



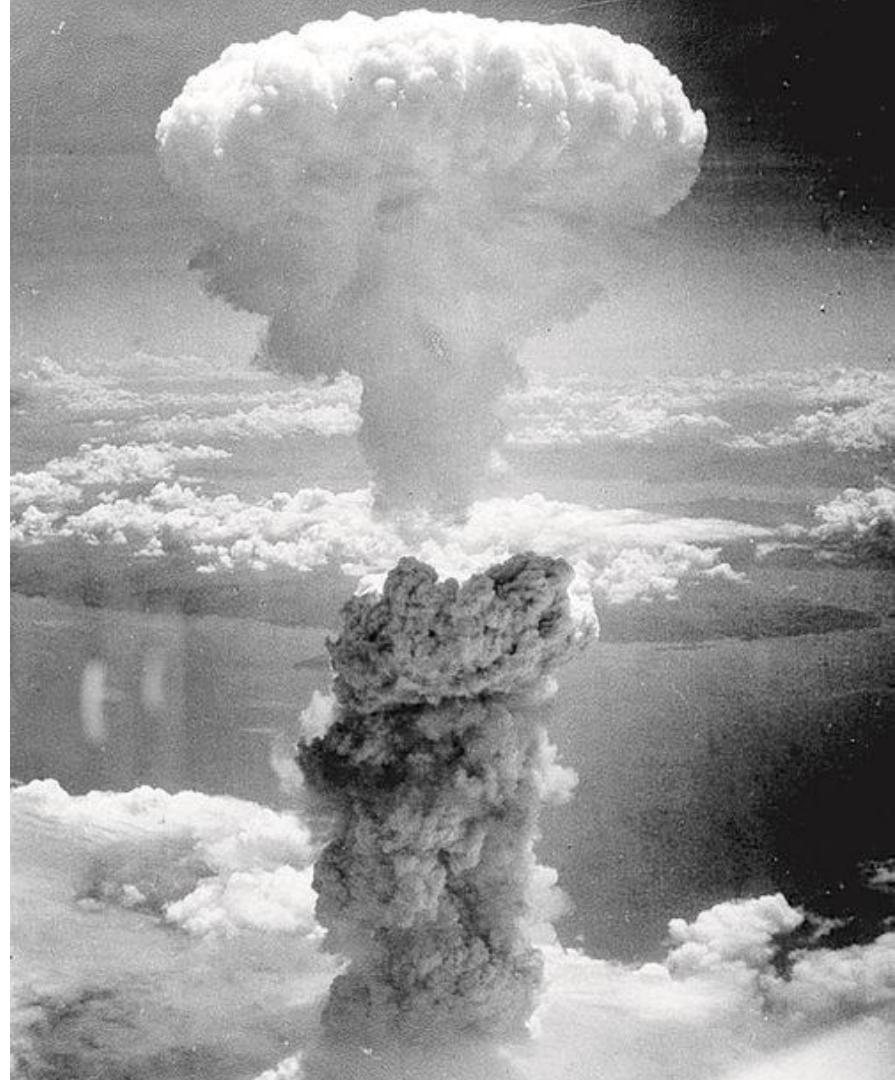
LoRaWAN by The Things Network Syros

ΕΛ/ΛΑΚ Athens 5 April 2019

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The IoT

- Billions of devices, large areas of interest, low power
- The IoT Mushroom Cloud
- The “I” and the “T”



The “Things”

Autonomy
Reliability
Use-case
Cost



The “Internet”

Infrastructure
was not built for that

Protocols
were not built for that

Do you really need it?

Network Infrastructure

- ▶ Built for population coverage
- ▶ Public infrastructure sits in low density areas

Water facilities

Garbage treatment

Natural resources

Agriculture

Wildlife



Low Power Wide Area Networks

- NOT “internet”
- Broadcast systems
- Proprietary technologies
- Open or Proprietary communication protocols

Just pick up one and give it a go.



LPWAN as a new radio alternative

- Redesign your “things”!
- Rewrite your App Software
- Rethink your Use Cases



LPWANs are not the tool to give long range capabilities to existing products



LPWAN as Infrastructure

LPWANs are Infrastructure technologies and should be treated as such.

- Design ahead
- Long term support schemes
- Future proof deployment
- Avoid tailored deployment
- Keep an eye on the technology

Social aspects

Policies

Management

Infrastructure

Services

Low Power Wide Area Networks

The tradeoffs: Power | Range | Data Rates

- WiFi is low power \ high data rate but doesn't go through your living room
- 4G is long range \ high data rate but you do have to charge your mobile every other day
- LPWANs can cover tens of km but you can't post on Instagram

LPWANs as the new kid on the block

- non-LPWAN technologies have dealt with smaller scale deployments and are designed as “connectivity solutions”
 - State the problem
 - Design the solution
 - Pick the correct connectivity solution
 - ...or go hybrid
- LPWANs deal with the same connectivity issue but from the point of infrastructure
 - LPWAN technologies are not there to replace existing ones. Use With Care!

LPWAN as Infrastructure

Go back to the 1800s and built a train track for anyone who needs to transport goods.



PERFECT, YOU JUST KILLED THE TRAIN!

LPWANs



- Based on existing TelCom Infrastructure (3GPP standardization)
- Small but emerging developer community
- Hardware is far from ready

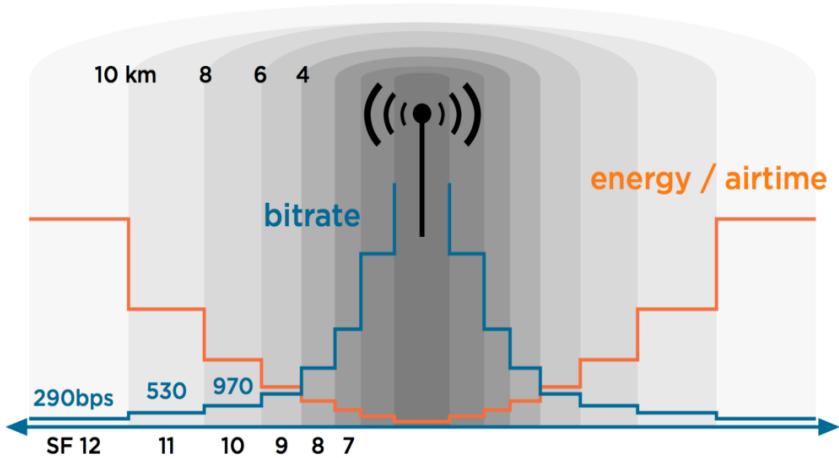


Proprietary, way too proprietary

- Patented modulation
- Patented protocol
- Full control on hardware, network, backend etc



Fully open standard



- Chirp Spread Spectrum
 - interference and fading immunity
 - doppler effect "shifting frequency" immunity
 - below the noise level
- Proprietary Modulation (physical layer)
- Up to 11kbps Data Rate
- ISM Frequency band
 - ETSI limitations (duty cycle, dwell time etc)
- Adaptive Data Rates
 - Or why you should treat it as Infrastructure
 - Or where the fun starts

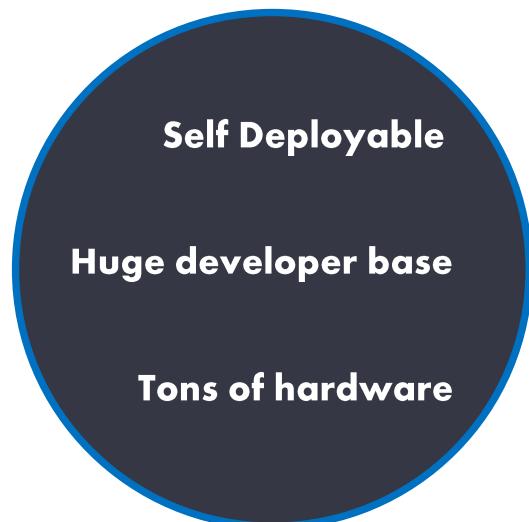
The LoRa Modulation

In theory communication can reach hundreds of kilometers

In practice ... it actually does!

In production

Rural areas ~20km | Low density urban areas ~10Km | High density urban areas ~2Km



Ok, what's the catch?

ISM regulations

Spray and pray

Low Data Rates

The LoRa Alliance

Semtech's approach to come up with an industry standard

Focus on the need for a protocol that will unlock the ability to deploy LoRa as infrastructure based on the success of previous open standards

- LoRaWAN Specs 1.1 is publicly available!
- Official software stack on Semtech's GitHub!



LoRaWAN

- Communication Protocol for LPWAN based on LoRa Modulation
- Specifies
 - Packet encapsulation
 - Communication flow
 - ISM restrictions
 - Encryption methods
 - Adaptive Data Rate techniques
 - Collision avoidance techniques
 - etc

LoRaWAN: End Devices

- Class A
 - Transmit, listen, listen again, sleep
- Class B
 - Transmit, listen on scheduled windows, sleep
- Class C
 - Transmit but keep your receive windows open
- Deploy your own
 - Bare metal LoRa transceivers
 - LoRa Modules
 - Evaluation and prototype boards
 - Ready products

LoRaWAN: Gateways

- Transparent components
 - uplink data to the LoRaWAN Server
 - downlink data to the Nodes
 - Just-In-Time queue
 - Backhaul gateway-2-gateway communication!
- Range from simple UDP packet forwarders to full blown operating systems
 - Some even run the whole LoRaWAN server functionality

LoRaWAN: Network Server

Routing to your App Server is just the tip of the iceberg

- Deduplication, device lookup, frame counter check
- Encrypt/Decrypt, deploy and maintain keys
- Schedule, route and configure downlink
- Adaptive Data Rate Calculations, MAC Commands, Device state
- Gateway stats and metadata

Popular Implementations

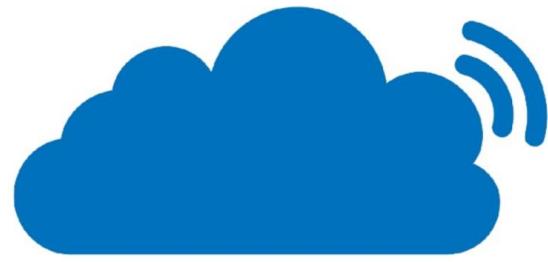
Thanks to the open spec implementations keep popping up

From OpenSource



To Enterprise





**THE THINGS
N E T W O R K**



- A free global IoT Network based on LoRaWan - Infrastructure for IoT
- A decentralized open and crowd sourced IoT data network owned and operated by its users
- TTN Manifesto

"We believe that this power should not be restricted to a few people, companies or nations. Instead this should be distributed over as many people as possible without the possibility to be taken away by anyone."

- TTN is a contributor member of the LoRa Alliance



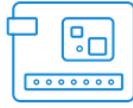
137
countries

6977
gateways

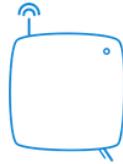
67541
members

Building Blocks

Devices



Gateways



Network



Applications



Devices

The Things Node

- LoRaWAN module
- Temperature sensor
- Digital accelerometer
- Light sensor
- Button
- RGB LED



The Things Uno

- Based on Arduino Leonardo
- Microchip LoRaWAN module



Any certified LoRaWAN device

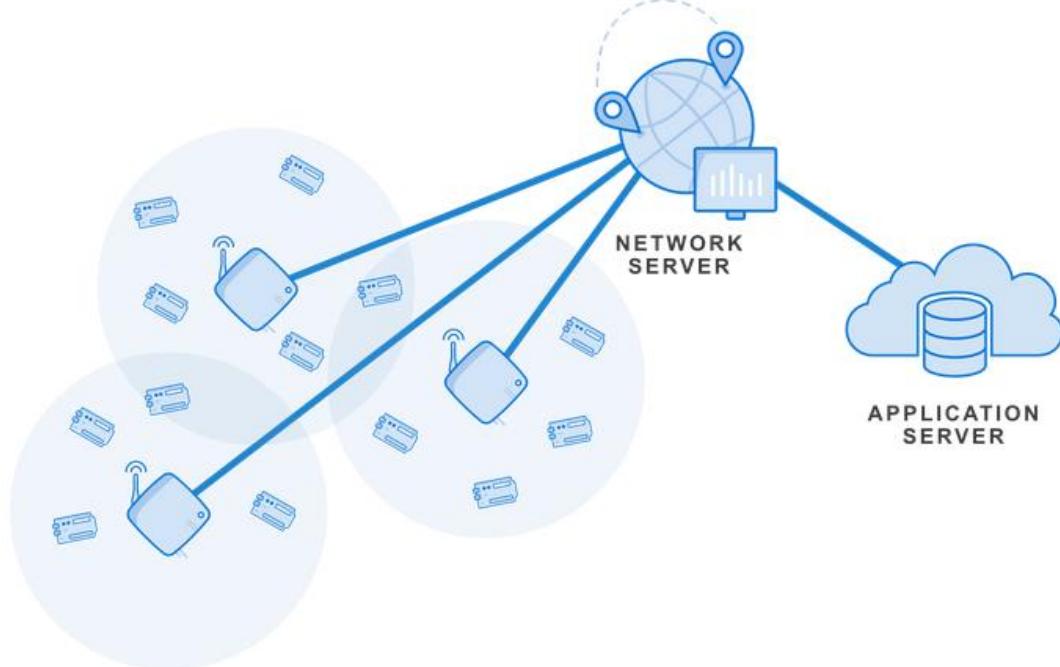
Gateways

- The Things Gateway
 - ~300K€ - kickstarter campaign
- DIY Gateway
 - A LoRa concentrator board to receive LoRaWAN packets
 - An antenna, to amplify the signal
 - A computer, to process incoming and outgoing LoRaWAN packets (e.g. BeagleBone, Raspberry Pi)
- Other vendors



Network

The Things Network Server is positioned between the gateways and the applications and takes care of these routing and processing steps.



Applications

Multiple options to integrate applications with The Things Network

- APIs
 - Data API
 - Application Manager API
- SDKs
- Platform Integrations (click-and-run)
 - AWS IoT
 - OpenSensors
 - TTN Mapper

SDK Matrix

SDK	Data API	Application Manager API
Go	Yes	Yes
Java	Yes	Yes
Node.js	Yes	Yes
Python ↗	Yes	Yes
Node-RED	Yes	No

Example Applications

- Cattle Tracker
- Smart Irrigation
 - Remote Sensor Station Platform for agriculture irrigation
 - Supports soil sensors
- Smart Parking Sensor
- Smart mouse traps

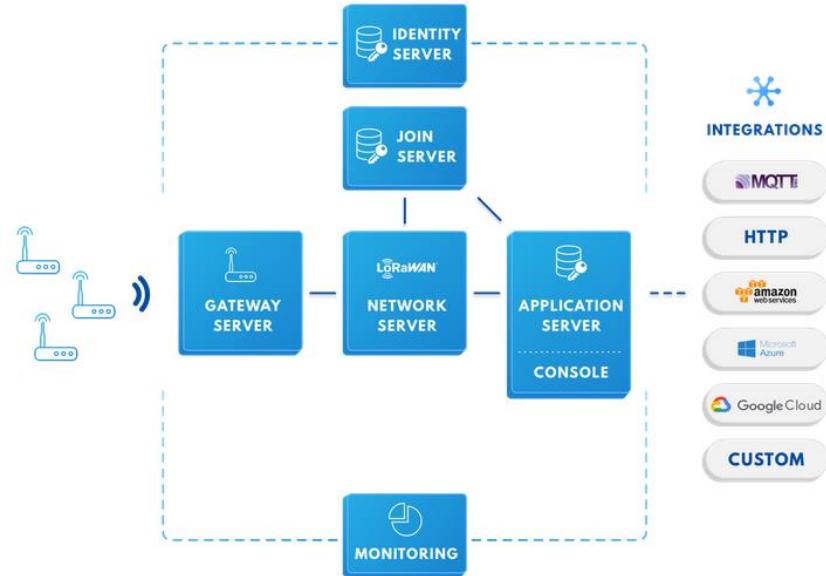


IN-GROUND



TTN LoRaWAN Stack V3

- Supports LoRaWAN versions:
1.1, 1.0.2 and 1.0
- All components to run a
network are open source

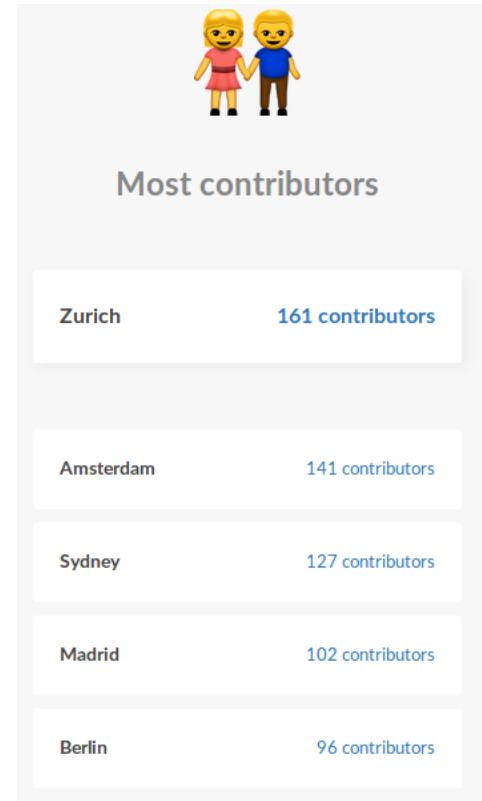
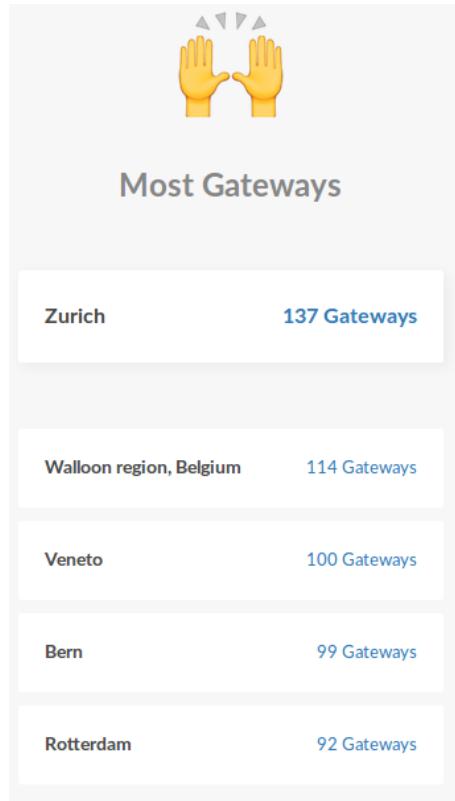


How to start

1. Deploy a gateway
2. Build your end device
3. Register an application
4. Register the device
5. Build and monitor your application

Join

- Connect Gateways
- Contribute OSS
- Join developer ecosystem
- Build your Community



Build a local community

- Build the network in a specific defined area
- Budget for purchasing the LoRaWAN gateways
- Technical skills for configuring the gateways and connecting devices
- Proper locations for placing the gateways
- Organizational skills for building a thriving network of people
- Transfer (technical) knowledge
- Enhance creativity and discover business opportunities

The core principles of the TTN community

- Endorse the principles mentioned in the Manifesto
- Open for anyone
- People are the foundation of the community, not gateways
- Regular social contact is the driving force of the community's development
- Diversity is crucial

The Things Network Syros



The numbers

4

Gateways

18

Contributors

08/16

Founded

The beginning

- Back to spring 2016
- The 1rst gateway for personal development
- Engage the academic community and friends / early adopters
- 4 gateways on August 2016
- Coverage tests with extraordinary results
 - 50km radius
 - Tinos, Mykonos, Paros, Antiparos, Serifos, Kythnos
- TTN Syros Official Community
- Improve DIY Gateways with more robust implementations
- Set up monitoring mechanism for the infrastructure

Beyond TTN

- Advanced GIS Visibility Analysis
- Signal Propagation Analysis
- Network status monitoring / alert

Indoor coverage



	time	frame	RSSI	frequency
CQ0FA6sAAA==	10:42:37	701	-111	868.100K
CQ0FA6sAAA==	10:42:32	700	-113	868.100K
CQ0FA6sAAA==	10:42:27	699	-108	868.300K
CQ0FA6sAAA==	10:42:22	698	-112	868.100K
CQ0FA6sAAA==	10:42:17	697	-111	868.500K
CQ0FA6sAAA==	10:42:12	696	-111	868.500K

SAMSUNG

10:42

...

...

Island to island testing



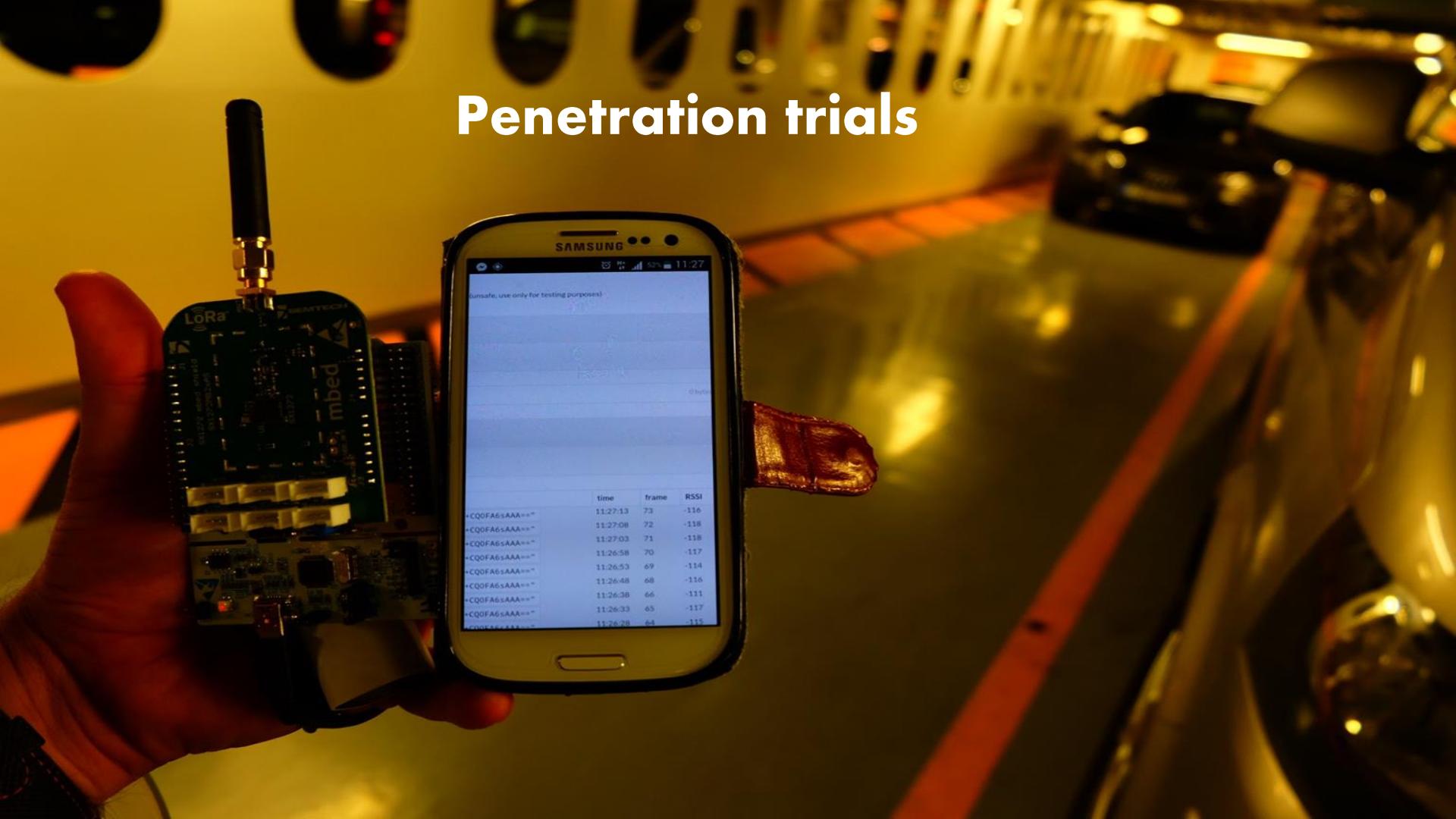
Mobile trials





Extreme weather conditions

Penetration trials



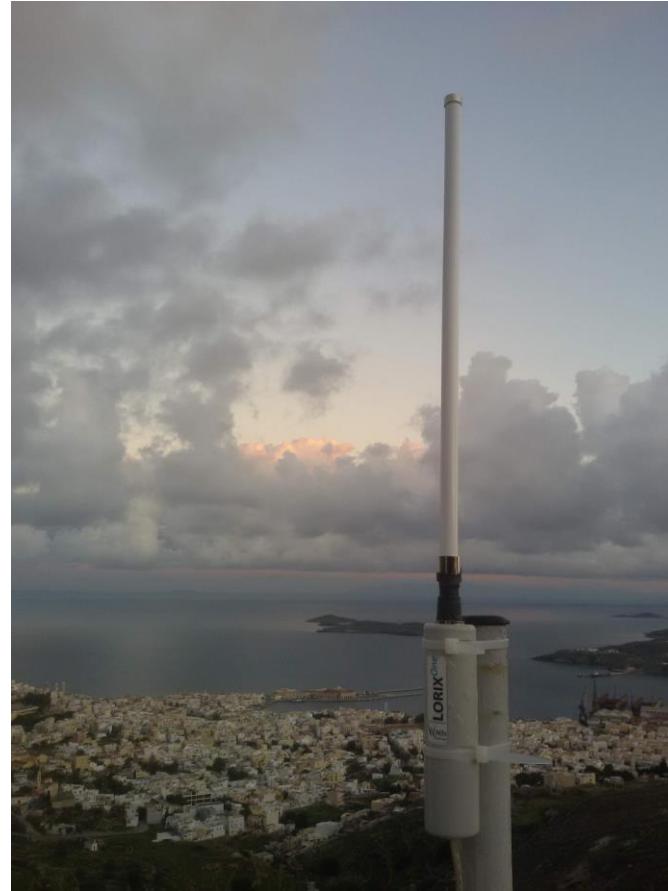
(unsafe, use only for testing purposes)

	time	frame	RSSI
+CQ0FA6sAAA==	11:27:13	73	-116
+CQ0FA6sAAA==	11:27:08	72	-118
+CQ0FA6sAAA==	11:27:03	71	-118
+CQ0FA6sAAA==	11:26:58	70	-117
+CQ0FA6sAAA==	11:26:53	69	-114
+CQ0FA6sAAA==	11:26:48	68	-116
+CQ0FA6sAAA==	11:26:38	66	-111
+CQ0FA6sAAA==	11:26:33	65	-117
+CQ0FA6sAAA==	11:26:28	64	-115

The hardware | Devices & Gateways



Building the infrastructure

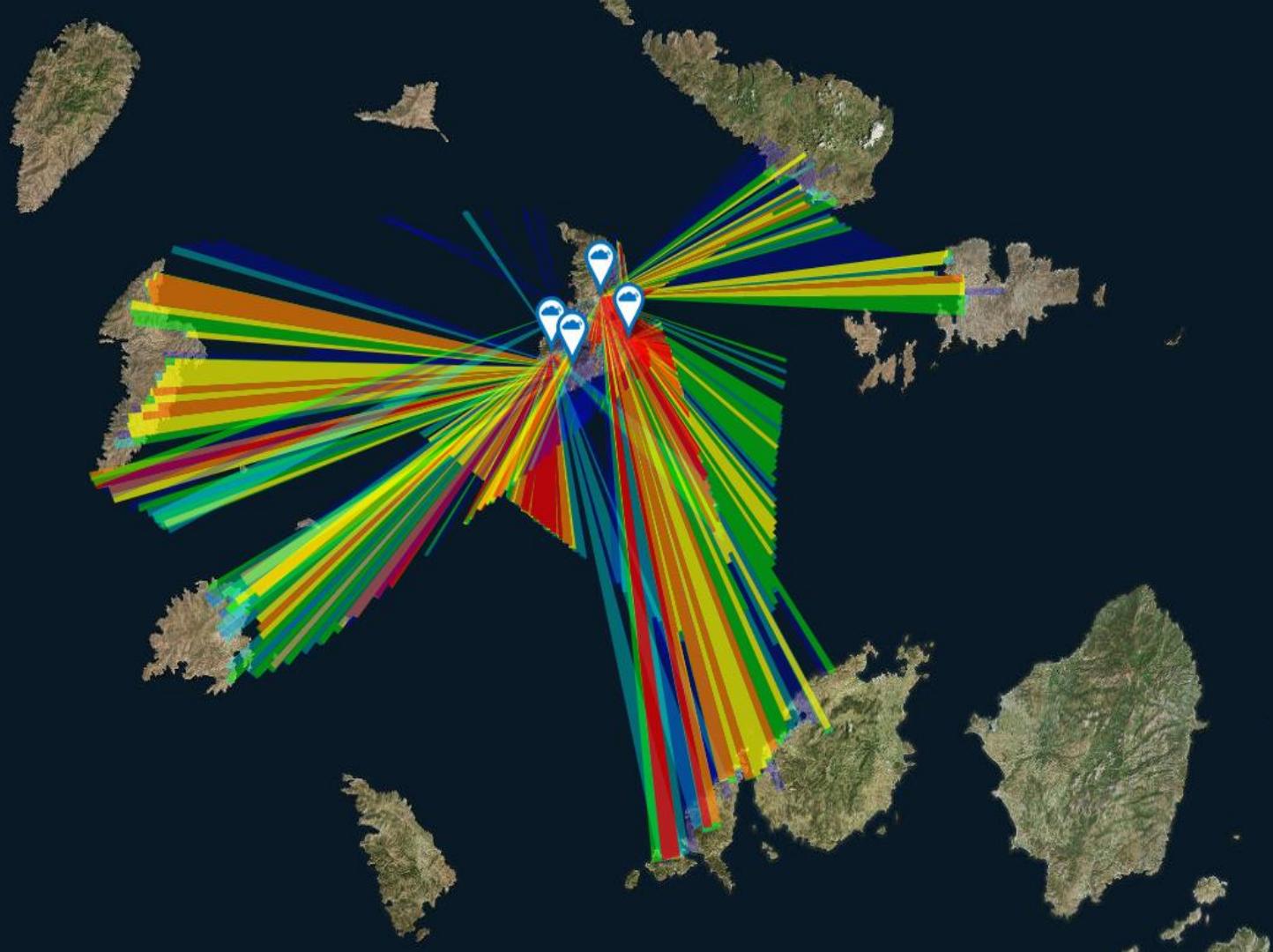


Island Hopping



Coverage trials





Building the human network

- Communication with local enterprises
- GPS trackers to hikers and hunters
- Geofencing trials for kayaks
- 3D print cases for devices
- Brainstorming and small private projects (agriculture, water management)
- Collaboration with public organisations is difficult without a legal entity
- An interesting community funded project

Syros AirMon | the motivation

- Find a matter that will drive the community
 - Health and wellbeing
- Public Funding
 - More than 20 people and local businesses microfunded
- Publicly available visualization and data
- Engage Local non-techies
 - 15+ volunteers
 - 6 hosts of gateways and sensors
 - 200 facebook users following the data



Syros AirMon | the tools

- 4 devices for environmental monitoring
 - Temperature, Pressure, Humidity
 - CO₂, PMs, VOCs etc
- Backed by a Worldwide Air Monitoring Project
- Supporting Backend
 - Databases
 - Monitoring tools



Syros AirMon | the vision

- Extend the coverage with 10-20 outdoor devices
- Engage local authorities
 - Deploy to schools and public buildings
- Educational workshop for the development of mobile devices
 - OpenLab
 - University of the Aegean
- 2 Dissertation theses
 - University of the Aegean
 - University of Thessaly
- Data management plan
 - Make use of the data
 - Data beyond graphs

25-31/3/2019 Weekly measurements



Knowledge Sharing & Collaboration

“Making Sense of the Data: Air Quality Index (AQI)”

<https://bit.ly/2UvjsZH>

“Particulate Matter (PM) Concentrations: Making Sense of the Data”

<https://bit.ly/2CYxNEa>

TTN Syros: Incubation

- Water resources management
- Water sports applications
- Voice interfaces
 - Custom skill “TTNSyros” / “SyrosAirMon” for Alexa
 - “Alexa, ask TTNSyros if my home is **too hot**”
 - “Alexa, ask TTNSyros if the shipyard is **too noisy**”
 - “Alexa, ask SyrosAirMon for **air quality** data”
- FB Messenger: “TTNSyros” Bot
 - Is VOC AQI over threshold today?
 - The VOC AQI is at a comfortable 150

TTN Syros: Challenges & Vision

- Grow the network
 - Full coverage of Syros island
 - Deploy more gateways
 - Expand to other islands
- Reliable Network Operation
- Grow the community
 - Engage the educational community
 - More community based projects
- Sustainability plan
- Greek Islands as LPWAN testbed
- The islands are special ecosystems
- Island Culture

How to join

Donate | build | host a gateway



Donate | host sensor devices



Design a service | deploy an application



Come to a meetup | come to Syros



Talk to us



Spread the word

A scenic view of a coastal town at sunset, with buildings built on a hillside overlooking the sea. The town features a mix of traditional and neoclassical architecture, with colorful facades and red-tiled roofs. In the foreground, the dark blue water of the sea meets the town's waterfront. The sky is filled with warm, golden light from the setting sun.

Thank you!

Resources

The Things Network - <https://bit.ly/2hUs4GO>

TTN Manifesto - <https://bit.ly/2TWH84X>

The Things Network @ Github - <https://bit.ly/2WMctch>

The Things Network Syros

Home page: <https://bit.ly/2FUgFjB> - Social: <https://bit.ly/2CXOi3r>

Syros Air Monitoring Project

Blog: <https://bit.ly/2G27W01> - Social <https://bit.ly/2YMxaq9>