

Discussion on latency performance of Uu-based sidelink resource allocation

**3GPP TSG-RAN WG1 Meeting#94
Gothenburg, Sweden, 20th - 24th August 2018
R1-1808300**

- In RAN #80 meeting, the new SID NR-V2X has been agreed with the following principle and objective [1]:

Principle:

- NR V2X shall complement LTE V2X for advanced V2X services

Objective 3: Uu-based sidelink resource allocation/configuration (LTE V2X Mode3-like and Mode4-like) [RAN1, RAN2]:

- Identify necessary enhancements of LTE Uu and NR Uu to control NR sidelink from the cellular network
- Identify necessary enhancements of NR Uu to control LTE sidelink from the cellular network

■ Use case groups in NR-V2X [2]

- Vehicle platooning, advanced driving, extended sensors, and remote driving
- Stringent latency requirements: the maximum end-to-end latency of 3 ~ 10ms

■ Study the latency performance for Uu based resource allocation mode (mode 3) NR-V2X.

[1] RP-181480, “New SID: Study on NR-V2X”, La Jolla, USA, June 11th – 14th, 2018.

[2] TS 22.186, “Enhancement of 3GPP support for V2X scenarios; Stage 1”, V14.2.1, March 2017.

Analysis of latency performance

- Two scenarios:
 - LTE Uu control NR sidelink scenario
 - Case 1: FDD network, LTE Uu with 1 ms TTI, NR sidelink with 0.5 ms TTI
 - Case 2: FDD network, LTE Uu with 0.14 ms sTTI, NR sidelink with 0.5 ms TTI
 - NR Uu control NR sidelink scenario
 - Case 1: TDD network, NR Uu with 0.5 ms TTI, NR sidelink with 0.5 ms TTI
 - Case 2: FDD network, NR Uu with 0.5 ms TTI, NR sidelink with 0.5 ms TTI
- Propagation delay and receiver processing delay are not included
- Assume extremely short gNB processing time: e.g. < 0.14 ms
- Assumption on UE processing capabilities

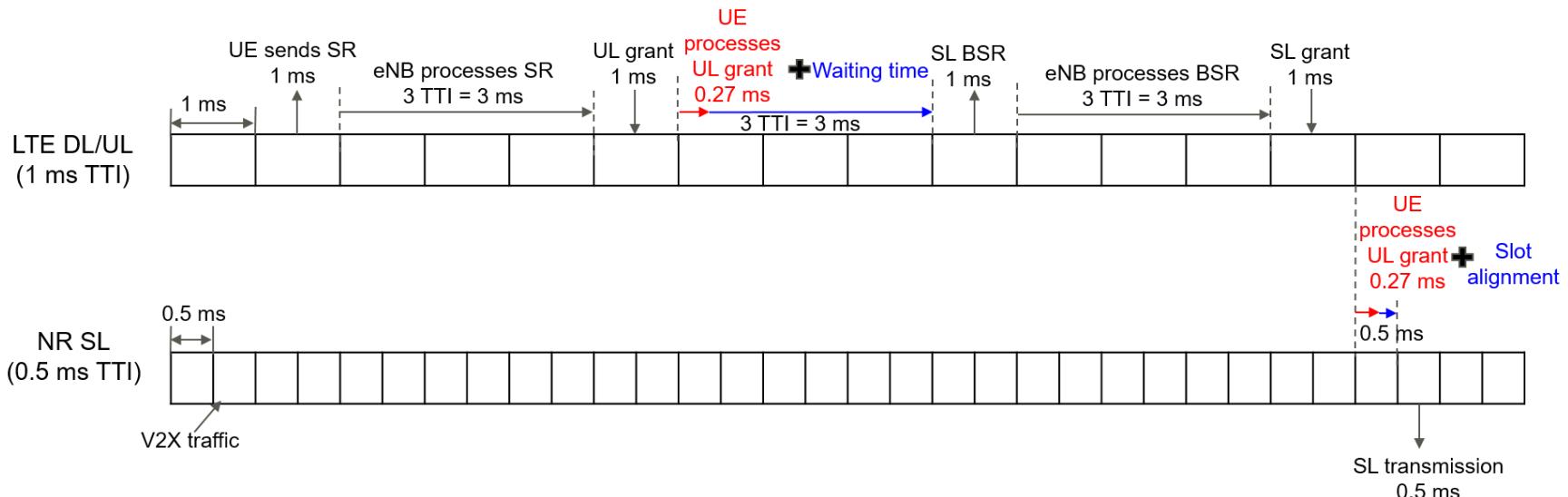
μ	Capability 1		Capability 2	
	PUSCH preparation time N_2 [symbols]	$T_{proc,2}$ (ms)*	PUSCH preparation time N_2 [symbols]	$T_{proc,2}$ (ms)*
1	12	0.5	5.5	0.27

* The values for $T_{proc,2}$ is calculated based on TS 38.214 subclause 6.4

Latency for case 1 in LTE Uu control NR sidelink scenario

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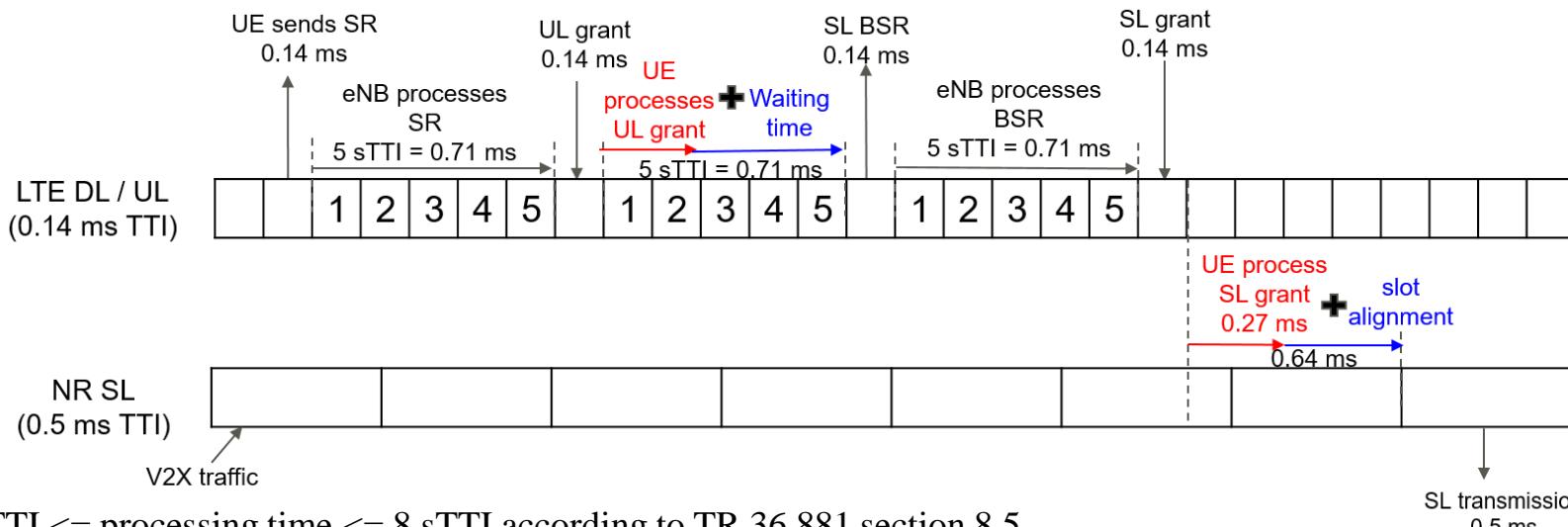
Step	Description	Delay (ms)
1	Average waiting time for PUCCH (1/2 SR period)	$\frac{1}{2} \text{ TTI} = 0.5$
2	UE sends SR on PUCCH	1
3	eNB processing delay (eNB decodes SR and generates UL grant)	3
4	eNB transmits UL grant	1
5	UE processing delay (UE decodes UL grant and encodes UL data with SL BSR) + waiting time for PUSCH	3
6	UE sends SL BSR	1
7	eNB processing delay (eNB decodes SL BSR and encodes SL grant)	3
8	eNB transmits SL grant	1
9	UE processing delay (UE decodes SL grant and encodes SL data) + slot alignment	0.5
10	UE sends SL data	0.5
	Total delay (ms)	14.5



Latency for case 2 in LTE Uu control NR sidelink scenario

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Step	Description	Delay (ms)
1	Average waiting time for PUCCH (1/2 SR period)	$\frac{1}{2} \text{sTTI} = 0.07$
2	UE sends SR on PUCCH	$1 \text{sTTI} = 0.14$
3	eNB processing delay (eNB decodes SR and generates UL grant)	$5 \text{sTTI} = 0.71^*$
4	eNB transmits UL grant	$1 \text{sTTI} = 0.14$
5	UE processing delay (UE decodes UL grant and encodes UL data with SL BSR) + waiting time for PUSCH	$5 \text{sTTI} = 0.71^*$
6	UE sends SL BSR	$1 \text{sTTI} = 0.14$
7	eNB processing delay (eNB decodes SL BSR and encodes SL grant)	$5 \text{sTTI} = 0.71^*$
8	eNB transmits SL grant	$1 \text{sTTI} = 0.14$
9	UE processing delay (UE decodes SL grant and encodes SL data) + slot alignment	0.64
10	UE sends SL data	0.5
	Total delay (ms)	3.93

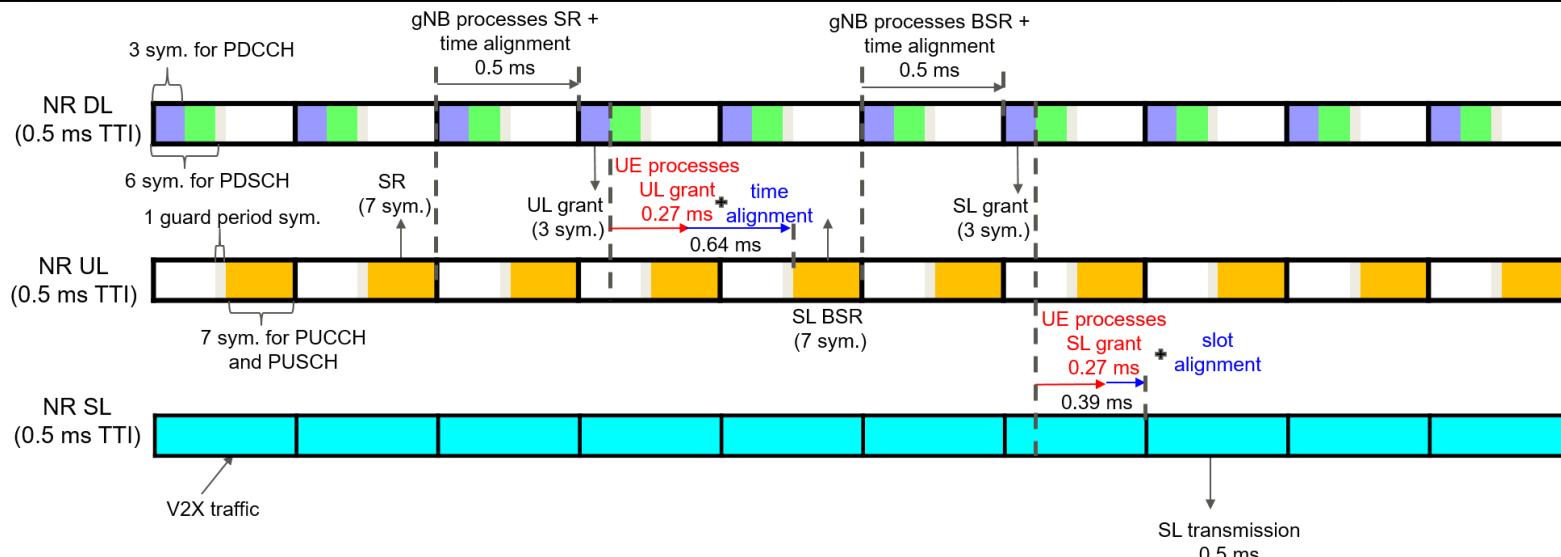


* 4 sTTI <= processing time <= 8 sTTI according to TR 36.881 section 8.5

Latency for case 1 in NR Uu control NR sidelink scenario

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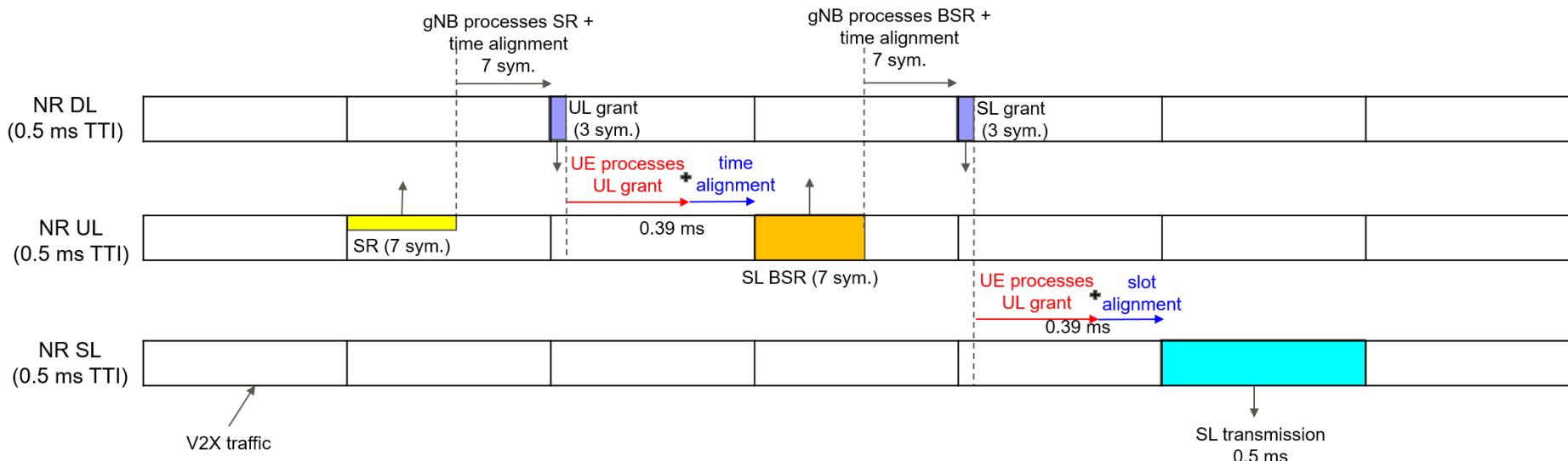
Step	Description	Delay (ms)
1	Average waiting time for PUCCH (1/2 SR period)	$\frac{1}{2} \text{ TTI} = 0.25$
2	UE sends SR on PUCCH	7 sym. = 0.25
3	gNB processing delay (gNB decodes SR and generates UL grant) + time alignment	0.5
4	eNB transmits UL grant	3 sym. = 0.11
5	UE processing delay (UE decodes UL grant and encodes UL data with SL BSR) + time alignment	0.64
6	UE sends SL BSR	7 sym. = 0.25
7	gNB processing delay (gNB decodes SL BSR and encodes SL grant) + time alignment	0.5
8	gNB transmits SL grant	3 sym. = 0.11
9	UE processing delay (UE decodes SL grant and encodes SL data) + slot alignment	0.39
10	UE sends SL data	0.5
	Total delay (ms)	3.5



Latency for case 2 in NR Uu control NR sidelink scenario

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Step	Description	Delay (ms)
1	Average waiting time for PUCCH (1/2 SR period)	$\frac{1}{2} \text{ TTI} = 0.25$
2	UE sends SR on PUCCH	7 sym. = 0.25
3	gNB processing delay (gNB decodes SR and generates UL grant) + time alignment	7 sym.s = 0.25
4	eNB transmits UL grant	3 sym. = 0.11
5	UE processing delay (UE decodes UL grant and encodes UL data with SL BSR) + time alignment	0.39
6	UE sends SL BSR	7 sym. = 0.25
7	gNB processing delay (gNB decodes SL BSR and encodes SL grant) + time alignment	7 sym. = 0.25
8	gNB transmits SL grant	3 sym. = 0.11
9	UE processing delay (UE decodes SL grant and encodes SL data) + slot alignment	0.39
10	UE sends SL data	0.5
	Total delay (ms)	2.75



* 7 sym. for PUCCH and PUSCH; 3 sym. for PDCCH

Observations and Proposals

- Observation 1: The latency target for NR-V2X is 3 ms.
- Observation 2. The latency requirement of 3 ms cannot be achieved for LTE Uu controlled mode 3 NR-V2X without any enhancement.
- Observation 3: Latency enhancements for NR Uu controlled mode 3 NR-V2X are also necessary to fulfil the requirement in Rel.16 NR-V2X use cases.
- Proposal 1. Discuss latency reduction mechanisms for **LTE Uu and NR Uu** controlled mode 3 NR-V2X.

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