Fraunhofer IIS

Fraunhofer Institute for Integrated Circuits IIS

mioty® - the Best Technology for Satellite-Based IoT Applications

NTN Days 2025, Toulouse

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mioty

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Introduction to Fraunhofer Society and Fraunhofer IIS

Fraunhofer-Gesellschaft
At a glance

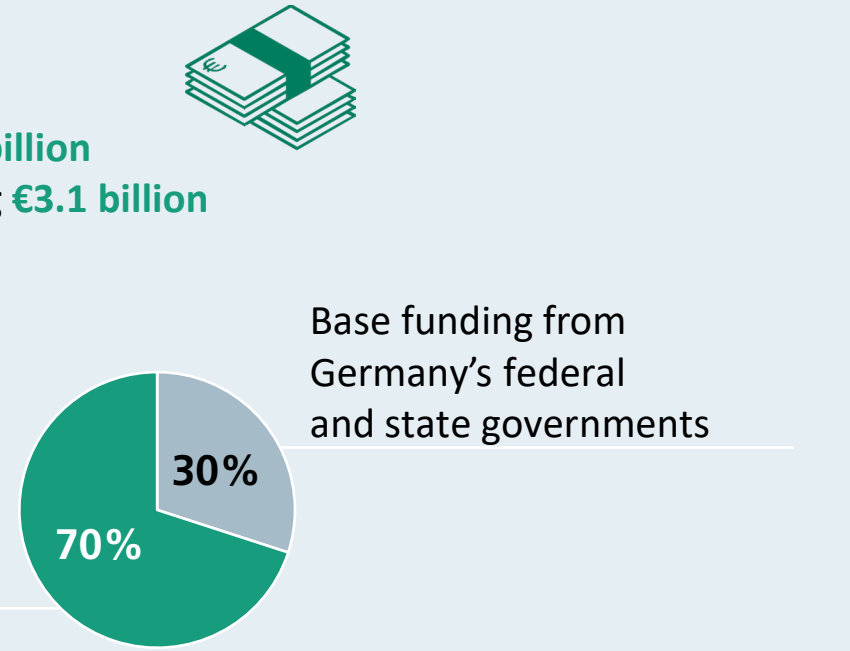
Mission: Applied research

Applied research focusing on key future-relevant technologies and the commercialization of findings in business and industry. A trailblazer and trendsetter in innovative developments.

Approx. 32,000 employees

75 institutes and research units

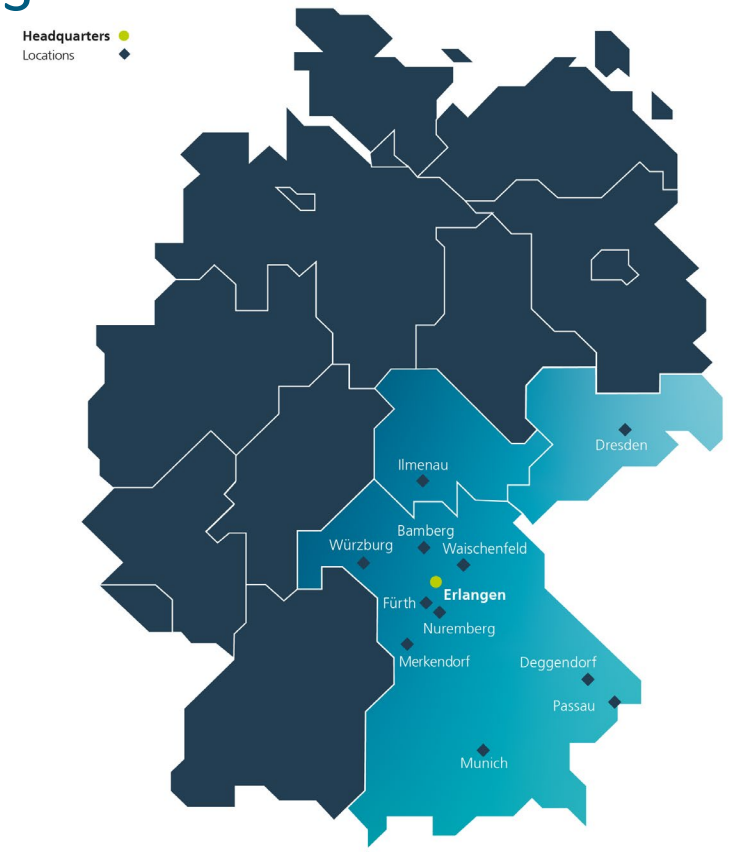
Business volume of €3.6 billion
Contract research totaling €3.1 billion



Fraunhofer Institute for Integrated Circuit IIS

Overview

Fraunhofer IIS is the **largest** Institute in Fraunhofer-Gesellschaft



1.200+
employees

12
sites
headquarter
in Erlangen

240 Mio. €
anual budget

Fraunhofer IIS

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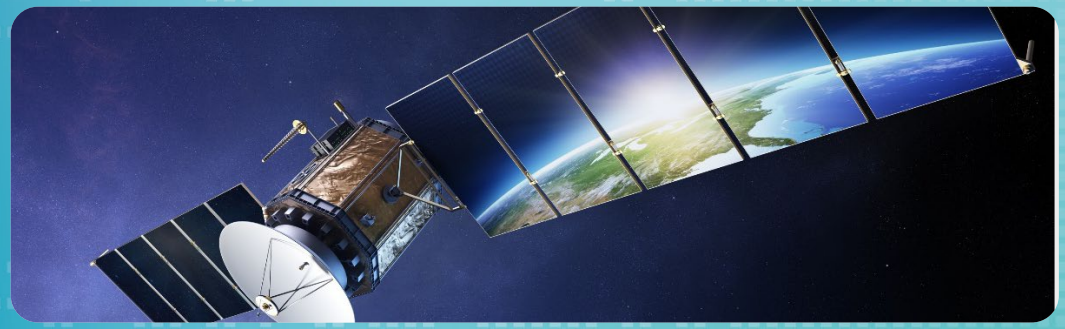
RF and SatCom Systems Department



We develop solutions for satellite communications and customized antenna systems to connect people and things everywhere.

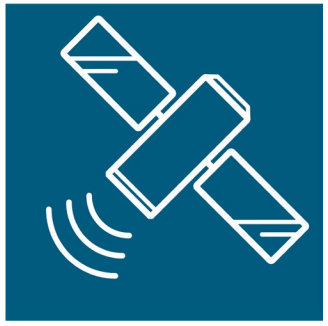
Our Mission,
Department RF & SatCom Systems

Department RF und SatCom Systems
Clustering of R&D Activities

NTN (Sat-5G)

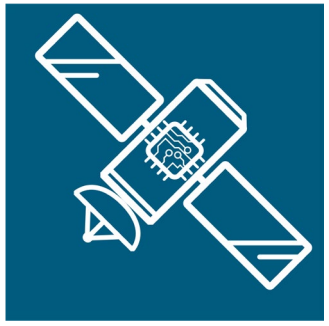
Sat-IoT

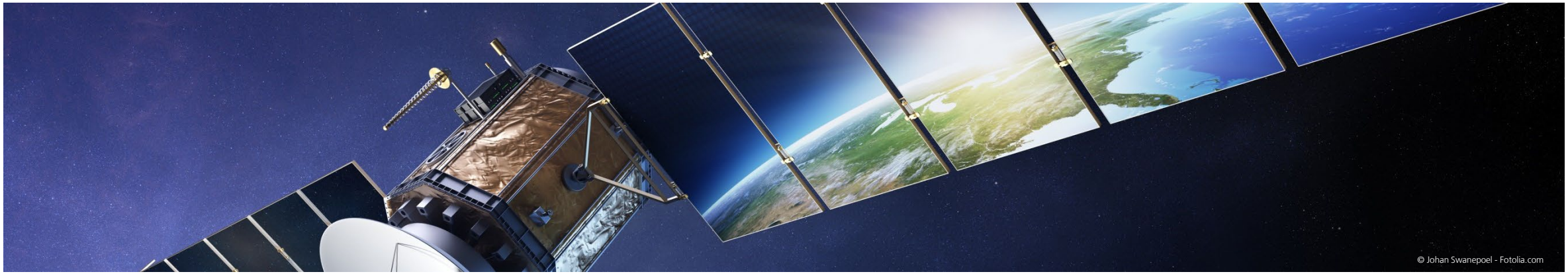
High Throughput Systems



Antennas

On-Board Processing





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Our (Sat) IoT Solution – mioty®

mioty®
Terrestrial IoT Solution of Fraunhofer IIS

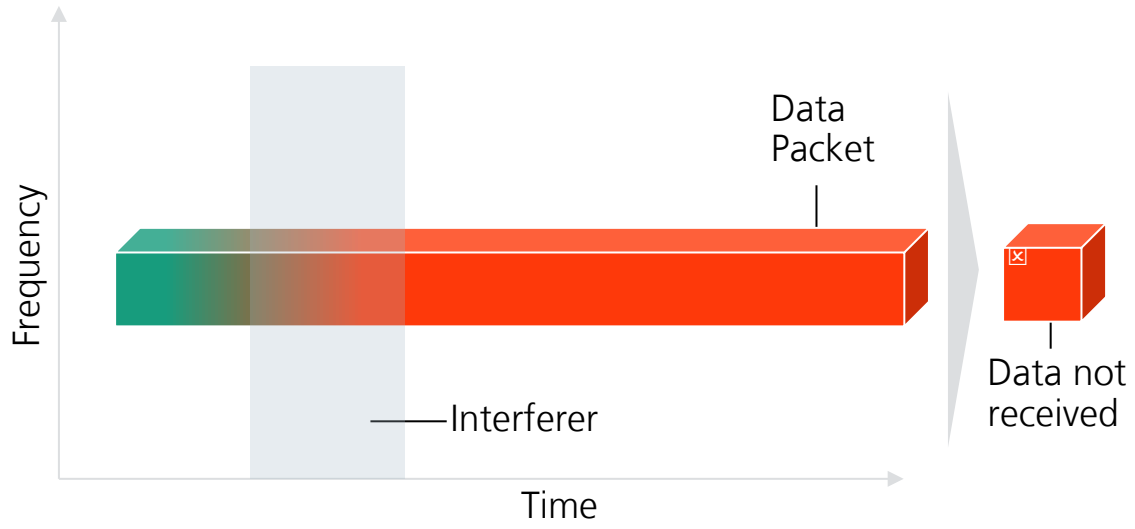
- IoT technology: Long history at IIS („Smart Metering“)
  - mioty® / TS-UNB
- LPWAN system (terrestrial) up to 30 km
- TS-UNB → ETSI standard TS103357
- ALOHA based access technology
- Telemetry data transmission
  (10-245 Bytes per telegram)
- Supporting bidirectional communication
- ISM frequencies: e.g. 868/915 MHz [EU/US]
- Small bandwidth (typ. 200 kHz)
- Up to 3.6 million messages/day @ PER <1%
- Low computing power for receiving and decoding possible (e.g. based on Raspberry Pi 4)
- Energy efficient sensor nodes
- Low-cost devices (COTS, multi source)
- mioty™ alliance established in 2020 (mioty-alliance.com)

mioty alliance

The mioty®-Technology

A new protocol for wireless data transmission - tailor-made for large sensor networks

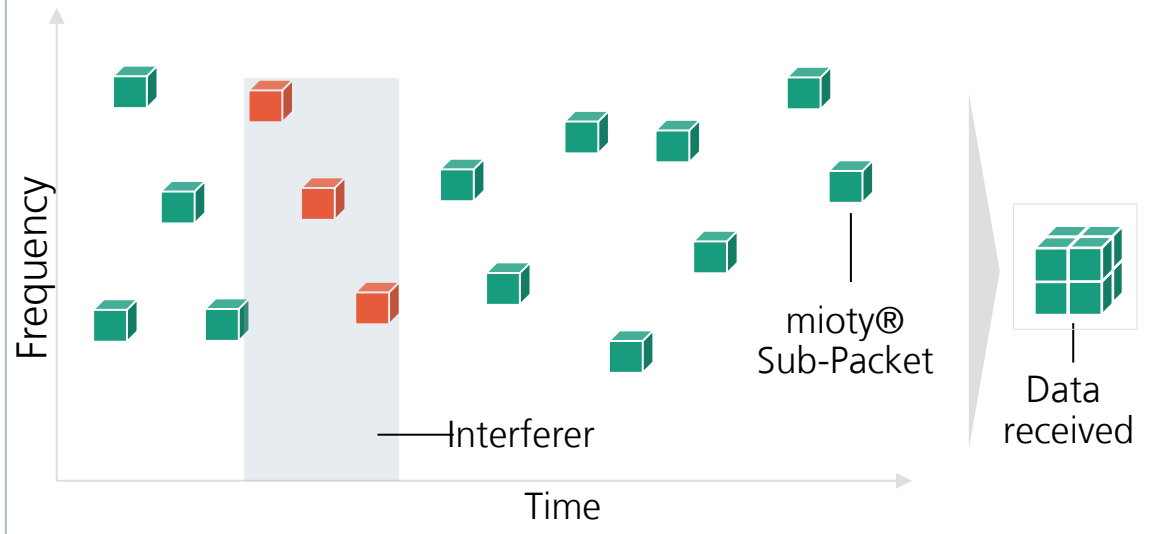
Legacy LPWAN
- Unlicensed bands -



Data is transmitted as a complete package

- Low resistance to interference
- High power consumption
- Packet error rates (PER) of >10% are common
- Limited suitability for Massive IoT

Telegram Splitting: mioty®
- Unlicensed bands -



Data is transmitted via small sub-packets

- Interference immunity thanks to forward error correction
- Long transmission-free periods enable energy recovery
- High reliability and robustness (<1% PER)
- Well suited for massive IoT-applications

The mioty-alliance
Driving Innovation Together

mioty alliance

Our Goals:

- Increase the worldwide awareness
- Develop the Eco-System
- Expand in new markets
- Create interoperable solutions
- Increase the members‘ value

The Value for our Members:

- Know-How Transfer
- Marketing by the mioty alliance
- Collaboration across the IoT value chain
- Joint international Events
- Lead Generation Programs

The mioty Alliance empowers members to drive mioty innovation and shape the future of standardized IoT technology.

Full Members

DIEHL Metering, Fraunhofer, Texas Instruments, STACKFORCE, WIKA, SWISSPHONE, WEPTECH, LORIOT, Sentinum

Associated Members

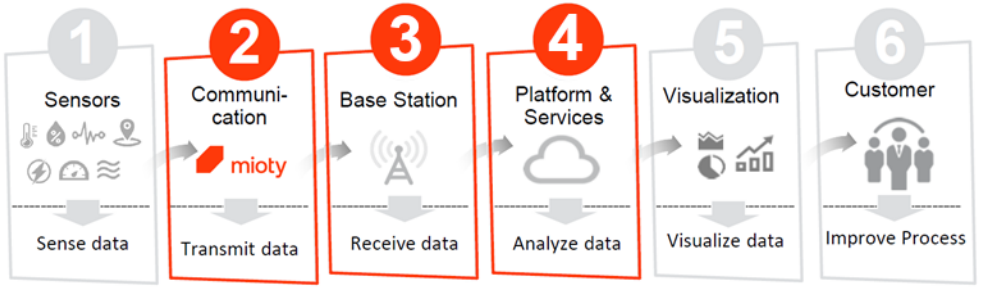
AST-X, Friendcom, Radiocrafts, com-t-ac, LANSEN, Silicon Labs, WiTRA, FAU, tecnun Universidad de Navarra, Stadtwerke Garbsen, iot-shop, SAF, LZE, RELISTE, HELIOT Europe, miromico, Stadtwerke Duisburg Metering, Radio Technikum, PhoboSys, senseca, UTEQ, Digimondo, eBZ, SWE digital, infoteam software, DeviceLab, Optimus Tower, EcoGuard, OLYMPUS, N-ERGIE, KEMPER, emsys, akenza.io, RAK, HMF, iotech, ROTIOT, CGF, schnell, GT Greatech, KŘIŽÍK, SPEKTER, connected, GLYN

From Terrestrial to Satellite IoT

„mioty® over Satellite“ IoT at Fraunhofer IIS

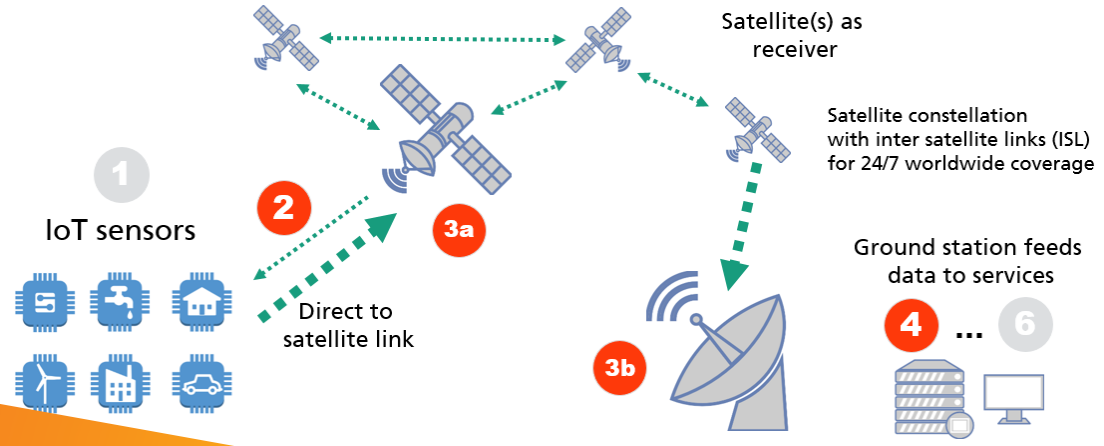
Reuse of proven terrestrial LPWAN technology

- Smart metering → Low data rate / small message sizes
- Massive machine type communication (mMTC)
- Technical boundaries of terrestrial IoT systems (Limited cell size / coverage & Availability
- Integration in existing mioty® value chain/eco system
- IoT for GEO and LEO scenarios → 100% compatible to TN



Satellite IoT at Fraunhofer IIS – our competences

- Air interface and waveform development and advancement
- System design assessment & optimization
- Antenna and demonstration platform development



Next steps (technology aspects)

- Demonstrations of mioty® in a LEO satellite environment

Looking for partners and satcom/IoT operators

From Terrestrial to Satellite IoT

Why mioty® for satellite IoT networks?

KPI System Capacity:
6.25M Messages/day/200kHz/beam

Multi-source transceiver hardware & low cost nodes

Energy efficiency
Long battery lifetime of nodes

Open ETSI standard
TS-UNB, vendor independent

High market readiness, entire value chain available → mioty® alliance

Easily adaptable & scalable to specific satellite scenarios

LPWAN protocol with highest system capacity
→ mioty® for large roll-outs
See mioty® comparison study
https://mioty-alliance.com/mioty-vs-lora-study-report/

Robust against Doppler and interference
Developed in ESA and DLR projects

Enabling Hybrid Networks:
Same protocol for terrestrial and satellite networks

IoT via Satellite
System Capacity Considerations

System Capacity
- Number of successful packet transmissions
- Measured within a specific time-frame
- Considered within a given channel bandwidth

Capacity importance in NTN
- Large cell → crucial for handling more users
- High capacity: Essential for high user density without service degradation
- From economic perspective:
  - Supporting a wide range of commercial applications necessary
- Not feasible to densify existing deployments (done in (LoRa) TN networks)

System Capacity is THE key feature for successful SatCom IoT business cases

Capacity Analysis
- Capacity simulations need to model realistic node distribution, i.e. more nodes with lower reception power.
- Dynamic range for terrestrial: 69 dB
- Dynamic range for satellite: 10 dB
- Higher Capacity for satellite system:
  - due to smaller dynamic range weaker messages don't get overshadowed by stronger ones.

Doubled capacity for mioty® over satellite!

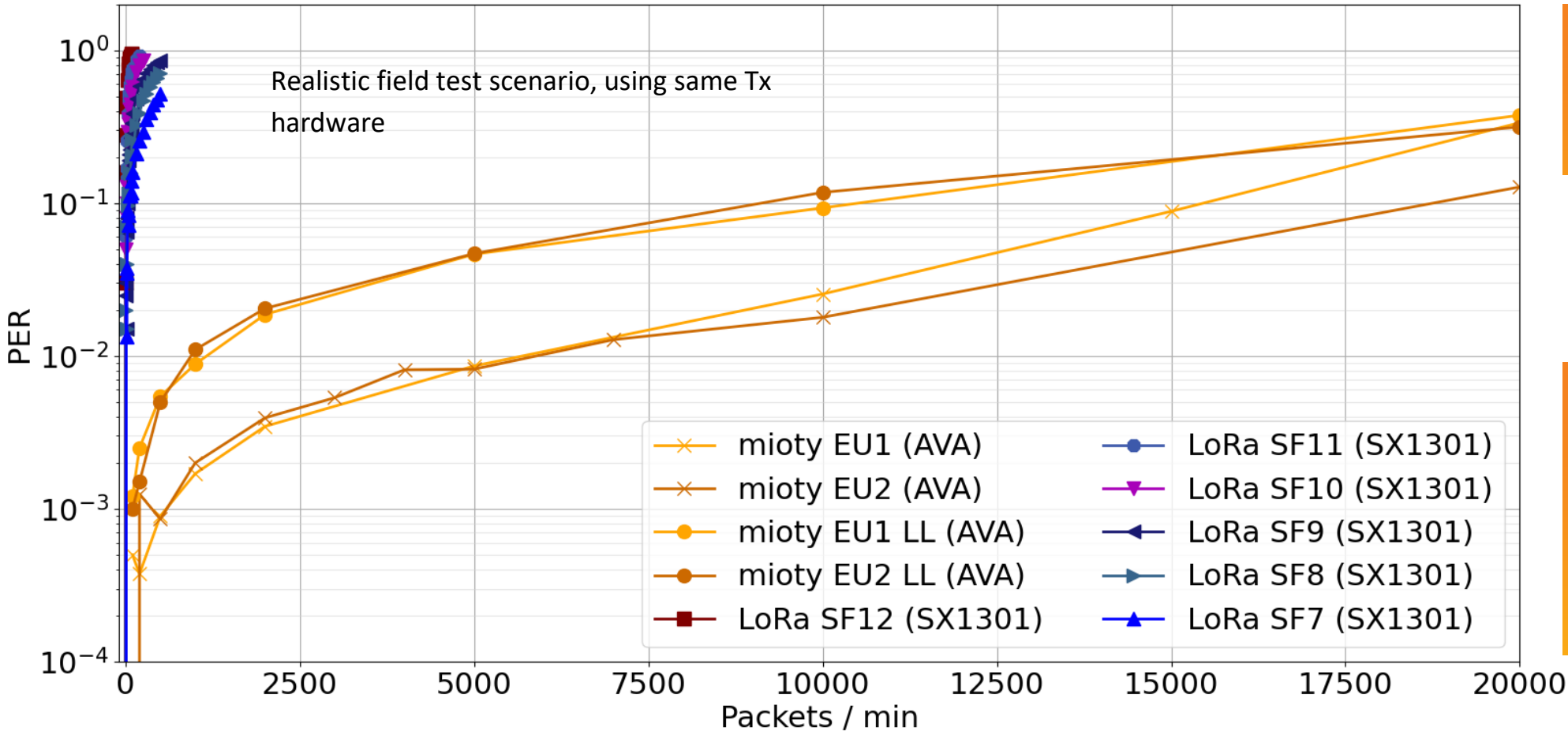
Current detailed analysis show that direct to satellite mioty® system can deliver **6.25 Mio Messages/day/200kHz** instead of 3.6 Mio

See: J. Mrazek, S. Kisseleff, C. Rohde, J. Robert, J. Kneissl and F. Leschka, "mioty superiority over both LoRa-versions in satellite-IoT applications," *41st International Communications Satellite Systems Conference (ICSSC 2024)*, Seattle, USA, 2024, pp. 63-70, doi: 10.1049/icp.2024.4613.

mioty® Comparative Study Report (mioty® vs LoRa) by TU Ilmenau

System Capacity as KPI

Reference: https://mioty-alliance.com/mioty-vs-lora-study-report/



mioty® is suitable for large roll-outs

Realistic Field Test scenario
→ Do not trust field trial results with few devices

mioty® Comparative Study Report (mioty® vs LoRa) by TU Ilmenau

mioty® vs LoRa/ LoRa-FHSS

Recently released:
mioty® vs LoRa-FHSS

Reference: https://mioty-alliance.com/mioty-vs-lora-study-report/

Key Points of updated study

- LoRa-FHSS significantly increases the capacity wrt. classical LoRa
- Still, mioty® has approx. 8x – 13x higher system capacity than LoRa-FHSS

- Energy consumption is 40% higher than LoRa SF12 (making it 6 times more power hungry than mioty®!)
- Sensitivity goes down 3dB in comparison with LoRa SF12 (lowering the range)
- Transmission and on-air time goes up (limiting the no. of messages allowed to send within the duty cycle limitations)

- The header bursts are not robust, making LoRa FH-SS vulnerable to noise, especially classical LoRa
- LoRa FHSS still relies on classical LoRa for the downlink

04

Key Takeaways & Outlook

Key Takeaways and Outlook

Our Offer:

Fraunhofer IIS supports national and international SatCom players in:

- Consulting
- R&D in SatCom
- System Design
- System Simulations
- Constellation Design
- Test & Verification

1. **mioty®** can easily be adopted to specific SatCom IoT scenarios
2. **System Capacity is key feature** for successful SatCom **business cases**
3. **TS-UNB/mioty® outperforms IoT/LPWAN protocol competitors**
4. mioty® enables **Hybrid Networks:** terrestrial and satellite networks

References

1. Fraunhofer IIS https://www.iis.fraunhofer.de/
2. Fraunhofer IIS SatCom https://www.iis.fraunhofer.de/en/ff/kom/satkom.html
3. Fraunhofer IIS Satellite IoT https://www.iis.fraunhofer.de/en/ff/kom/satkom/satellite_iot.html

4. mioty® Alliance http://mioty-alliance.com/
5. Mioty® vs LoRa study report https://mioty-alliance.com/mioty-vs-lora-study-report/
6. Paper ICSSS 2024: mioty® Superiority over Both LoRa®-Versions in Satellite-IoT Applications https://s.fhg.de/H66

7. Paper „Time Variant Doppler Compensation for TS-UNB" https://ieeexplore.ieee.org/document/10192999
8. Paper "Doppler Localisation of TS-UNB IoT Nodes from LEO satellites" https://ieeexplore.ieee.org/document/10572039
9. Paper E2UT https://ieeexplore.ieee.org/document/9384419
10. Paper "Doppler Localisation of TS-UNB IoT Nodes from LEO satellites" https://ieeexplore.ieee.org/document/10572039

11. ESA Project Webpage Energy Efficient User Terminal https://artes.esa.int/projects/e2ut
12. ESA Project Webpage M2MSatNet Study https://artes.esa.int/projects/m2msatnet

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