

# Study on UE Aggregation for Industry with Multi-connectivity

2021-9-28



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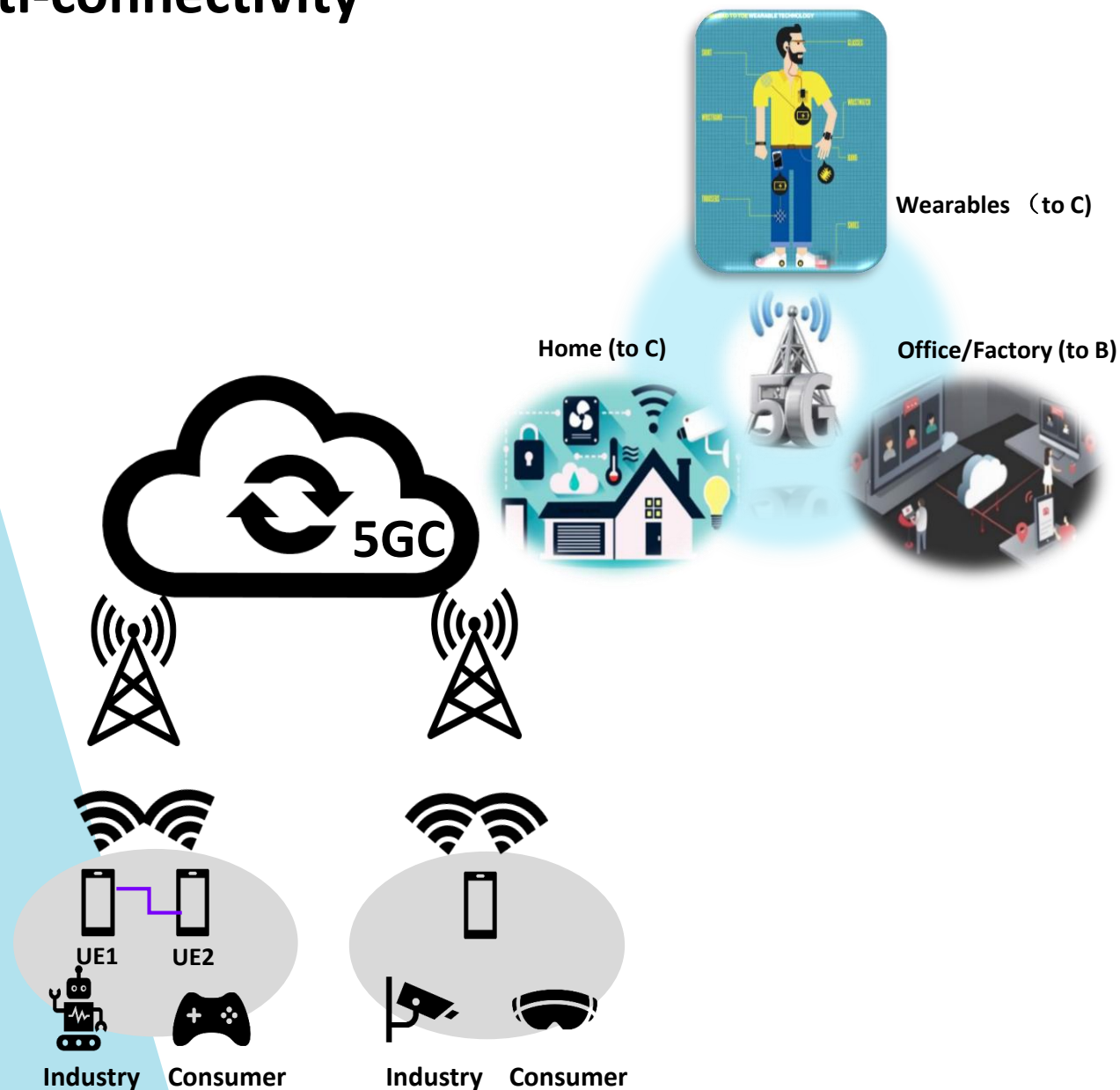
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# UE Aggregation for Industry with Multi-connectivity

## Motivations

- Address the issue of the shortage of UL UE transmission power in 5G, while two or more UEs in hand are more and more popular
- Address the issue of failing to meet the high reliability communication
- Improve user experience by switching User service from device to device, i.e. based on UE link quality
- Quite a few papers proposed to study UE aggregation for coverage and throughput such as RWS-210172(vivo), RWS-210355(CMCC), RWS-210451(Huawei), RWS-210479(ZTE), RWS-210422 (interdigital), RWS-210192(FGI), RWS-210199 (Rakuten)



# UE Aggregation for Industry with Multi-connectivity

## Scenarios

### Service Switching

Enable fast service switching across UEs without data loss

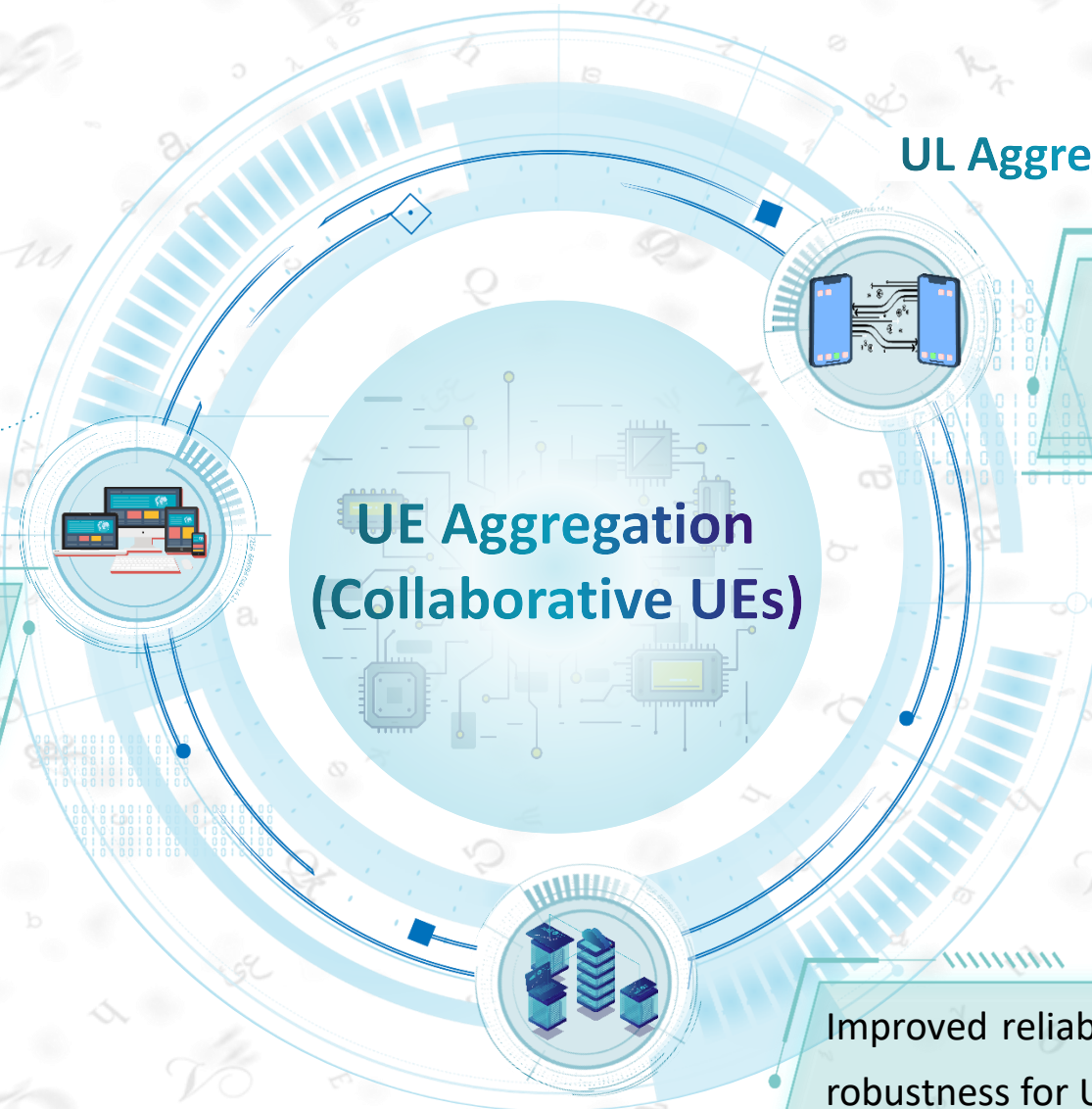
### UE Aggregation (Collaborative UEs)

### UL Aggregation

UL throughput improvement and separated UL transmission.

### UE Backup

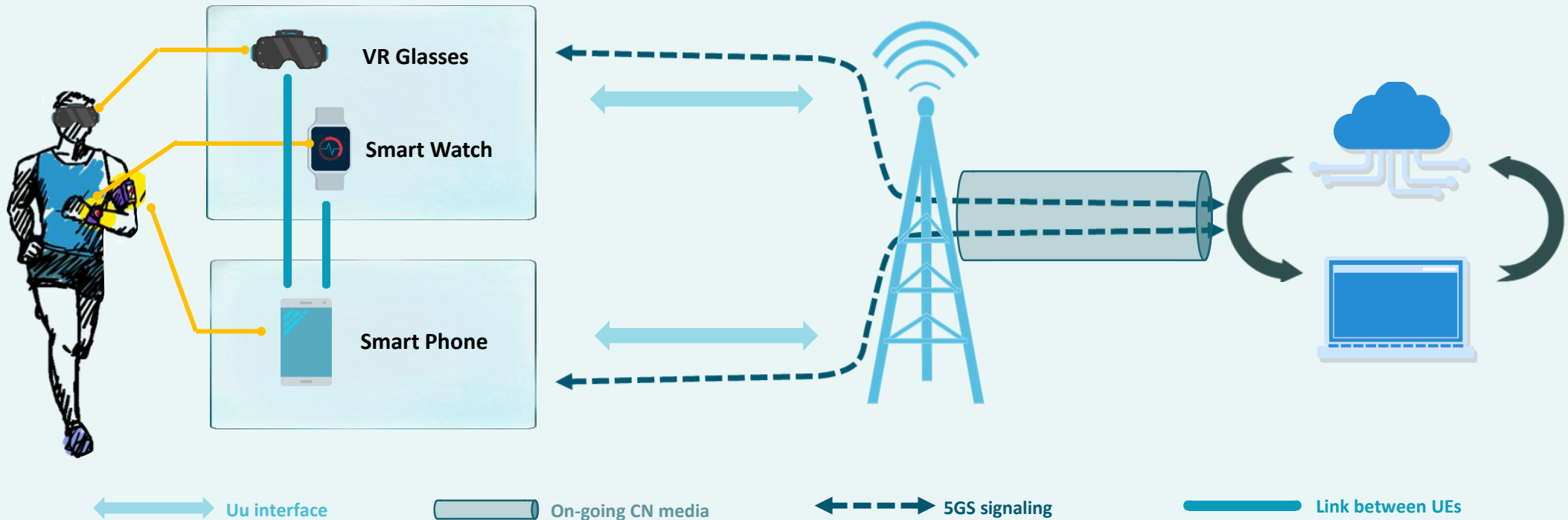
Improved reliability and enhanced robustness for URLLC scenario



# UE Aggregation for Industry with Multi-connectivity

## Scenarios - UL aggregation

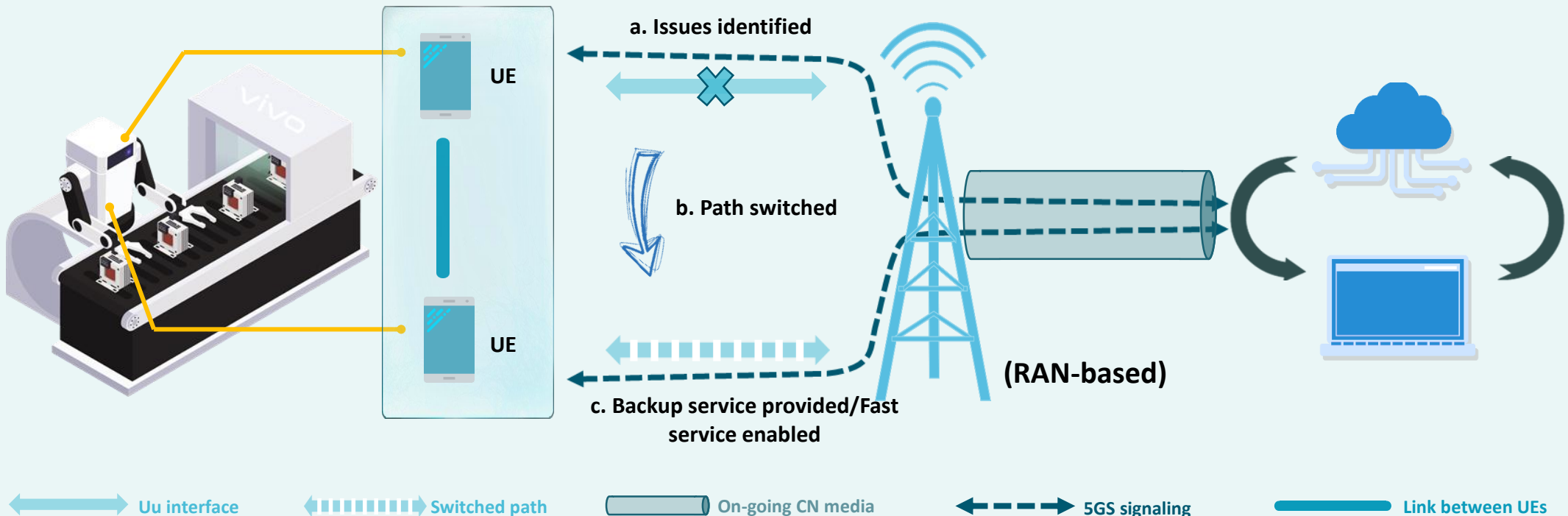
- UL throughput improvement in coverage limitation case
- Separated UL transmission from different UEs for UL boosting



# UE Aggregation for Industry with Multi-connectivity

## Scenarios - UE backup/service switching

- Improved reliability and robustness for URLLC scenario
  - E.g. An industrial machine/Robot equipped with two/multiple UEs working in a factory
- Enable fast service switching across UEs without data loss
  - Service continuity (with user-friendly experience) can be promised





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# UE Aggregation for Industry with Multi-connectivity

## MP-TCP/UDP based solution

- The high layer cannot be aware of the condition of air interface and can neither appropriately allocate the radio resources according to the radio link condition, nor achieve the gain from the link adaptive
- It require that both UE and server to support this solution. But, currently not all server support it

## Using higher Power UE

- High power is still one UE. For UE aggregation there is no normative limitation of UL transmission power on the aggregated UEs since the number of the aggregated UE can be flexibly extended
- Does not support to accommodate various UL bandwidth requirement of different applications
- Much more expensive then multiple normal power UEs

## Application level solutions for aggregation

- Existing application level solutions can be only supported in the special customized applications resulting to UE aggregation can not be widely spread.

## Multi-path SL Relay based solution

- Restrict the connection between UEs and may not be feasible to extend the scale of aggregated UEs
- Not all operators would deploy Relay function



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# UE Aggregation for Industry with Multi-connectivity

## Consideration 1: Assistance for RAN based solutions

### • Characteristics of the study

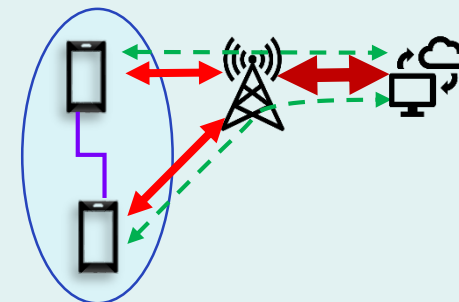
- UEs with **3GPP defined aggregation layer, e.g., PDCP+**, integrated in a device or connected via direct link (e.g., WIFI, Bluetooth, wireline)
- All UEs camp on same RAN node (but do not define interaction between UEs)

### • Benefit

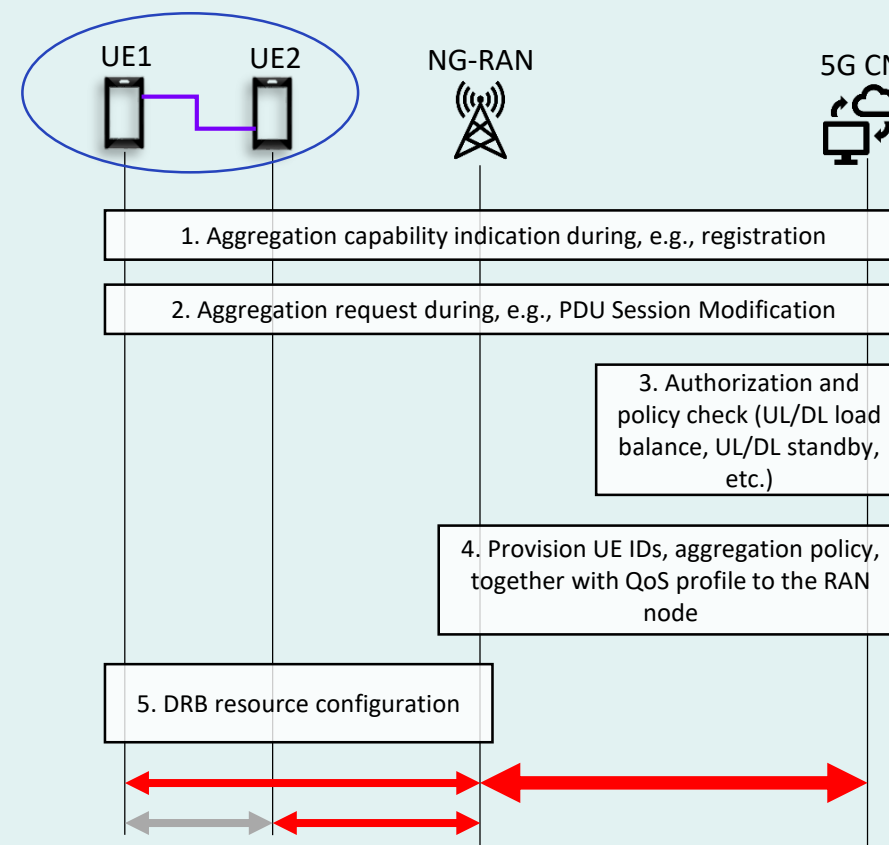
- Minimal packet retransmission via another connection when one connection fails

### • Objectives

- How to provision group information and policy for UE aggregation to RAN, e.g., load balance, standby, etc.
- How to handle RAN report of connection failure for fast switch



High level concept of RAN based UE aggregation for an QoS Flow





# UE Aggregation for Industry with Multi-connectivity

## Consideration 2: CN based solutions

### Requirement :

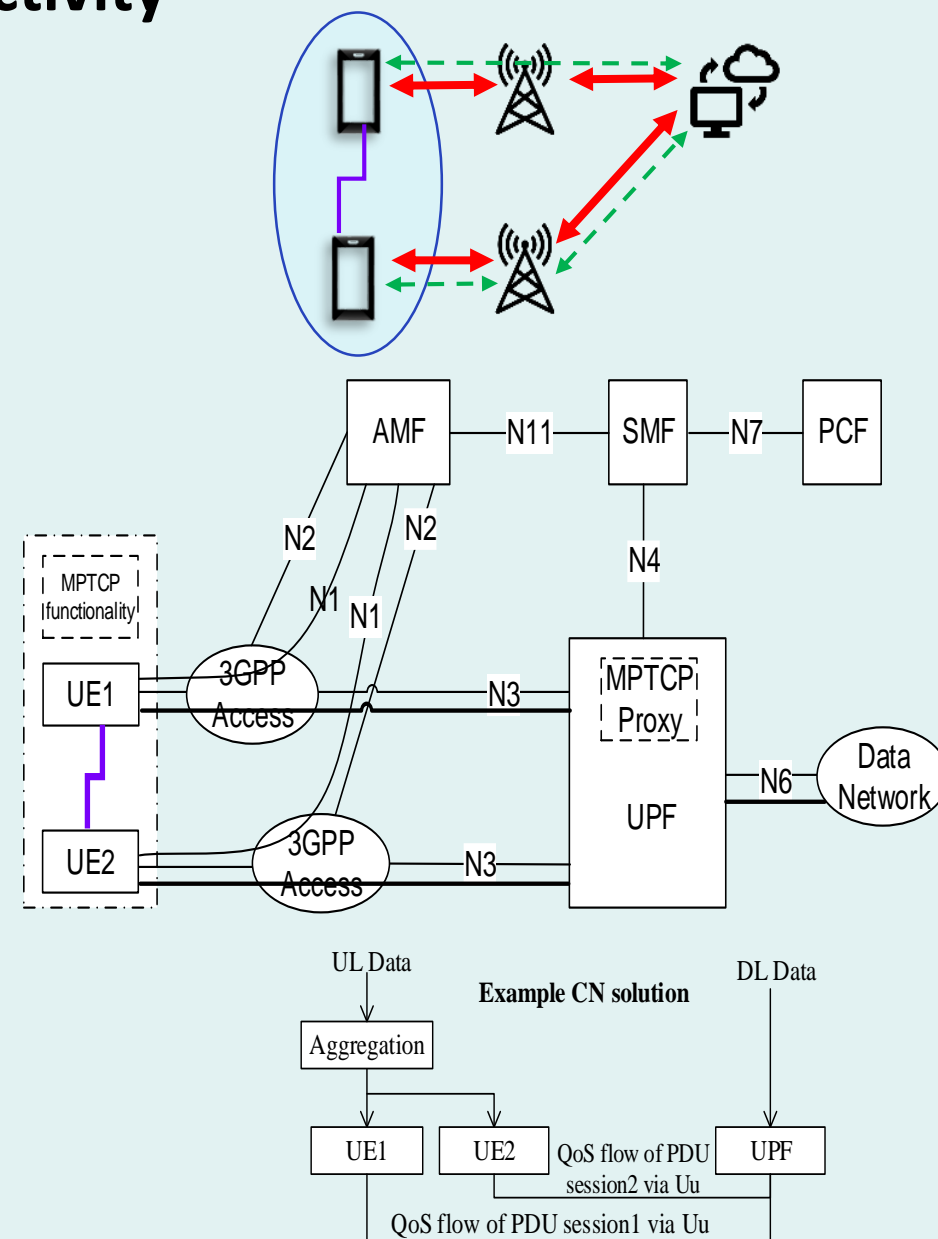
1. **Two UEs** integrated in a device or connected via direct link (e.g., WIFI, Bluetooth, wireline) ;
2. Multi-path based on **two UE's PDU sessions** with **user planes both on 3GPP access** controlled by the same SMF/UPF;
3. UE aggregation layer on High-Layer (e.g. based on MPTCP);

### Objectives :

1. How to anchor aggregated PDU sessions of UEs to same SMF/UPF;
2. Policy enhancement for UE aggregation provided to UE and UPF, e.g., load balance, standby, etc.
3. How to handle RAN report of connection failure for fast switch

### Major difference of ATSSS :

1. **Single UE** with both 3GPP and non-3GPP registration;
2. Multi-path based on **single UE's MA PDU session** with **user planes on 3GPP access or non-3GPP access or both**;
3. Traffic routing, splitting or switching based on MPTCP or ATSSS-LL functionality





# UE Aggregation for Industry with Multi-connectivity

## SID objectives

- **SA2 aspects**
  - Support of binding for multiple UEs and enforcement of policy, e.g., load balance, standby, etc.
  - Support of anchoring UP for multiple UEs:
    - Support of anchoring UP on same gNB and UPF for **RAN based solution**
    - Support of anchoring UP on same UPF for **CN based solution**
  - Support of UE backup and fast switch when one connection with a UE fails
- **Coordination aspects**
  - Study the possible coordination with other SA WGs for, e.g., charging, security
  - Coordination with RAN WGs for assisting RAN solutions



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# UE Aggregation for Industry with Multi-connectivity

## Timeline

### Timeline of the study

- Expect to start with other Rel-18 studies
  - **5 TUs for study phase, 2 TUs for WI**
- Send to SA plenary for information in **SA#96 June 2022**
- Send to SA for approval in **SA#97 Sept. 2022**

# UE Aggregation for Industry with Multi-connectivity

## Work Tasks

Work Task	TUs (study)	TUs (normative)
Support of binding for multiple UEs and enforcement of policy, e.g., load balance, standby, etc. (WT#1)	1.5	0.5
Support of anchoring UP for multiple UEs (WT#2)	2	1
Support of UE backup and fast switch when one connection with a UE fails (WT#3)	1.5	0.5



**THANK YOU.**  
**谢谢。**