Semtech LoRa® Overview
Emitech IoT days
November 2017
Semtech: Creator of LoRa Technology

- 60+ years of low-power mixed signal design
- Creator of LoRa Technology
- Founding member of the LoRa Alliance™
- Millions of LoRa® radios deployed globally
- IHS Technology – 2017 LPWAN report
  - LoRa expected to be dominant LPWAN technology
  - Over 40% of all LPWAN connections will use LoRa
- Gartner – Market Trends 2017
  - LoRa offers low risk, high reward opportunity
Low Power, Low Data Communication

Then: People sending messages

Now: Machine driven wireless

Unlike cellular, Wi-Fi or Bluetooth, LoRa® is designed specifically for LPWAN applications
LoRa Addresses Technology Gap

<table>
<thead>
<tr>
<th>Traditional Cellular</th>
<th>Local Area Network</th>
<th>Personal Area Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low battery life</td>
<td>Short Range</td>
<td>Short Range</td>
</tr>
<tr>
<td>High Cost</td>
<td>Low battery life</td>
<td>Medium battery life</td>
</tr>
<tr>
<td>MNO controlled</td>
<td>Short range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium battery life</td>
<td></td>
</tr>
</tbody>
</table>

**LPWAN**
- Long Range
- Low data rates
- Long battery life

**NB-IoT**
- Low data rates
- Long battery life

**Sigfox**
- Low data rates
- Long battery life

**802.15.4**
- Wireless
- Short range
- Medium battery life

**2G**
- Second Generation
- Short range
- Long battery life

**3G**
- Third Generation
- Short range
- Long battery life

**4G LTE**
- Long Range
- Low battery life

**Wi-Fi**
- Short range
- Medium battery life

**LoRa**
- Long Range
- Low data rates
- Long battery life

**Sigfox**
- Short range
- Medium battery life

**Bluetooth**
- Short range
- Medium battery life
LoRa Technology Enables Massive IoT

Launch of LoRaWAN

Network roll outs, Sensor and solution deployments Business models evolve

Network densification Vertical markets mature New disruptive solutions

Global coverage Massive IoT Defacto LPWAN standard

LoRa market introduction

2013  2020
LoRa: Disruptive Technology

Shannon capacity

GFSK

0.3kbps

≈30 miles field results
Enabling true digital transformation

Solutions
• Ease of access - Modules, SIP, LoRaWAN modem
• Monetization models – embedded connectivity, new disruptive subscriber models
• Cloud, fog and edge trade offs - required for mass deployments

Network Coverage
• Gateways – from Macro Outdoor to Pico Indoor connectivity
• Hybrid deployment models public, private, viral networks
• Next Gen cellular and broadband interoperability with optimal latency and throughput

Technology
• Features – Connectivity, Geolocation, Security, Provisioning
• Silicon – size and power efficiencies all the way to disposable solutions
• Global radio regulation compliancy and spectral efficiency
LoRaWAN™ Network

- Multi-channel gateways
  - Simultaneous reception of messages
  - Scalable capacity
  - Indoor or outdoor
  - Adaptive data rate
  - Supports geo-location

- LoRaWAN sensors
  - Smart Building
  - Smart City
  - Agriculture
  - Supply chain
  - Smart Energy
  - Insurance
  - Smart Health
LoRa - Brief history

2013 • Launch of first LoRa radio by Semtech

2014 • First mobile network operator trials
     • Launch of LoRa Alliance

2015 • Multiple sensors, gateways, modules available
     • Public, private, hybrid network deployments

Today • Over 500 LoRa Alliance members
     • LoRaWAN spec downloads over 20K
     • Low power geolocation introduced
     • Multi source value chain
Ecosystem – Multi-Source Value Chain

Chipset  Module  Device  Base Station  Network Server  Application Server  Network Operator  Solution Provider

Silicon to Solutions
LoRaWAN™ Geolocation Feature

Overall power consumption

Network & Location Server

Radio

Sensor

MCU

GPS

Low Power

GPS-free location

Optimize operations

Radio

GPS

Sensor

MCU
LoRaWAN Vertical Successes: Examples

- Parking sensor
- Asset tracker
- Smart meter
- Leak detection
- Cattle monitor
Semtech LoRa® Roadmap

2017 and beyond
Semtech LoRa® IC Products

**Sensor Radio IC**
- SX1276 (Global)
  - Sub-GHz LoRa, FSK,
  - 10mA Rx, 20dBm
- SX1278 (China)
  - Sub-GHz LoRa, FSK,
  - 10mA Rx, 20dBm

**Gateway ICs**
- SX1301
  - Macro Cell Gateway Baseband demodulator
  - -142 dBm, -40 to 70C
- SX1308
  - Pico cell Gateway Baseband demodulator
  - -139 dBm, 0 to 70C
- SX1255/7
  - Gateway Radio (RF to IQ)

**LoRa Alliance™ members offer complete LoRaWAN based products and solutions today**
## End Node Reference Designs

<table>
<thead>
<tr>
<th>Part</th>
<th>Design</th>
<th>Band</th>
<th>Region</th>
<th>$P_{OUT}$</th>
<th>Platform</th>
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</thead>
<tbody>
<tr>
<td>SX1272</td>
<td>SX1272MB1DCS</td>
<td>868MHz</td>
<td>EU</td>
<td>14dBm</td>
<td>Mbed</td>
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<tr>
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<td>SX1272MB2DAS</td>
<td>868MHz/915MHz</td>
<td>EU/US</td>
<td>14dBm</td>
<td>Mbed</td>
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<td>SX1272RF1xAS</td>
<td>868MHz/915MHz</td>
<td>EU/US</td>
<td>20dBm</td>
<td>Eiger, Prototype</td>
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<tr>
<td>SX1276</td>
<td>SX1276MB1JCS</td>
<td>433MHz/868MHz</td>
<td>EU/US</td>
<td>14dBm</td>
<td>Mbed</td>
</tr>
<tr>
<td></td>
<td>SX1276MB1MAS</td>
<td>433MHz/868MHz</td>
<td>EU/US</td>
<td>14dBm</td>
<td>Mbed</td>
</tr>
<tr>
<td></td>
<td>SX1276MB1LAS</td>
<td>433MHz/915MHz</td>
<td>US</td>
<td>14dBm/20dBm</td>
<td>Mbed</td>
</tr>
<tr>
<td></td>
<td>SX1276RF1IAS</td>
<td>169MHz/868MHz</td>
<td>EU</td>
<td>20dBm/14dBm</td>
<td>Eiger, Prototype</td>
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<tr>
<td></td>
<td>SX1276RF1JAS</td>
<td>433/868/915MHz</td>
<td>EU/US</td>
<td>14dBm/20dBm</td>
<td>Eiger, Prototype</td>
</tr>
<tr>
<td></td>
<td>SX1276RF1KAS</td>
<td>490MHz/915MHz</td>
<td>China/US</td>
<td>20dBm/14dBm</td>
<td>Eiger, Prototype</td>
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</table>

Design Files are available under Docs & Resources of Semtech’s LoRa Product Page
LoRaWAN™ for sensor nodes

- LoRaWAN specification defined by the LoRa Alliance
- Open source stack for ARM Cortex-M MCUs
- Portable to other MCU or CPU architectures

- Option 1: GitHub
  - https://github.com/Lora-net/LoRaMac-node (Master & develop branches)
  - http://stackforce.github.io/LoRaMac-doc/ (Documentation)

- Option 2: ARM mbed
  - https://developer.mbed.org/teams/Semtech/code/
  - Many sample applications on mbed™ platform
LoRa Gateway Reference Designs
## LoRa Gateway Reference Designs

<table>
<thead>
<tr>
<th>Baseband IC</th>
<th>DATA ONLY (V1.X)</th>
<th>DATA + GEOLOCATION (V2.X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SX1301 / SX1308</td>
<td>SX1301</td>
<td></td>
</tr>
<tr>
<td>TX Channels</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>RX Channels</td>
<td>8</td>
<td>16 to 64</td>
</tr>
<tr>
<td>Antennas</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Duplex</td>
<td>Half</td>
<td>Half / Full</td>
</tr>
<tr>
<td>Power Output</td>
<td>up to 23dbm</td>
<td>up to 30dbm</td>
</tr>
</tbody>
</table>

### Architecture

| Modems | 1 | 2 to 8 |
| DSPs | 0 | 2 |
| FPGA | - | 1 |
| Radio FE | Yes | Yes |

- LoRaWAN gateway products available from multiple suppliers
- Reference design and SW available from Semtech
- Macro cell for outdoor, data and geolocation
- Pico cell design intended for indoor environments

*Base-band extender for GW v2.1
<table>
<thead>
<tr>
<th>Gateway hardware reference design</th>
<th>Pico 1.0</th>
<th>V1.0</th>
<th>V1.5</th>
<th>V2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>License agreement</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Environment</td>
<td>Indoor</td>
<td>Indoor / outdoor</td>
<td>Indoor / outdoor</td>
<td>Outdoor</td>
</tr>
<tr>
<td>RX Channels</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>16-64 (No Diversity) 8-32 (with Diversity)</td>
</tr>
<tr>
<td>Region</td>
<td>All except JP and Korea</td>
<td>All except JP and Korea</td>
<td>JP, Korea EU (above 20 dBm) (LBT required)</td>
<td>All</td>
</tr>
<tr>
<td>Packet Forwarder</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>HAL</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Interface</td>
<td>USB / UART</td>
<td>SPI</td>
<td>SPI</td>
<td>SPI</td>
</tr>
<tr>
<td>TX power</td>
<td>20dBm</td>
<td>27dBm</td>
<td>27dBm</td>
<td>27dBm</td>
</tr>
<tr>
<td>RX Sensitivity</td>
<td>Down to -140dBm</td>
<td>Down to -140dBm</td>
<td>Down to -140dBm</td>
<td>Down to -140dBm</td>
</tr>
<tr>
<td>RF Frequency</td>
<td>&lt;1GHz ISM Bands 470-928MHz</td>
<td>&lt;1GHz ISM Bands 470-928MHz</td>
<td>&lt;1GHz ISM Bands 470-928MHz</td>
<td>&lt;1GHz ISM Bands 470-928MHz</td>
</tr>
<tr>
<td>LoRa GeoLoc Capable</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>MCU/FPGA Function</td>
<td>MCU (USB-SPI, Power Consumption)</td>
<td>No</td>
<td>FPGA (TX filtering for EU, LBT for JP / KR)</td>
<td>FPGA + DSP (fine time stamping, freq conversion, Tx filtering)</td>
</tr>
<tr>
<td>Full Duplex</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Additional Resources

- **Pico Cell gateway information**
  - SX1308 datasheet
  - SX1257/55 datasheet
  - Picocell gateway ref design user guide
  - Ref design files (schematic, layout, BOM)
  - HAL and packet forwarder are on github

- **All other gateway reference designs**
  - HAL and packet forwarder for v1.x are on github
  - [https://github.com/Lora-net](https://github.com/Lora-net)
  - Contact Semtech for GW v2.1
LoRaWAN Roadmap

**TODAY**
- **LoRaWAN 1.0.0**
  - Initial Spec Release
  - Released
- **LoRaWAN 1.0.2**
  - APAC Updated
  - Regional Requirements
  - Available to Alliance Members
  - Released

**2017**
- **LoRaWAN 1.1**
  - Roaming, Join Server
  - Class Switching
  - In IPR review
LoRa Community

- One stop resource for suppliers and customers
- Promote your products and find products
  - Over 200 LoRa based products and solutions
  - Eco-system partners and alliance members are active users
- Learn what the market needs
  - New use case announcements from the eco-system
  - Idea exchanges and support forums tell you what your customers experience on the ground
- Get support
  - Experts in the community including Semtech provide technical support
- Education
  - Many videos, training material, application briefs, white papers available

http://www.semtech.com/iot
Thank You