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Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Study on evaluation for 2 receiver exception in Rel-15 vehicle mounted User Equipment (UE) for NR
(Release 16)

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Foreword

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

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where:

x the first digit:

1 presented to TSG for information;

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3 or greater indicates TSG approved document under change control.

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

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

1 Scope

The present document is a technical report for NR vehicle mounted UE with 2Rx antenna at FR1 in Rel-15. The purpose is to gather the relevant background information and studies in order to address 2Rx exception for NR vehicular UEs in a few specific NR bands such as n7, n38, n41, n77, n78 and n79 since NR UE shall be equipped with 4Rx ports as a baseline is mandated for these NR bands.

To allow 2 RX exception for vehicular UEs, as requested by 5GAA, it is essential for 3GPP RAN 4 to further study the design of telematics control units (TCU) in vehicles to gain confidence that performance is not degraded at system level by deploying 2 RX. As a part of allowing the 2 RX exception, RAN 4 needs to evaluate identification of vehicle mounted UEs in the network and corresponding test methods

This Technical Report contains the evaluation results for the impact of 2Rx vehicle mounted UE on coverage and throughput considering the realistic RF architecture and link budget with reasonable antenna gain of 2Rx vehicle UE. Also propose the methods to distinguish vehicle UE from handheld UE to verify conformance and GCF certification.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

[2] 3GPP TR 30.007: "Guideline on WI/SI for new Operating Bands".

[3] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[4] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[5] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[6] R4-1811897 "WF on Evaluation for 2 RX exception in Rel-15 vehicle mounted UE".

[7] RP-182169 "LS on impact of 2Rx vehicle mounted UEs on coverage".

[8] R4-1814143 "WF on 2 Rx vehicle UE: Link budget simulation assumptions".

[9] R4-1816253, "Response LS to RAN4 on method to distinguish vehicle UE from handheld UE".

[10] R4-1815465, "Method to distinguish vehicle NR UE with 2Rx Exception".

[11] R4-1816650, "Updated WF on 2 Rx vehicular UE".

[12] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".

[13] 3GPP TS 29.272: "Evolved Packet System (EPS); Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) related interfaces based on Diameter protocol".

[14] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[15] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[16] 3GPP TS 36.423: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP)".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

3.2 Symbols

For the purposes of the present document, the following symbols apply:

$\Delta R_{IB,4R}$ Reference sensitivity adjustment due to support for 4 antenna ports

3.3 Abbreviations

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

BS	Base Station
FR	Frequency Range
FRC	Fixed reference channel
GCF	Global Certification Forum
HHUE	HandHeld UE
NR	New Radio
OTA	Over-The-Air
RCT	Radio Communication Tester
REFSENS	Reference Sensitivity
RF	Radio Frequency
RX	Receiver
TCU	Telematics Control Units
TX	Transmitter

4 Background

The present document is a technical report for NR vehicle mounted UE with 2Rx antenna at FR1 in Rel-15. The document contained the following objectives due to urgent market demands of the automotive industry for 5G

Aspects to study in allowing 2 RX exception for vehicle mounted UEs in frequency bands where 4 Rx is mandated:

- Investigate the impact of 2Rx vehicle mounted UE on coverage and throughput and the possible ways to avoid or at least minimize such impact.
  - Link budget with 2 RX vehicular UE
  - TCU receiver RF chain and architecture
  - Coverage and throughput impacts at system level
- Methods to distinguish vehicular UE from handheld UE

- Methods to define vehicle mounted UEs
- Methods to verify conformance and GCF certification (excluding OTA scope)

5 General aspects for NR vehicular UE at FR1

This section contains relevant aspects for the link budget evaluation.

5.1 Antenna implementation for 2 Rx vehicle mounted UE

The following implementation examples are a selection of typical antenna implementation including cable loss.

5.1.1 Typical Baseline Rx Antenna Gain in the Market

The sub-section illustrates selection of antenna gain values of prominent vehicle manufacturers.

5.1.1.1 Baseline Antenna Gain Values: OEM A

The cable loss depends on the chosen package and mounting concept of the telematics unit and the antenna. OEM A has chosen a concept which allows to eliminate the cable loss completely in nearly all cars.

- The average gain of the 2x2 MIMO antenna is about -1 dBi at 2.6 GHz.
- The average loss of a coax cable is about 1 dB/m.
- This is an example for better performance than baseline antenna values including cable loss.

5.1.1.2 Baseline Antenna Gain Values: OEM B

The following antenna gain (dBi) values are expected minimum in the frequency ranges until 3.8GHz:

- 2 RX scenarios:
    - Antenna 1: Average Antenna gain (theta=60°-90°, phi=0° to 359°, Car implementation on PEC) including cable loss: 1 dBi, based on a rooftop antenna implementation
    - Antenna 2: Average Antenna gain (theta=60°-90°, phi=0° to 359°, Car implementation on PEC) including cable loss: 0 dBi, based on a second radiator in rooftop antenna implementation
- This is an example for better performance than baseline antenna values including cable loss.

5.1.1.3 Baseline Antenna Gain Values: OEM C

The cable loss depends on the chosen package and mounting concept of the telematics unit and the antenna.

- The average gain of the 2x2MIMO antennas is about -2/-3 dBi at 2.5 GHz.
- The average loss of a coax cable is about 1 dB/m at 2.5 GHz
- Window antenna:
    - Antenna Gain: -2 dBi / Cable length: 2 m / Overall gain: -4 dBi

This is an example for performance which is closer to baseline antenna values including cable loss.

5.1.2 Antenna measurement procedures

For clarification, the following overview of active and passive measurement procedures indicates the difference between the measurements for both types of devices.

Active antenna measurements:

- Here the transceiver of the HH establishes a wireless link against an RCT (radio communication tester (=BS simulator)). The RCT measures the power received by antennas of the test setup. The test setup has been calibrated that way, that the losses in power caused by the distance between the sending and receiving antenna are known and that the measured results exclude these losses.

- One procedure is to rotate the DUT on a turn table in discrete steps, the receiving antenna is moved around the DUT in discrete steps. Both movements together give measurements results at different radiation directions. Results are usually accumulated and averaged of several directions -> E.G. This gives the angle dependent gain values.
- Subtracting the conducted power (RCT directly connected to the HH, without any antenna) of the radiated power gives the antenna efficiency.
- HH are usually measured this way

Passive antenna measurements:

- Here power is fed to the antenna by measurement cables. The power at a receiving antenna is measured e.g. by a power meter. The test setup has been calibrated that way, that the losses of the measurement cables as well of the losses in power caused by the distance between the sending and receiving antenna are known and that the measured results exclude these losses.
- The DUT is rotated on a turn table in discrete steps, the receiving antenna is moved around the DUT in discrete steps. Both movements together give measurements results at different radiation directions. Results are usually accumulated and averaged of several directions -> E.G. This gives the angle dependent gain values.
- Vehicles are usually measured this way, HH usually only during development but not for any certification purposes.

5.2 Baseline Rx antenna gain

Table 5.2-1 defines the baseline Rx antenna gain for the link budget calculation.

Table 5.2-1: Reference baseline Rx antenna gain

Link budget parameter name	Link budget parameter value
Rx antenna gain	-3 dBi

Note: Based on the WF [11] in RAN4#89, the Rx antenna gain in table 5.2-1 was revised.

6 Evaluation on the coverage related issue

6.1 Coverage Evaluation

6.1.1 Link budget simulation assumption

RAN4 agreed on the RF parameters to evaluate the coverage related issues as shown in Table 6.1.1-1 [8].

Table 6.1.1-1: RF parameters for Link budget evaluation

		4Rx HHUE (Outdoor browsing)	**4Rx HHUE (Passenger Holding browsing)**	**4Rx HHUE (Dash board)**	**2Rx V-UE**
Antenna Configuration		4Rx/2Tx	4Rx/2Tx	4Rx/2Tx	2Rx/2Tx
BS Antanna Gain[1] [dBi]		18	18	18	18
UE Antenna Gain	Antenna system gain per element [2,5] [dBi]	-7.5	-7.5	-4.5	-3
	Penetration Loss[3] [dB]	0	9	9	0
	Total [dB]	-7.5	-16.5	-13.5	-3
Fading Margin [dB]		9	9	9	9
Interference Margin [dB]		3	0.5	0.5	3
DL	BS Tx Power [dBm]	46	46	46	46
	UE REFSENS[4] [dBm]	-87.4	-87.4	-87.4	-84.7

Note 1: Ericsson proposed value during AH meeting in RAN4 #88BIS.
Note 2: Antenna system gain per element = (ant. efficiency + directivity) + cable/Body Loss. The detail values for n7/n41 are based on follows
- HH UE : HH-UE : https://www.gsma.com/newsroom/wp-content/uploads/TS-24-v3-01.pdf
- Vehicle UE: LS (R4-1811528) from 5GAA
Note 3: O2I car penetration loss is based on TR 38.901 [12], 7.4.3.2
Note 4: 4 Rx REFSENS = 2 Rx REFSENS (TS 38.101-1 [3], Table 7.3.2-1) + $\Delta R_{IB,4R}$ (TS 38.101-1 [3], Table 7.3.2-2)

Note: Based on the WF [11] in RAN4#89, the RF parameters and Note 5 in table 6.1.1-1 were revised and removed.

6.1.2 Coverage evaluation results

In this section, the coverage evaluation results based on the agreed coverage analysis parameters are provided in Table 6.1.2-1.

Table 6.1.2-1: Coverage analysis for n41

		4Rx HHUE (Outdoor)	4Rx HHUE (Passenger Holding)	4Rx HHUE (Dash board)	2Rx VUE
UE Antenna Configuration		4Rx/2Tx	4Rx/2Tx	4Rx/2Tx	2Rx/2Tx
BS Antenna Gain [dB]		18	18	18	18
UE Antenna Gain[1]	Antenna system gain per element [4] [dBi]	-7.5	-7.5	-4.5	-3
	Penetration Loss[2] [dB]	0	9	9	0
	Total [dB]	-7.5	-16.5	-13.5	-3
Fading Margin [dB]		9	9	9	9
Interference Margin [dB]		3	0.5	0.5	3
DL	BS Tx Power [dBm]	46	46	46	46
	UE REFSENS[3] [dBm]	-87.4	-87.4	-87.4	-84.7
	Maximum allowable path loss [dB]	131.9	125.4	128.4	133.7

Note 1: UE Antenna Gain including cable & body loss is based on [6]. Detailed values for n41 are based on follows:
HH-UE : https://www.gsma.com/newsroom/wp-content/uploads/TS-24-v3-01.pdf
Vehicle UE: 5GAA LS (R4-1811528)
Note 2: O2I car penetration loss is based on TR 38.901 [12], 7.4.3.2
Note 3: 4 Rx REFSENS = 2 Rx REFSENS (TS 38.101-1 [3], Table 7.3.2-1) + $\Delta R_{IB,4R}$ (TS 38.101-1 [3], Table 7.3.2-2)
Note 4: Antenna system gain per element = (ant. efficiency + directivity) + cable/Body Loss

The smallest difference in DL Maximum allowable path loss is observed to be 1.8dB from the analysis.

From evaluated Maximum allowable path loss value, actual cell coverage in n41 based on typical pathloss model defined in TR 38.901 [12] are shown in Figure 6.1.2-1 with relative cell coverage ratio which is normalized with 4Rx HHUE at outdoor.

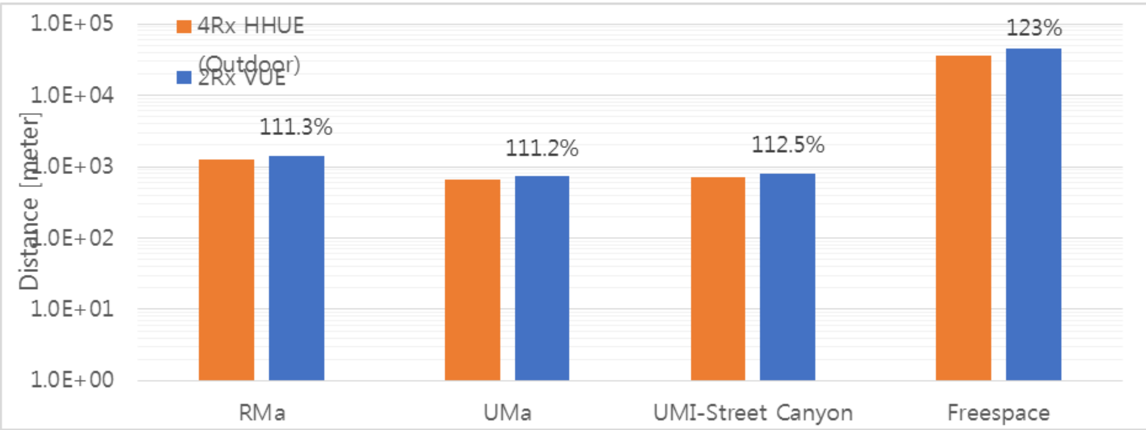

Figure 6.1.2-1. Evaluated n41 cell coverage based on pathloss model in TR 38.901 [12]

Based on Table 6.1.2-1 and Figure 6.1.2-1, interpretations are:

- ***2 Rx Vehicular UE can provide larger Maximum allowable path loss value than 4 Rx HH UE.***
- ***2 Rx Vehicular UE can provide at least 11% larger cell coverage than 4 Rx HH UE.***

6.1.3 Conclusions

According to the discussions and performance evaluation results captured in the previous section, the following conclusions can be drawn:

- 2 Rx vehicular UE achieve higher Maximum allowable path loss in the evaluation scenarios

  - Because of the fixed mounting of antennas several vehicle specific advantages (e.g. better antenna gain due to the limitation of the required sphere, no body losses) are given and result in the higher Maximum allowable path loss

- 2 Rx vehicle implementation are less arbitrary in the performance as the number of possible antenna positions is much more limited compared to the handheld use cases and holding positions.

  - Even in browsing mode there are several usage and holding positions whereas the vehicle has clear defined position because of the mounting.

- No performance degradation in cell-edge coverage was identified in case of allowing 2 Rx vehicular UEs

Conclusion: Based on the results of the cell-edge performance evaluation, there was no indication for a degradation of the cell-edge coverage performance by using 2Rx vehicular UEs in bands where 4Rx is mandated. This conclusion is valid when the vehicular UE reflects antenna system gain per element which is at least -4.8 dBi due to difference in maximum allowable path loss between 2 RX Vehicular UE and 4 RX HH UE outdoor in Table 6.1.2-1.

6.2 Evaluation on European Commission's Broadband vision

This section aims at summarizing the several studies which were conducted since RAN #80 meeting in order to conclude the evaluations of 2 RX impacts with respect to throughput required for European Commission's Broadband vision.

6.2.1 Scope of the Study

In RAN 4 #88 meeting, a WF was agreed [6], where following agreements were reached:

- Throughput study is out of scope of RAN 4.

- Coverage is based on link budget analysis

In RAN #81 meeting, the following was agreed and LS was sent to RAN 4 [7]:

- The impact of 2RX vehicular UEs on coverage in terms of cell edge performance has to be evaluated.

- Cell capacity analysis is not considered essential.

- As a reference to the cell edge performance for link budget evaluation, the requirement of the European Commission's Broadband Europe vision of 30 Mbps downlink throughput could be used

- To augment the existing pass/fail limit for reference sensitivity, an analysis could be provided of the downlink signal level at which a certain throughput target is reached.

6.2.2 Analysis of cell edge performance

Intensive discussions and studies have been carried out to analyze link budgets and parameters for link budgets have been discussed extensively in several meetings and agreed in [8]. Based on the agreed parameters in [8][11], the following link budget study provided in section 6.1.

It can be seen that Maximum allowable path loss values have been mentioned for analyzing cell coverage. As a part of the link budget discussions in [6][8][11], reference sensitivity values specified in TS 38.101-1 [3] have been taken into account for the frequency bands under discussion (example n41). It should be noted that reference sensitivity values mentioned in TS 38.101-1 [3], correspond to Fixed reference channel (FRC) for receiver requirements seen in TS 38.101-1 [3].

The maximum throughput averaged over 1 frame which shall be met with FRC defined in TS 38.101-1 [3] is up to 34.603 Mbps. It is evident that the downlink signal level for meeting EC throughput requirement at cell edge performance, of 30 Mbps mentioned in [7], has been satisfied while calculating 2 RX link budgets for vehicular UEs.

Furthermore, it has been shown in section 6.1 that actual cell coverage analysis based on Table 6.1.1-1 using path loss models (RMa, UMa, UMI-SC, Freespace) does not impact the network and as well meets the required throughput limits recommended by RAN [7]

Conclusion: The downlink signal level for meeting EC vision at cell edge performance, of 30 Mbps, has been satisfied while calculating link budgets for 2 RX vehicular UEs.

7 Evaluation on the throughput related issue

Based on the agreed WF [6], the throughput evaluation is out-of-scope of RAN WG4. Hence, RAN4 do not need further discussion for the evaluation on the throughput issues. However, RAN4 has studied the cell edge performance based on link budget evaluation to satisfy the European Commission's Broadband Europe vision (see note) of 30 Mbps downlink throughput [7] in cluase 6 based on vehicle link budget evaluation.

NOTE: https://ec.europa.eu/digital-single-market/en/broadband-europe

8 Method to distinguish the 2Rx vehicular NR UE from 4Rx NR UE

Based on the study in RAN4, following options in table 8-1are adopted to distinguish vehicular UE and other type of UE.

Table 8-1: Methods to distinguish vehicular UE and other type of UE

No	Solution	Objective	Action
1	UE vender's declaration for GCF certification	For different UE type declaration, different requirements should be applicable and verified for certification test.	RAN5 should define different test cases for different UE type though in a same band.
2	# of MIMO layer	Consider maximum supported MIMO layer signaling to distinguish 2Rx vs 4Rx UE	Existing UE capability signaling can be used in networks
3	Vehicular UE definition	Define clearly the characteristic of vehicular UE in the spec.	RAN4 needs to work out an appropriate definition for vehicular UE
4	Vehicular UE identification	For different UE type, operator can further check the applicability, identify the 2Rx vehicular UE, authorize and perform service management.	RAN plenary CR

For option1, GCF sent LS [9] to RAN4 that 2Rx for vehicular UE exception could be handled as:

- **For module certification:**

  The module manufacturer shall declare the intended use:

  - Intended for 4Rx devices; or
  - Intended for 2Rx vehicle mounted devices; or
  - Intended for 4Rx devices or 2Rx vehicle mounted devices.

- **For device certification:**

  The device manufacturer shall declare if the intended use:

  - Vehicle mounted use only; or
  - Other

  For device certification the 2Rx exception will ONLY be valid for devices declared as 'Vehicle mounted use only'. Such device may use a pre-certified module declared as 'Intended for 2Rx vehicle mounted devices' or

  'Intended for 4Rx devices or 2Rx vehicle mounted devices'.

  For devices declared as 'Other' the certification shall be based on 4Rx, i.e. the 2Rx exception will NOT apply. If a pre-certified module is used, then shall the module have a valid certification for 4Rx.

For option 2, basically, there is no direct coupling between maximum supported MIMO layer and number of UE Rx port in LTE. But, in NR, following decision was captured in endorsed UE feature list during last RAN plenary meeting [3].

For single CC standalone NR, it is mandatory with capability signaling to support at least 4 MIMO layers in the bands where 4Rx is specified as mandatory for the given UE and at least 2 MIMO layers in FR2. Some relaxations to this requirement may be applicable in the future (including in Rel-15). Mandatory in all cases means mandatory with capability signaling.

It means that NR UE supporting 4 Rx should also support up to 4 layer MIMO at least for current 4 Rx mandated NR bands for single CC standalone NR. Thus, we can assume the maximum supported MIMO layer is directly coupled into the number of UE Rx port based on above decision. Also for CA/DC UE, the CA/DC UE capability for MIMO layer will be discussed and decided as separately. So the option2 is still useful to distinguish 2RX and 4RX UE.

For option3, the definition of vehicular UE should be specify in TS 38.101-1 [3] to distinguish vehicular UE and Handheld UE. Also need to make different REFSENS requirements. Then RAN5/GCF will define different test cases for different UE type though in a same band.

For option4, one possible solution is to adopt the approach of using the RFSP/SPID parameter and to define a new SPID value for "vehicle authorised for 2Rx use", as in Annex I of TS 36.300 [14]. The advantage of using the RFSP approach is that it is already fully standardised for both EPC and 5GCore. It is based on the RFSP parameter being loaded using existing O&M processes into the HSS/UDM, and supplied to the MME/AMF when the UE Attaches (or does Tracking Area Update) in that MME/AMF. Then at every RRC Connection Establishment, the MME/AMF supplies the RFSP value to the RAN, and the RAN can then use"vehicle authorised for 2Rx use" value in combination with the UE's Radio Access Capabilities, to control (e.g. limit or reject) radio resource allocation to 2Rx devices that are not in authorised vehicles. With regard to RFSP, the relevant EPS specifications are the system level Stage 2 specification in TS 23.401 (see clause 4.3.6); the HSS to MME signalling in TS 29.272 [13] (see clauses 7.3.2 and 7.3.46); the E-UTRAN stage 2 specification in TS 36.300 [14] (clause 16.1.8 and Annex I); the MME to eNB signalling in TS 36.413 [15] (e.g. see clauses 8.3.1.2, 8.3.4.1, 8.4.2.2, 8.6.2.2, and 9.2.1.39) and similar signalling for X2 handovers in TS 36.423 [16]. The specification references for 5GCore and NG-RAN can be derived from the EPS references.

Based on the summary in Table 8-1 and GCF reply LS, RAN4 decide that UE vendor's declaration is a solution for the certification aspect and the existing RRC signaling for # of MIMO layers are used to differentiate 2Rx vehicular UE from 4Rx NR UE.

Therefore, RAN4 conclude as follow based on [11]:

Conclusion 1: Declare and differentiate 2 RX Vehicular UE through 3GPP compliance testing via GCF/other certification organizations [9].

a. 3GPP do not need to consider UE outside 3GPP compliance.

Conclusion 2: RAN 4 agree on existing UE capability signaling for # of MIMO layers to differentiate 2 RX UE from 4 RX UE.

Conclusion 3: Definition of Vehicular UE in TS 38.101-1 [3] is needed.

Vehicular UE: A UE which is integrated in a vehicle with externally radiating antennas for NR operating bands

Note: Integrated UE does not refer to other UE form factors placed inside the vehicle.

Conclusion 4: For Vehicular UE, network based identification is required for authorization purposes. The actual implementation of network based identification method does not impact 3GPP decision on 2 RX exception.

a. A possible solution to implement conclusion 2 is based on SPID value in 36.300[14] / 38.300 (Annex I), targeting rel-15 and beyond, to be captured in TR 38.826.

b. Other network based identification proposals in 3GPP are not precluded.

c. RAN 4 recommends RAN to consider other network based identification proposals without additional RAN signaling.

Final Conclusion: 2 RX Vehicular UE can be distinguished based on conclusion 1+2+3+4

Annex A: Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**		**Rev**	**Subject/Comment**	**New version**
2018-08	RAN4 #88	R4-1810449				TR38.826 Skeleton for Study on evaluation for 2Rx exception in rel-15 vehicle mounted UE for NR	0.0.1
		R4-1811897				"WF on Evaluation for 2 RX exception in Rel-15 vehicle mounted UE" Volkswagen AG, LG Electronics, Samsung, General Motors, Ericsson, Huawei, Telecom Italia, Vodafone, CMCC	
2018-10	RAN4 #88BIS	R4-1812250				TR38.826 v0.1.0 update: Study on evaluation for 2Rx exception in rel-15 vehicle mounted UE for NR	0.1.0
		R4-1814143				"WF on 2 Rx vehicle UE: Link budget simulation assumptions" Samsung, LG Electronics, Volkswagens AG	
		R4-1814319				TP on general aspect for vehicle mounted NR UE, Volkswagens AG	
2018-11	RAN4 #89	R4-1816778				TR38.826 v0.2.0 update: Study on evaluation for 2Rx exception in rel-15 vehicle mounted UE for NR	0.2.0
		R4-1816771				WF on 2Rx exception for NR vehicle UE	
		R4-1816651				Conclusion of T-put results	
		R4-1816773				Conclusion on Rx link budget evaluation	
		R4-1816777				Conclusion of vehicle UE distinction methodology	
		R4-1816790				TR38.826 v0.3.0 update: Study on evaluation for 2Rx exception in rel-15 vehicle mounted UE for NR	0.3.0
2018-11	RAN#82	RP-182305				v1.0.0 submitted for plenary approval	1.0.0
2018-12	RAN#82					Approved by plenary – Rel-16 spec under change control	16.0.0