

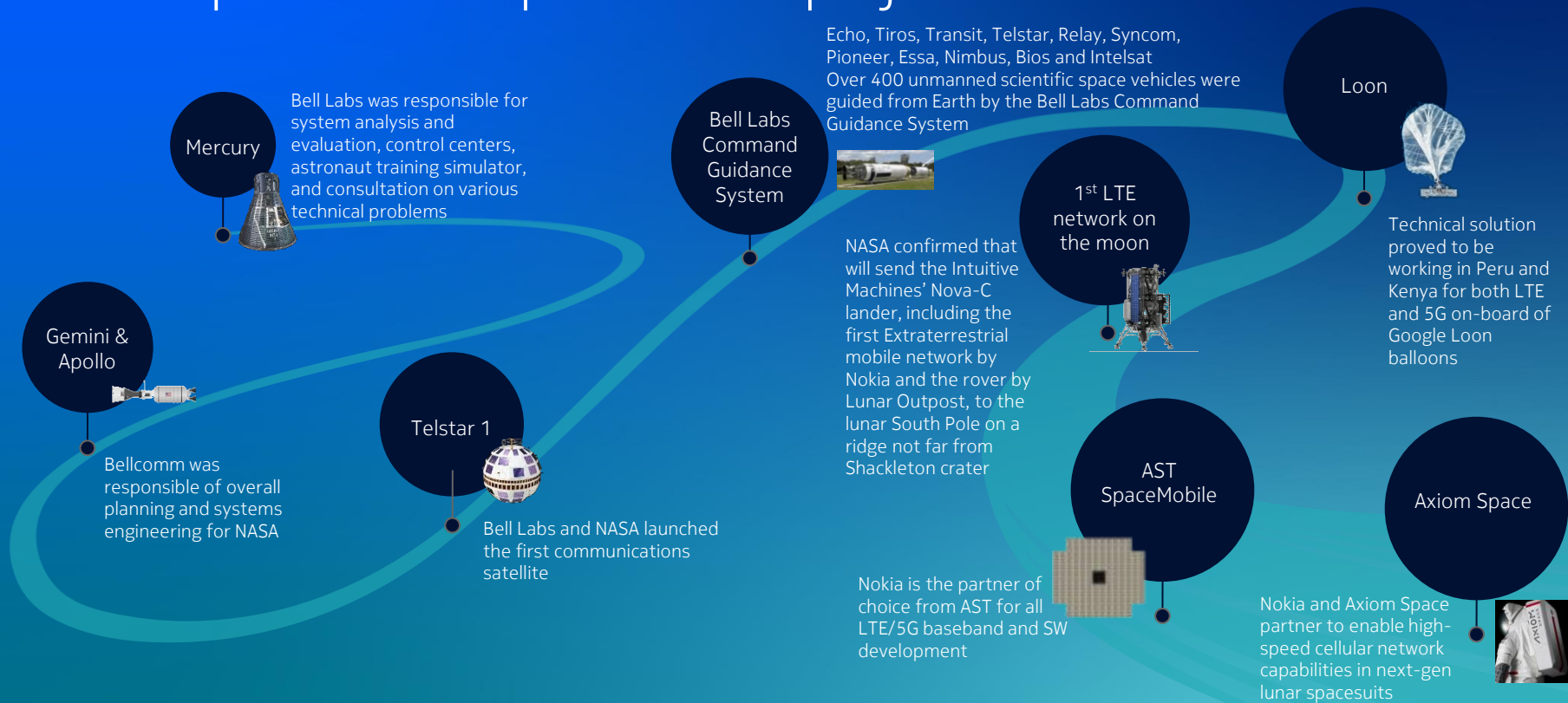
Non-Terrestrial Networks

Evolution, Challenges and Opportunities

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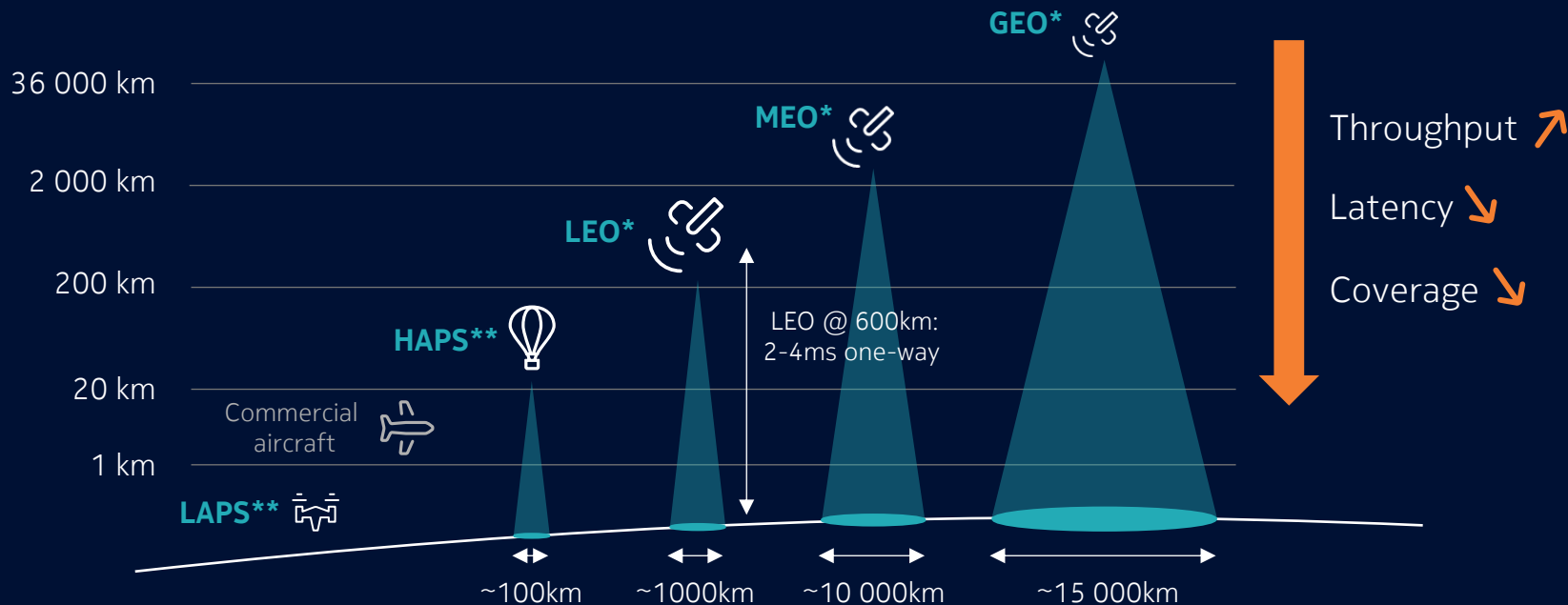
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Nokia experience on space-based projects



Non-Terrestrial Networks are wireless communication networks

Leveraging satellites, drones, or other aerial platforms



* LEO/MEO/GEO = Low/Medium/Geostationary Earth Orbit

** LAPS/HAPS = Low/High Altitude Platform Systems

Non-Terrestrial Networks give rise to a plethora of new use cases



Ubiquitous connectivity



Mobile network expansion
(Direct-to-Device or SCS*)



Upscaling IoT connectivity
(e.g., asset tracking, agriculture)



Network backup
(disaster recovery)



Remote fixed connectivity
(VSAT**)



Defense applications
(e.g., secure comms)



Space-compatible cloud
and Wide-Area Networks



Security applications
(e.g., satellite-based Quantum
Key Distribution)

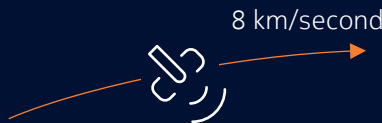
* SCS = Supplemental Coverage from Space

** VSAT = Very Small Aperture Terminal (mounted devices with directional antenna's)

There's more than one way to connect a satellite to a 3GPP phone

NTN processing?

- Frequency & time shifts
- Larger latency (vs. terrestrial)
- Different mobility procedures



Pre-Rel. 17

- Connect to **unmodified 3GPP phones**
- Requires terrestrial spectrum partnership
- **NTN processing on network side**
 - Satellite = “just another terrestrial antenna”



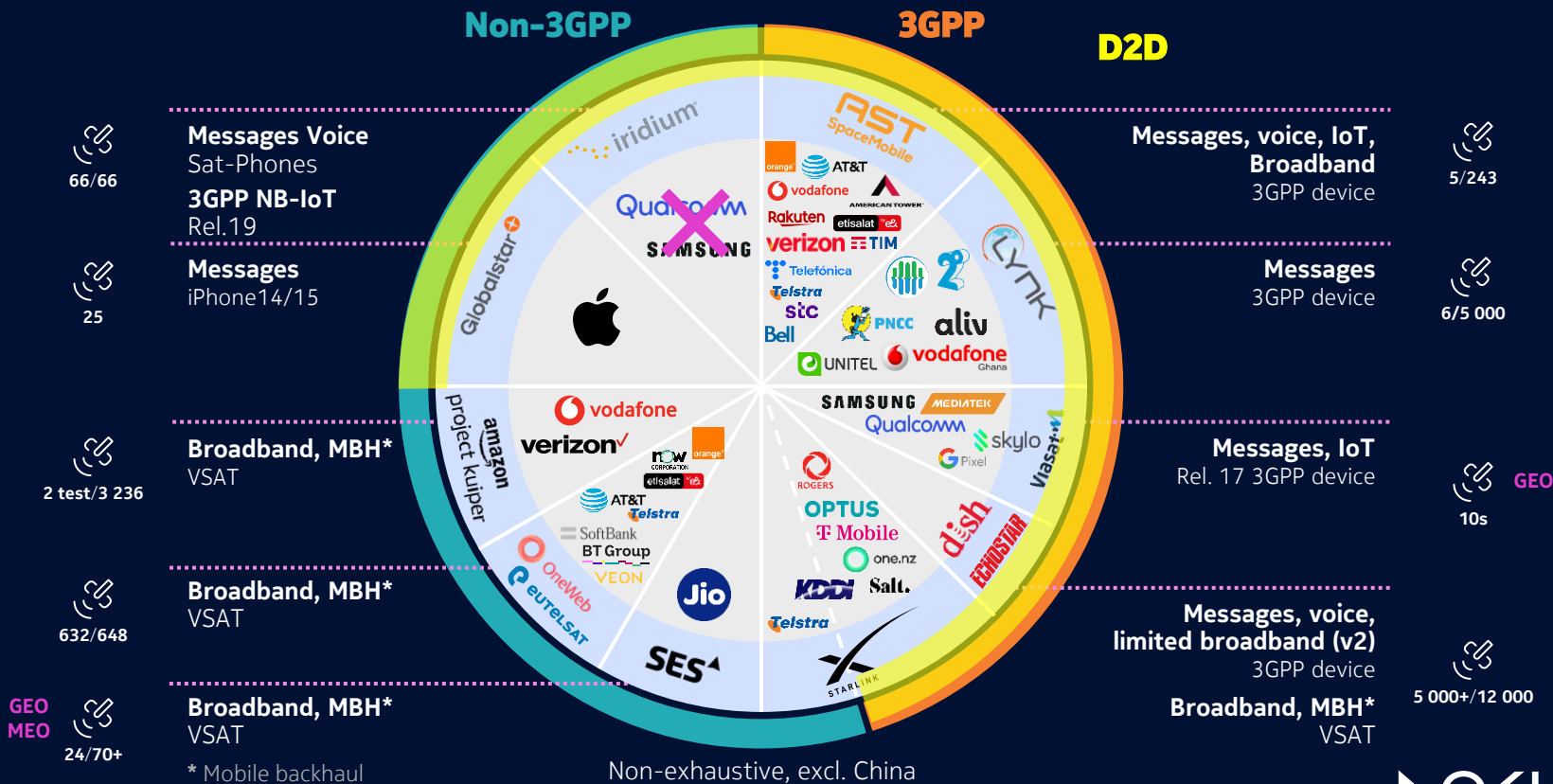
Rel. 17

- 1st 3GPP NTN release (broadband & IoT)
- Some **NTN processing on phone**
 - Requires **Rel. 17 phone**
- GNSS mandatory

Beyond Rel. 17

- Increasing TN/NTN convergence
- Coverage enhancements
- Reduce/remove GNSS dependency
- Support high frequencies for ~fixed services (Ku, 10+ GHz)

NTN partnerships and momentum are burgeoning



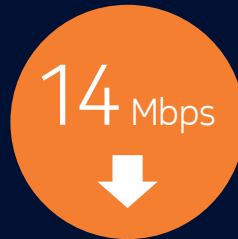
World's first space-based voice calls and broadband data

Using everyday unmodified smartphones

AST
SpaceMobile



Downlink



Uplink



Using commercial AT&T spectrum (5 MHz)
and unmodified smartphone



NOKIA

AST recently launched its first five commercial satellites

Using the launch capabilities of its biggest competitor (SpaceX)

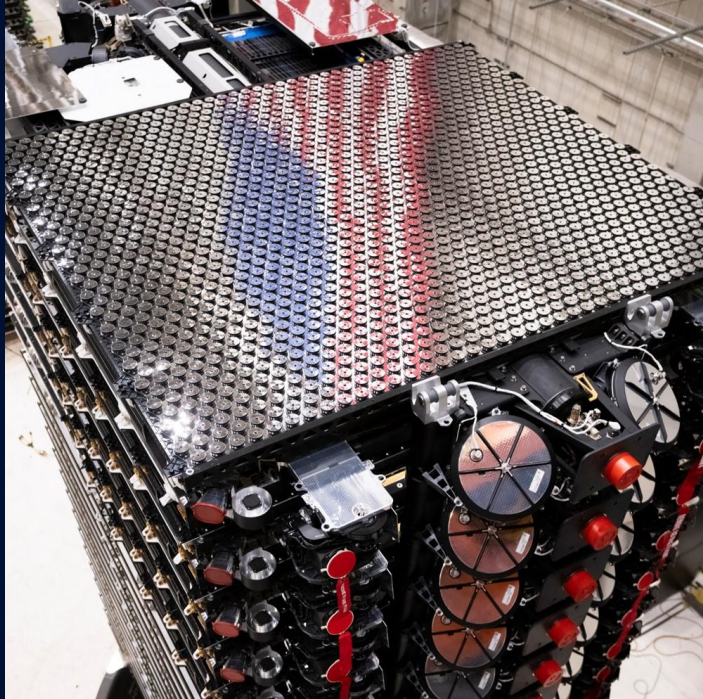
5 Bluebird satellites

Launched: Sept. 12th, 2024

Phased array ~64 m²

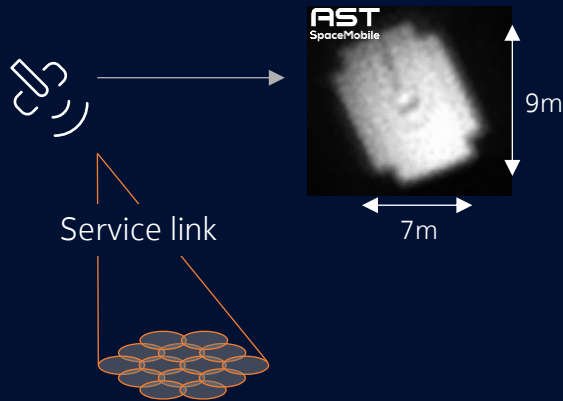


Starlink Direct to Cell



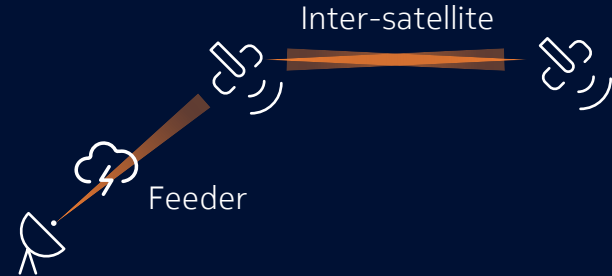
Some of the technology enablers in LEO constellations

Large **Phased Arrays**



- High gain = improved link budget
- Small beam size = more cells on earth, support for higher user density

Free-space **optical** links



- Higher data rate, more secure, no licenses
- Technical challenges: pointing/tracking, atmospheric turbulence (reliability)

The Security for a space mission

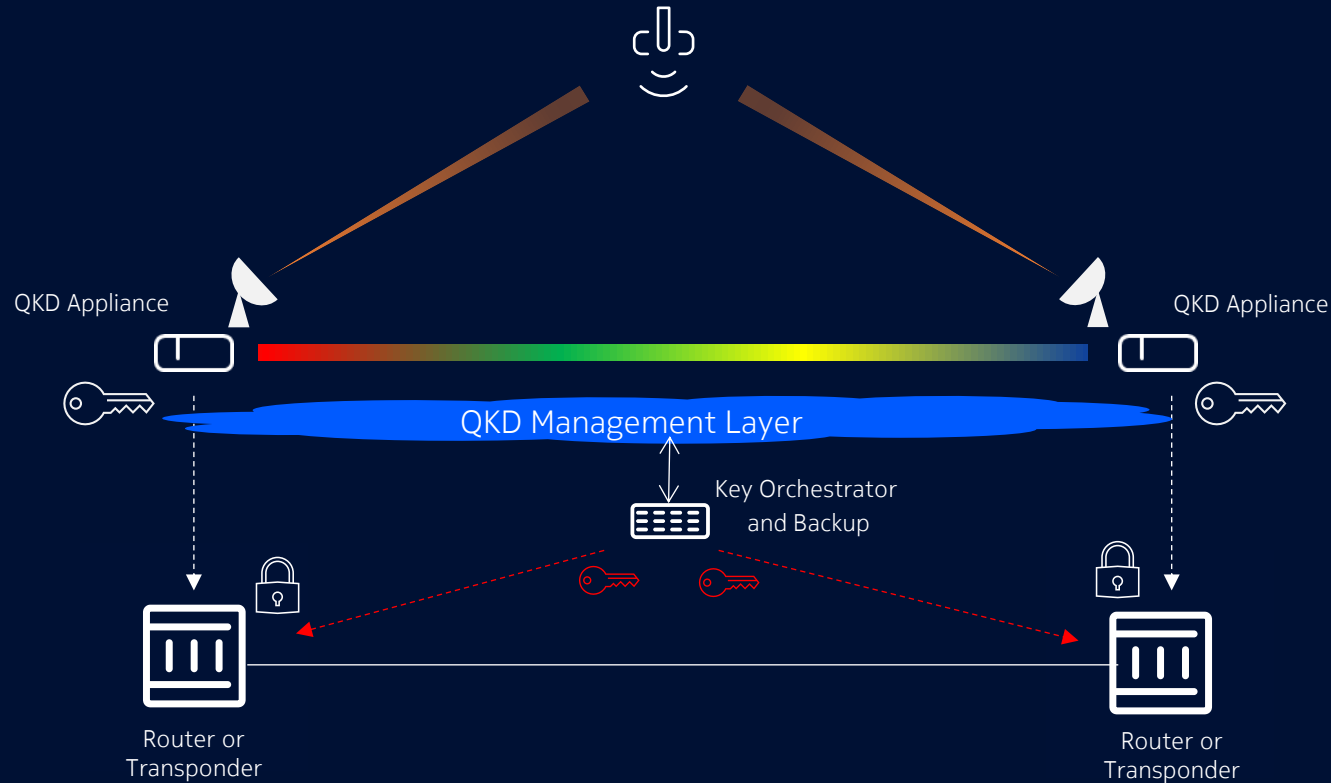
Access Points

- The extended **land-based infrastructure** that sustains space-based assets including **ground stations**, **terminals**, related companies, and end-users.
- The **satellites** themselves (e.g. Communication links – feeder or user)
- The **supply chain** (Vendors/System Integrators)



The Security that will come from the space

Satellite Quantum Key Distribution



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