Network Derived Geolocation

For the battery powered IoT

The Missing Link

Geolocation: a new pillar in IoT

- Unique data identifier
- Richer experience = $$
- Detect deviations

Types of location usage

Navigate

Determine directions to something or someone

Track

Follow the path of something or someone

Locate

Find the position of something or someone

Manage

Manage proximity using data fusion

Geolocation Choices

Beacons

- Infrastructure Cost, low power
- High accuracy
- Very localised indoor/outdoors

Cellular

- High Power & Cost
- Low accuracy
- Wide Area coverage

GPS

- High Power & Cost
- High accuracy
- Outdoor only

Wifi

- Low Power & Cost
- Good accuracy
- Indoor or outdoor Urban

- Zero impact on Cost or Power
- Good Accuracy
- Wide area coverage

Selection criteria

By the end of 2020, there will be more than 15 Billion connected devices in IoT. Of those, approximately one-third will be critically dependent on geodata, and 60% will potentially include geodata in the application.

Machina Research

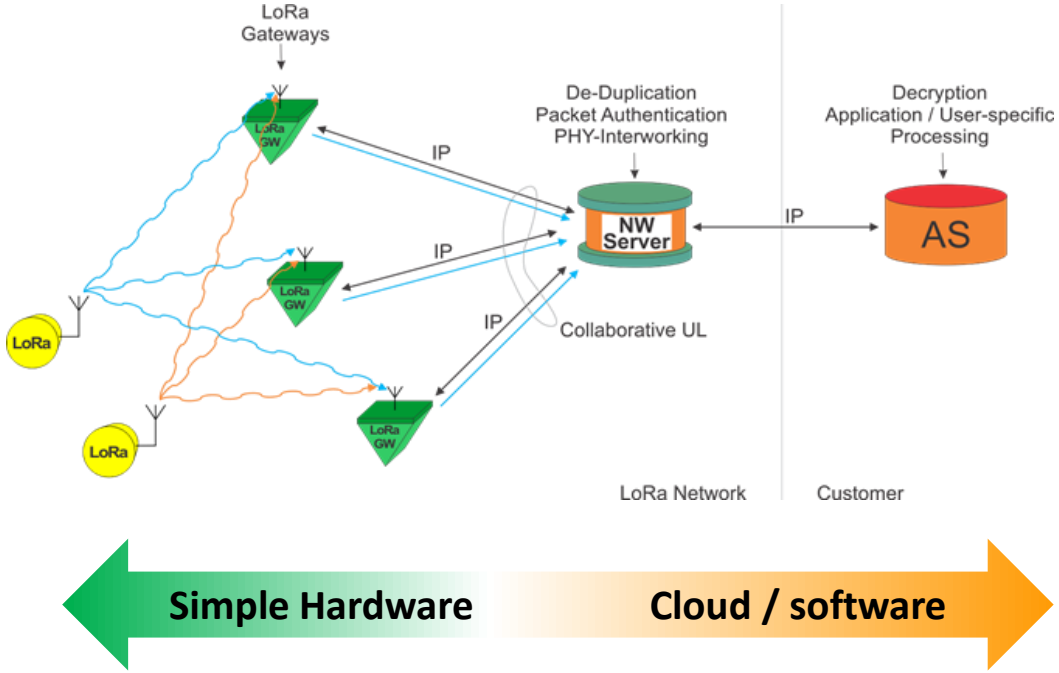
- **Indoor - Outdoor**
- **Stationary - Moving**
- **Continuous – One off**
- **Pinpoint - Approximate**

‘Clean-sheet’ network

Minimal dedicated hardware
(super-simple gateways)

All network functions are performed in the cloud

Sensors connect to the ‘cloud’ and NOT to a base-station
(all gateways are identical)



LoRaWAN™ Geolocation Trial

All base stations (gateways) share a common time-base

E.g. provided by GPS, GNSS, DTI or similar

An end-device transmits a packet

Packet received by at least three gateways

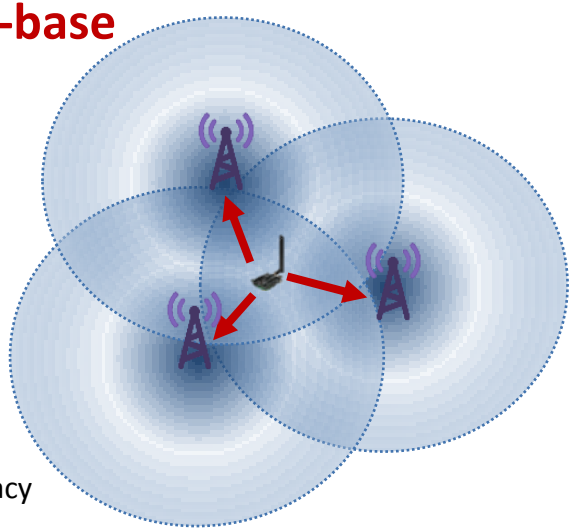
Each gateway reports the precise time of arrival & other meta data such as signal strength, signal to noise ratio etc.

Algorithms compare the time of arrival (DTOA)

Taking into account signal strength and other parameters

Compute the most likely position of the sensor

Hybrid data fusion techniques & map matching enhancements improve accuracy



Note: All LoRaWAN gateways receive on all channels & data rates at all times

The system completely relies on synchronisation!

Multi-path transmission

Add more antennas

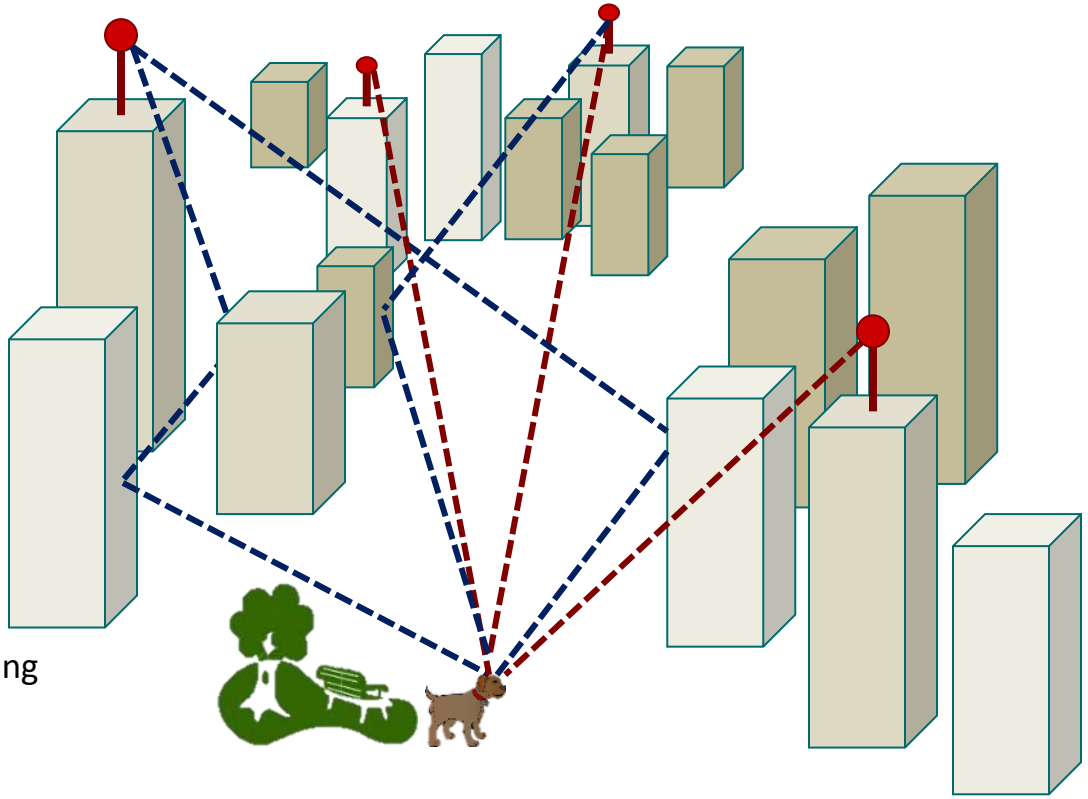
- Add gateways
- Add antenna diversity

Send more packets

- More transmissions
- More channels

Improve Solver

- Machine learning
- Statistical enhancements
- Tracking/predictive map matching



Live Trial Accuracy

Mean Rural accuracy	20-50 meters
Mean Urban accuracy	120-200 meters

Optimizations

Antenna Diversity

Best effect on weakest signals
Average 20% improvement

Gateway Diversity

Average 25% improvement
from 3 to 4

Shape of Grid

Regular spaced grid improves
results by 25% or more

Frequency Diversity

On average 50% improvement
with repetition of packets

Importance of Time-base

Local consistency

Absolute time is not an issue, local consistency is important

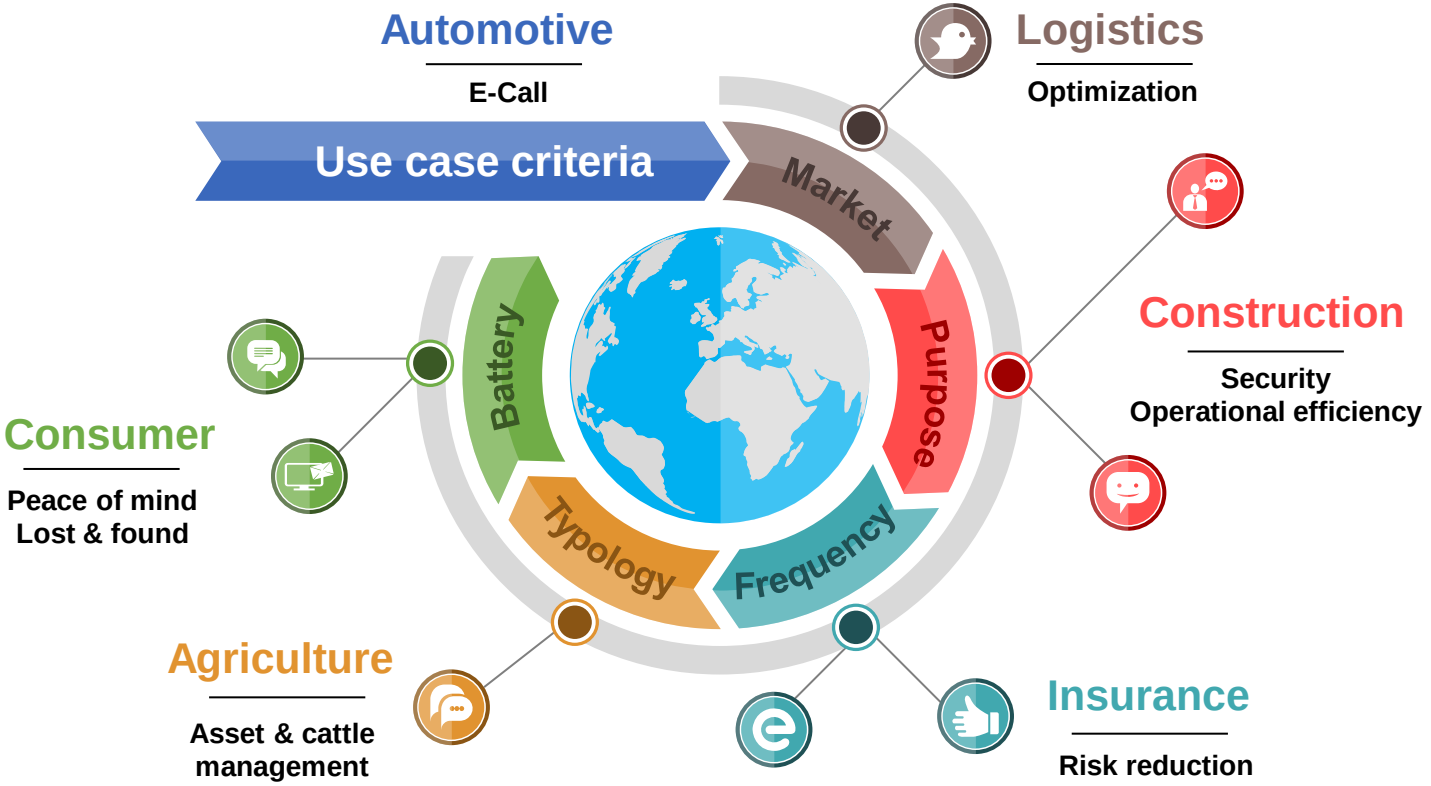
Robust accuracy

3ns = 1 Metre
Reduced by processing but GNSS close to 30ns locally is good

Mitigate vulnerabilities

Sub 100ns solution required avoiding GNSS reliance

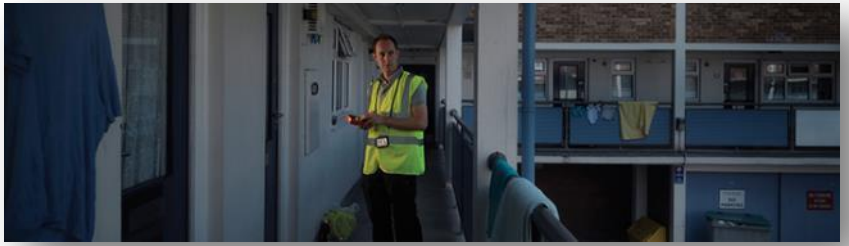
Typical Use Cases



Smart City: From Street lights & traffic lights, to Waste, Recycling & Environmental?

Sensors for fill level:

- *Optimise emptying time*
- *Geolocation aids route optimization*
- *Improved public safety & street scene*
- *Optimise to location/time/date/event*



Lone worker alarms:

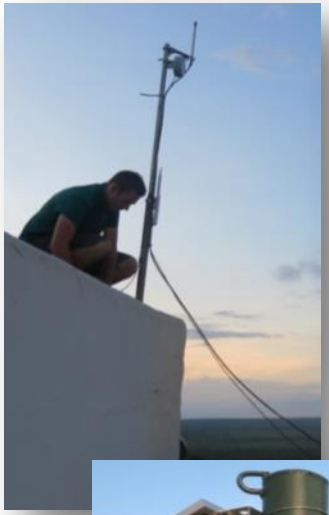
- *Never need charging*
- *Built into uniform*
- *Fall detection, Panic button*
- *Geolocation the casualty*

The ‘internet of cows’

From collars to permanent implants, the connected cow gets a lot of attention:

- *Increased milk & calf yield*
- *Reduced A.I. costs*
- *Reduced mortality rate*
- *Reduced theft & insurance costs*

Saving Endangered Species



Rhino Poaching:
400% up in 4 yrs!

(Images courtesy of www.theinternetoflife.com)

Saving Endangered Species

Installing a GPS based sensor in a rhino's horn.

GPS sensor with LoRaWAN: update every 45 mins for 2 years.

A GPS-free LoRaWAN sensor would update every 5 minutes for 10 years!

(Images courtesy of www.theinternetoflife.com)

Call to Arms

1. Robust Sub 100ns (<30 🙂) Sync

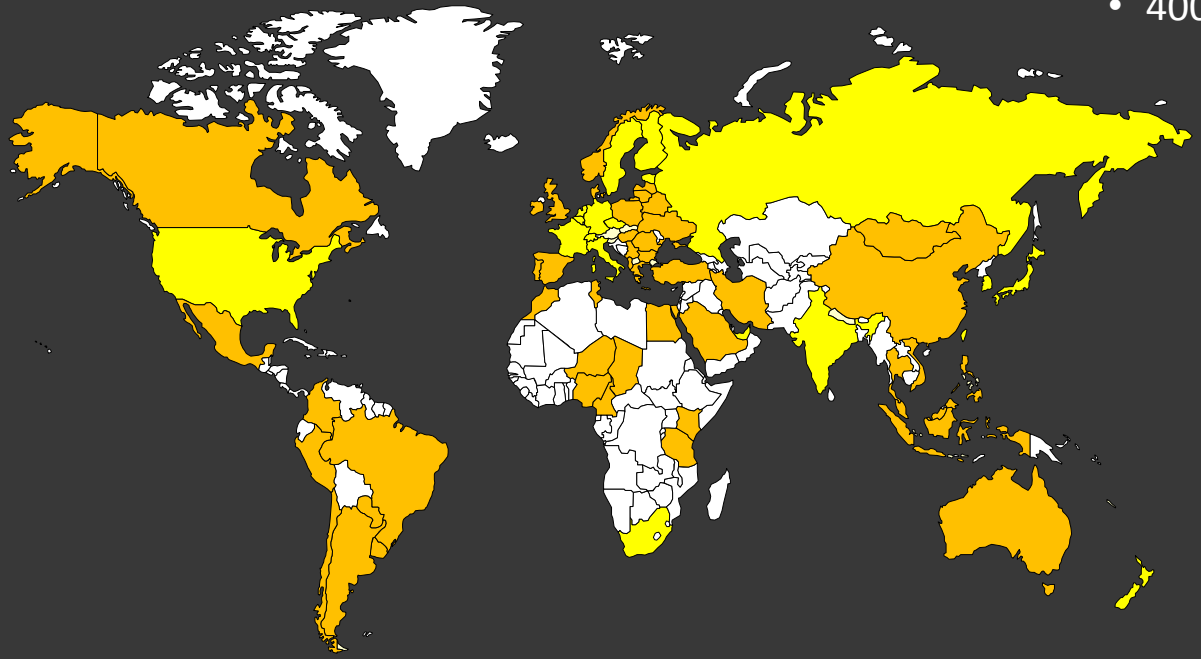
2. Wireless options as well as cabled

References

LoRaWAN:	The LoRa Alliance	www.lora-alliance.org
Internet of Cows:	Invenit/Clickey,	www.clickey.eu
Rhino Preservation:	The Internet of Life	*www.theinternetoflife.com*
Wildlife Preservation:	Shadowview Foundation	www.shadowview.org

Countries – LoRaWAN Networks

- 28 Publically Announced Operators
- 150+ on-going trials & city deployments
- 400+ members in the Alliance



Legend:

- Publicly Announced
- Other deployments

LoRaWAN™ & Geolocation