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Space-Terrestrial Integrated Internet-of-Things

Marco Guadalupi

"Imagine you are a mobile operator.

You can extend coverage globally and

without deploying a single new cell tower.

Would you take that deal?"

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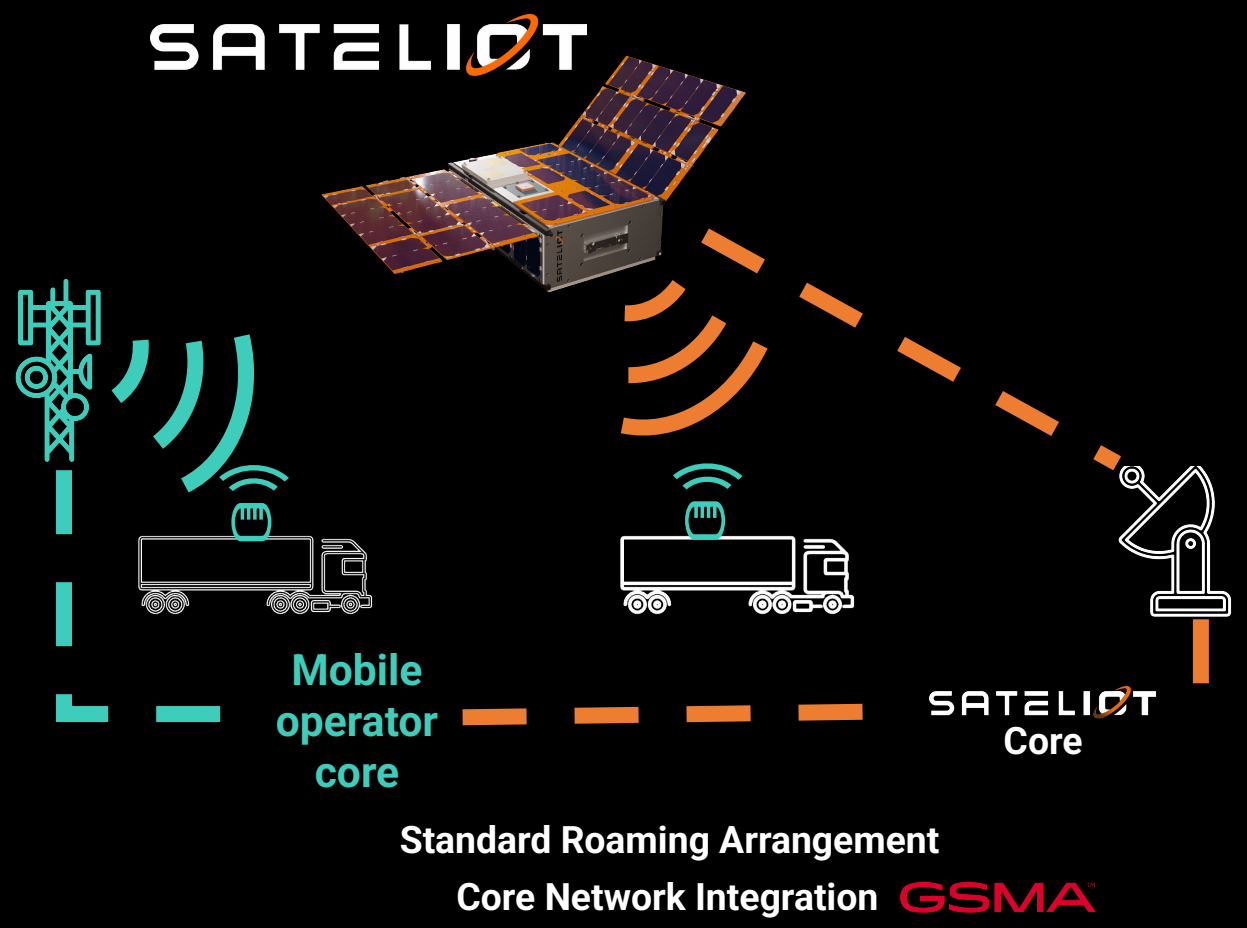
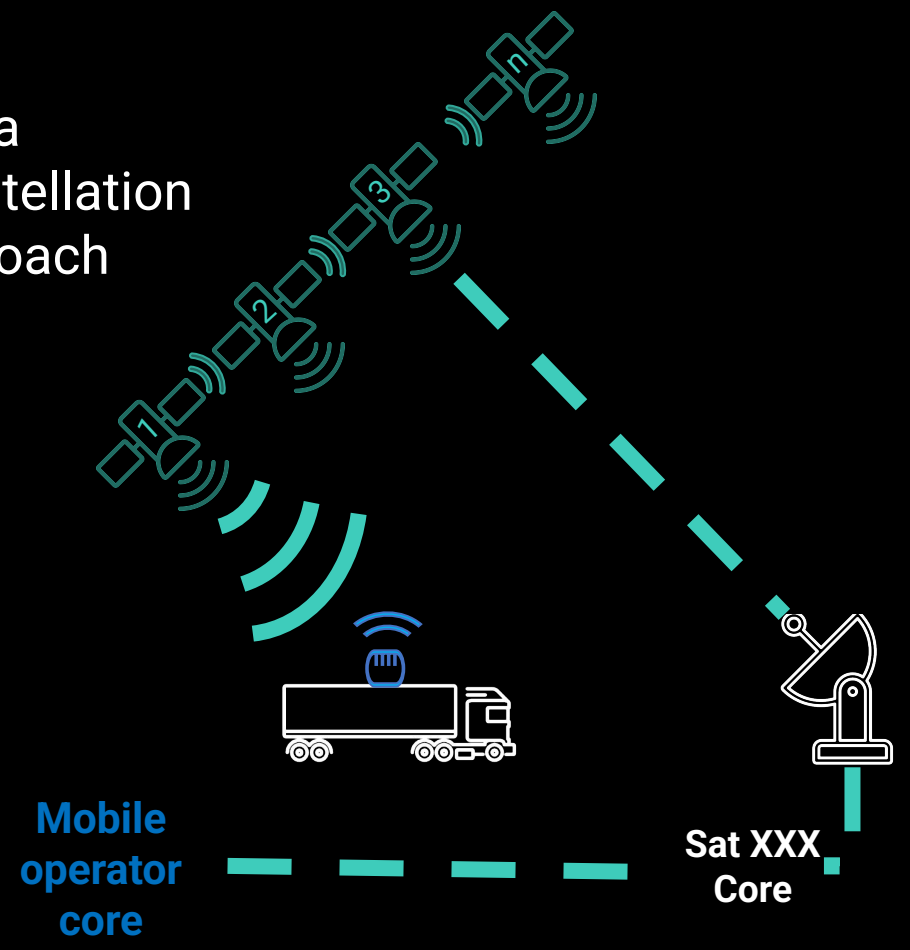
Cost-efficient 3GPP Rel 17 extension for MNOs



- Standard 3GPP Rel 17 device (<$5 OTS)
- Seamless end-user experience (roaming)
- Customer keeps 1 point-of-contact for billing/support
- New capex-free revenue stream for the MNO

Discontinuous Coverage and Store&Forward in 3GPP

Mega constellation approach



+1000 satellites to start commercial roaming

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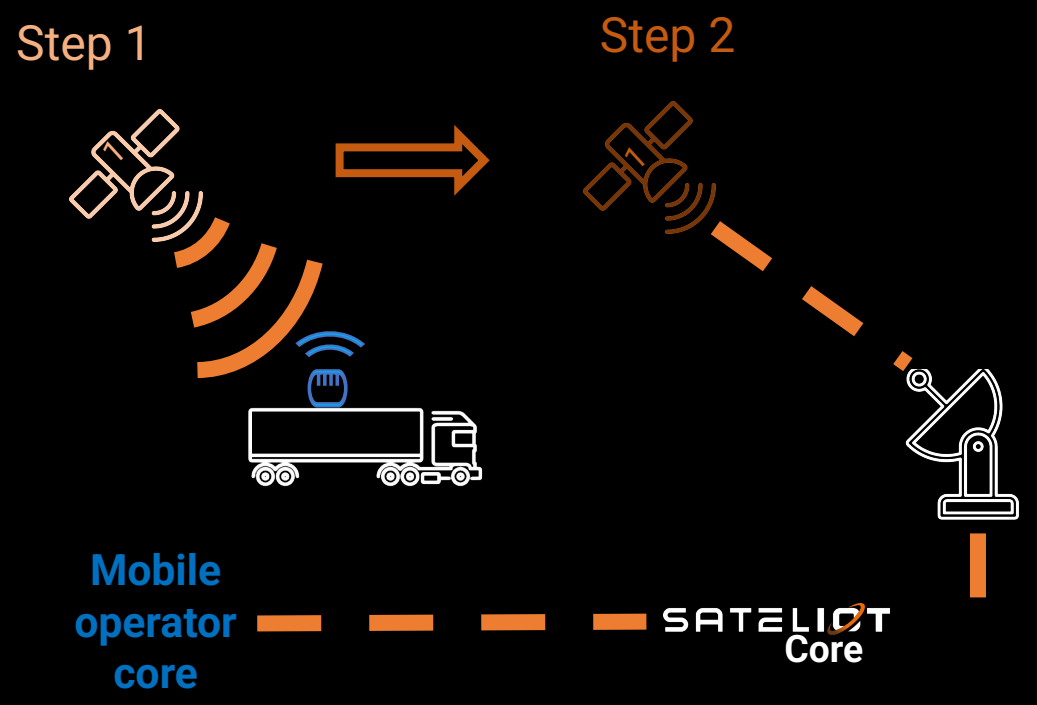

Only 4 satellites to start commercial roaming

Delay Tolerant IoT Service

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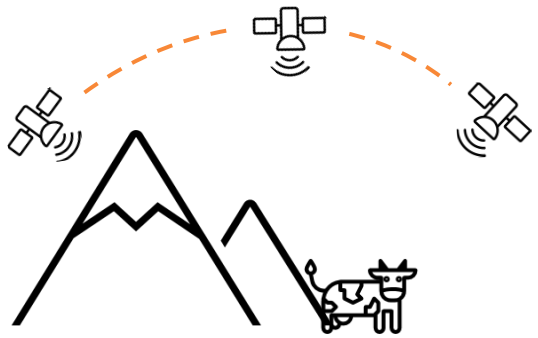
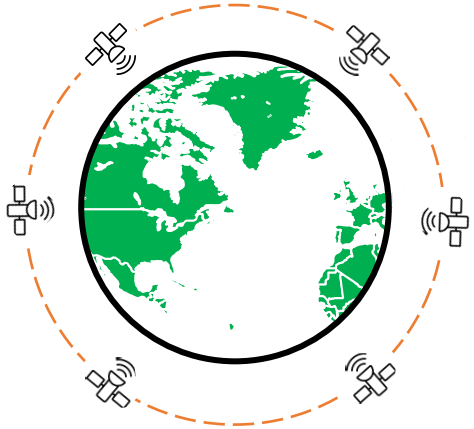
A LEO solution is the only way to offer coverage everywhere

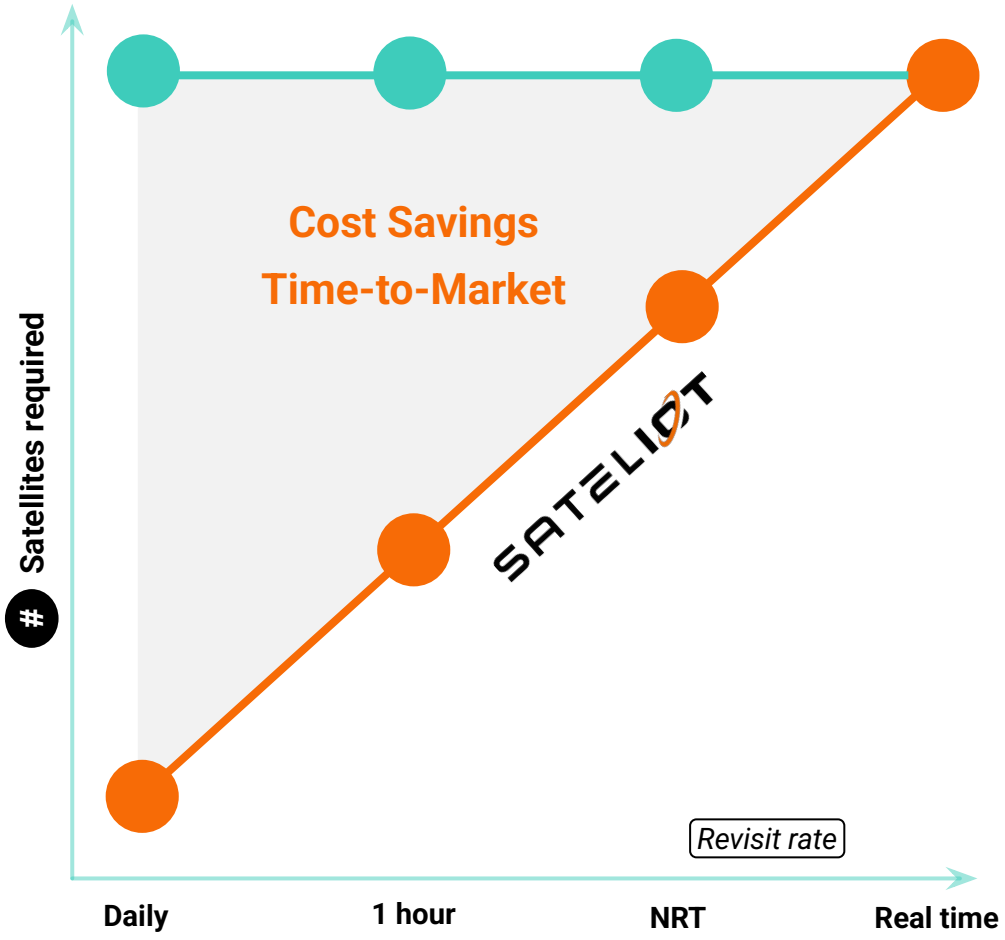
LEO



Unencumbered

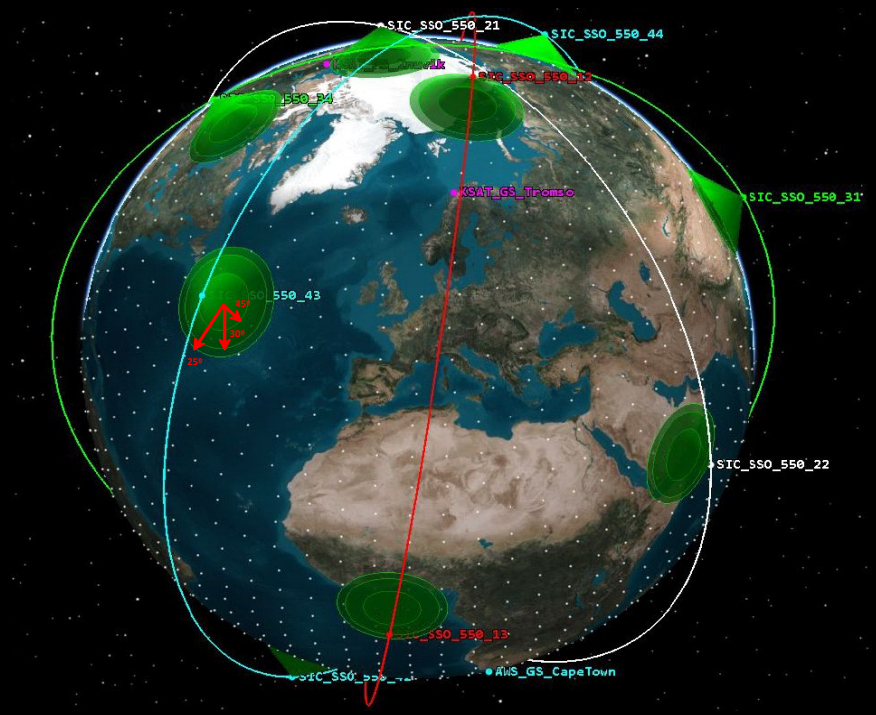


Global coverage



Building the first LEO constellation under 5G standard

- Altitude ~600 Km
- SSO (Sun Synchronous Orbit)
- Global coverage in different orbital plane
- Better link budget due to the much lower distance
- More capacity per Km2



Illustrative constellation representation

Verticals digitalization is booming and looking for extension of coverage

Logistics

Agro

Livestock

Environmental

Utilities

Oil and Gas

SIC-4 mission, main milestones and achievements

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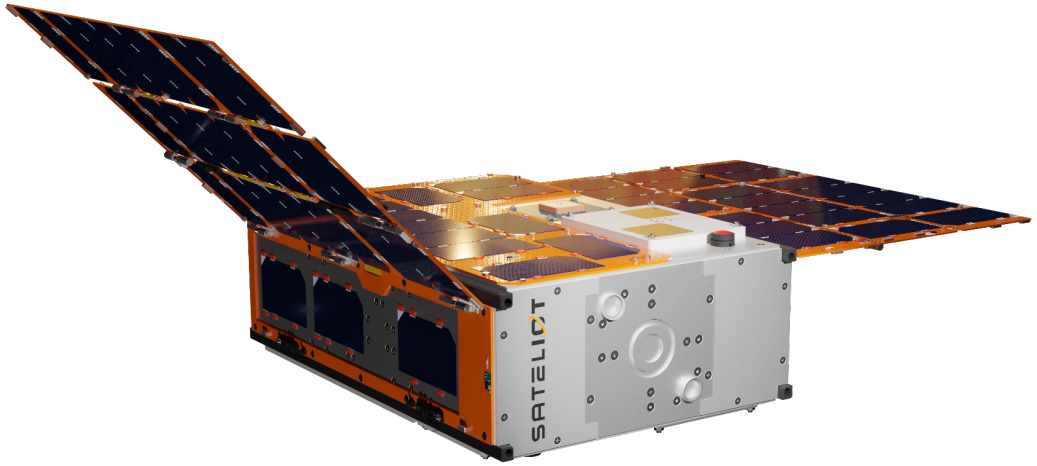
From Vision to Orbit: Deploying a Global NB-IoT Network

- **4 × 6U CubeSats** in a 590 Km SSO
- **On-board electric propulsion**
- **Global coverage**
- **Service and market validation**

- Phasing of 90° for **optimised discontinuous coverage** which equals to **Minimum 1 message/day** - Equator
- **Ongoing daily** service testing activity



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From Vision to Orbit: Deploying a Global NB-IoT Network

- Rel 17 NB-IoT NTN modem capabilities, controllable via AT commands
- Wideband front-end covers NB-IoT NTN E-UTRA band 256:
  - Uplink: 1980MHz - 2010MHz
  - Downlink: 2170MHz- 2200MHz .
- Nominal output power of +23 dBm.
- Embeds internal S band antenna, replaceable by an external S band antenna
- Embeds a GNSS receiver with an internal GNSS antenna, replaceable by an external GNSS antenna.
- Embeds a SIM card reader.
- Embeds a Raspberry Pi 4B for IoT application integration.
- Remote monitoring and control via an embedded 4G modem.

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SIC-4 mission: Field test
(For details contacto Marco Guadalupi, MAIL OBJECT: [ASMS] Field test info)

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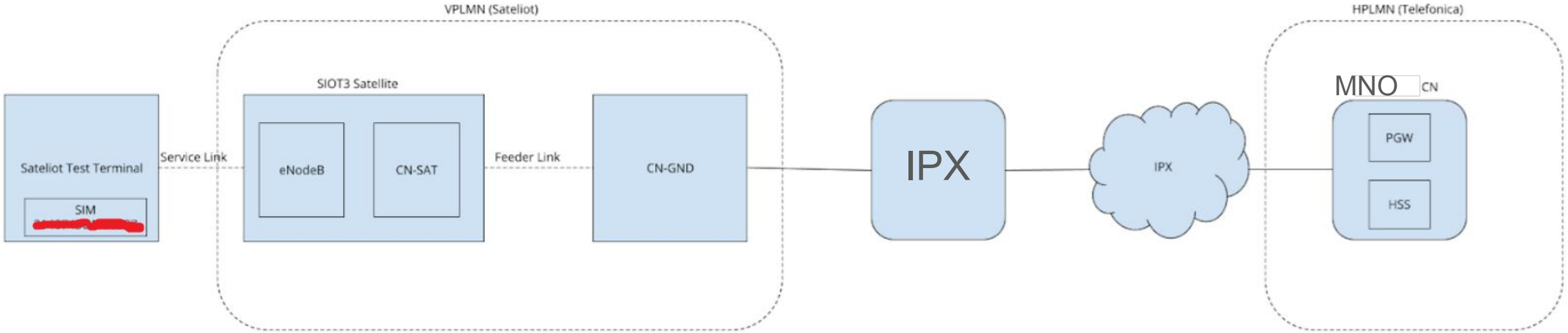
SIOT-1: Attach Reject received by the UE

- Setup **without external antenna**. Test Terminal using internal 0 dBi antenna.
- Setup of fixed UE installations around the region.

SIOT-3: 2 Steps Attach Complete against an MNO



- **UE:** Sateliot Test Terminal with physical SIM *YYYYYxxxxxxxxx*.
- **Satellite:** SIOT3 equipped with onboarded eNodeB and MME function, operating in LEO (590 km orbit).
- **Core Network Operation:**
  - **Store & Forward (S&F):** Intermittent connectivity between CN-SAT (onboard) and CN-GND (ground).
  - **Integration:** Sateliot CN-GND connected with MNO's CN through the IPX network.
- **Operational Mode:** Home routed roaming using HPLMN SIM.

S&F extensions added in Rel-19 in splitted-MME

- The specification of S&F Satellite operation well progressing in 3GPP under Release 19:
  - MILESTONE: Work in Rel-19 S&F feature completed at Stage-2 level in SA2#167 (17-21 February 2025, Athens)

- Instrumental "tools" being added to the standard:
  - S&F reject cause: To support the 2-step NAS procedures such as the initial attach
  - S&F Wait Timer: To prevent UE from access a satellite before UE context is updated
  - S&F Monitoring List: To prevent UE from access to satellites without UE context.

A **Connected World** is a **Better World**

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