Perspectives in small satellite IoT networking

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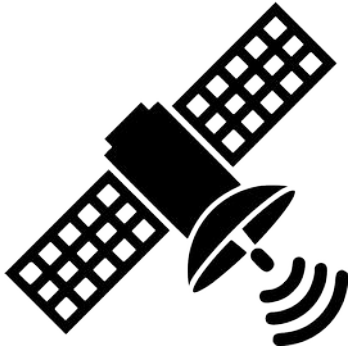
Who am I?



Sebastian, physicist by background,
25+ years wireless networker and developer,
Community Networks, IoT, Sustainable Energy,
TinyML, Satellite Networking

Research Lab Manager at DASYALab
IT University of Copenhagen

Network Trainer and developer at the NSRC

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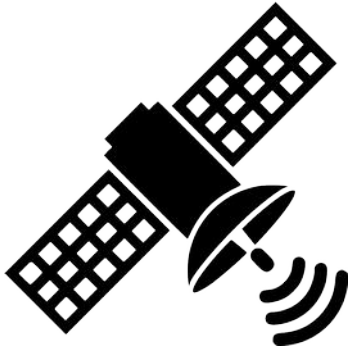
NSRC
Network Startup Resource Center

DASYA

What is new with Satellites?



Satellites as communication platforms have been around for decades (1950s, 1960s)

Starlink is a widely available satellite broadband constellation

The **new qualities** are

low power
low cost
small size

driven by two developments:

1/ Tiny satellites: Cubesats and smaller
2/ New LPWAN standards, e.g. LoRaWAN

Commercial Companies

LEO
Low earth orbit
200-1000 km

GEO
Geostationary
35,700 km

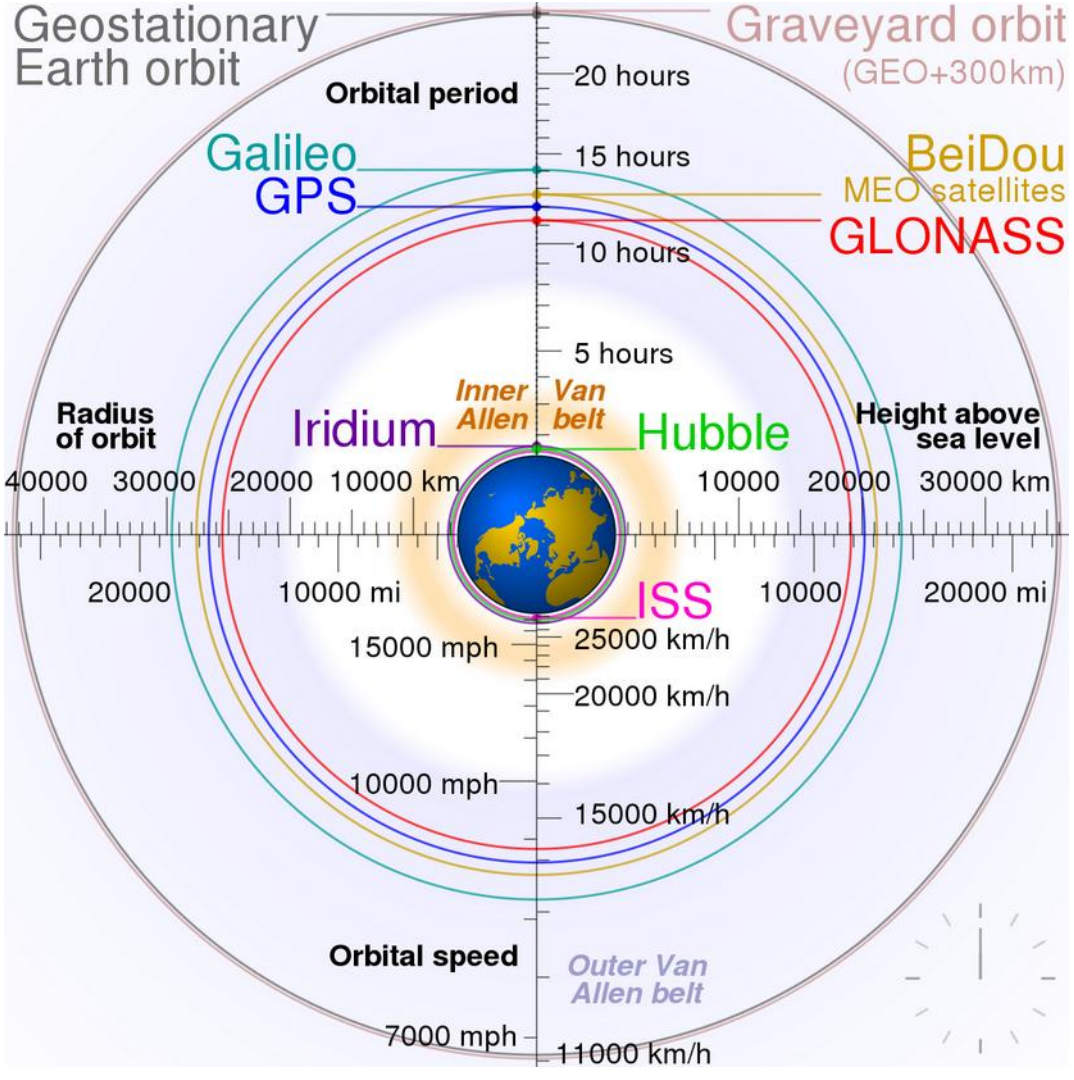
[last update: March 2023]

Asiasat GEO/LEO
Astranis GEO
Astrocast LEO
Echostar GEO
eSat global GEO
Eutelsat GEO/LEO
Fleet LEO LORA
Globalstar LEO
Inmarsat GEO/LEO
Iridium LEO
Kineis LEO LORA
Lacuna LEO LORA
Mokolora (?)
Myriota
Orbcomm LEO
Skylo GEO
Swarm LEO
Thuraya GEO
Wyld

Orbits

LEO
Low earth orbit
200-1000 km

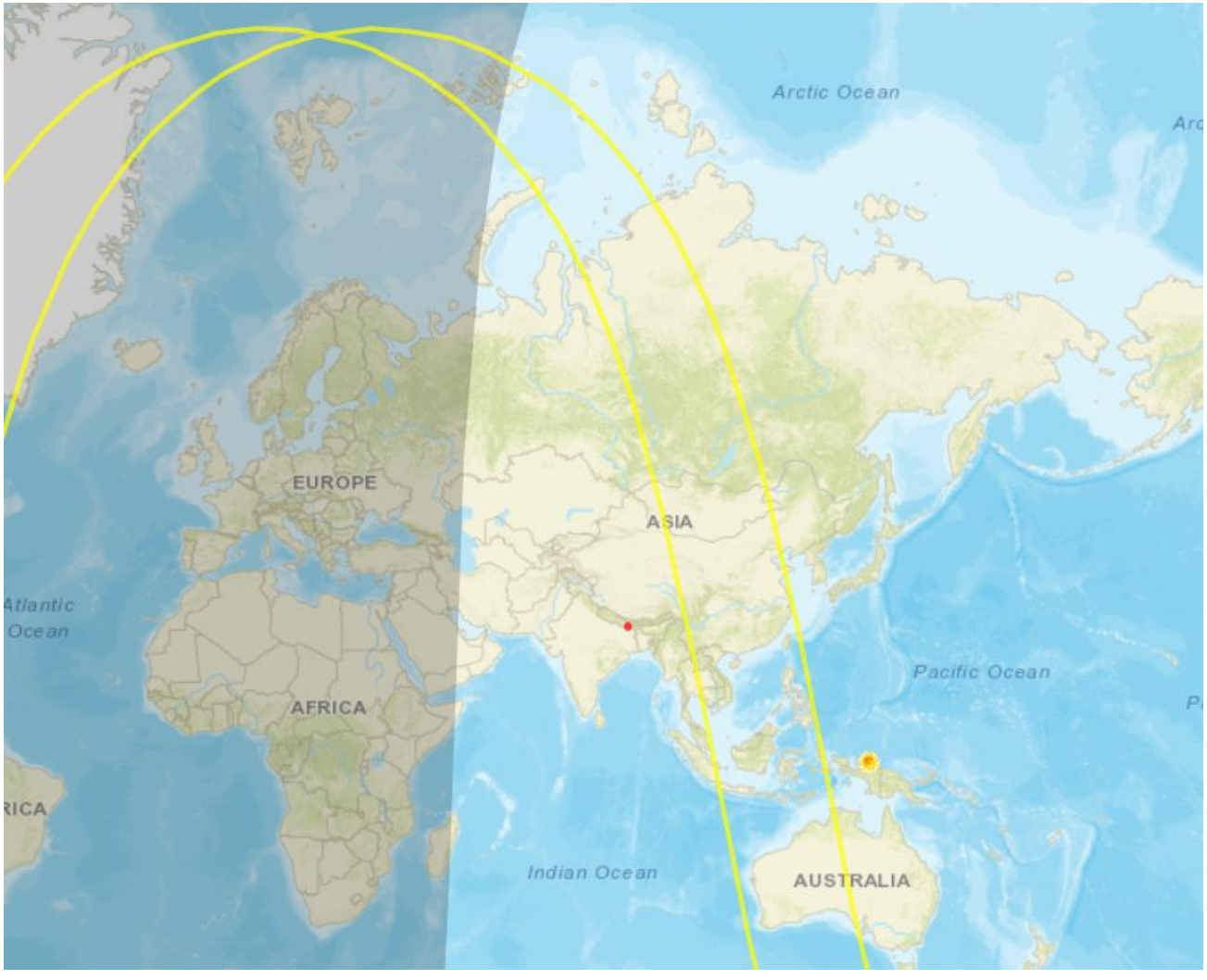
GEO
Geostationary
35,786 km



Orbits

LEO

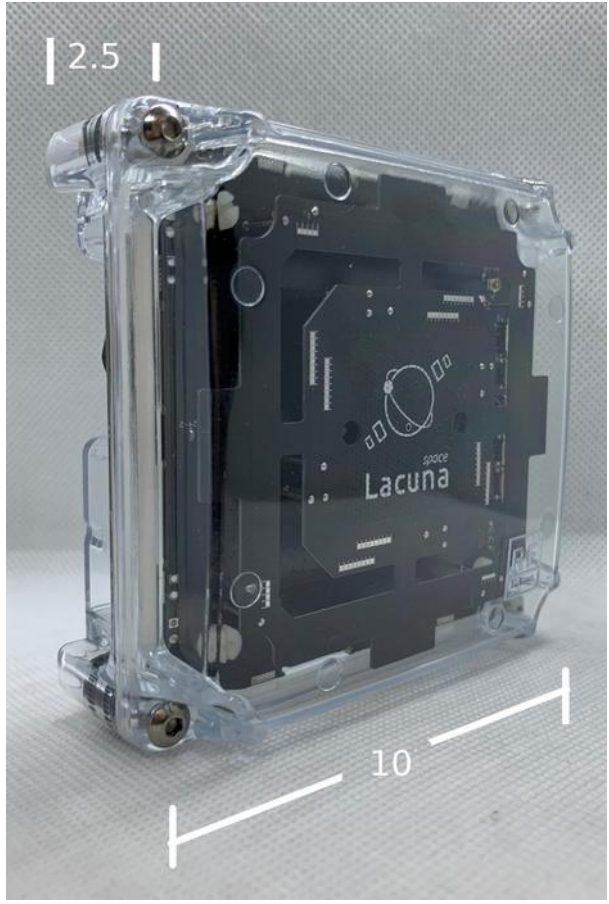
Polar Orbits



Characteristics

For the **node device**

Power consumption:
mW class rather than 10s of Watts (Starlink 20-70W)
Cost:
$100 class,
possibility to build your own
Cost of service:
some $ per device and month
Size: < 10 cm
Accessibility:
Open Source /
Open Hardware



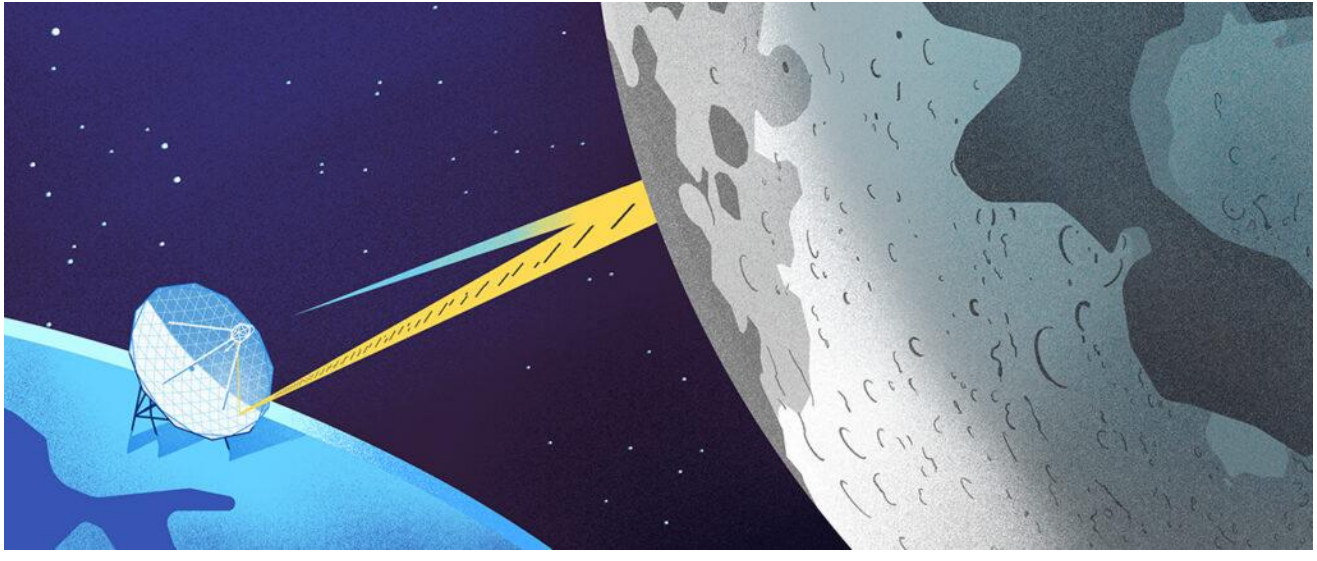
source: lacuna.space

Impact of LoRa

extreme low power, long distance

LEO satellites can easily be reached by small battery powered nodes (distance to satellite 400 … 1500+ km)

World record is a bounce off the moon
(700,000 km - however strongly amplified)



source: lacuna.space

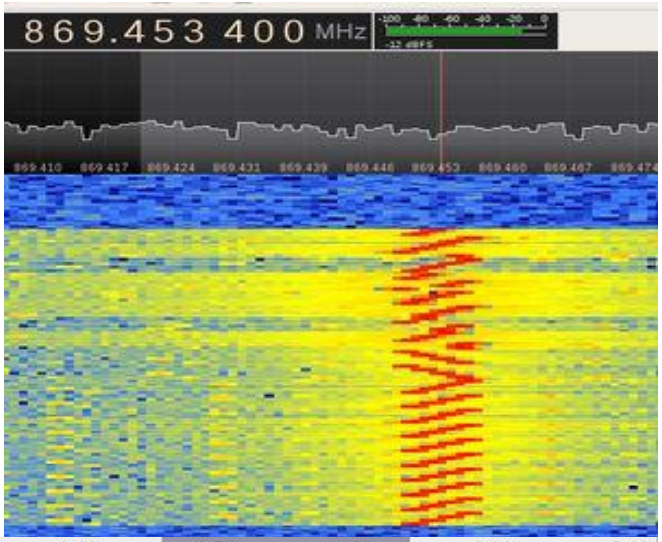
What makes LoRa so strong?

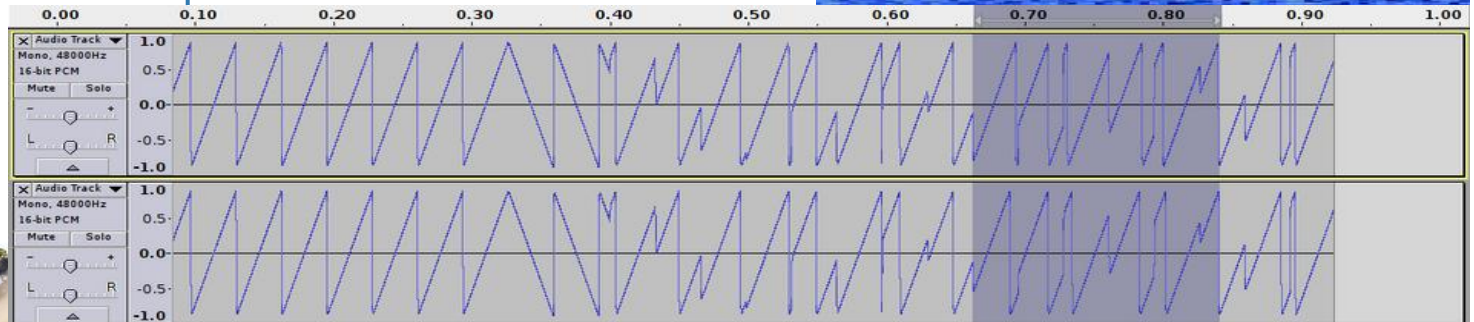
Due to modulation,
Chirp Spread Spectrum and
Frequency Hopping Chirp Spread Spectrum,

Receive sensitivities go down to -150 dBm

Choice of frequency:
free in principle,
most popular:
ISM bands at

433 MHz
868/902/915 MHz
2.4 GHz

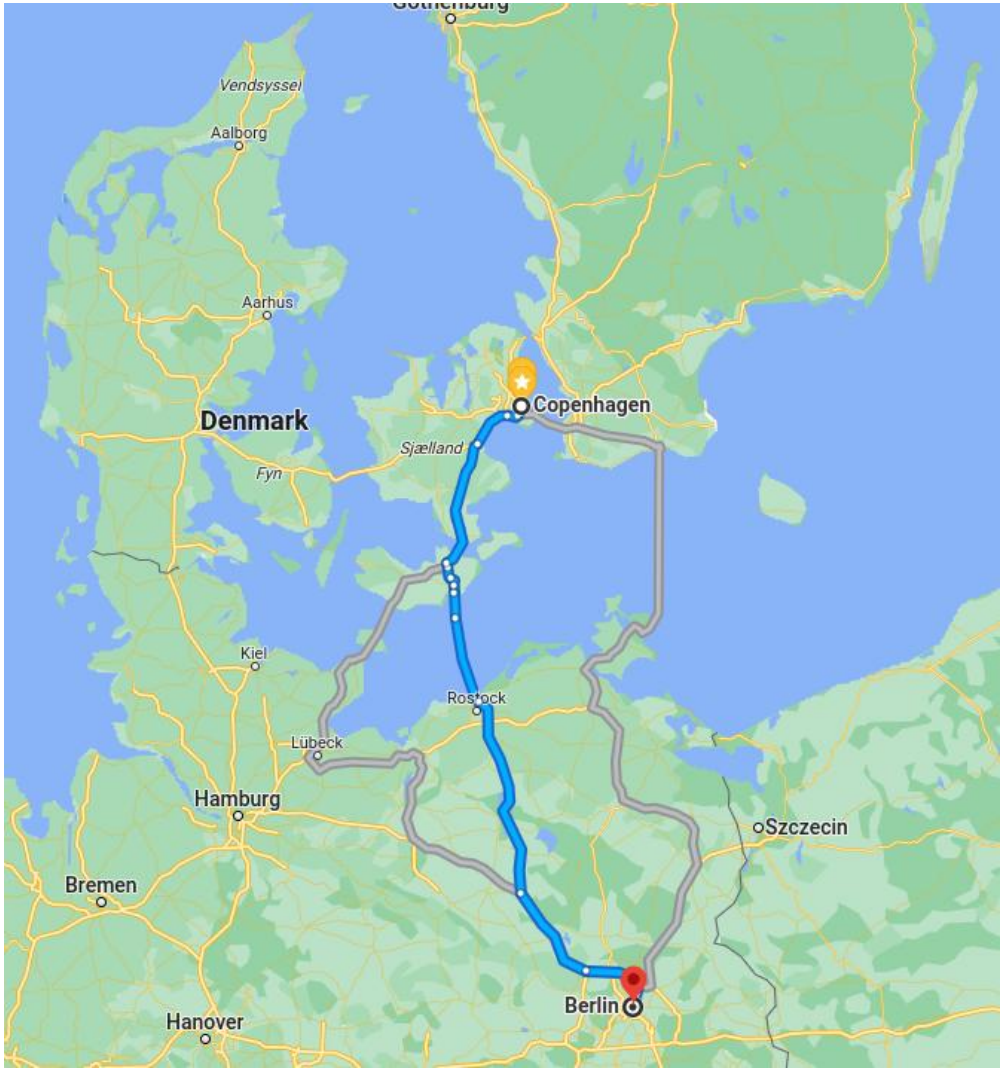




LoRa already strong terrestrial

example 1

Sea Cruise from Denmark’s islands to Berlin

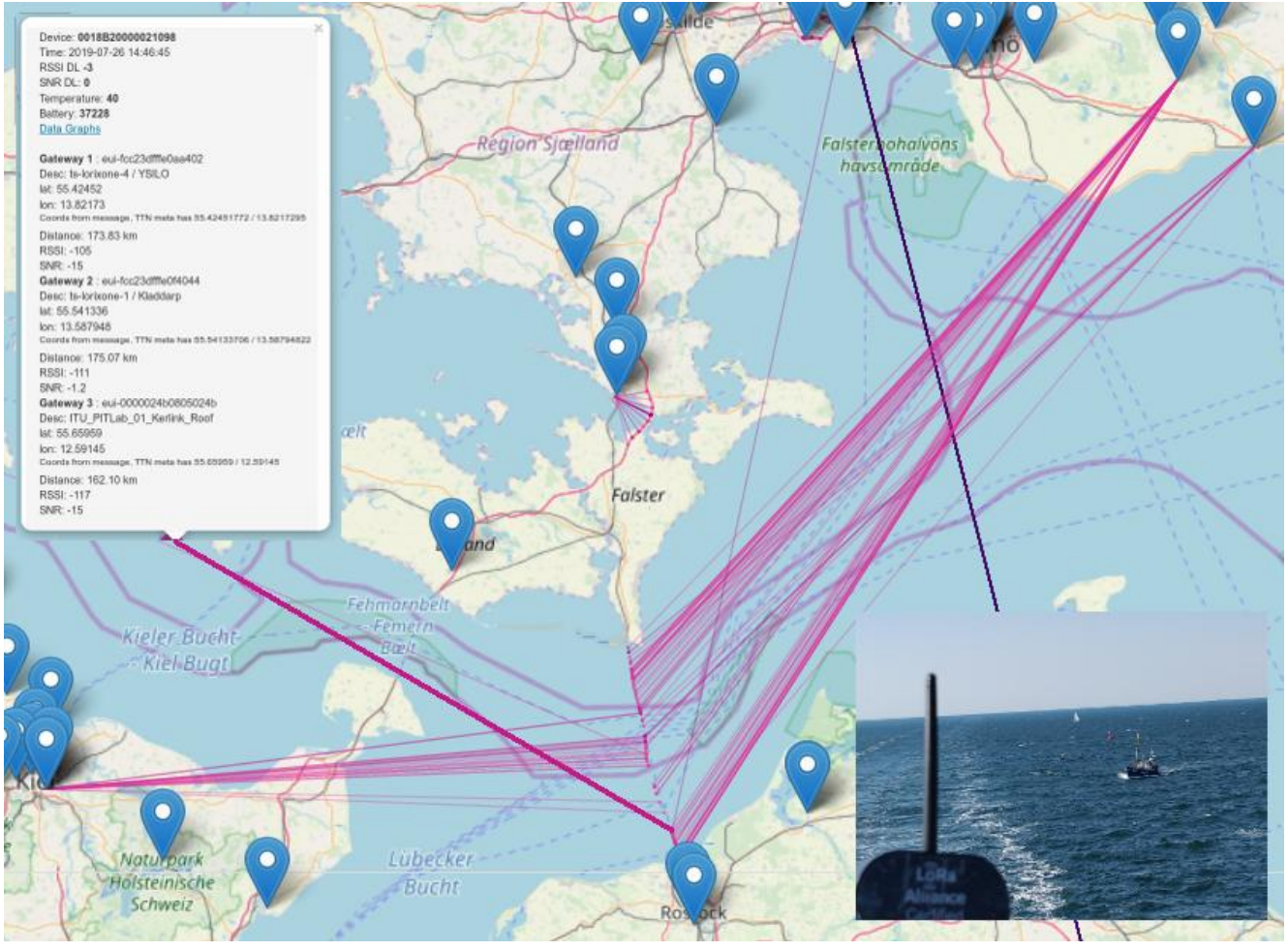


LoRa already strong terrestrial

example 1

Sea Cruise from Denmark's islands to Berlin

200+ km LoRa links



LoRa already strong terrestrial

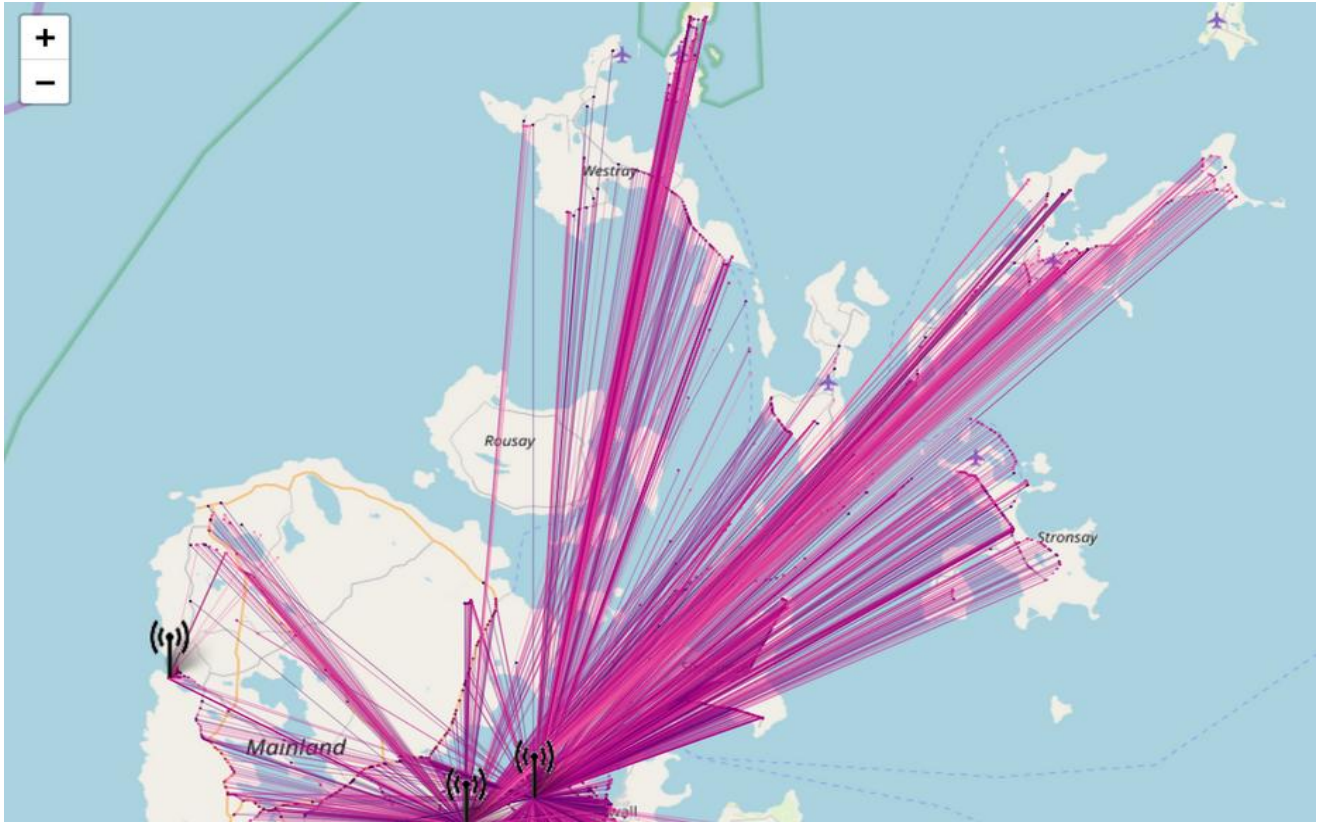
example 2

Orkney Archipel UK

LoRa already strong terrestrial

example 2

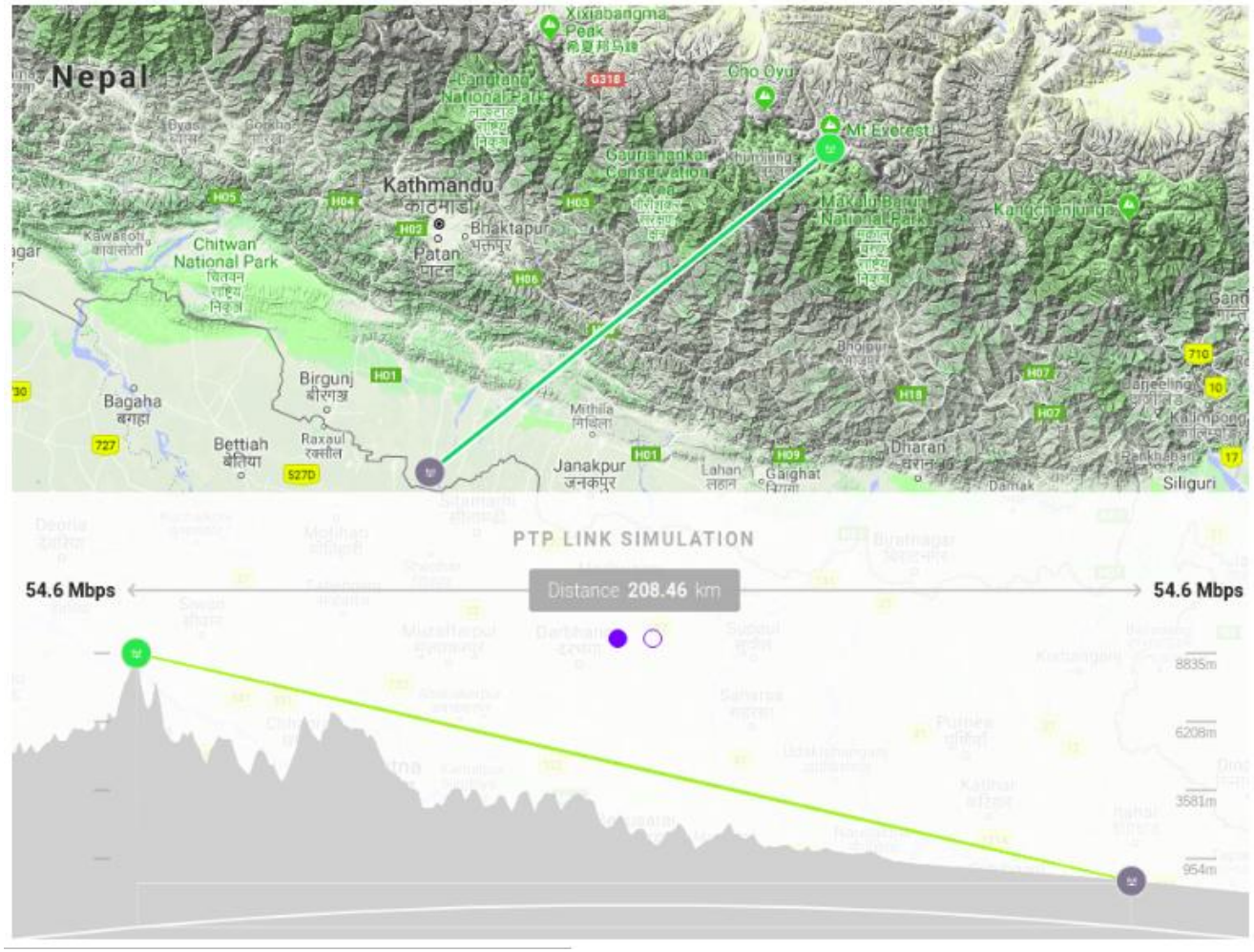
Orkney Archipel UK



LoRa already strong terrestrial

Nepal would offer fantastic possibilities

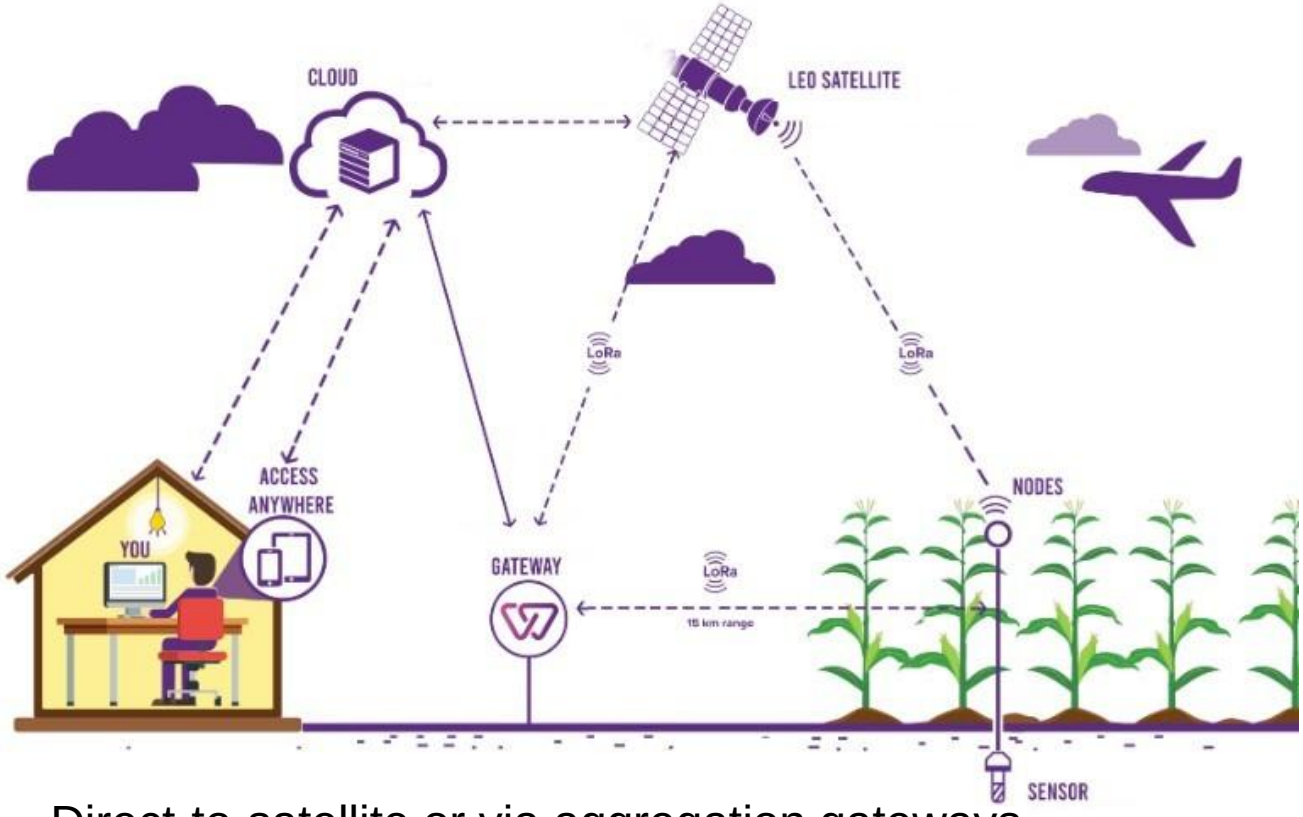
because of its topology



But when terrestrial

is not an option

You go up!



Direct-to-satellite or via aggregation gateways

When is Satellite LoRa the right choice?

for extreme remote networking

absence of terrestrial networks

small data

low power

if that s not the case,

go terrestrial or other IoT networks

Three scenarios that are particularly interesting:

Remote mountains
Out at sea
Wildlife tracking

Mountain tracking

Extreme low power GNSS tracking for trekking

Maritime tracking

Fishery Management, Security at Sea, Wildlife Conservation, Environmental Research

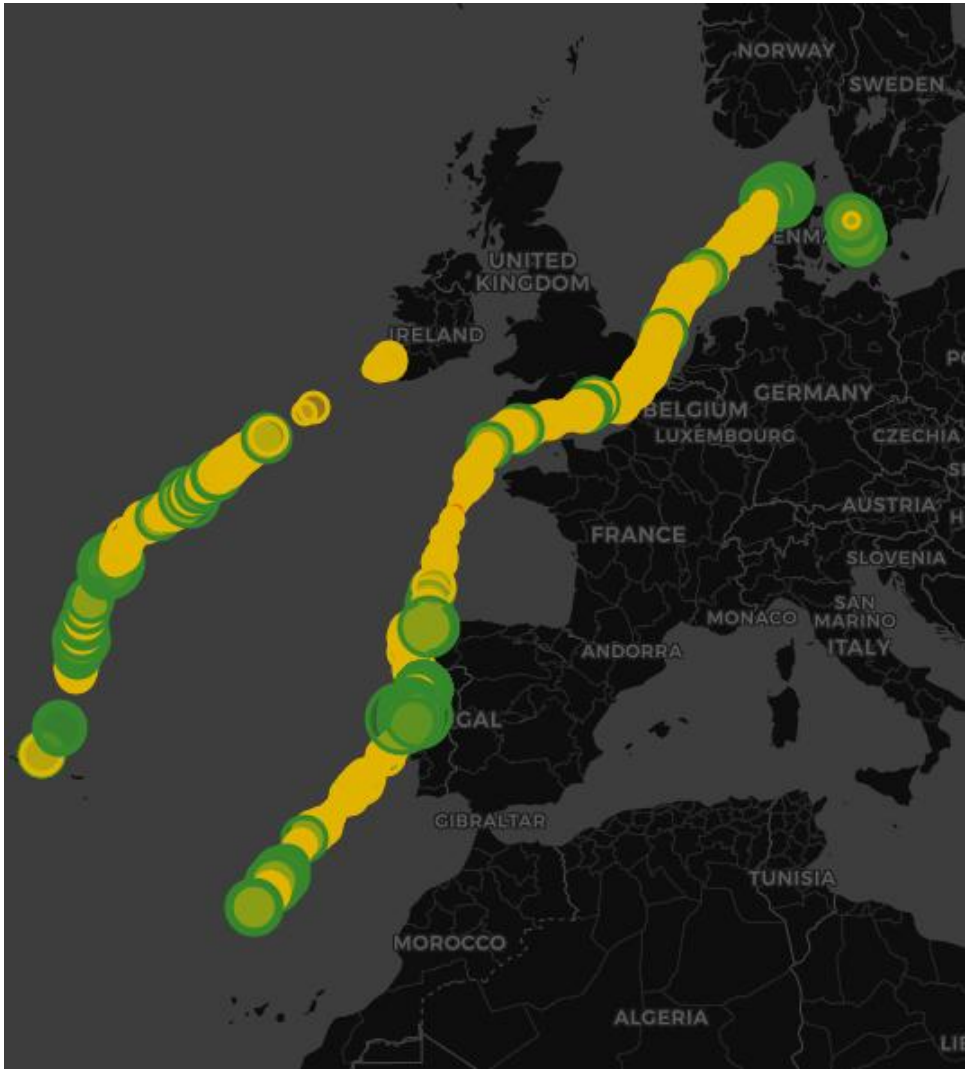
Wildlife tracking

From animals to waterholes, nature resources, etc

Some of our experiences:

Tracking at Sea

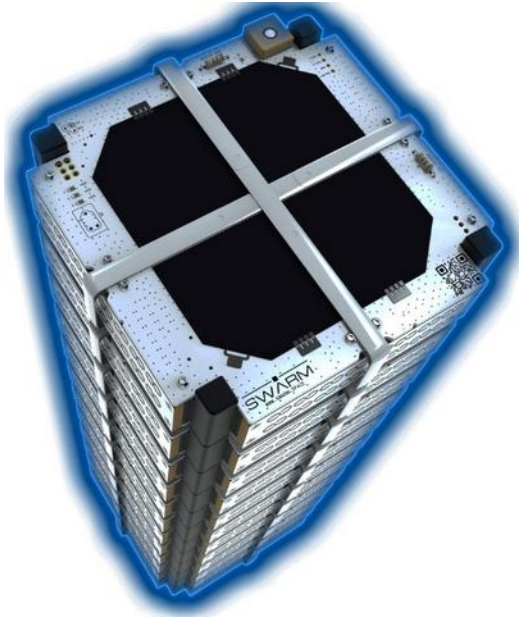
Swarm satellites



Sailing Denmark/UK to Madeira/Canares

swarm.space

SWÄRM



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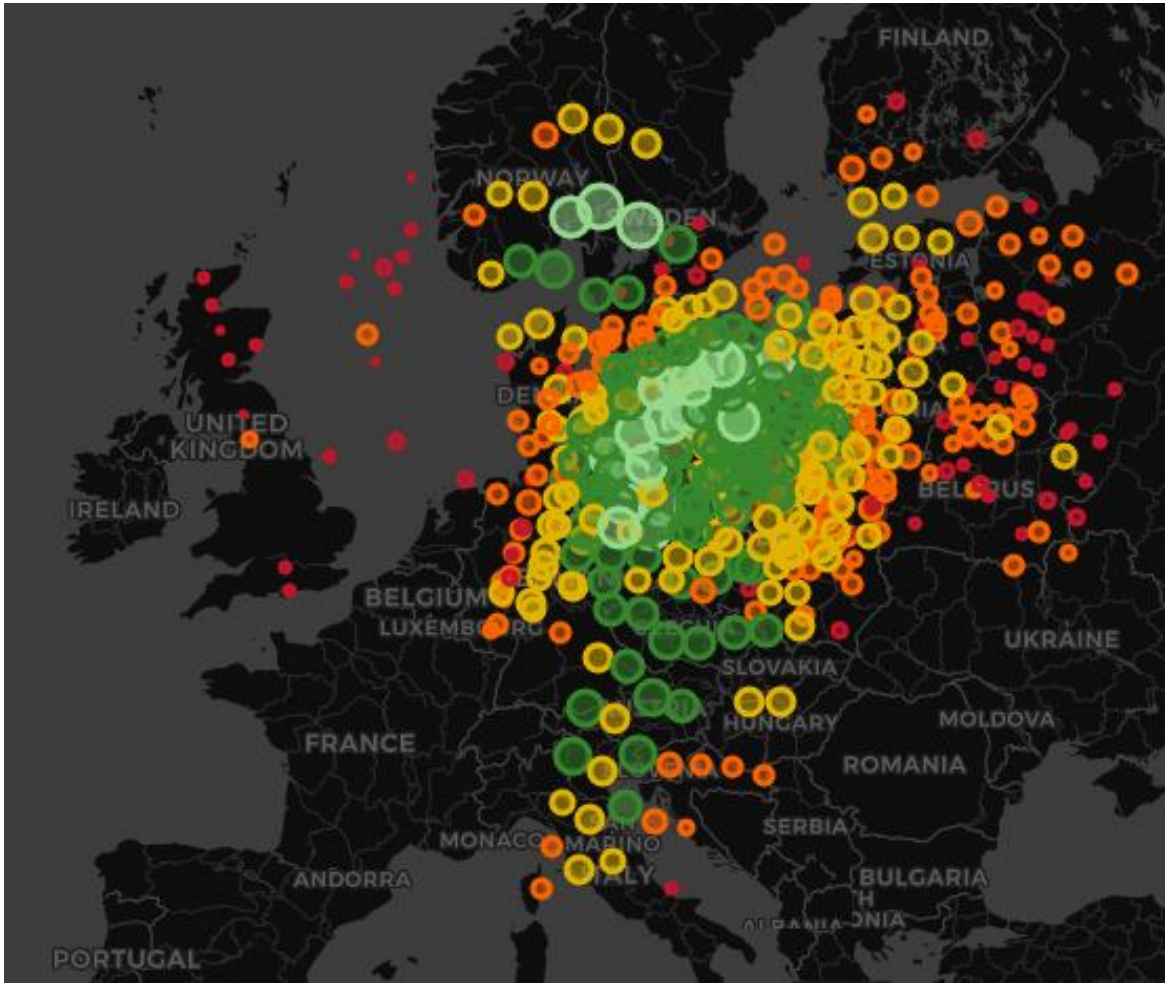
Some of our experiences:

Mapping one Lacuna satellite

Connections up to 1500 km



From an urban fixed location (Copenhagen) ^^^
←and in East Africa

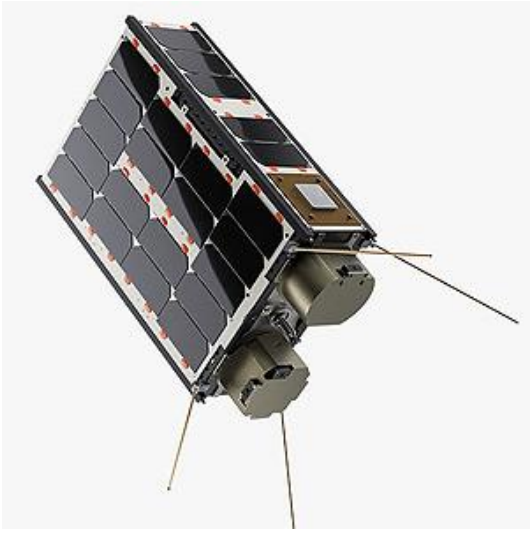
Some of our experiences:

Lacuna test deployments

East Africa

Some of our experiences:

Lacuna test deployments



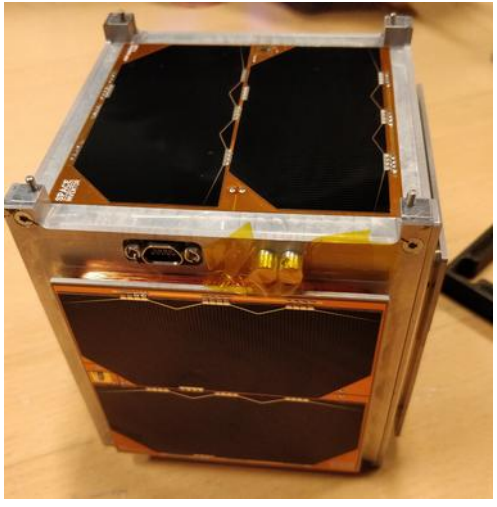
Vietnam, Fabien Ferrero

Some of our experiences

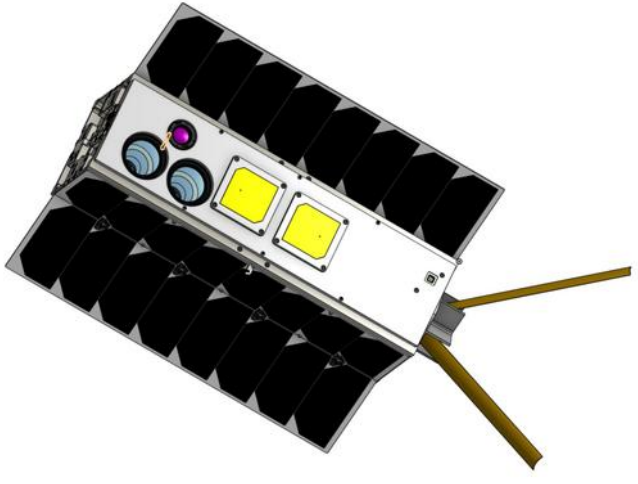
DISCOSAT - Danish Student Cubesat Program

https://discosat.dk

DISCOSAT1 (April 2023) flies a Coral TPU into space

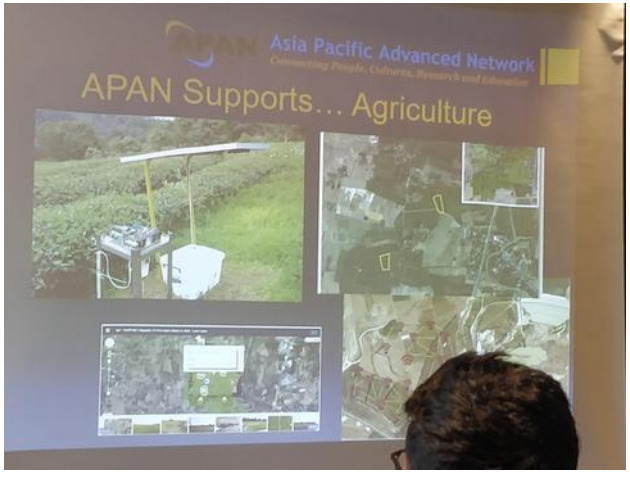


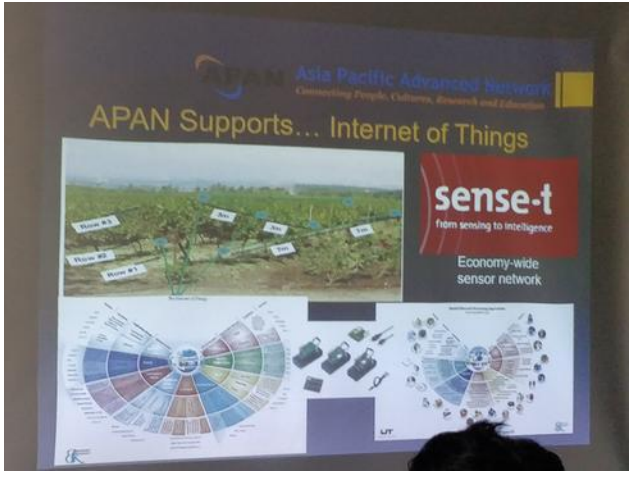
DISCOSAT2 (2024) will have multiple LoRa radios on board

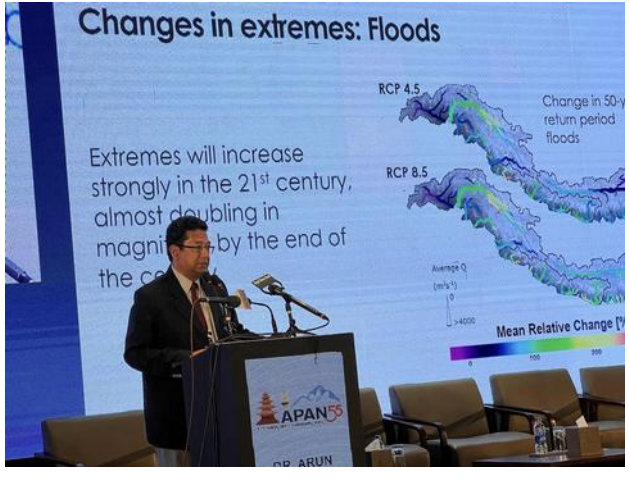


Why should NRENs / APAN

support his?







What is needed to make this happen,

and what can NRENs contribute with?

Skills and Capacity

NRENs are optimally positioned to help building this capacity

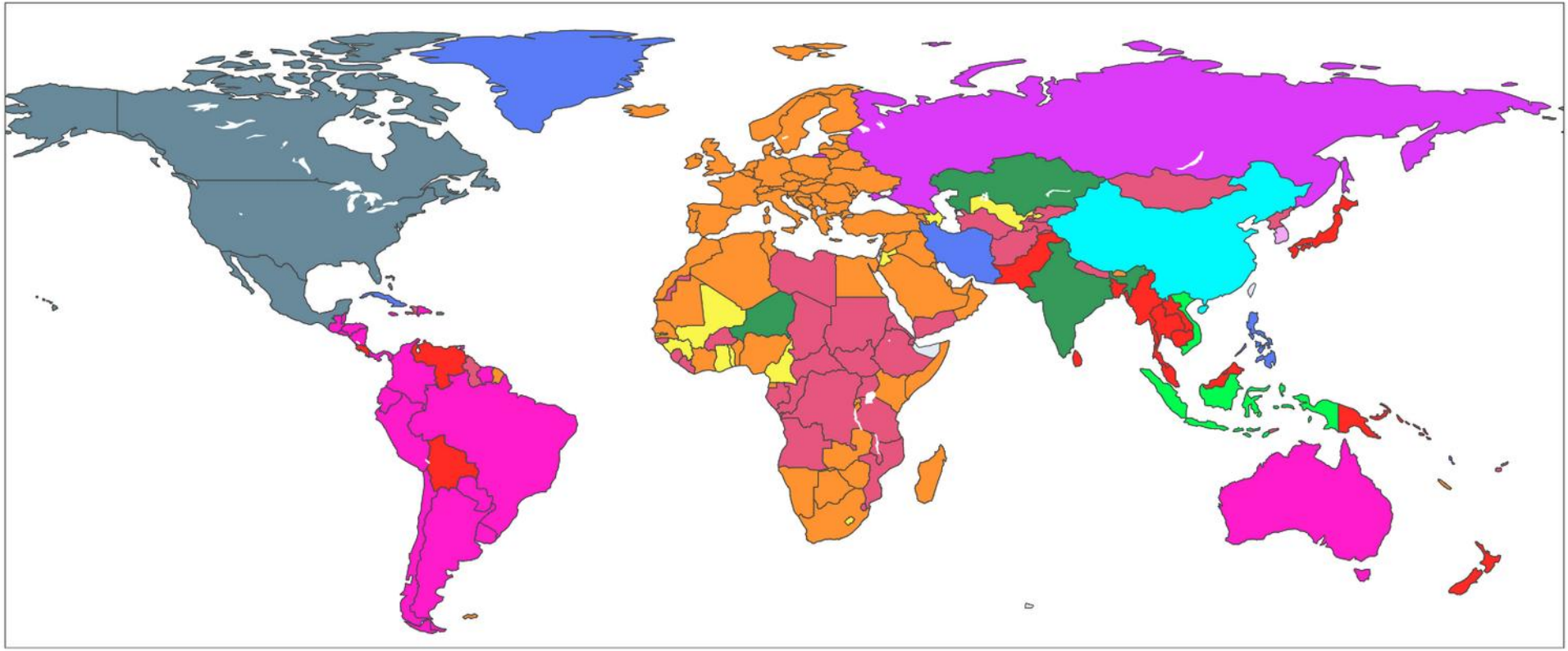
Terrestrial infrastructure, from networks to data infrastructure

Core competencies of NRENs

Regulations framework

Liaise with Regulators in the interest of Research, Education and Business

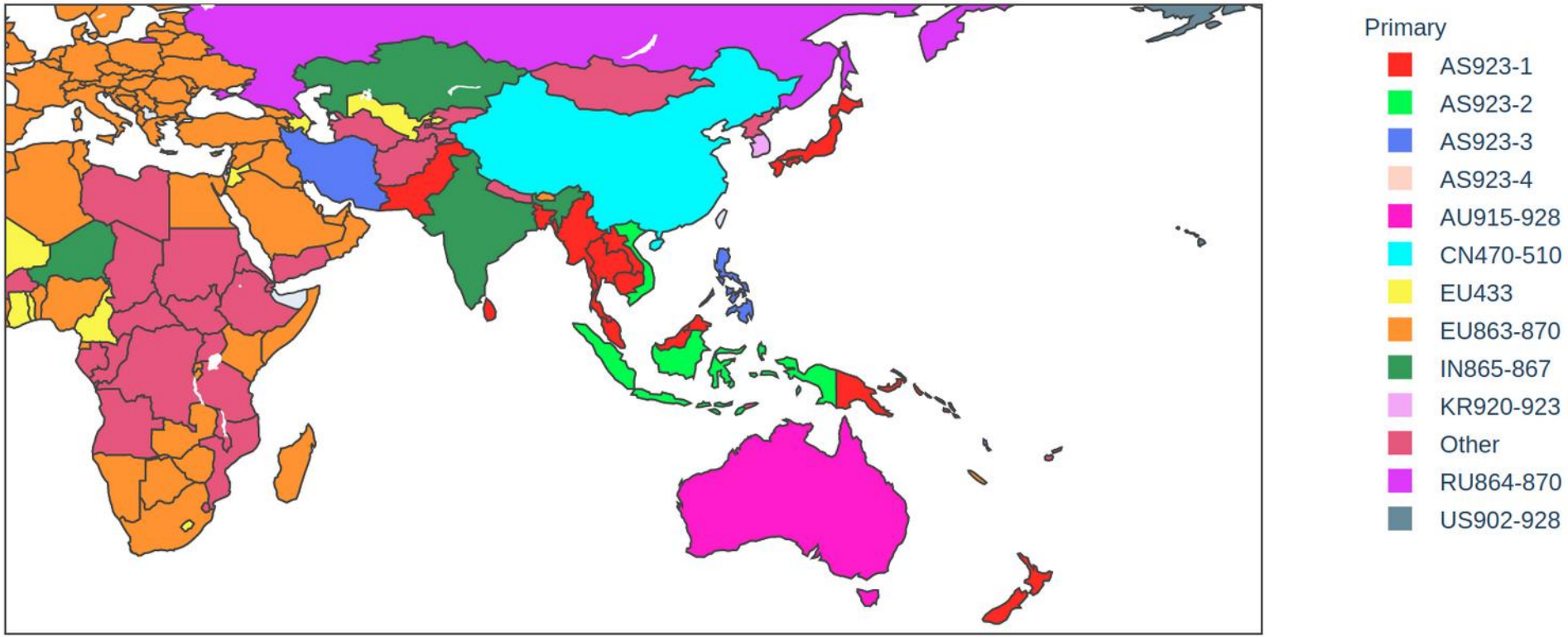
A word on regulations



SRD frameworks

Global harmonization around 3-4 frequency bands

A word on regulations



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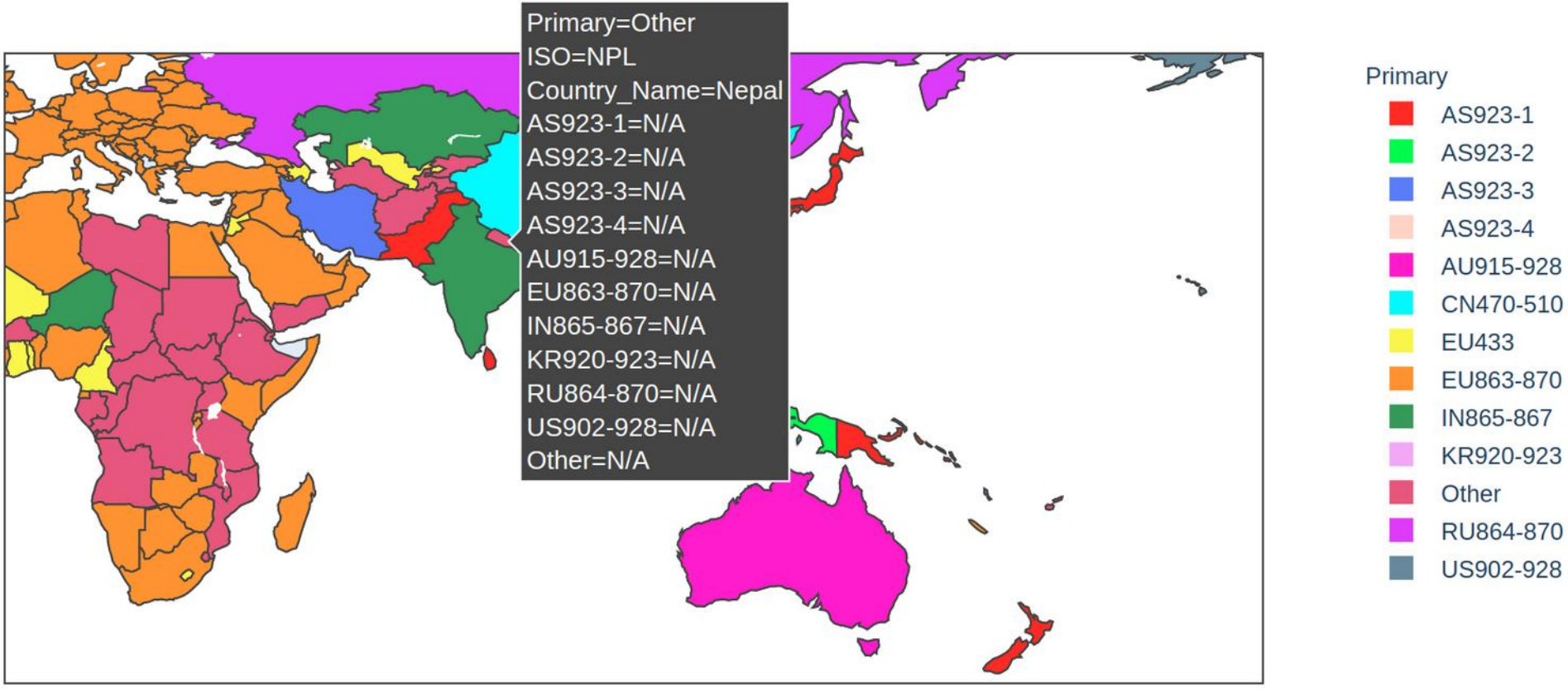


Nepal currently still in progress

Risks of satellite networking

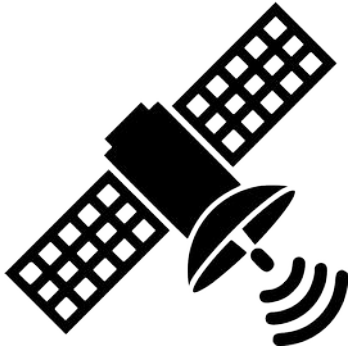
especially in LEO

Lack of global policies
Exploding number of constellations

Chance of “Kessler Syndrome” event -
the collision of satellites/debris leading to a chain reaction

source: https://www.forbes.com/sites/jamiecartereurope/2023/03/09/do-we-need-an-orbital-treaty-there-are-now-100-trillion-bits-of-space-junk-circling-our-planet-and-its-about-to-get-a-lot-worse/?sh=39e6f25a34a5

The way forward



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NSRC
Network Startup Resource Center

Work towards responsible use of satellite technology in the interest of research and education and humanity at large.

Engage in dialogue with regulators.
Build capacity.
Start pilot projects.