IoT Constellation Comparison, for UNISEC-Global #56

Connecting the Unconnectable

Harwell Space Campus

A strong UK space economy

Lacuna is situated at the heart of the UK space industry in Harwell Campus.

Surrounded by our supporters, sub-contractors and agencies

Lacuna Commercial IoT Service

A data acquisition service enabling IoT systems integrators to build ultra-low-power solutions to solve remote monitoring challenges.
Focused on use-cases taking hourly readings, delivered to the cloud daily

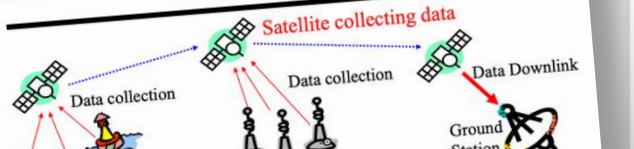
SENSORS
Open-sourced

space
Lacuna

GLOBAL COVERAGE
2, 3, 4 contacts per day

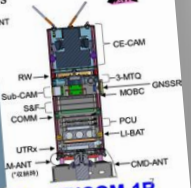
DATA, DELIVERED
Within 2 hours

Common Mission: "Store & Forward (IoT)"



Application areas: disaster prediction, water level monitoring, soil moisture, PH.....

Low power transmission is key: 8 -130 mW RF power, low data rate (300bps) transmission was successful. (2018)



3kg TRICOM-1R

Merit of "IoT" as Common Mission

- IoT satellite can be developed in 3U-6U size and does not require so high level satellite-bus
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Use case of "Store and Forward"

Monitoring Animal Movements over wide area

Wild Fire Detection and Monitoring (temperature sensor network)

Flood Detection and Monitoring (Water Leven Sensor Network)

Agriculture Field Monitoring (PH, moisture level sensors)

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Global Problems on the Earth are Becoming Severer

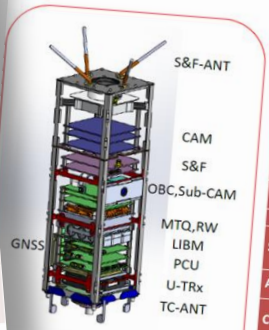
- Global problems on the Earth
  - Global Warming
  - Wildfire
  - Deforestation
  - Desertification
  - Flood and Drought
  - Earthquake
  - Tsunami
  - Volcano explosion, etc.
- The situation seems to be getting worse

What information should be collected from wide area to mitigate such problems ?

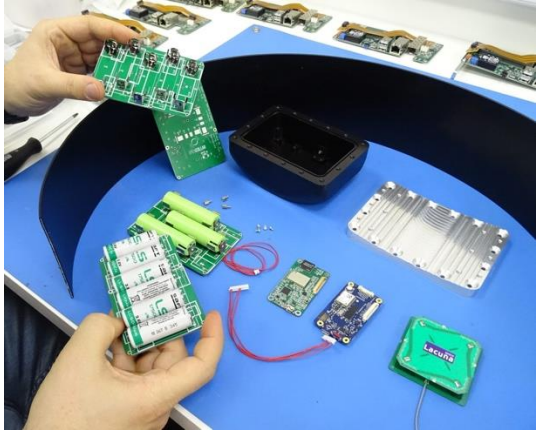
TRICOM-1R Weak Signal Receiver for Data Collection Capability

Item	Specification
bit rate	300 bps, maximum 8 channels in parallel
Transmission duration	< 300 sec
Transmission power from ground	20 mW
Frequency band	920 MHz (no license of usage is required if using 20mW power)

3U CubeSat "TriCom-1R" - S&F Test Satellite (2018.1) -



Items	Values	Miscellaneous
Size	10x10x30cm	3U size
Weight	< 3kg	
OBC	"Bocchan"board	Internal made
Power (average)	4W	AZUR GaAs cell
Battery	Li-Ion 41 wh	LIBM
Downlink (H/K&data)	W 1.2kbps	460MHz AFSK "U-TRx"
Uplink(H/K)	50W 9600bps	401MHz
Attitude	Simple 3 axis	B-dot law only
Sensor	magnetic sensor, gyro GPS receiver	"GNSS"
Actuators	magnet torquer despun wheel	"MTQ" "RW"
Camera	GSD 314 m VGA @180km	"CAM"
Sub-Camera	GSD 67 m @600km	"Sub-CAM"




Use case of "Store and Forward"
GPS positioning information is uplinked
Monitoring Animal Movements over wide area
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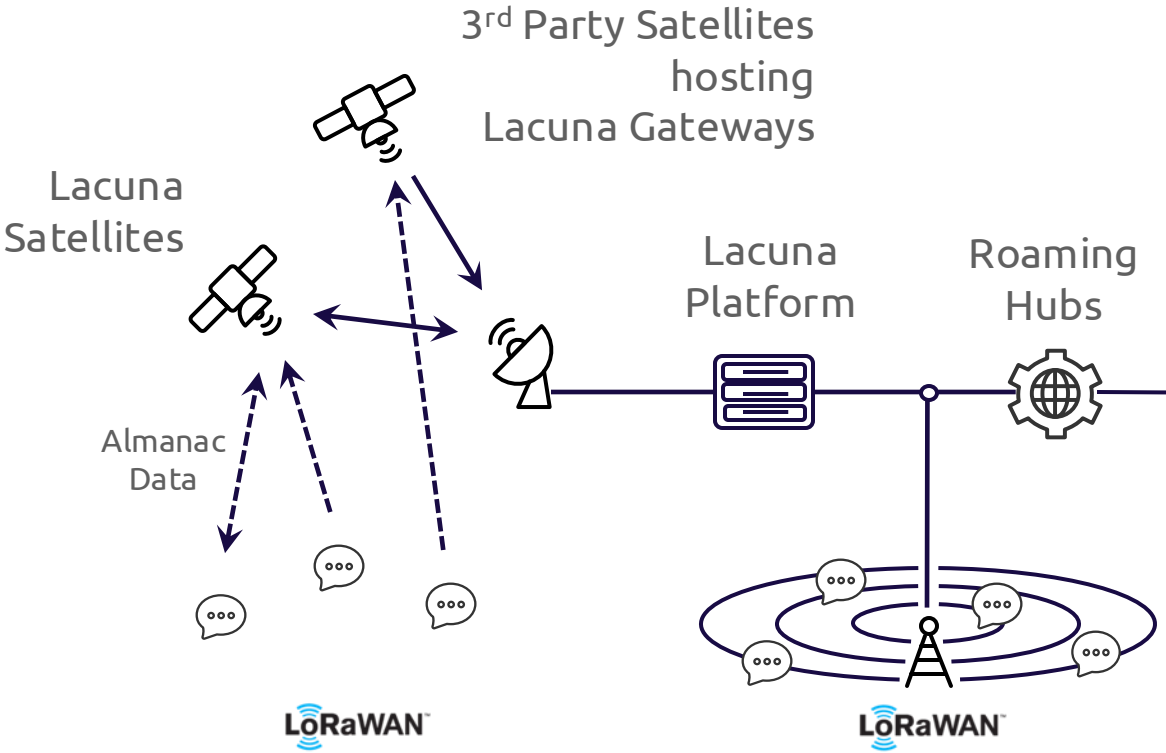
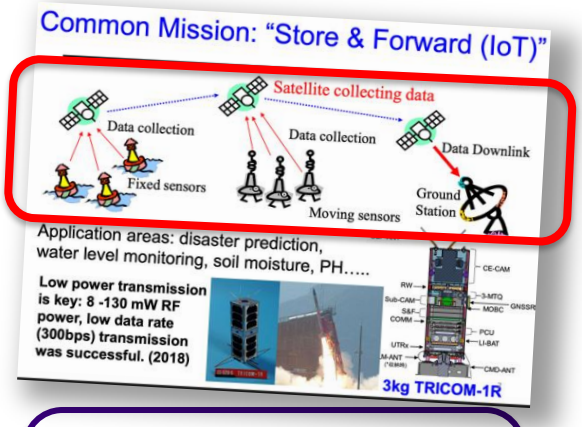
Agriculture Field Monitoring (PH, moisture level sensors)


smart parks
Elephant-Tracker-3
EDIT
LOCATION
LATITUDE
LONGITUDE
SPEED
0km/h
COURSE
44°
BATTERY
TIME
Mon, Feb 24, 13:22:23

Hybrid LoRaWAN Coverage

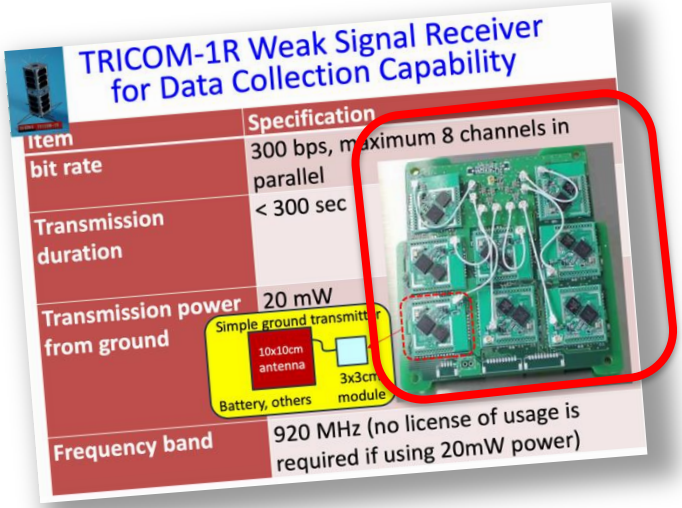


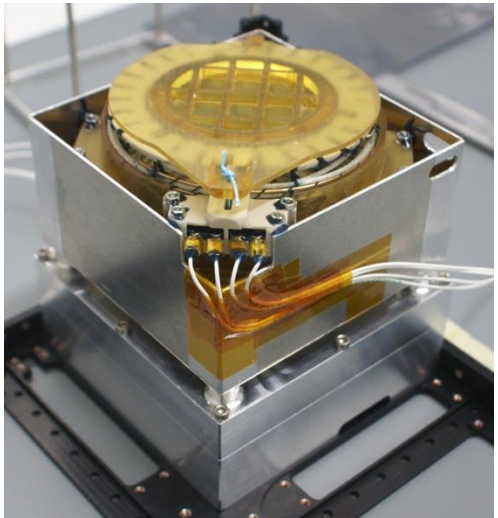


Note : interoperability to existing LoRaWAN ecosystem

SDR IoT Payload plus antenna

- World's highest capacity LoRaWAN gateway
- LR-FHSS via Software-Defined Radio
- Highly parallel GPU implementation
- Coupled to high-gain deployable antenna
- 7 dBic, 30 half-cone angle
- 863-868 & 902-928 MHz bands (continental switching)
- Six year heritage across 10 payload missions
- Available to 3rd party constellations





- Design iterations across 3u, 4u, 6u chassis suppliers
- 255 bytes over 4.18 sec packet = 488 bps
  - But this is raw data.
  - LoRaWAN MAC and LR-FHSS coding has overhead
  - Effective 46 bytes user payload = 88 bps
- 40 minutes data ? Unsure of assumptions
- Lacuna would expect 1-to-2 minutes at any single point

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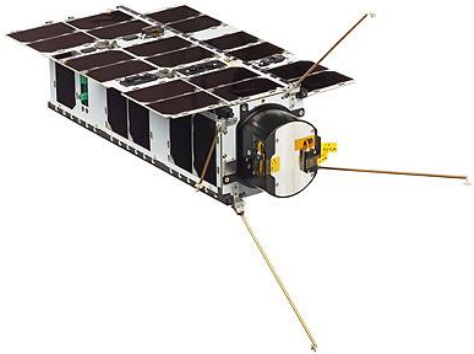

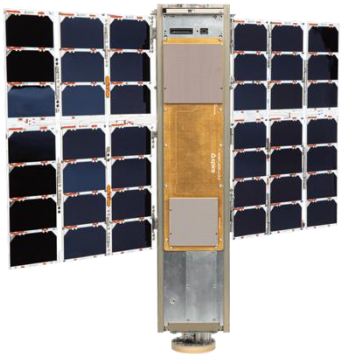

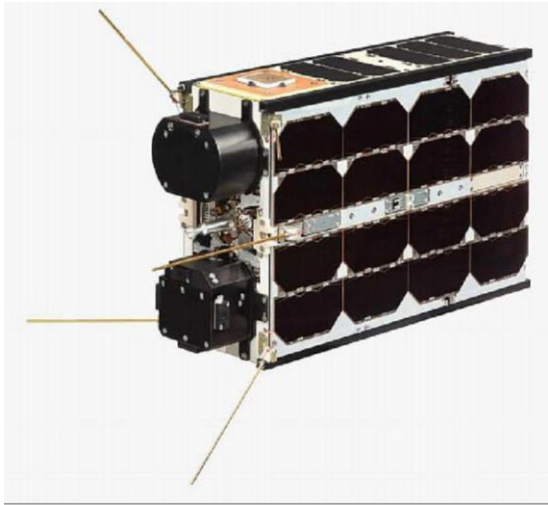

Low Earth Orbit

500 km altitude

100 minutes

15x per day

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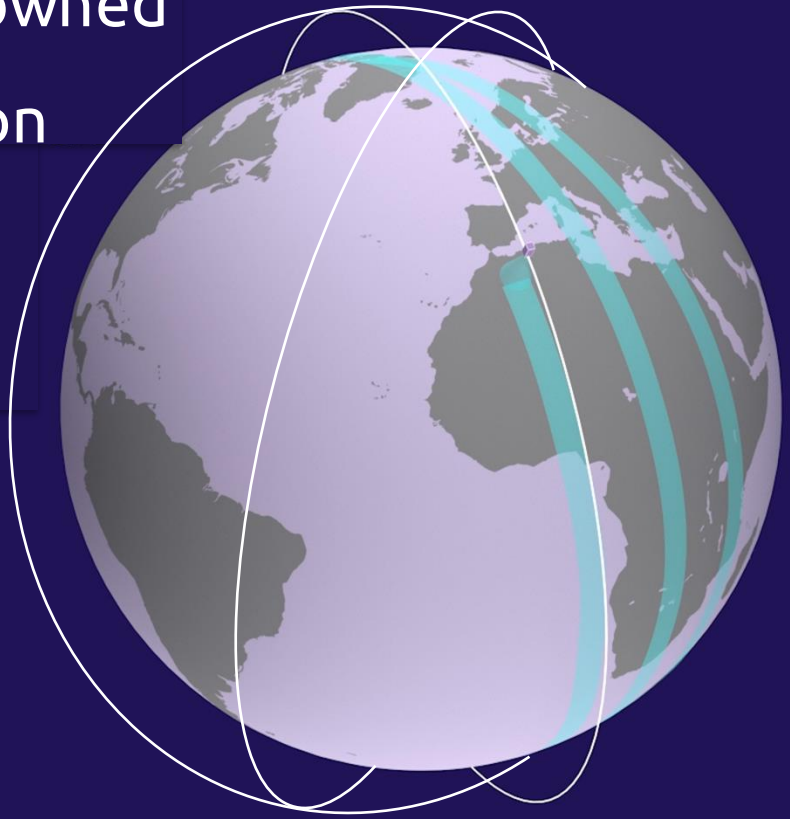
Lacuna funded/owned

core constellation

of 6 LEO sats

in 3 planes



Plus 3rd party constellations hosting Lacuna payloads

dstelecom 500km

KISPE 500km

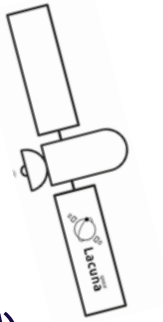
OneWeb 1,200km

omnispace 10,000km

Lacuna's Reference Design

1,000 km to LEO

10,000 km to MEO
36,000 km to GEO
(* MEO/GEO use S-band)



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- ✓ Same power levels as terrestrial LoRaWAN
- ✓ Same battery life as terrestrial LoRaWAN
- ✓ Same radio chips/modules as terrestrial LoRaWAN
- ✓ Same protocol stacks as terrestrial LoRaWAN
- ✓ Same cost basis as terrestrial LoRaWAN

Key differences:

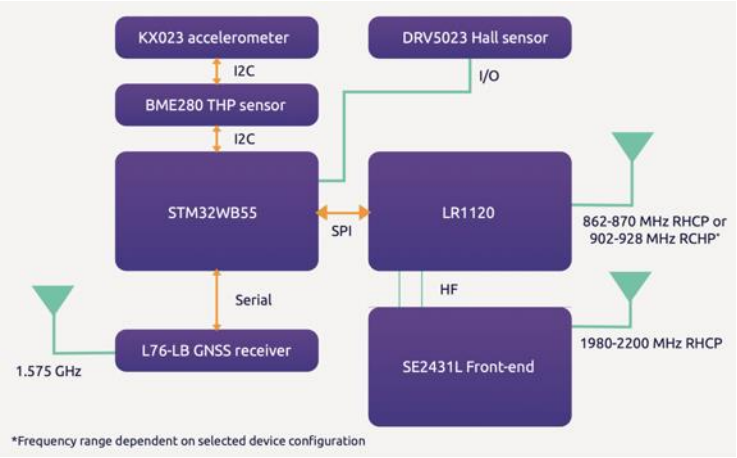
- Upward pointing antenna (circular polarised) 8x8 cm
- LR-FHSS modulation settings, for capacity
- Library to sync timing with constellation

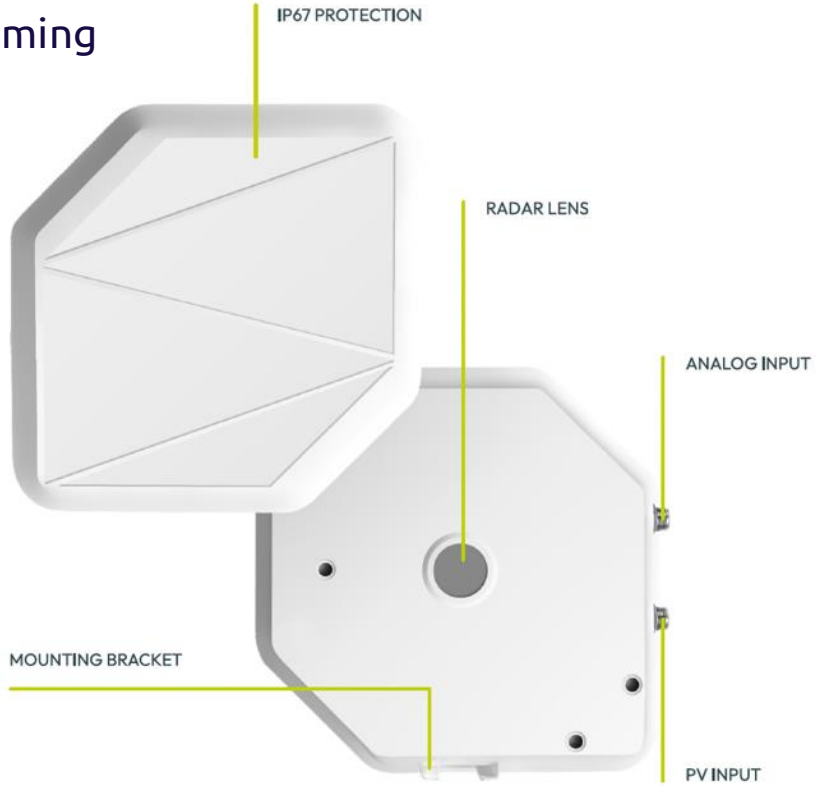
Users Evolve & Extend Lacuna's Reference Design

Proven RF section and antenna, successfully passed certifications

Lacuna Satellite Modem (LSM) firmware framework

Lacuna Pass Predictor (LPP) library for constellation timing





Mass Market Interoperability

LR-FHSS Modules

Wyld

miromico

muRata
INNOVATOR IN ELECTRONICS

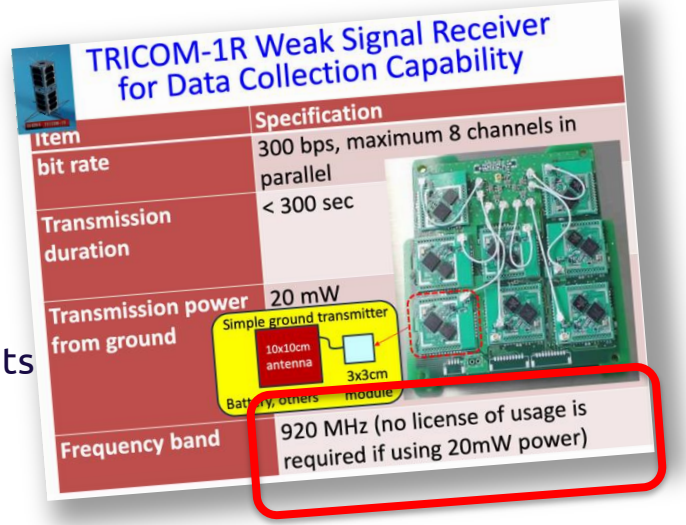
IMST

DRAGINO

RAK®

Licence-Free Spectrum

- This assumption of "*general authorisation*" is typically **NOT** the default case with most regulators
- Regulators never anticipated that :
  - devices could reach LEO orbits within these power constraints
  - Operators such as Lacuna would be willing to use shared spectrum, on non-protected, non-interference terms
- Lobbying regulators, with necessary studies and evidence is a significant task
- Lacuna invested 6 years in spectral scanning, and holds a global database of spectrum profiles
- Some coordination of lobbying efforts via LoRa Alliance



What is stopping you using Satellite IoT today?

Good services are already available from:
Iridium, Viasat/Inmarsat, Kineis, Myriota, Astrocast, Globalstar, SWARM

❌ High power drain	✓ 25mW to LEO !
❌ Large & directional antennas	✓ 8 x 8cm hemispherical
❌ Expensive service	✓ Cheap!
❌ Expensive terminals	✓ BYOD, open-sourced
❌ Regional limitations (licencing)	✓ Licence-free spectrum
❌ No inherent terrestrial (hybrid) compatibility	✓ LoRaWAN standards
❌ Sovereignty concerns	✓ Lacuna payload on your satellite
❌ Proprietary > single-sourced, vendor lock-in	✓ Fast-followers already exist

Call to Action

- Don’t wait, **start NOW.** Service and devices are available
- Can migrate terrestrial > Lacuna constellation > UNISEC constellation (using LoRaWAN)
- Lacuna’s best-in-class SDR IoT payload is available to use on UNISEC common mission
- Lacuna can support on technical and regulatory challenges

space Lacuna

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space

Lacuna