3GPP TSG-RAN WG4 Meeting #112 DraftR4-2413516

**Maastricht, NETHERLANDS, 19th – 23th August, 2024**

**Agenda item:** 8.8.4

**Source:** Samsung

**Title: draft Way Forward** for [112][329] NTN\_testing\_NGSO\_channel\_model

**Document for:** Approval

# Introduction

This t-doc provides WF for [112][329] NTN\_testing\_NGSO\_channel\_model.

# WF

## Sub-topic 1-1 General

**Issue 1-1-1: Work plan on channel model and requirements**

* Offline agreement
	+ Focus on TE-emulated channel model in initial stage for NGSO testing
		- Once sufficient progress made for channel model introduction, RAN4 can start the discussion on corresponding requirements and tests according to WI objective.

**Issue 1-1-2: Relation-ship between TE-emulated channel model for satellite motion and fading channel model**

* Offline agreement:
	+ Decouple TE-emulated time-varying Doppler (frequency) and delay shifts due to satellite mobility from traditional fading channel

## Sub-topic 1-2 TE emulated channel model for statellite mobility

**Issue 1-2-1 Methodology for Time varying Doppler and Delay shifts modelling**

* Offline agreement
* RAN4 aims to introduce TE-emulated time varying doppler shift and delay shift model for satellite motion with following candidate options:
	+ Option 1: Eckstein-Hechler model
	+ Option 2: Keplerian model (checking with R&S?)
	+ Option 3: Existing model from TR 38.811 5.3.4.3
	+ Option 4: Proposal 2 from R4-2412552

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| $$d\_{h}\left(t\right)=mod\left(v\_{NGSO}⋅t, 2d\_{h,max}\right)-d\_{h,max}$$$$T\left(t\right)=\frac{d\left(t\right)}{c}=\frac{\sqrt{d\_{h}(t)^{2}+h\_{NGSO}^{2}}}{c}$$$$F\left(t\right)=-f\_{d}\frac{d\_{h}\left(t\right)}{d(t)}=-f\_{d}\frac{d\_{h}(t)}{\sqrt{d\_{h}\left(t\right)^{2}+h\_{NGSO}^{2}}} $$where* $T\left(t\right)$: Propagation delay of the signal from the satellite at time $t$,
* $F(t)$: Doppler (frequency) shift of the signal from the satellite at time $t.$
* $d\_{h}(t)$: the horizontal distance between the satellite and UE at time $t$,
* $d(t)$: the distance between the satellite and UE at time $t$,
* $d\_{h,max}$: the maximum horizontal distance between the satellite and UE, i.e., $h\_{NGSO}/tan⁡(E)$,
* $c$: the speed of light,
* $f\_{d}$: Maximum Doppler shift (Hz)
 |

* + Option 5: Proposal 2 from R4-2412783

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| * The instant satellite speed $v$ is given as:

$$v=\sqrt{\frac{μ}{R+h}}$$* The initial angle $β$ of vector geocentric to UE relative to the x axis is given as:

$$β=π-α-arcsin⁡\left(\frac{R∙cos\left(α\right)}{R+h}\right)$$* The satellite position $s$ is given as:

$$s=j∙\left(R+h\right)$$* The UE position $u$ is given as:

$$u=R∙e^{j∙\left(β+\frac{v∙t}{R+h}\right)}$$* The Doppler $f\_{d}$ is given as:

$$f\_{d}=\frac{v}{c}∙f\_{c}∙real\left(\frac{u-s}{\left|u-s\right|}\right)$$* The delay $T$ is given as:

$$T=\frac{|u-s|}{c}$$where $μ=398600.4418×10^{9}{m^{3}}/{s^{2}}$ is standard gravitational parameter, $R=6371008.7714m$ is earth average radius, $h=600000m$ is satellite altitude for LEO-600, $α$ is initial angle of vector UE to satellite relative to vector UE to clockwise side horizon, $t$ is the time, $c=299792458{m}/{s}$ is the speed of light, $f\_{c}=2×10^{9}Hz$ is the carrier frequency. |

* + *Other options not precluded*

 *Note: Companies are encouraged to bring more information for option 1 and option2.*

* Predefined files which generated by GMAT can be considered as reference for the comparison purpose of proposed channel model
	+ FFS on the initial ephemeris information and parameters

**Issue 1-2-2 Parameters for TE-emulated channel model**

* Offline agreement
* RAN4 further discuss the necessary parameters with associated channel model, following parameters list for information purpose:
	+ Satellite altitude:
		- Option 1: LEO -600km only
	+ Option 2: Both LEO-600km and LEO-1200km Elevation angle range
	+ UE position
	+ Whether to consider a non-zero time-varying feeder link delay
* Other parameters not precluded

**Issue 1-2-3 Test procedure/configuration**

* Offline agreement
	+ During test, ephemeris information shall be updated periodically and aligned with TE-emulated channel model ~~which match with satellite motion trajectory~~
	+ ~~Further discuss details together with channel modelling~~
	+ ~~Further discuss if Ephemeris information is needed for the dynamic channel model.~~
		- ~~If complete test of UE behaviour (RAN5), Ephemeris data is required.~~
		- ~~If RAN4 needs only Doppler and Delay channel variation for e.g. frequency error or demodulation (RAN4), Ephemeris data may not be required.~~

## Sub-topic 1-3 RAN4 requirements and tests

**~~Issue 1-3-1 RRM requirements~~**

* ~~Recommended WF~~
	+ ~~RAN4 further discuss RRM requirements impact and how to apply TE-emulated channel model for UL timing test cases pending on channel model discussion progress.~~

**Issue 1-3-2 demodulation requirements**

* Offline agreement
	+ RAN4 further discuss how to apply the varying Doppler and delay shifts to the UE performance requirements and necessary simulation assumption on UE side pending on channel model discussion progress.
		- UE assumption on propagator model for satellite motion for RAN4 simulation purpose
			* Option 1: Keplerian model
			* other options not precluded
	+ RAN4 further discuss test applicability if new PDSCH demodulation requirements introduced pending on channel model discussion progress.

**~~Issue 1-3-3 Frequency error test cases~~**

* ~~Recommended WF~~
	+ ~~RAN4 further discuss whether and how to apply the varying Doppler shifts to RAN5 frequency error test cases if needed pending on channel model discussion progress.~~

# Reference

[1] R4-2413429, “Topic summary for [112][329] NTN\_testing\_NGSO\_channel\_model “, Moderator (Samsung)