Gatehouse Satcom

5G NTN
Technical Feasibility Study

5G NTN
Technical Feasibility Study

Gatehouse
Satcom

Analysis and estimations of your future 5G NTN service performance

Are you building a business case for a 5G NTN (Non-Terrestrial Network) service? Are you looking for an analysis of what you can expect your 5G service performance to look like? The feasibility study will provide detailed simulations, analysis, and recommendations regarding your future 5G NTN service's potential strengths and weaknesses based on your specific combination of technology (NR, NB-IoT or eMTC) and the satellite-based network you plan to use for offering NTN services.

The feasibility study will be tailored to your specific challenges but will generally include system capacity calculations, performance trade-offs and suggestions on how to maximize performance under the chosen link/fading conditions and network configuration.

With a feasibility study you will be able to evaluate and compare different system configurations prior to infrastructure investments and launch of service. Engaging GateHouse SatCom as your partner and support in network building or transformation allows you to free up internal development effort while infusing deeply specialized knowledge of technical challenges and possibilities of 5G NTN into your organization. This will effectively reduce your time to market.

Whether you are looking to build a business case and 5G NTN service from scratch, based on a current system, or optimize your current system, GateHouse SatCom will guide and perform your technical analysis. The analysis will enable you to improve your system capacity or choose the ideal system configuration for establishing a strong 5G business case and commercial viability.

A thorough technical analysis will enhance the probability of a successful demonstration and commercialization of your future 5G NTN service.

FEASIBILITY → DEMONSTRATION → DEPLOYMENT

Benefits

A technical feasibility study from GateHouse SatCom will enable you to:

- Estimate future network capacity
- Confirm efficient use of your spectrum
- Compare technologies based on their estimated network performance
- Make strategic system architecture decisions for current or future satellites
- Secure a strong market position by being ready for standardized 5G NTN
- Ensure desired end-user experience relating to e.g., Quality of service
- Obtain an unbiased analysis from independent waveform experts

Process

The process from initial thoughts to final feasibility study can be tailored to your specific case and needs with regards to output and timeline.

Generally, the process will include the following steps:

1. Initial exploration and clarification meeting(s) to define relevant challenges and questions for the feasibility study. (Joint meetings)

2. Technical input from Company as examplified in 'input/output' section. (What input is required will be based on the Company challenges and questions defined in the previous phase)

3. Definition of work packages (GateHouse SatCom)

4. Review(s) of the work packages to confirm and align work package content (Joint meetings)

5. Kick off and final input from Company regarding scenarioes and parameters. (Joint Meeting)

6. Feasibility Study executed (Output delivered by GateHouse SatCom)

7. Feasibility Study handover (Joint Meeting)

8. Feasibility Study feedback and next steps (Joint Meeting)

Challenges

What questions are you looking for answers to regarding 5G NTN? Each feasibility study will be guided by the challenges relevant to your specific case.

Some of the questions we have helped others answer are:

Satellite

Can your current satellite system support 5G NTN and what performance can be achieved?

How can a new satellite system be designed to efficiently support 5G NTN, based on targeted performance and capacity?

How will different technologies affect satellite antenna and power consumption requirements?

Service Link

Can our chosen frequency band support 5G NTN services?

What will the performance of 5G NTN services be in a live environment?

What will link-level and system level performance trade-offs be in 5G NTN (NB-IoT, eMTC, and NR), considering different altitude satellite constellations and technologies?

What are link budget, data rates for connections and system capacity?

What are the achievable Block Error Rates (BLER) for various Modulation and Coding Schemes (MCS) for NB-IoT/eMTC/NR?

How will performance be affected by different fading models?

Network

How to integrate 5G NTN services into existing network infrastructure for maximized performance? For example, by one payload for several network types, or individual payloads, or different satellites.

How can your future system be configured to support your business case?

How many devices can register in one beam?

How many devices can send data in one beam in a specified time period?

What is the optimal usage of available capacity based on chosen system configurations?

Input

Every feasibility study will be tailored to your specific case and needs, based on your input.

Firstly we will need to know what technology you are targeting: NB-IoT, eMTC, New Radio or other?

Secondly we will ask you to define your overal goal: Do you have a current system you want to analyze the achievable performance of? Or, do you have a desired system performance you want to achieve?

Depending on the overall objective we will ask for technical input as specified in the columns to the right.

Based on your chosen technology and overall objective we will jointly define a set of questions you want to answer through the feasibility study.

We will of course assist you in formulating these based on our expertise and your current system configurations or desired performance of your future 5G system.

Current system configurations

- What is the targeted height of orbit? (X km, or GSO)
- What is your available spectrum/bandwidth/carrier frequency?
- What is your maximum EIRP per antenna beam?
- What is the available power budget on the satellite?
- What is the targeted fading environment (urban, suburban, rural, oceanic etc.)?
- What is your size of beams (HPBW)?
- What is your antenna gain?
- What is your G/T or Noise Figure assumptions?

Targeted performance

- What is your targeted traffic model?
- What is your targeted UE density?
- What is your targeted coverage area?
- Are there any specific trade-offs that are of particular interest?

Output

The output of the feasibility study will be a report providing you with an analysis and estimation of your future 5G system configurations and performance.

The output will vary depending on the questions and focus areas defined for each case. In most cases, the output will consist of a simulation and analysis documentation delivered in appropriate formats.

The study can provide analysis and recommendations on:

- Optimal usage of capacity based on chosen system configurations (payload configuration trade-offs)
- Calculation of achievable capacity for the chosen system configurations
- Trade-offs in Satellite- or RAN configuration and associated KPIs
- Link-budget and possible data-rates for connections
- Identification and definition of system configurations that could be developed and tested during a pilot project
- Simulation of link performance under different fading models
- If required: Identification and definition of system configurations to be emulated during service link demonstration

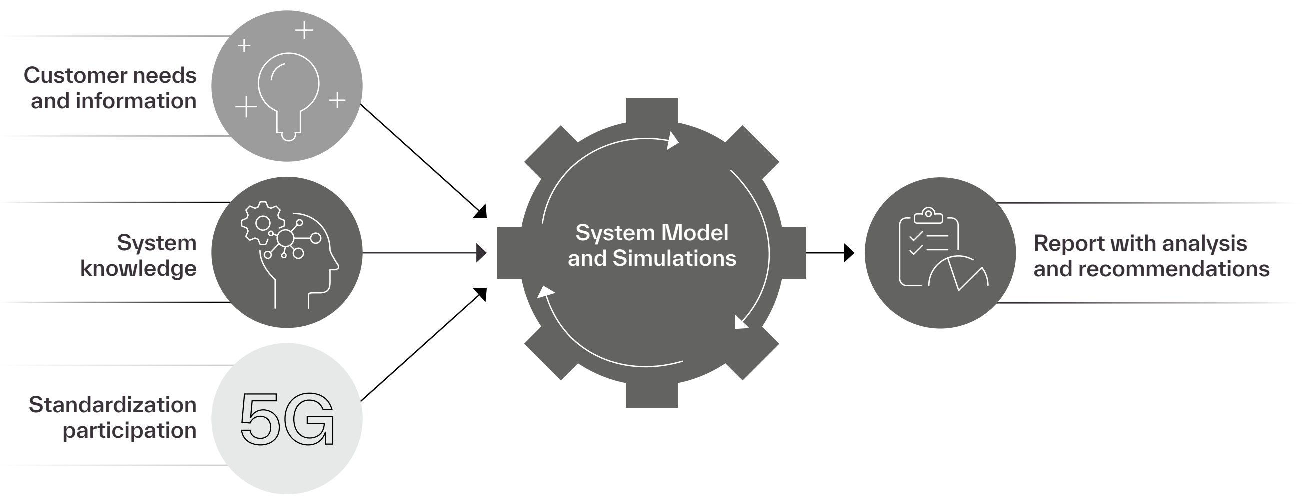
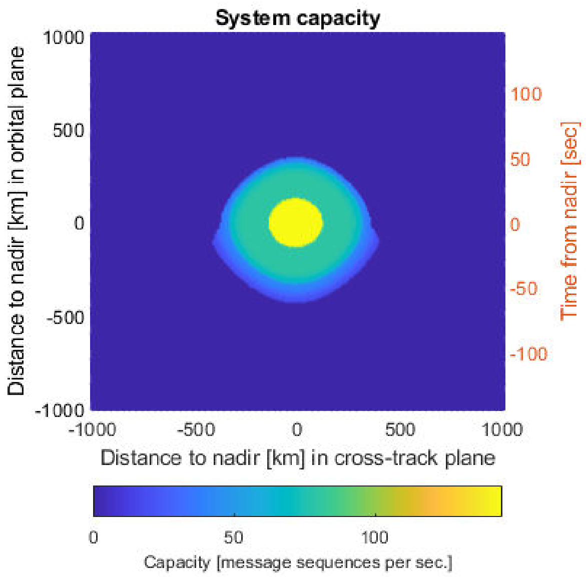


Fig. 1



Analysis example

The mission/satellite scenario in this example is a LEO CubeSat at 600 km orbital height.

The traffic scenario is 210 bytes of MO-payload data. MO = mobile originating, i.e. UE sending data to a server.

Figure 1 depicts the system capacity in terms of the achievable number of DoNAS exchanges per second in the cell footprint.

Space is represented as follows:

- The plot shows the view one would get by looking straight down into nadir from the eNodeB (satellite)
- The satellite is moving in the positive Y-axis direction

Capacity: The capacity in PUSCH/PDSCH is calculated based on a CP-optimized message exchange for data transmission (DoNAS) where the time-frequency resources required for each message are evaluated over time as a function of the available link-budget and given SNR-thresholds from a BLER analysis of 3GPP's NTN fading-models.

The capacity is calculated for each point based on the assumption that all resources are allocated to UEs in that specific point.

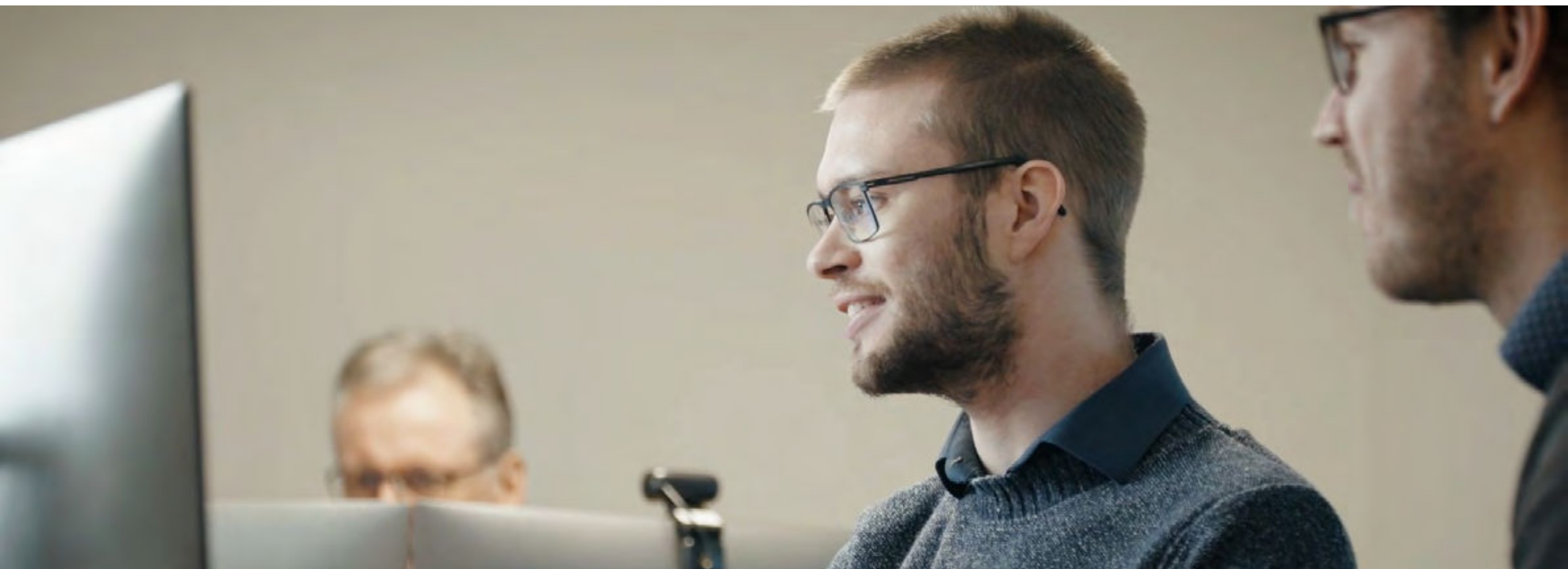


Fig. 2

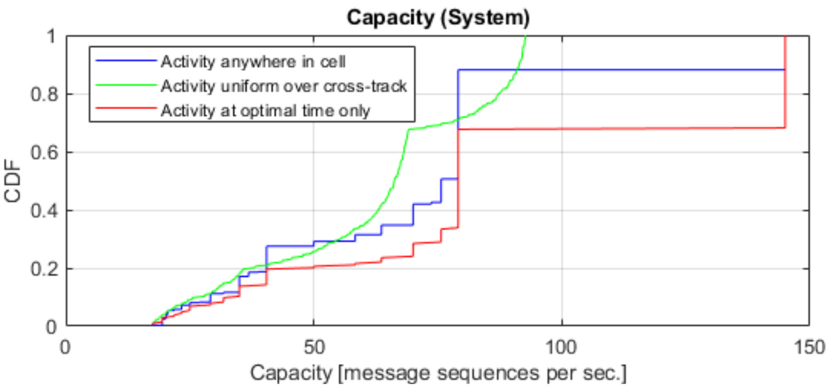
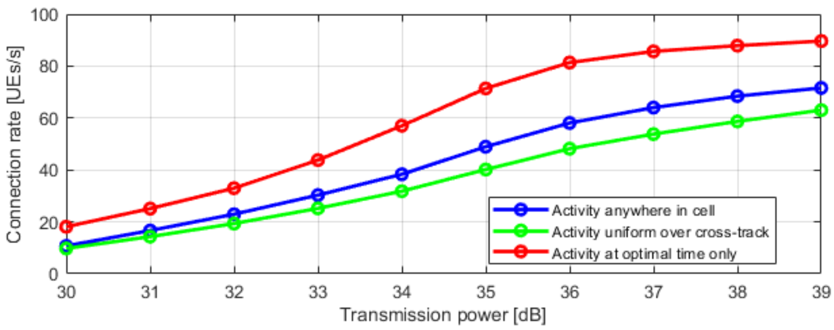


Fig. 3



To evaluate the capacity throughout the cell in a meaningful way we may convert to a CDF (Cumulative Distribution Function) representation as seen in figure 2.

Figure 2 shows the CDF of the system capacity given with respect to different modes of operation.

- The blue line tracks the CDF for a scenario where UEs wake up (and TX) randomly and attempt to transmit
- The green line tracks the CDF for a scenario where UEs will wake up (and TX) at least once during a pass, but wake-up (and TX) at a random time within the cell
- The red line tracks the CDF for a scenario where UEs will wake up (and TX) at the optimal time to do so

The expected (mean) capacity for each of these CDFs can be computed – trade-offs can be evaluated for various parameter changes, eg. total transmission power [dB], RACH overhead or antenna/beam-offset.

Figure 3 shows the mean capacity as a function of the total transmission power (The system has two DL carriers, so the transmission per carrier is halved, i.e. X-3dB).

A UE that has data to transmit, or is paged by the eNodeB, will always have to go through the access stage before exchanging data/ messaging.

So, the system is not fully described by only its capacity for data messages, but one must also account for the capacity of the access stage of the system, the random-access channel (RACH), and the paging capacity.

Figure 5 depicts the capacity of the RACH given a two CE-level configuration with an overhead of around 40% of a PUSCH carrier's spectrum.

This overhead must be accounted for when evaluating the data capacity.

Figure 6 shows how the specific RACH configuration splits traffic between the defined CE-levels and how this affects the blocking probability.

Fig. 5

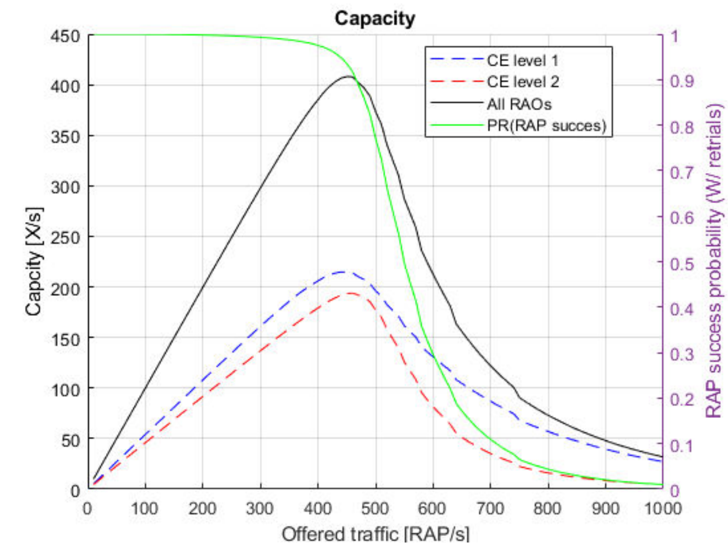
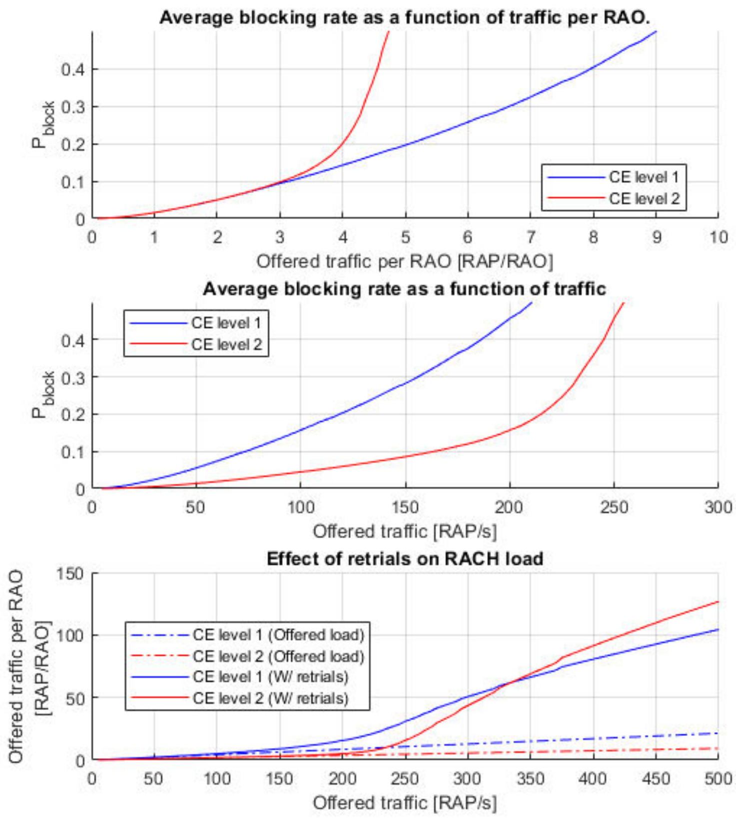


Fig. 6



Get in touch

Get in touch with us to learn how you can realize 5G NB-IoT, eMTC or New Radio on your current or future satellite fleet to compete in the evolving market. You can contact us at sales@gatehouse.com and set up a meeting to discuss your 5G strategy.

Gatehouse Satcom

Let's unlock the power of satellite communications software