

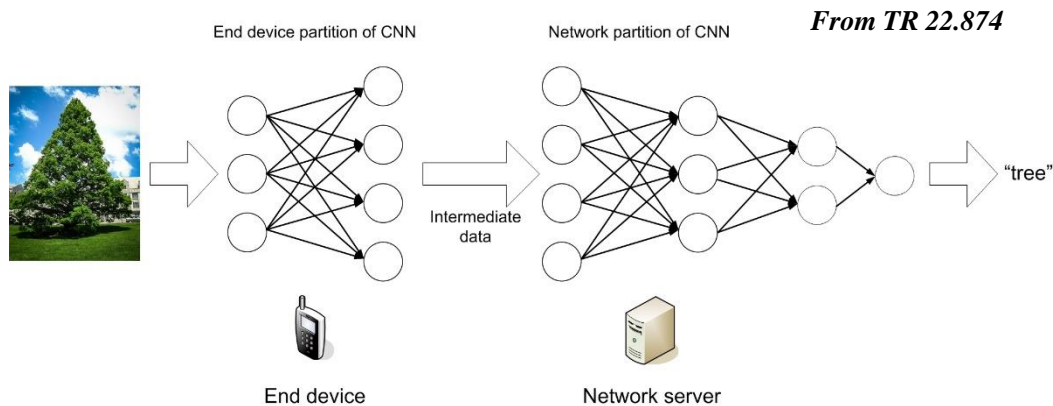
Source: ZTE, Sanechips
Agenda: 9.13

Uplink Enhancements for 5G Advanced



Uplink enhancements for UL heavy applications

Machine Vision



The required uplink data rate is in the order of Gbps/10Gbps (From TR 22.874) with 2-10ms latency requirement

More UL-heavy applications have emerged:

- Machine vision e.g. split AI/ML image/video recognition (from TR 22.874), remote-controlled robotics, AR display/gaming, remote driving...
- Broadband access in a crowd (from TR 22.261) - The scenario for very dense crowds, for example, at stadiums or concerts. In addition to a very high connection density the users want to share what they see and hear, putting a higher requirement on the uplink than the downlink

Uplink enhancements for UL heavy applications

Requirements for split AI/ML image/video recognition (from TR 22.874)

User application	Latency requirements			Required UL data rate	
	Required end-to-end latency	Image recognition latency	Intermediate data uploading latency	AlexNet (Fig. 5.1.1-1, Note 4)	VGG-16 (Fig. 5.1.1-2, Note 4)
One-shot object recognition at smartphone	Several seconds	~1s	~100ms	1.6~21.6Mbps	8~240Mbps
Person identification in security surveillance system	Several seconds	~1s	~100ms	1.6~21.6Mbps	8~240Mbps
Photo enhancements at smartphone	Several seconds	~1s	~100ms	1.6~21.6Mbps	8~240Mbps
Video recognition	Several seconds	33ms@30FPS	~10ms	16~216Mbps	80Mbps~2.4Gbps
AR display/gaming	7~15ms (Note 1)	<5ms	2ms	80Mbps~1.08Gbps	0.4~12Gbps (Note 5)
Remote driving	10ms (Note 2)	<5ms	2ms	80Mbps~1.08Gbps	0.4~12Gbps (Note 5)
Remote-controlled robotics	10~100ms (Note 3)	<5ms	2ms	80Mbps~1.08Gbps	0.4~12Gbps (Note 5)

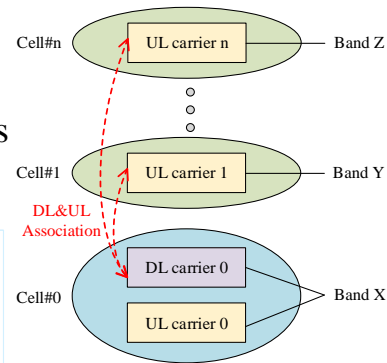
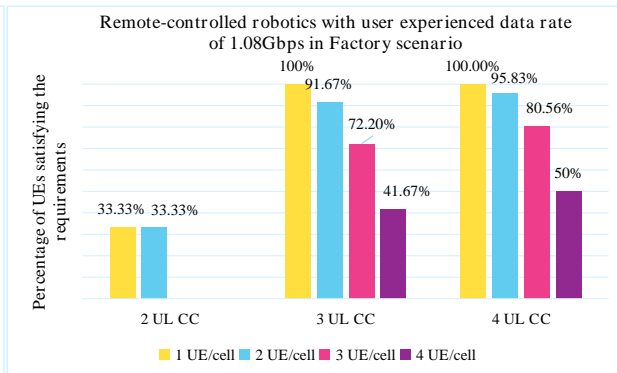
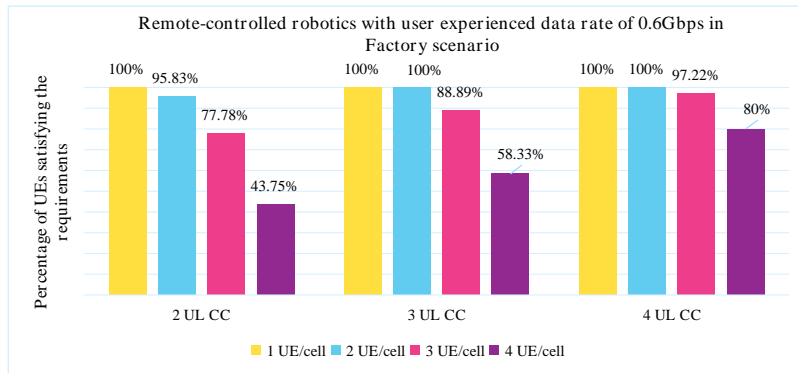
Requirements for broadband access in a crowd (from TR 22.261)

	Scenario	Experienced data rate (DL)	Experienced data rate (UL)	Area traffic capacity (DL)	Area traffic capacity (UL)	Overall user density	Activity factor	UE speed	Coverage
4	Broadband access in a crowd	25 Mbit/s	50 Mbit/s	[3,75] Tbit/s/km ²	[7,5] Tbit/s/km ²	[500 000]/km ²	30%	Pedestrians	Confined area

Uplink enhancements for UL heavy applications

- Potential Enhancements:
 - Enhancements on UL CA or BWP
 - e.g. more UL carriers than DL carriers, flexible association of DL and UL carriers

NOTE: can be supported by minimal spec impact based on the CA framework



NOTE 1: URLLC requirements with 2ms air interface latency and 99.999% packet reliability are considered as defined in TR 22.874.

NOTE 2: For Factory scenario, centralized cell coordination among all 12 cells is enabled for better performance.

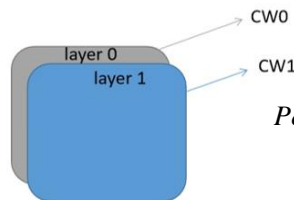
URLLC requirements should be considered when evaluating these enhancements for UL throughput.

Uplink enhancements for UL heavy applications

- Potential Enhancements (cont’):

- UL spatial multiplexing/layer mapping

- More MIMO antennas/layers e.g. 8 layers
 - Layer to codeword mapping (support 2 MCS or modulation orders for 2-4 layers)
 - Frequency selective precoding



- Modulation

- Enhanced modulation scheme, higher order modulation for Fixed wireless access

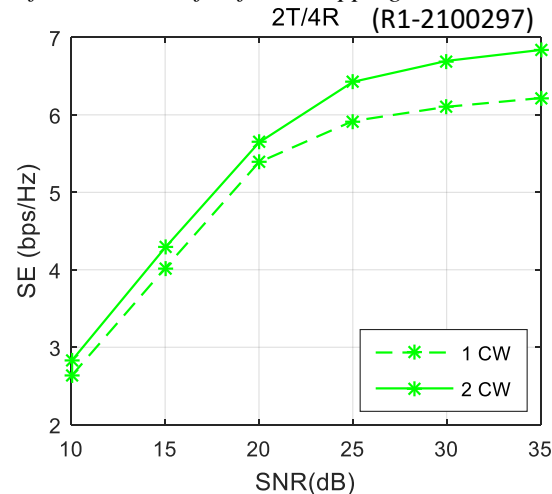
- Uplink beam management

- Enhance the case where beam correspondence cannot be utilized e.g. more UL carriers than DL carrier
 - UL simultaneous multi-panel transmission

- Interference coordination

- User virtualization and cooperation

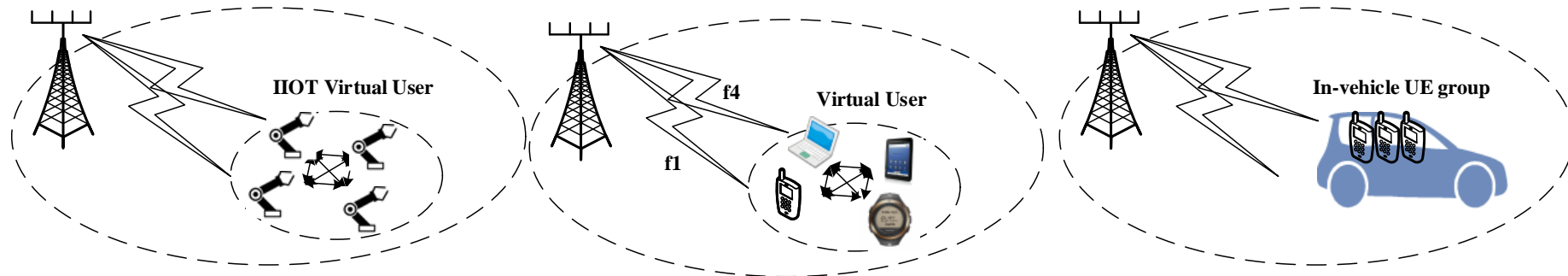
Performance benefit of CW mapping enhancement



Performance benefit of Simu. Multi-panel Tx

UPT (Mbps)	mean	5%-ile	95%-ile
UE panel selection (R15-17)	211.9	76.2	305.19
Multi-panel simultaneous transmission	245.05	86.84	403.27
	(+15.6%↑)	(+14.0%↑)	(+32.1%↑)

User Virtualization and Cooperation



- User virtualization can be done among multiple devices especially for the devices in proximity. e.g. A user often owns multiple devices e.g. laptop, cellular phone, smart wearable device, tablet, etc.
- Multiple devices can form a virtual user where multiple devices can collaboratively transmit and receive data from the network.
 - E.g. one device helps another device to transmit uplink data to effectively boost up the antenna/power capabilities i.e. more RF chains can be utilized in a virtual user.
- Collaboration can be done in multiple ways depending on the links among the devices.
 - Users can share their capabilities e.g. MIMO, PA, carrier processing.

Thanks



Tomorrow never waits

