3GPP system shall support users, applications and devices to register, identify, address and reach other devices, regardless of how each device is connected to 3GPP network
  - The 3GPP system shall be able to provide means for efficient light-weight communication to and from devices (e.g., appliances, wearables, vehicles)

Connectivity Aspects

- The Internet of Things will support various connectivity models. The devices can
  - Connect with the network directly or
  - Connect with the network using another device as a relay UE, or
  - They may be capable of using both types of connections
- The devices can
  - Range from simple wearables such as a smart watch or a set of sensors embedded in clothing, to a more sophisticated wearable device monitoring biometrics
  - Be non-wearable devices that communicate in a Personal Area Network such as
    - A set of home appliances (e.g., smart thermostat and entry key), or
    - The electronic devices in an office setting (e.g., smart printers), or
    - A smart flower pot that can be remotely activated to provide water to the plant
- The relay UE can access the network using 3GPP or non-3GPP access networks (e.g., WLAN, fixed broadband access)

Connectivity Modes for Devices

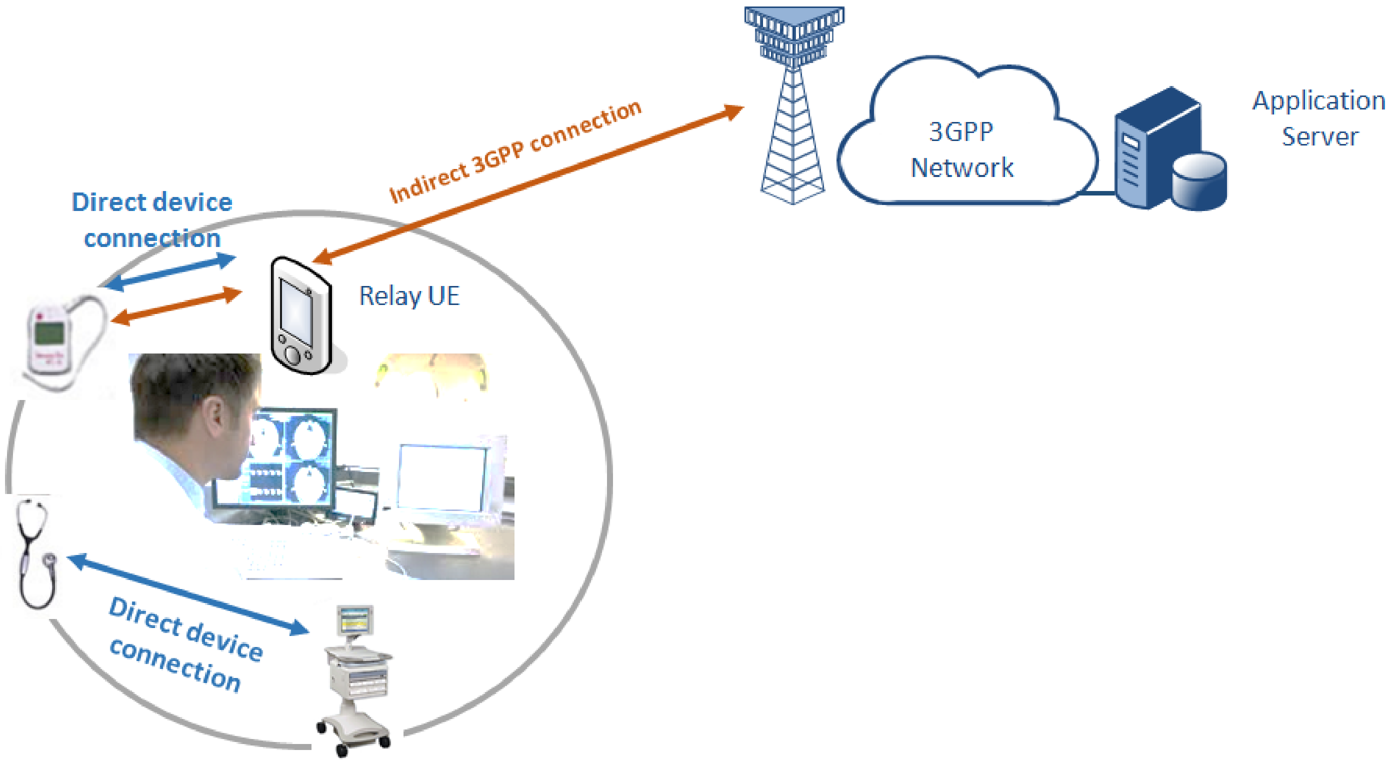
- Essentially, one or more of the following connection models will apply for any device
  - Direct 3GPP connection (e.g., a sensor that communicates with an application server or with another device through 3GPP network)
  - Indirect 3GPP connection (e.g., a smart wearable that communicates through a smart phone to the 3GPP network)
  - Direct device connection (e.g., a bio metric device that communicates directly with other biometric devices or with a smart phone associated with the same patient)



Combinations of Connectivity scenarios

- 3GPP and non-3GPP RATs may be supported for connectivity scenarios
  - 3GPP RAT over licensed or unlicensed band may be supported for connectivity scenarios
- Various combinations of these connectivity scenarios will also need to be supported
  - Devices that can switch between a direct 3GPP connection and an indirect 3GPP connection
  - Devices that can switch between indirect connection using 3GPP RAT and indirect 3GPP connection using non-3GPP RAT
  - Devices that only support a direct device connection (e.g., does not support 3GPP connection)
  - Groups of devices that communicate among themselves using a direct device connection, and also through an indirect 3GPP connection to the network through one of the devices (e.g., personal area network, home office network)

Connectivity Modes for Devices Using Direct Device Connection and Indirect 3GPP Connection



- An example of a combination connectivity scenario
  - A group of biometric devices that communicate among themselves using a direct device connection and
  - Also communicate with a 3GPP network through an indirect 3GPP connection

Scenarios in Indirect 3GPP Connection Mode

- Some additional scenarios might apply when a Personal Area Network of devices (e.g., a person wearing several smart wearables) is in indirect 3GPP connection mode:
  - A relayed device (e.g., smart watch) and relay UE can belong to the same subscriber or different subscribers of the same PLMN
  - A relayed device (e.g., smart watch) and relay UE can have subscriptions associated with different PLMNs. This is a roaming case

  In either case, the relay UE needs to determine that the device is authorized for an indirect 3GPP connection before a 3GPP connection is established

- Both devices also need to be authenticated with the network before the 3GPP connection is established

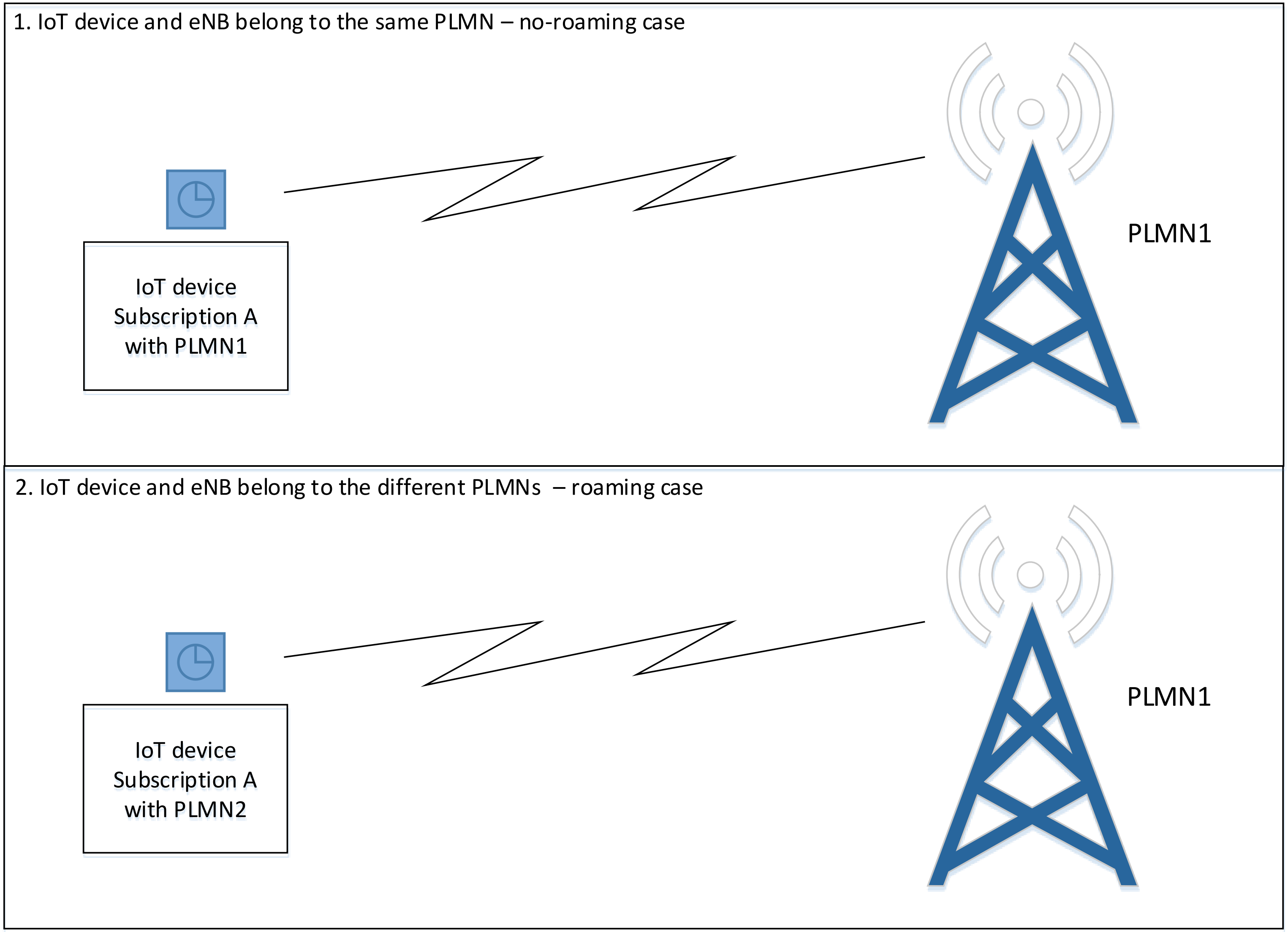
Traffic Scenarios for Connectivity Aspects

- Traffic scenario 1: a device in direct 3GPP connection mode
- Traffic scenario 2: a device in indirect 3GPP connection mode
- Traffic scenario 3: a device in indirect 3GPP connection mode in the roaming case
- Traffic scenario 4: devices communication with each other in direct device connection mode
- Traffic scenario 5: service continuity

Scenario 1: A Device in Direct 3GPP Connection Mode

- The traffic scenario below is a device in a direct 3GPP connection mode
- It covers both cases, when the device is accessing its home network, and when the device is roaming
  1. The device is accessing its home network, PLMN1
  2. The device is accessing a visited network, PLMN2
     - The PLMN1 and PLMN2 have a roaming agreement
- When the device is in direct 3GPP connection mode, the 3GPP system should support
  - The real time services including real time voice (e.g., at least 24.4Kbps) and/or real time video (e.g., at least 1Mbps), and
  - Non-real time services (e.g., at least 1Mbps)

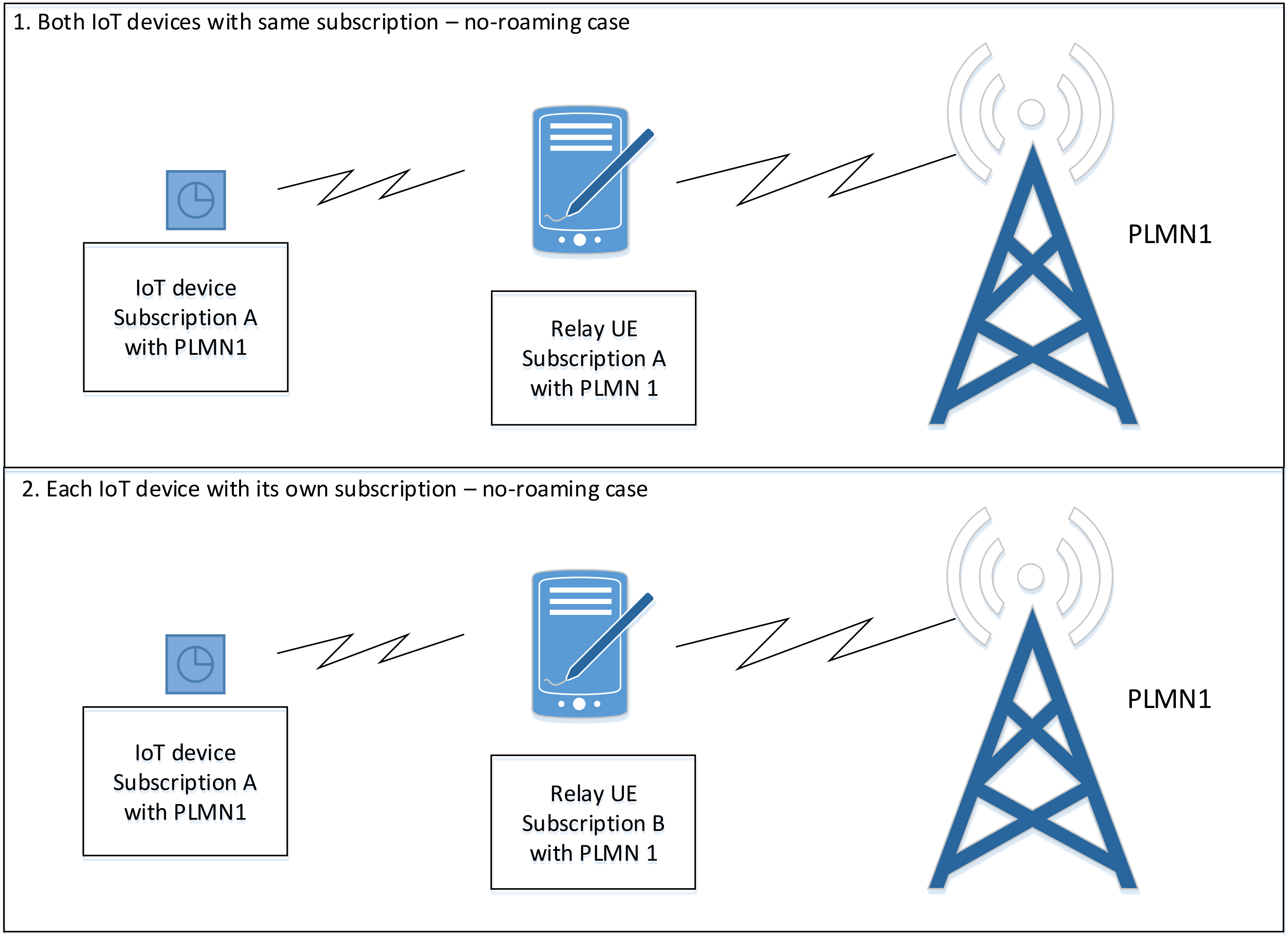
Scenario 1: A Device in Direct 3GPP Connection Mode



Scenario 2: A Device in Indirect 3GPP Connection Mode

- In this scenario, the device and the relay UE belong to the same PLMN and have the same or different subscriptions
- The detail scenario is as follows
  1. The device has subscription A with PLMN1
     - The relay UE has the same subscription A with PLMN1
     - The relay UE is accessing its home network, PLMN1
  2. The device has subscription A with PLMN1
     - The relay UE has the subscription B with PLMN1
     - The relay UE is accessing its home network, PLMN1
- For the case where 3GPP RAT is used between a relay UE and a relayed device
  – When the device is in indirect 3GPP connection mode, the 3GPP system should support the real time services including real time voice (e.g., at least 24.4Kbps) and/or real time video (e.g., at least 1Mbps), and non-real time services (e.g., at least 1M bps)
- For the case where non-3GPP RAT is used between a relay UE and a relayed device
  – When the device is in indirect 3GPP connection mode, the 3GPP system should support the real time services (e.g., real time voice and/or real time video) and non-real time services

Scenario 2: A Device in Indirect 3GPP Connection Mode

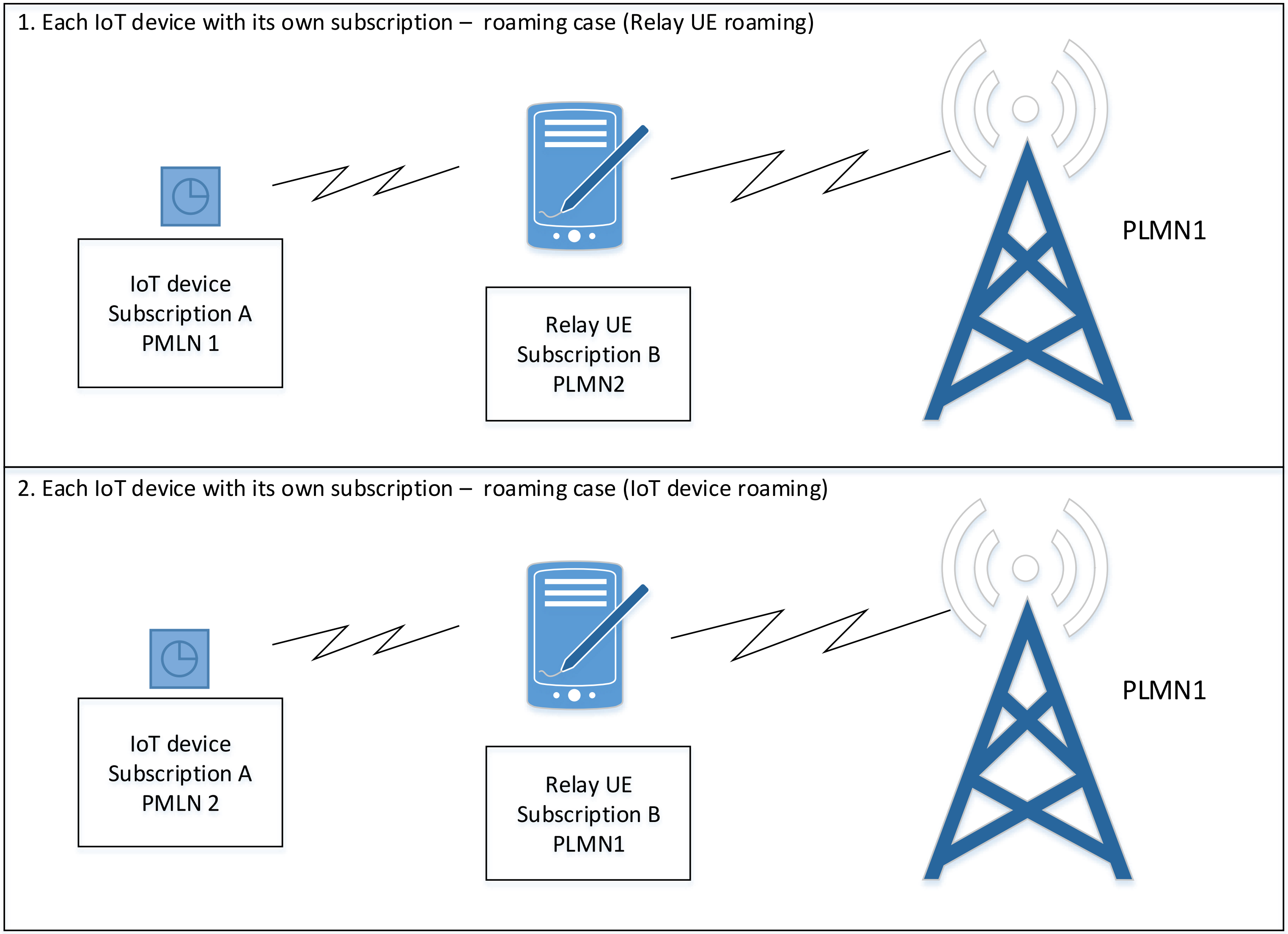


Traffic Scenario: A Device in Indirect 3GPP Connection Mode in the Roaming Case

- In this scenario, the device and/or the relay UE is accessing a visited network and have 2 cases
- One is when the device is accessing a visited network, and the other is when the relay UE is accessing a visited network. Detail scenarios:
  1. The device has subscription A with PLMN1
     - The relay UE has the subscription B with PLMN2
     - The relay UE is accessing a visited network, PLMN1
  2. The device has subscription A with PLMN2
     - The relay UE has the subscription B with PLMN1
     - The device is accessing a visited network, PLMN1, via the relay UE

  The PLMN1 and PLMN2 have a roaming agreement
- For the case where 3GPP RAT is used between a relay UE and a relayed device:
  – When the device is in indirect 3GPP connection mode, the 3GPP system should support the real time services including real time voice (e.g., at least 24.4Kbps) and/or real time video (e.g., at least 1Mbps), and non-real time services (e.g., at least 1Mbps)
- For the case where non-3GPP RAT is used between a relay UE and a relayed device:
  – When the device is in indirect 3GPP connection mode, the 3GPP system should support the real time services (e.g., real time voice and/or real time video) and non-real time services

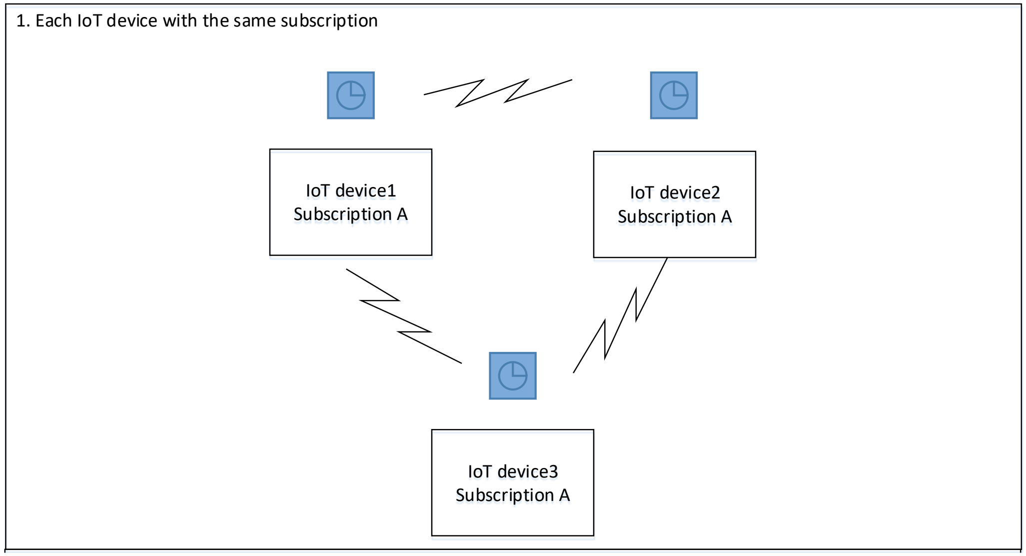
Traffic Scenario: A Device in Indirect 3GPP Connection Mode in the Roaming Case

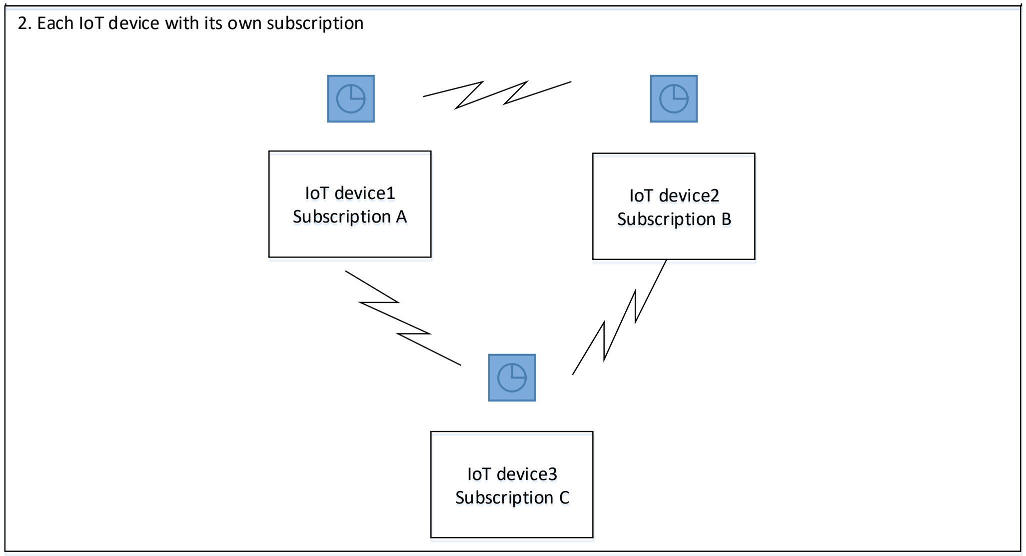


Scenario 4: Devices Communication in Direct Device Connection Mode

- In this scenario, each device has the same or its own subscription. The detail scenario is as follows:
  - Device 1, device 2 and device 3 have the same subscription A
  - The device 1 has subscription A. The device 2 has subscription B. The device 3 has subscription C
- For the case where 3GPP RAT is used between a relay UE and a relayed device:
  - When the devices are in proximity, the devices can communicate with each other using direct device connection mode using a 3GPP RAT
    - The devices support the non-real time service (e.g., at least 1Mbps) for communication with each other
- For the case where non-3GPP RAT is used between a relay UE and a relayed device:
  - When the devices are in proximity, the devices can communicate with each other direct device connection mode using a non-3GPP RAT
    - The devices support non-real time service for communication with each other

Scenario 4: Devices Communication in Direct Device Connection Mode



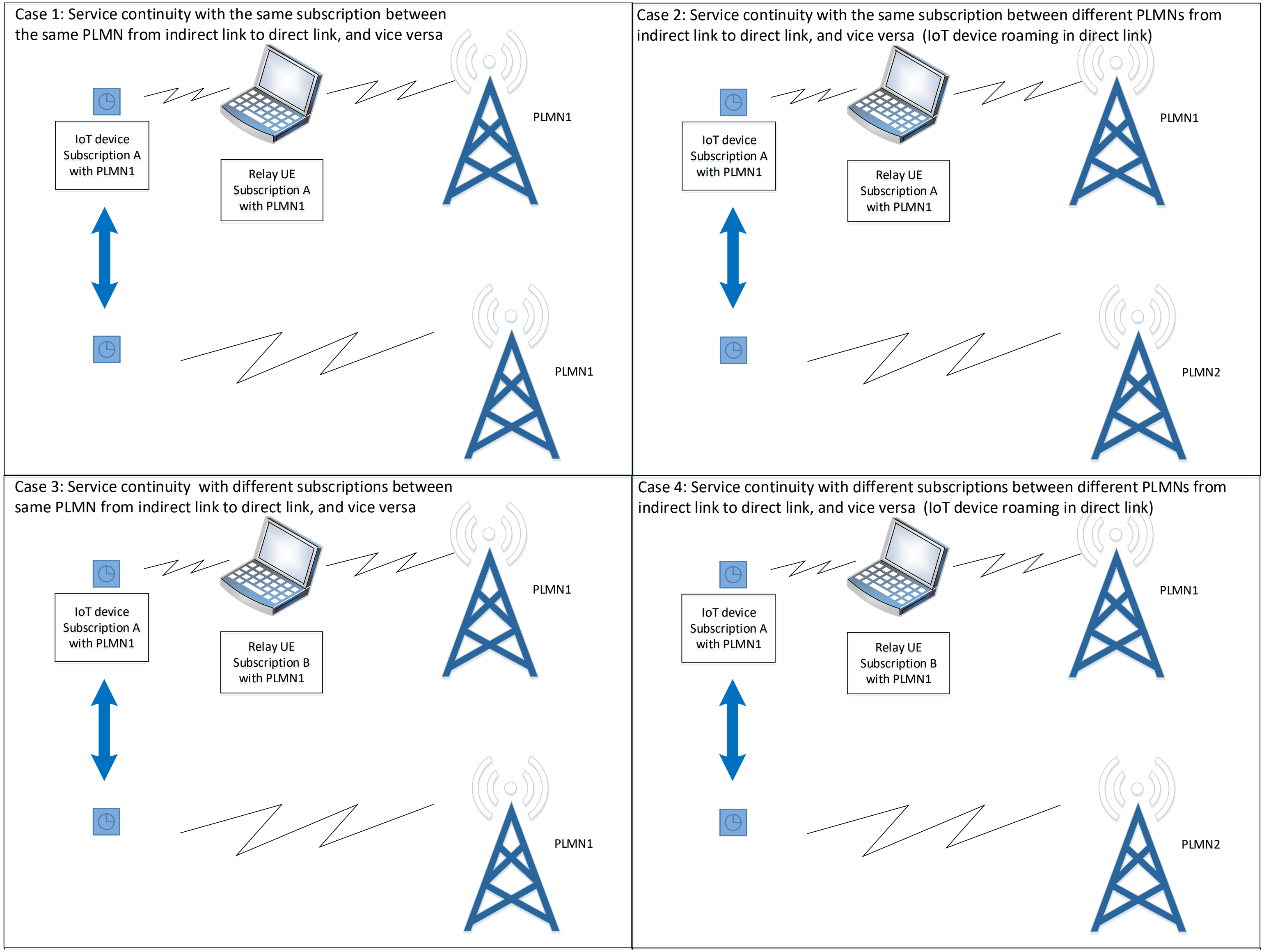


Scenario 5: Service Continuity

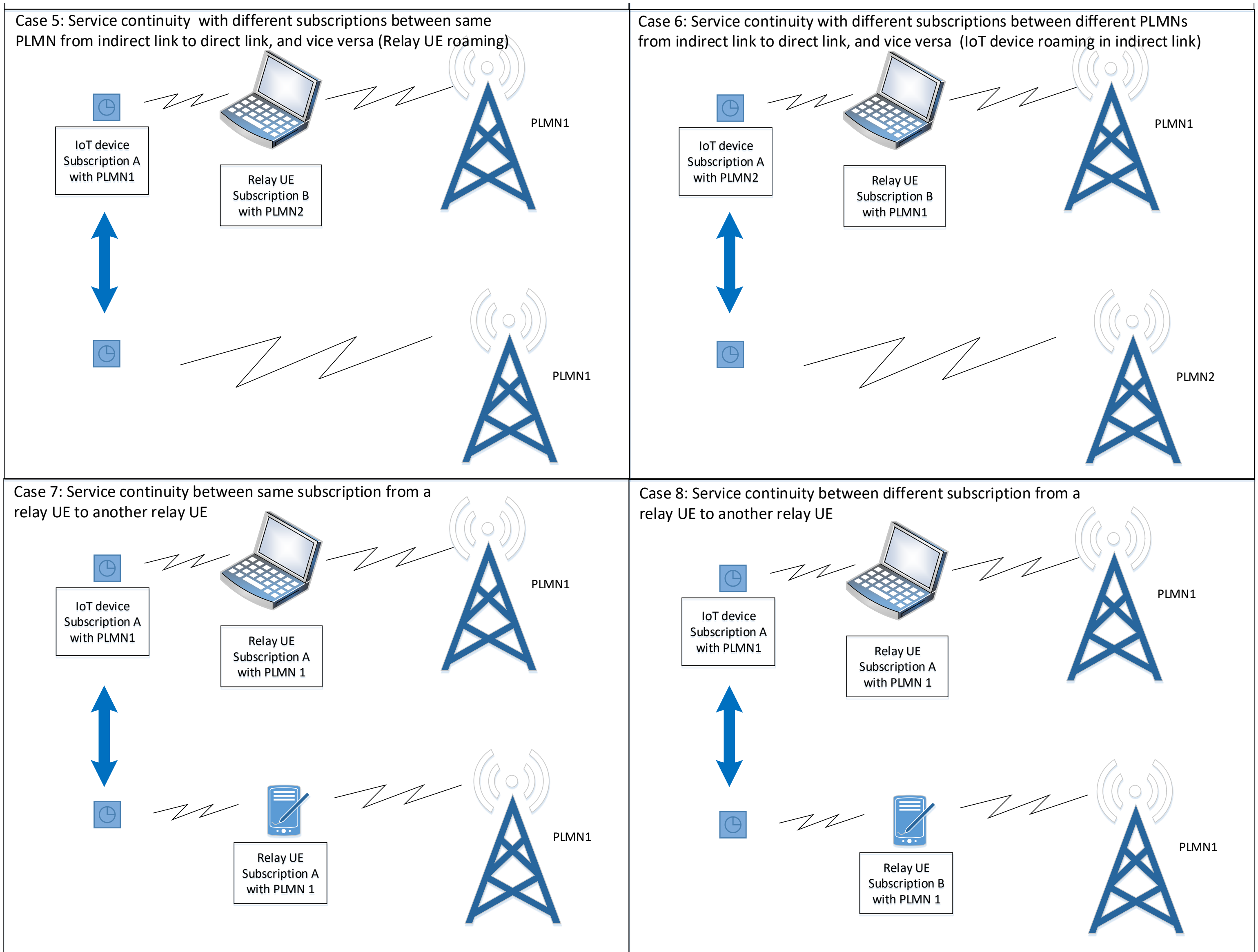
- For a device which supports direct 3GPP connection, indirect 3GPP connection, or both the 3GPP system needs to support the service continuity when:
  - The device changes from a direct 3GPP connection to an indirect 3GPP connection mode
  - The device changes from an indirect 3GPP connection to a direct 3GPP connection
  - The device changes from one relay UE to another in indirect 3GPP connection mode

- For these types of devices the 3GPP system will need to support service continuity for all the cases from case 1 to case 10

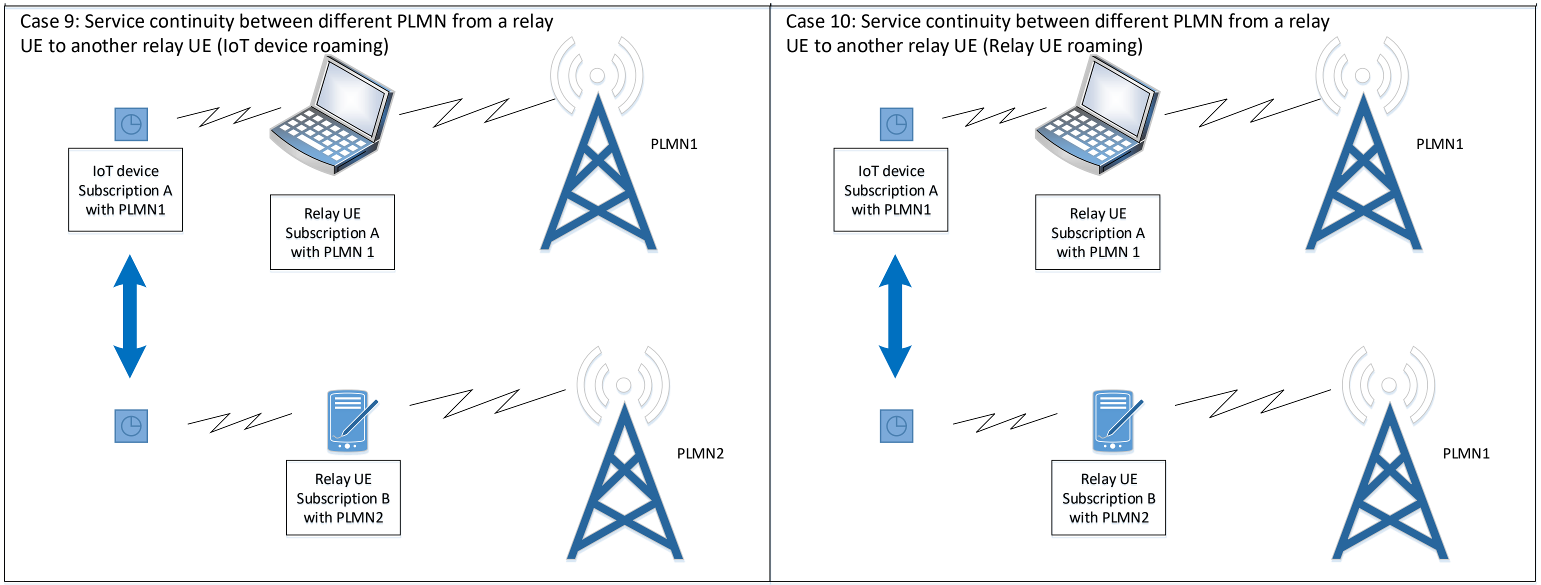
Service Continuity: Cases 1 - 4



Service Continuity: Cases 5 - 8



Service Continuity: Cases 9 - 10



Potential Requirements for Connectivity Aspects

General requirements

- [PR.5.2.3-001] The 3GPP system shall support a device to access to the 3GPP network in direct 3GPP connection mode
- [PR.5.2.3-002] The 3GPP system shall support a device to access to the 3GPP network indirectly via a relay UE when the device and the relay UE can communicate in direct device connection mode
- [PR.5.2.3-003] The 3GPP system shall have the means to authorize a relay UE to provide relay functionality to other devices
- [PR.5.2.3-004] A device shall determine the relay UE is authorized to serve as a relay before the device uses the indirect connection to the 3GPP network via the relay UE
- [PR.5.2.3-007] The 3GPP system shall support an indirect 3GPP connection where a device and a relay UE subscribe to different PLMNs, when the PLMNs have a roaming agreement
- [PR.5.2.3-008] A device which accesses the 3GPP network in direct 3GPP connection mode or in indirect 3GPP connection mode, shall have a 3GPP subscription
- [PR.5.2.3-009] The 3GPP system shall support real time services (e.g., real time voice and/or real time video) for a device, whether the device is in indirect 3GPP connection mode or in direct 3GPP connection mode
- [PR.5.2.3-010] The 3GPP system shall support non-real time services for a device, whether the device is in indirect 3GPP connection mode or in direct 3GPP connection

Potential Requirements – General Requirements (Cont.)

- [PR.5.2.3-011] The 3GPP system shall support service continuity for a device, when the device changes relay UEs that are connected via 3GPP access to the 3GPP core network in indirect 3GPP connection
- [PR.5.2.3-012] The 3GPP system shall support service continuity for a device, when the device changes from a direct 3GPP connection to an indirect 3GPP connection via a Relay UE that is connected via 3GPP access to the 3GPP core network, and vice versa
- [PR.5.2.3-013] The 3GPP system shall optimize the battery consumption of a device, whether the device is in direct 3GPP connection mode or in indirect 3GPP connection mode
- [PR.5.2.3-014] The 3GPP system shall optimize the battery consumption of a relay UE, via which a device is in indirect 3GPP connection mode
- [PR.5.2.3-015] The 3GPP system shall identify, address and reach a device, when the device is in indirect 3GPP connection mode
- [PR.5.2.3-017] The 3GPP system shall support a relay UE providing an indirect 3GPP connection with the network for multiple devices
- [PR.5.2.3-018] The 3GPP system shall support selection of different connectivity aspects (e.g., direct device connection, direct/indirect 3GPP connection) to be used for a device
- [PR.5.2.3-019] The 3GPP system shall support flexible selection of different RATs (e.g., 3GPP RATs, non-3GPP RATs) to be used for a device
- [PR.5.2.3-020] The 3GPP system shall support a timely, efficient, reliable and secure mechanism to transmit the same information to multiple devices

Potential Requirements for Connectivity Aspects - Specific Requirements

- Requirements specific to use of a 3GPP RAT
  - [PR.5.2.3-005] Devices shall determine they are authorized to engage in direct device communication with each other upon establishing a direct device communication using a 3GPP RAT
  - [PR.5.2.3-016] The 3GPP system shall support end to end QoS for a device, when the device is in indirect 3GPP connection mode
- Requirements specific to use of a non-3GPP RAT
  - [PR.5.2.3-006] Before establishing a direct device communication using a non-3GPP RAT, devices may use 3GPP credentials to determine if they are authorized to engage in direct device communication

Resource Efficiency Aspects

- 5G introduces the opportunity to design a 3GPP system to be optimized for supporting devices and services
  - While some support for IoT will be provided by current systems, there is room for improvement in efficient resource utilization that can be designed into a 5G system whereas they are not easily retrofitted into an existing system
  - Some of the underlying principles of the potential service and network operation requirements associated with efficient configuration, deployment, and use of devices in the 5G next generation network
    - include bulk provisioning, resource efficient access, optimization for device originated data transfer, and efficiencies
    - based on the reduced needs related to mobility management for stationary devices and devices with very restricted range of movement
- The next generation network will need to be designed to be flexible and elastic and adapt its resources and capabilities to the specific needs of the services and applications being executed, as well as to the types of devices accessing those services

Traffic Scenarios for Resource Efficiency Aspects

- Traffic scenario 1: Bulk provisioning
- Traffic scenario 2: Resource efficient access
- Traffic scenario 3: Diverse mobility needs of devices
- Traffic scenario 4: Device support for discovery mechanism

Scenario 1: Bulk Provisioning

- Understanding the IoT use cases depicting devices being deployed in large numbers in a given coverage area, a method by which they can be authenticated without requiring the arduous task of provisioning individual devices with identifiers and shared keys is required
  - The two characteristics that come into play in this scenario are that
    1) most likely the devices in a given deployment are owned by same entity, and
    2) the coverage area is limited (e.g., warehouse, disaster area, etc.)
  - Given this, the devices can be provisioned and authenticated in bulk whereby they are treated as a single device with many appendages
- Devices will range from very simple, limited function devices to very complex, sophisticated computing platforms
  - On the lower end of the device function range, not all such devices may use IMS and may not need to be equipped with an IMS client, and yet it would still be desirable to activate such a device remotely due to sensor deployment configurations
  - A light weight configuration mechanism may be used to provide the configuration information to the device

Scenario 2: Resource Efficient Access

- Devices will have to operate in modes quite different from other types of 3GPP UEs
- First and foremost is that much of time the traffic will have low data throughput and a low duty cycle
  - There may be no expectation of service continuity
- Devices may operate in a mode where all user plane traffic is originated by the device, with no response required from the network
  - Yet other devices may engage in both mobile and network originated communications
- These operational modes introduce opportunities for improving resource efficiency in supporting access by devices to a 3GPP network

Scenario 3: Diverse Mobility Needs of Devices

- Many devices will be stationary (e.g., smart parking meters) or have a limited range of mobility (e.g., smart household or office devices)
- Once activated, the location of these devices can be expected to remain the same, or move within a very limited area
  - For these types of devices, there are opportunities to reduce the use of mobility management resources compared to those required for EPS
- The 5G system should be designed to consider the different mobility management needs of devices

Scenario 4:
Device Support for Discovery Mechanism

Many devices will interact with each other (e.g., e-health devices, wearables)

- A clear example of a device that will be needed of discovery mechanisms is a printer connected to the 5G network
  - In the case a user would need to use this printer, the user needs to discover the printer and its functionalities before being able to use it (apart for any authorization mechanism which is out of scope of this traffic scenario)
- This discovery mechanism can be
  - Announcing mode (the printer announces itself in the network and the user listens to these messages) or
    - In the announcing mode, a printer will be sending to the network every certain period of time (e.g., 30 sec) messages where it announces that the device it is a printer, characteristics of the printer and also exposes interfaces to use this printer
    - These messages must be treated in an efficient way by the network
    - e.g., minimizing signalling, forwarding messages to the correct group of user and not to the whole network
  - Scanning mode (the printer reacts to requests from the user)

Potential Requirements for Resource Efficiency Aspects

- Bulk provisioning
  - [PR.5.3.3.1-001] The 3GPP system shall support a resource efficient mechanism to provide service parameters and activate groups of devices.
  - [PR.5.3.3.1-002] The 3GPP system shall support high density massive connections (e.g., 1 million connections per square kilometre) of grouped devices in an efficient manner
  - [PR.5.3.3.1-003] The 3GPP system shall be able to support devices, including groups of devices, (e.g., smart meter) with limited communication requirements and capabilities
  - [PR.5.3.3.1-004] The 3GPP system shall support a resource efficient mechanism for device configuration (i.e., service parameters)
  - [PR.5.3.3.1-005] The 3GPP system shall support a mechanism which provides an appropriate and efficient authentication mechanism for groups of devices

Potential Requirements for Resource Efficiency Aspects (Cont.)

- Resource efficient access
  - [PR.5.3.3.2-001] The 3GPP system shall minimize resources usage for infrequent data transfer from devices which send information without requiring a response
    - e.g., send status information to an application but do not need to receive information from the application
    - The 3GPP system shall minimize resources usage for transfer of infrequent small data units
  - [PR.5.3.3.2-002] The 3GPP system shall support a resource efficient mechanism to provide service parameters to devices
  - [PR.5.3.3.2-003] The 3GPP system shall support a resource efficient mechanism to activate groups of devices
  - [PR.5.3.3.2-004] The 3GPP system shall support significantly increased device power efficiency over what is supported by EPS
  - [PR.5.3.3.2-005] The 3GPP system shall support significant coverage enhancement over what is supported by EPS
  - [PR.5.3.3.2-006] The 3GPP system shall support a resource efficient mechanism to provide information to a stationary device
    - e.g., simplified device location mechanism
  - [PR.5.3.3.2-007] The 3GPP system shall provide a resource efficient mechanism to receive information from stationary devices
    - e.g., lower signalling to user data resource usage ratio

Potential Requirements for Resource Efficiency Aspects (Cont.)

- Resource efficiencies for mobility management
  - [PR.5.3.3.3-001] The 3GPP system shall provide efficient support for devices with restricted range of mobility (e.g., within a warehouse).
  - [PR.5.3.3.3-002] The 3GPP system shall provide resource efficient support for stationary devices with reduced mobility management
    - e.g., handover support, idle mode mobility management
- Resource efficiency for variable data size
  - [PR.5.3.3.4-001] The 3GPP system shall be able to efficiently and flexibly support any size of data transmissions (e.g., from a few bits to streaming video) from the same device
  - [PR.5.3.3.4-002] The 3GPP system shall minimize the signalling that is required prior to user data transmission
- Resource efficiency for discovery mechanisms
  - [PR.5.3.3.5-001] The 3GPP system shall efficiently support service discovery mechanisms where devices can discover
    - Status of other devices (e.g., sound on/off)
    - Capabilities of other devices (e.g., the device is a relay device) and/or
    - Services provided by other devices (e.g., the device is a colour printer)

6. Considerations

Considerations on security - General

- [PR.6.1-001] The 3GPP network shall support end-to-end integrity protection and confidentiality for data transmitted between the core network and a device when the device is in indirect 3GPP connection mode
- [PR.6.1-001a] The 3GPP network shall support end-to-end integrity protection and confidentiality for signalling transmitted between the core network and a device when the device is in indirect 3GPP connection mode
- [PR.6.1-002] The 3GPP network shall support a resource efficient mechanism to authenticate a device when the device is in indirect 3GPP connection mode
- [PR.6.1-002a] The 3GPP network shall support a resource efficient mechanism to authorize a device to use an indirect 3GPP connection
- [PR.5.2.3-004] A device shall determine the relay UE is authorized to serve as a relay before the device uses the indirect connection to the 3GPP network via the relay UE
- [PR.5.2.3-005] Devices shall determine they are authorized to engage in direct device communication with each other upon establishing a direct device communication using a 3GPP RAT
- [PR.5.2.3-006] Before establishing a direct device communication using a non-3GPP RAT, devices may use 3GPP credentials to determine if they are authorized to engage in direct device communication

Considerations on Security (Cont.)

General

- [PR.5.1.3.2-001] The 3GPP system shall support a secure mechanism to remotely provision a device that has not been pre-provisioned, with its subscription credentials
- [PR.5.1.3.3-001] The 3GPP system shall minimize the signalling for security that is required prior to user data transmission
- [PR.5.1.3.5-002] The 3GPP system shall be able to support enhanced authentication and authorization mechanisms to support various types of connectivity, with or without the presence of operator credentials in the device
- [PR.5.1.3.5-003] Enhanced authentication mechanism shall enable an operator to provide efficient means to authenticate a user and a device
- [PR.5.1.3.5-004] Enhanced authorization mechanism shall be able to provide a user and a device with on-demand connectivity based on operator policy
- [PR.5.1.3.6-001] The 3GPP system shall provide a capability for users, applications and devices to register, identify, address and reach other devices, regardless of how each device is connected to 3GPP network

Group Based Security

- [PR.5.3.3.1-005] The 3GPP shall support a mechanism which provides an appropriate and efficient authentication mechanism for groups of devices
- [PR.5.2.3-020] The 3GPP system shall support a secure mechanism to transmit the same information to multiple devices

Considerations on Charging

- [PR.6.2-001] The 3GPP core network shall support online and offline charging for a device whether the device is in direct 3GPP connection mode or indirect 3GPP connection mode
- [PR.6.2-002] The 3GPP core network shall be able to separately identify the charging data of a device from the charging data of a relay UE when the device is in indirect 3GPP connection mode via the relay UE
- [PR.5.1.3.5-002a] The 3GPP system shall be able to support enhanced charging mechanisms to support various types of connectivity (e.g., subscribed, connectivity), with or without the presence of operator credentials in the device
- [PR.5.1.3.5-005] Enhanced charging mechanism shall enable an operator to collect charging-related information for enhanced authentication mechanism and enhanced authorization mechanism

Considerations on Cross TR Dependencies

- While the four TRs, 22.861, 22.862, 22.863, and 22.864 separately address certain characteristics of a 5G system, they cannot be viewed as providing entirely standalone sets of potential requirements
  - In addition to the charging and security considerations, there are a number of other cross TR dependencies that must be accounted for
  - These include specifically requirements related to 5G devices, identities, and access types which may appear in one or more TR, but apply equally across others
- For example, use of the different access modes defined in TR 22.861 may apply as well for the automation and drone scenarios found in TR 22.862
  - Similarly, the KPIs defined in TR 22.862 are applicable for other IoT scenarios such as those described in TR 22.861
  - The broadband metrics defined in TR 22.863 are relevant to many scenarios in the other three TRs
  - And of course, the functionality such as network slicing, scalability, in-network caching defined in TR 22864, can be useful in meeting the KPIs for latency reduction and user density defined in TRs 22.862 and 22.863
- The cross TR dependencies need to be taken into account in developing normative requirements based on the studies

7. Consolidation of Potential Requirements
Resource efficiency

General

- [PR.5.1.3.1-002] The 3GPP system shall minimize signalling for device configuration [PR.5.1.3.3-001] The 3GPP system shall minimize the signaling that is required prior to user data transmission
- [PR.5.1.3.4-001] The 3GPP system shall be able to provide mechanisms to change the association between a subscription and address/number of a device within the same operator and in between different operators in an automated way
- [PR.5.2.3-013] The 3GPP system shall support mechanisms to optimize the battery consumption of a device
- [PR.5.2.3-014] The 3GPP system shall optimize the battery consumption of a relay UE via which a device is in indirect 3GPP connection mode
- [PR.5.3.3.2-001] The 3GPP system shall minimize resources usage for infrequent data transfer from send only devices which send information without requiring a response
  - e.g., send status information to an application but do not need to receive information from the application
- [PR.5.3.3.2-001a] The 3GPP system shall minimize resources usage for transfer of infrequent small data units
- [PR.5.3.3.2-004] The 3GPP system shall support significantly increased device power efficiency over what is supported by EPS

Potential Requirements – Resource efficiency (Cont.)

General

- [PR.5.3.3.4-001] The 3GPP system shall be able to efficiently and flexibly support any size of data transmissions (e.g., from a few bits to streaming video) to or from the same device
- [PR.5.3.3.1-002a] The 3GPP network shall support high density massive connections (e.g.,1 million connections per square kilometre) of devices in an efficient manner
- [PR.5.3.3.5-001] The 3GPP system shall efficiently support service discovery mechanisms where devices can discover, subject to access rights:
  - status of other devices (e.g., sound on/off)
  - capabilities of other devices (e.g., the device is a relay device) and/or
  - services provided by other devices (e.g., the device is a colour printer)
- [PR.5.1.3.6-002] The 3GPP system shall be able to provide a means for efficient light-weight communication to/from devices (e.g., appliances, wearables, vehicles)

Potential Requirements – Resource efficiency (Cont.)

Bulk operations

- [PR.5.3.3.1-002] The 3GPP network shall support high density massive connections (e.g., 1 million connections per square kilometre) of grouped devices in an efficient manner
- [PR.5.3.3.1-003] The 3GPP network shall be able to support devices, including groups of devices, (e.g., smart meter) with limited communication requirements and capabilities (e.g., devices without an IMS client)
- [PR.5.3.3.2-002] The 3GPP network shall support a resource efficient mechanism to manage (e.g., provide service parameters, activate, deactivate) devices, including groups of devices

Diverse mobility management

- [PR.5.3.3.2-007] The 3GPP system shall support a resource efficient mechanism to communicate with a stationary device (e.g., simplified mobility management, lower signalling to user data resource usage ratio).
- [PR.5.3.3.3-001] The 3GPP system shall provide efficient support for devices with restricted range of mobility (e.g., within a warehouse).
- [PR.5.3.3.3-002] The 3GPP system shall provide resource efficient support for stationary devices with reduced mobility management (e.g., handover support, idle mode mobility management)

Potential Requirements - Connection Models

General

- [PR.5.2.3-002] The 3GPP system shall support a device to access to the 3GPP network indirectly via a relay UE when the device and the relay UE can communicate in direct device connection mode
- [PR.5.2.3-007] The 3GPP system shall support an indirect 3GPP connection where a device and a relay UE subscribe to different PLMNs, when both PLMNs have a roaming agreement with the VPLNM
- [PR.5.2.3-009] The 3GPP system shall support real time and non-real time services (e.g., real time voice and/or real time video) for a device, whether the device is in indirect 3GPP connection mode or in direct 3GPP connection mode
- [PR.5.2.3-011] The 3GPP system shall support service continuity for a device, when the device changes from one relay UE to another and both relay UEs are connected via 3GPP access to the 3GPP core network in indirect 3GPP connection

Potential Requirements - Connection Models (Cont.)

General

- [PR.5.2.3-012] The 3GPP system shall support service continuity for a device, when the device changes from a direct 3GPP connection to an indirect 3GPP connection via a Relay UE that is connected via 3GPP access to the 3GPP core network, and vice versa
- [PR.5.2.3-015] The 3GPP network shall identify, address and reach a device with a 3GPP subscription when the device establishes an indirect 3GPP connection mode
- [PR.5.2.3-017] The 3GPP system shall support a relay UE providing an indirect 3GPP connection with the network for multiple devices
- [PR.5.2.3-018] The 3GPP system shall support selection of different connectivity aspects by the device (e.g., direct device connection, direct/indirect 3GPP connection) to be used for the device
- [PR.5.2.3-019] The 3GPP system shall support flexible selection of different RATs (e.g., 3GPP RATs, non-3GPP RATs) to be used for a device
- [PR.5.2.3-020] The 3GPP system shall support a timely, efficient, and reliable mechanism to transmit the same information to multiple devices

Potential Requirements - Connection Models (Cont.)

Requirements specific to use of a 3GPP RAT

- [PR.5.2.3-016] The 3GPP network shall support end to end QoS for a device when the device is in indirect 3GPP connection mode or direct 3GPP connection mode
- [PR.5.2.3-008a] A device which is able to access the 3GPP network in direct 3GPP connection mode using a 3GPP RAT shall have a 3GPP subscription
- [PR.5.2.3-017a] The 3GPP network shall be able to control 3GPP resources used in the communication path between a device and network when the device is in indirect 3GPP connection mode

Requirements specific to use of a non-3GPP RAT

- [PR.5.2.3-008b] A device which is able to connect to a UE in direct device connection mode shall have a 3GPP subscription, if the device needs to be identifiable by the core network
  - e.g., for device management purposes or to use indirect 3GPP connection mode

8. Conclusion and Recommendations

- The traffic scenarios cover three aspects of MIoT:
  - Operational aspects
  - Connectivity aspects
  - Resource efficiency aspects
- It is recommended to proceed with normative work
- The text of the present document will not be updated to align with normative specifications