



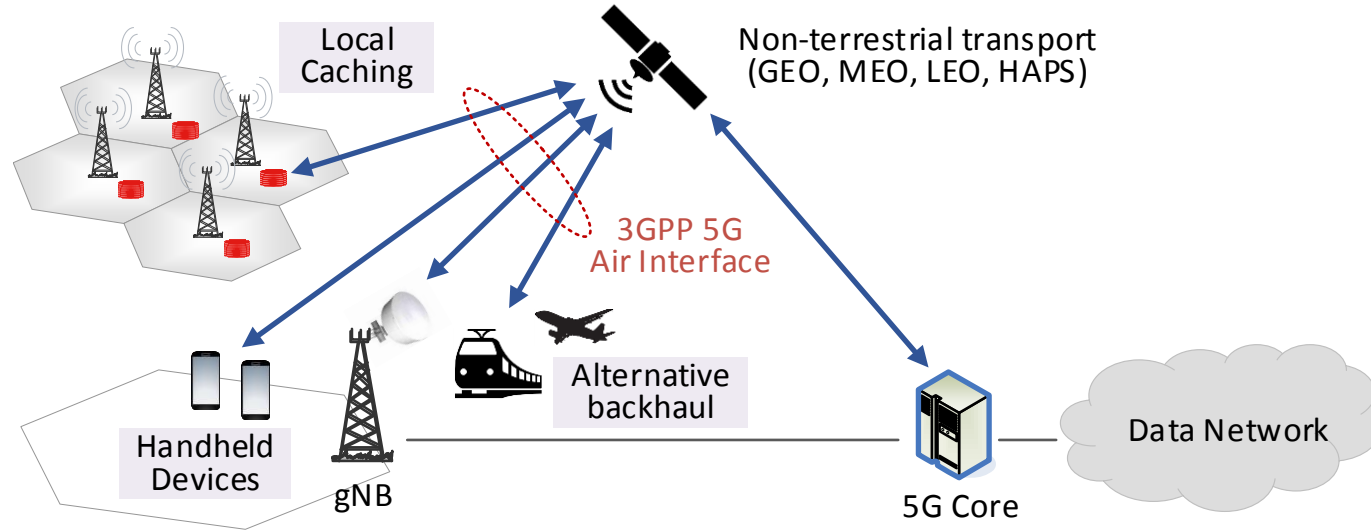
# 3GPP 5G New Radio Standardisation and Simulation for Non-Terrestrial Networks (NTN)

# Background Nomor Research GmbH

- ▶ Industry: IT Telecommunication
- ▶ Headquarter: Munich, Germany
- ▶ Founded: September 2004
- ▶ Spin off from Munich University of Technology
  - First real-time simulations GPRS/UMTS in 1999
  - Fully privately owned, always profitable from day one
  - Successful sale of LTE eNodeB Protocol Stack business in 2013
  - Today 17 highly qualified R&D engineers + admin staff
- ▶ Vendor independent research / consultancy services
- ▶ Service focussed around 4G/5G technology
  - Research/development projects and system simulation services
  - Demonstrators and HW/SW prototype development
  - Consultancy, standardisation and patents support
  - Technology training and knowhow transfer

# Our Vision

“Global internet connectivity using low cost devices provided by advanced satellite systems using a standardized 5G air interface”

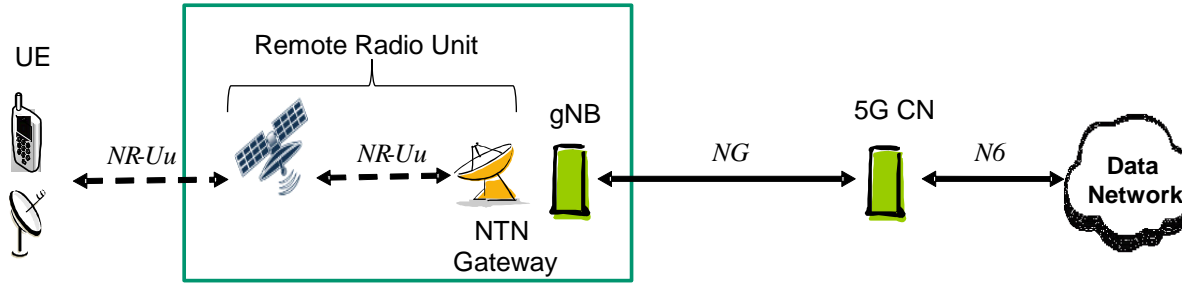


Nomor Research GmbH has a long history of ESA projects

# NTN Architecture Options

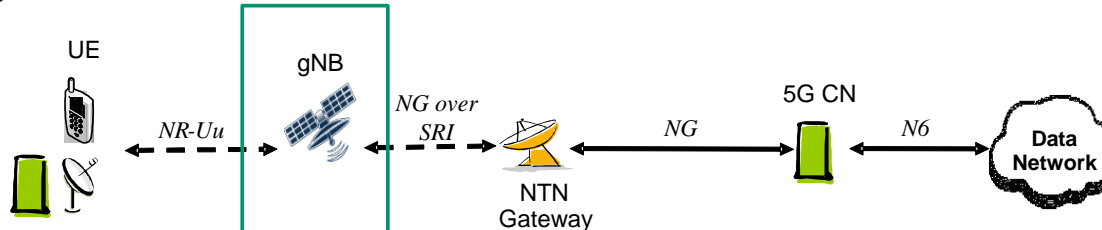
## 1. Transparent architecture

- Satellite acts like a repeater, repeating the base stations (gNB) signal



## 2. Regenerative architecture

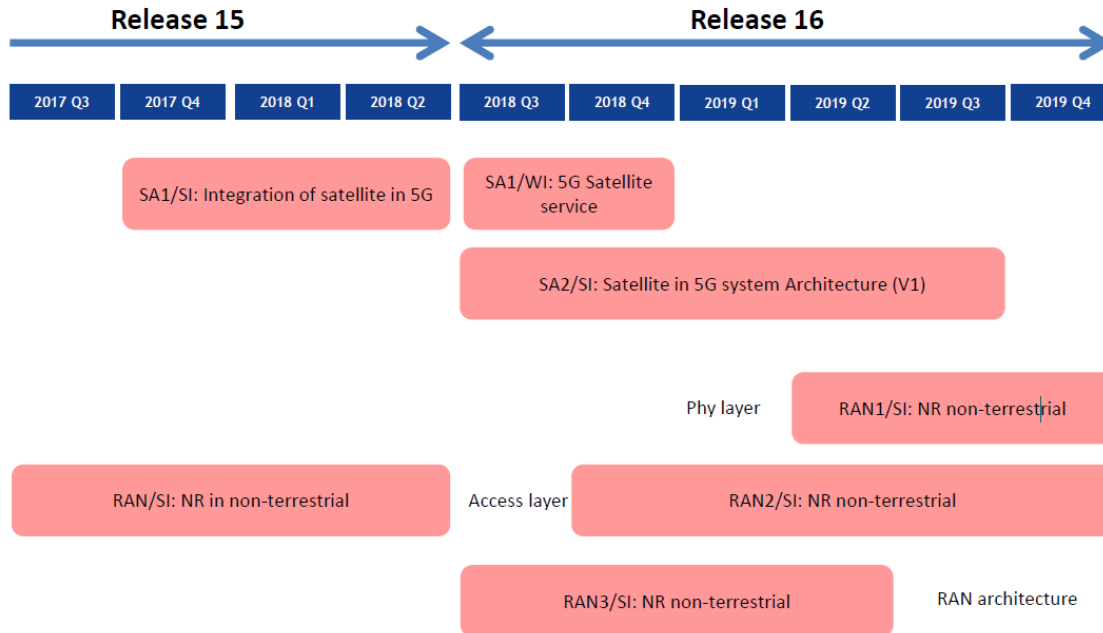
- Full or partial base station hosted by the satellite
- Might enable inter-satellite interface as well



Source: 3GPP TR 38.821

# Status 3GPP Standardisation of 5G NTN

- ▶ Successful creation of several Rel.15/16 work and study items
  - 3GPP SA1 on requirements and SA2 on architecture
  - 3GPP RAN (RAN1/RAN2/RAN3) to enhance 5G new radio for NTN



# ESA Project: ALIX

## ▶ Support of 3GPP Standardization of a Satellite 5G Air Interface

- ESA ARTES Program – Future Preparation

## ▶ Partners:

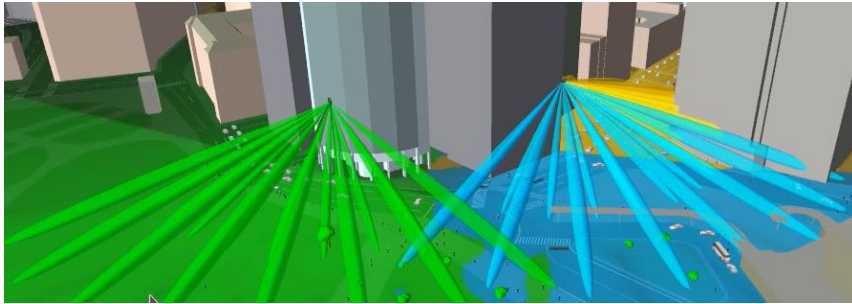


## ▶ Major achievements

- Rel.16 RAN study item supported by 64 companies and agreed
- 26 (!) 3GPP RAN1/2/3 WGs meetings during 2018 – 2019
- Large number of contributions (258 TDocs submitted/revised in 3GPP groups 2018)
- 13 calls of the Special Satellite Interest Group (SSIG)
  - Coordination of the satellite industry
  - SSIG members support our contributions in the different 3GPP groups
- Growing interest / contributions by mobile communication industry
  - Ericsson, Nokia, Huawei, ZTE, Vodafone, LG, Sony, Interdigital etc.
- Other activities in ETSI SCN, ITU-R and ITU-T

# NTN System Level Simulation

- ▶ Nomor Research – 15 years history of System Level Simulations
  - Simulators existing for UMTS, HSPA, WiMAX, MBMS, LTE, LTE-A, NR, WiFi
  - Leading member of H2020 evaluation group for 5G proposals submitted to ITU-R
  - Example: NR Massive MIMO scheme (16 x 16 antenna elements, 32 beams, SU-MIMO with 8 spatial streams, MU-MIMO with up to 12 UEs, IRC receiver)



- ▶ Simulator will be extended to support NTN
  - Satellite channel models, LEO mobility, earth moving beams etc.
  - Scheduling, link adaptation, HARQ supporting long propagation delays and limited link budget of satellite links etc.

# Interesting Links

- ▶ Nomor publications  
<http://nomor.de/resources/publications/>
- ▶ Nomor demonstrations  
<http://nomor.de/resources/demonstrations/>
- ▶ Nomor 3GPP Newsletter  
<http://nomor.de/resources/3gpp-newsletter/>
- ▶ Nomor Patents  
<http://nomor.de/resources/patents/>
- ▶ Our 3GPP LTE Standards Discussion Forum (ca. 60.000 members)  
<https://www.linkedin.com/groups/1180727>
- ▶ Our 3GPP NR Standards Discussion Forum (ca. 10.000 members)  
<https://www.linkedin.com/groups/7489690>



# Contact

Let us know if we can be of help to you?

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