

# LoRaWAN: Long Range and Low Power Communication for Enabling Massive IoT

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#### **Sensors Need Autonomy**



#### Low Power, But...





#### Long Range, But...





#### Need Low Power & Long Range



#### Low Power & Long Range



#### Low Power & Long Range



#### Low Power & Long Range



## Trackers

- 3 **9 ONE WAY RENTALS** PICK UP FROM ANYWHERE C'est ici ₹**5/KM** 0
- Tracking scooters @ India
- Tracking belongings @ France
- Panic button @ India

#### **Smart Cities**

Q Ø ✿ Q ▲ Q 2015/09/28 FT 1216.5 ThingPark Powered by Fii 衯 富智屏 数据大屏 < 首页 教展的展 23.85<sub>GB</sub> IN COMPRESS OF 总传感器数: 90,440 1003.101

- Fire alarm
- Acidity and oxygen levels in rivers
- Parking space availability
- Manhole cover security

@ Shanghai

# Metering



• Water metering @ France



#### **Connected Street Cabinets**

- Unauthorized access
- Power loss
- Over-heating/fire

@France, Switzerland, Belgium, Netherlands, ....



#### Features





Coverage	Lifetime	Cost	Usage	
2 - 10+ km Deep indoor Star topology Bi-directional	10+ year battery Adaptive Data Rate (ADR) Traffic profiles	License-free spectrum Open standards/src Ground-up design Low-cost infra	Public/private networks Geoloc (no GPS) 300bps-50Kbps	

#### Features

Characteristics	LoRa RF
Modulation	LoRa (Chirp Spread Spectrum)
Frequency	Sub-GHz ISM (868/915Mhz)
Channel bandwidth	125-500 KHz
Data rate	300 bps – 50 kbps
Link budget	155 – 170 dB
Payload size	11 – 242 bytes (variable)
Battery consumption	5mA RX / 18mA (10dBm) TX
Communication type	Bi-directional unicast, network multicast
Interference immunity	Spread-spectrum w/ FEC
Scalability	Self-scaling network capability through Adaptive Data Rate
Mobility	Handover support, geo-location

#### Network Stack

App layer		Арр	Wiroloss	Modbus app stack	Zigbee app stack	Proprietary app stacks
	DLMS app stack	UDP/IP	M-Bus app			
		SCHC	SLACK			
Link layer	LoRaWAN					
Physical layer			L	oRa		

#### **End-device Classes**

Class name	Intended usage		
Α	Battery powered sensors, or actuators with no latency constraint		
B	<b>Battery powered actuators</b> Slotted communication synchronized with the network beacon		
С	Mains powered actuators Listen continuously		



#### Adaptive Data Rates



# Geolocation



- Physical broadcast + TDoA (Time Difference on Arrival -- nanosec)
- No extra hardware or processing cost on device

 $\rightarrow$  20-100m accuracy

#### **Passive Roaming**



#### Collaborative reception

- Enables higher data rates, lower power (ADR!)
  - Less interference
  - More network capacity
  - Longer battery life
- Better TDOA/RSSI geoloc accuracy

### Security



#### Gateways



Macro-cell





Dev-kit

# Range



#### LoRa Range and Coverage

- Coverage map from a single gateway/concentrator
  - Cisco Webex building in San Jose
- >30miles from San Jose to San Bruno



# Actility

SEMTECH

#### Sky is the Limit









#### NEXT PASS OF NORSAT 2 OVER YOUR CURRENT LOCATION

STAI	START MAX		END		TOTAL	
AZIMU	AZIMUTH ELEVATION		AZIMUTH		DURATION	
Jan 31 23:07	27° NNE	23:12	18°	23:18	152° SSE	11m 15s

#### LoRaWAN<sup>™</sup> Operators: Global Adoption



#### LoRaWAN Coverage Examples













Marketing Committee

Technical Committee

Certification Committee

Amazon, Google, Cisco, Intel, Orange, ZTE, Comcast, ARM, SKT, Sagemcom, NEC, NTT, Softbank, Alibaba, Tencent, Schneider, Tata, ...

#### LPWAN Backbone



#### LoRaWAN vs SigFox



Sub-Ghz ISM Public networks Closed ecosystem Single business model Constrained (\*) traffic

#### Early start

(\*) 12 byte frame, 140UL/4DL per day, 100bps

#### Actility

Sub-Ghz ISM Public + private networks Open ecosystem Flexibles business models Less constrained traffic Dynamic power management Collaborative networking

#### LoRaWAN vs NB-IoT



Licensed bands Public networks Emerging deployments

Real-time Higher data-rate (250Kbps) Marketing power (GSMA)



ISM (unlicensed band) Public + private networks Accelerating deployments Low-power (1/5<sup>th</sup>! of NB-IoT) Low-cost infra Collaborative networking

#### Fertile R&D Ground

#### Fresh and challenging problem space

- Small number of packets (few packets/day)
- Extended battery life (5-10 years)
- Small packet size (10s of bytes)
- Long range (10+ km)
- Secure
- ISM band (shared use)
- Asymmetric network capacity
- High scalability: Millions uplink/day/BS
- Wide range of use cases and traffic patterns

#### **Open standards**

Open source code

Free developers tools

Low-cost hardware

Unlicensed deployment

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