Innovation dans l’IoT
De l’Open Hardware aux nouveaux réseaux pour l’IoT

Nicolas Damour, Directeur des Partenariats Technologiques

Journée IoT INSA - January 2019
Sierra Wireless – Comprehensive Global IoT Offering
AirPrime® AR Series with Legato® delivers high-speed cellular connectivity for Car-Net platform:

- In-vehicle internet-based services
- Remote vehicle access
- Roadside assistance
- Diagnostics and maintenance
Sierra Wireless and Automotive & Mobility customers
How to foster innovation with open hardware
Typical IoT Solution Development Cycle

1-3 months: Technological investigation

3-6 months: PoC development

2-4 months: Device redesign

2-4 months: PoC deployment

4-9 months: Device cert. & prod.

Total project duration: 12 to 26 months
Requirement #1 - Easy to prototype

Ease of use
• All-in-one package with HW & connectivity
• Works out of the box

Code samples
• Time To First Hello World < 1 hour

Flexibility
• Application processor choice
• Tooling & language choice
• 3D printable and modifiable files

Expandability
• Arduino & Raspberry Pi ecosystem leverage
• Accept multiple sensors & networks
• Extension boards & options
Requirement #2 - Easy to productize

**Industrial design**
- Industrial-grade onboard components
- Industrial connectors

**Pre-certified hardware**
- Pre-certified radio modules

**Business-friendly licenses**
- Creative Commons Attribution
- Allows to modify & resell with no strings attached

**Modular design to continue to adapt**
- Accept multiple sensors & networks
- Extension boards & options
Requirement #1: IoT Hardware choices today

Proprietary devkits

- Telit
- Gemalto

Open source boards

- Ublox
- Sierra Wireless
- Raspberry Pi
- Beagle Board
- Arduino
- MangOH

Proprietary devkits vs. Open source boards
MangOH Open Hardware: One-go reference platform

IOT Connectors provide plug and play wireless, wired, sensor connectivity

- WiFi
- CAN
- ZigBee
- Bluetooth
- Modbus
- USB
- tHREAD
- dust networks
- ANT+
- PROFIBUS
- FlexRay
MangOH: Evolving to meet your needs

**mangOH™ Green**

1st Generation – 2017

**mangOH™ Red**

2nd Generation – 2018
MangOH Yellow: Super Smart Edge for IoT
MangOH ecosystem ready for you

BUILT AND TESTED

BUILT ACTIVE COMMUNITY

LAUNCHED IOT CARDS

TUTORIALS AND VIDEOS
Rapid development on the software side: Legato
MangOH and Legato: Open source initiatives

- Test your prototype in market conditions
- Develop your applications

**Legato**
Open source Linux embedded application development platform

**mangOH**
Open source sensor-to-cloud hardware platform

IDEA to PROTOTYPE to PRODUCT
The business license issue: what is Open Hardware?

• **Design published in the public domain** (including source files)
• **Business-friendly** Open Source License ( "CC attribution")
  – Freely available to share, copy and modify
  – Freely available to build commercial products with no restrictions / fees attached
  – Non-revocable license

• **IoT needs**: highly expandable (natively, with no need to modify the design)

Goals

• Encourage copies, new hardware designs, business
• Build a developer community & a business ecosystem
## Open Hardware Licenses – examples

<table>
<thead>
<tr>
<th>Platform</th>
<th>Schematics &amp; Gerber published</th>
<th>Free to copy &amp; modify</th>
<th>Business friendly license</th>
<th>Open processor &amp; drivers</th>
<th>Industry Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi</td>
<td>YES</td>
<td>NO – Proprietary</td>
<td>NO – Proprietary</td>
<td>Proprietary (Broadcom)</td>
<td>Demos &amp; technology testing</td>
</tr>
<tr>
<td>mBed HDK</td>
<td>YES</td>
<td>NO – Proprietary</td>
<td>NO – Proprietary</td>
<td>Proprietary (ARM)</td>
<td>ARM dev kit</td>
</tr>
<tr>
<td>Arduino</td>
<td>YES</td>
<td>YES</td>
<td>CC share-alike*</td>
<td>Atmel + Arduino certified procs</td>
<td>Build open source product upon it</td>
</tr>
<tr>
<td>BeagleBoard</td>
<td>YES</td>
<td>YES</td>
<td>CC share-alike*</td>
<td>Proprietary (TI)</td>
<td>Build open source product upon it</td>
</tr>
<tr>
<td>Particle (Spark)</td>
<td>YES</td>
<td>YES</td>
<td>CC share-alike*</td>
<td>Proprietary variants (TI, ...)</td>
<td>Build open source product upon it</td>
</tr>
<tr>
<td>Tessel</td>
<td>YES</td>
<td>YES</td>
<td>CC share-alike*</td>
<td>Proprietary (ARM)</td>
<td>Build open source product upon it</td>
</tr>
<tr>
<td>openPicus</td>
<td>Partly (no Gerbers)</td>
<td>YES</td>
<td>Yes – CC attribution</td>
<td>FlyPort interface OSS framework</td>
<td>Build commercial product upon it</td>
</tr>
<tr>
<td>mangOH</td>
<td>YES</td>
<td>YES</td>
<td>Yes – CC attribution</td>
<td>CF3 socket OSS framework</td>
<td>Build commercial product upon it</td>
</tr>
</tbody>
</table>

**Disclaimer:** When selecting an open hardware platform other important criteria to consider include: processor/microcontroller, hardware features, extensions, operating systems, tooling, code samples, community, ...

*Viral license: the resulting product must use the same license.*
### Agricultural Asset Tracking

**Location and health of assets**

<table>
<thead>
<tr>
<th></th>
<th>Estimate without open source</th>
<th>Actual with mangOH/Legato</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>resource</strong></td>
<td>2 people</td>
<td>5-6 people</td>
</tr>
<tr>
<td><strong>code</strong></td>
<td>8k lines</td>
<td>250k lines</td>
</tr>
<tr>
<td><strong>cost</strong></td>
<td>200 k</td>
<td>600 k</td>
</tr>
<tr>
<td><strong>TTM</strong></td>
<td>&lt; 4 months</td>
<td>5-6 months</td>
</tr>
</tbody>
</table>

“By using mangOH Red and Legato framework, the POC for 100 units was deployed in field trials within 3 months!”

**Location and health of assets**

- **TTM (Time to Market):**
  - Using mangOH and Legato, the POC deployment was within 3 months.
  - **TTM** refers to the time taken to market the product.

- **Resource:**
  - The resource requirement was significantly reduced from 5-6 people to 2 people.

- **Code:**
  - The code size was reduced from 250k lines to 8k lines.

- **Cost:**
  - The cost decreased from 600k to 200k.

- **TTM:**
  - The time taken to deploy the POC was reduced from < 4 months to 5-6 months.
“Legato and the open source MangOH development hardware allowed us to design and launch our product within 6 months!”

Brandon Wright
CEO, Brnki.io
## Drone as a Service

### Surveillance Data Provider

<table>
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<tbody>
<tr>
<td>resource</td>
<td>6 people</td>
<td>3 people</td>
</tr>
<tr>
<td>code</td>
<td>50k lines</td>
<td>15k lines</td>
</tr>
<tr>
<td>cost</td>
<td>120k</td>
<td>40k</td>
</tr>
<tr>
<td>TTM</td>
<td>2 years</td>
<td>9 months</td>
</tr>
</tbody>
</table>

*The MangOH Red open hardware will allow us to create our MVP and redesign and launch our product all within 9 months! Legato has greatly simplified the access to the board sensors!*

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*Enric Pastor*

Research Lead, UPC Barcelona
Vehicle Tracking

Telemetry Data

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<th>Resource</th>
<th>Estimate without open source</th>
<th>Actual with mangOH/Legato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>200k</td>
<td>65k</td>
</tr>
<tr>
<td>TTM</td>
<td>1 year</td>
<td>4 months</td>
</tr>
</tbody>
</table>

The mangOH red prototyping platform and Legato application framework allowed Glassboard to design and deploy a 100 device vehicle asset tracking platform pilot in just four months!

Drew Westrick
VP of Technology
Other examples in Toulouse
New Cellular Networks with 4G+ and 5G
Massive IoT (LTE-M and NB-IoT)
Critical IoT
Massive IoT – also known as Cellular LPWA / Mobile IoT

**Coverage**
- 5-10x greater than 4G LTE
- 2x better than LoRa

**Consumption**
- 100x lower power than 4G LTE
- 10+ years battery life

**Cost**
- 50% reduction from 4G LTE
- Think 2G or Bluetooth

**Plus all the benefits of cellular**
- Global Service
- Trusted Ecosystem
- Durable Investment
Beyond the 3 C’s – do not forget some business aspects

- Global Service
  - Global Coverage
  - 675+ Networks
  - 140+ Countries

- Trusted Ecosystem
  - Healthy competition
  - Flexibility
  - Built-in Security

- Durable Investment
  - Scalability
  - Long-term availability
  - 5G-Ready
• Focused on very low data rates
• Ideal for simple static sensor applications

• Highest bandwidth of any LPWA technology
• Ideal for fixed and mobile applications

Design in multi-mode global modules and choose based on:
• Regional availability
• Lowest rate plans
Scalable cellular module for all cellular generations

- **2G**
  - GSM
  - GPRS
  - EDGE

- **3G**
  - HSDPA
  - HSUPA
  - WCDMA

- **4G**
  - LTE Cat-4
  - LTE Cat-1

- **LPWA**
  - LTE-M
  - NB-IoT

- **5G**

= Easy Migration Path
Looking forward: think multi-mode modules

• 4G coverage is still a requirement for LTE-M or NB-IoT: think 2G fallback!
• Some operators started with LTE-M, some with NB-IoT
• Network features may not be all available at the same time
• Different use cases may require different access technologies

Focus on scalable multi-mode modules with embedded SIMs
Looking forward: over-the-air evolutions

• Firmware upgrades: support for future 3GPP features:
  – Improved coverage (LTE-M EC Mode B), Improved bandwidth (NB-IoT Cat-NB2)
  – Location support (eCell-ID, OTDOA), Message broadcast, Better spectral efficiency...

• Firmware upgrades: the key to security

• Software upgrades: allows your application to evolve

• Smart SIM / eUICC-eSIM upgrades: to switch network operator anytime
Massive IoT – Cellular LPWA is available NOW

**LTE-M**
- 375/300 kbps
- Low latency – Mobile

**NB-IoT**
- 60/20 kbps
- Med latency – Stationary

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**Consumption**

- Global
- Durable
- Trusted

**Coverage**

- Cost

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2016: HL77xx
First LTE-M modules worldwide

2017: WP77xx
LTE-M+NB-IoT (+2G) smart modules

2018: HL78xx
2nd gen. LTE-M/NB-IoT/2G modules

2018: LX60
Integrated LTE-M/NB-IoT routers

**All available now**

- $375/300 kbps
- Low latency – Mobile
- 60/20 kbps
- Med latency – Stationary

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*SIERRA WIRELESS*

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*Orange™*

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*SFR*

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*bouygues*

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So what was that about...
High-level 5G Use Cases – from ITU

Enhance Mobile Broadband (eMBB)

- Gigabytes in a second
- 3D video, UHD screens
- Work and play in the cloud
- Augmented reality
- Industry automation
- Mission critical application
- Self Driving Car

Massive Machine Type Communications (mMTC)

- Smart Home/Building
- Voice
- Smart City

Ultra-reliable and Low Latency Communications (URLLC)

- Smart Home/Building
- Voice
- Smart City
What is 5G exactly?

Enhanced Mobile Broadband (eMBB)
- Immersive video
- Augmented reality
- 3D video

Critical IoT (URLLC)
- Autonomous vehicles
- Smart grid
- Factory automation

Massive IoT (mMTC)
- Smart cities
- Smart logistics
- Smart metering

Definitions

<table>
<thead>
<tr>
<th>mMTC</th>
<th>massive Machine Type communications</th>
</tr>
</thead>
<tbody>
<tr>
<td>URLLC</td>
<td>Ultra reliable low latency communications</td>
</tr>
</tbody>
</table>
What is 5G exactly?

**Enhanced Mobile Broadband (eMBB)**
- high peak speed
- high average speed
- spectral efficiency
- high capacity

**Critical IoT (URLLC)**
- low latency
- high reliability
- 0ms hand-offs
- high mobility

**Massive IoT (mMTC)**
- high density
- low cost
- low power
- high coverage

**Definitions**
- **mMTC**: massive Machine Type communications
- **URLLC**: Ultra reliable low latency communications
Introduction of 5G pillars over time

- Massive IoT - LPWA (NB-IoT & LTE-M)
- Enhanced Mobile Broadband
- Critical IoT

Today

Future

Source: GSM Association
Critical IoT and 5G New Radio – 2019 and 2020

- Launched - limited availability
- Deployed - selected areas only
- Expected 2019
- Expected 2020
- Launched - event service only; full launch 2019
- Expected 2018
3GPP 5G C-V2X Technology Evolution

• C-V2X includes C-V2N and C-V2V
  • C-V2N
    – ONLY SUPPORTED BY LTE – NOT NR!!
    – will naturally follow evolution of 5G LTE and 5G NR
    – requires multi-cast support (MBMS and SC-PTM)
  • C-V2V is a major feature V2X
    – C-V2V uses the D2D also called PC5, proximity services, or sidelink
    – In licensed spectrum, V2V needs LTE system support for grants and configuration
    – In dedicated band (5.9 GHz) will not require LTE system support
    – Evolution of C-V2V must be backward compatible
• NR C-V2X is a new R16 study item

KEY TAKEAWAYS
• C-V2N only support by LTE now
• C-V2X evolution independent from 5G LTE and 5G NR
• New Rel 16 NR C-V2X study
## 5G Bands submitted to 3GPP

<table>
<thead>
<tr>
<th>Frequency range/LTE band</th>
<th>Operators whose request is included in the frequency range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3-4.2 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, China Unicom, China Telecom, KT, SK Telecom, LG Uplus, Etsalat, Orange, Telecom Italia, British Telecom, Deutsche Telekom</td>
</tr>
<tr>
<td>4.4-4.99 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, China Unicom, China Telecom,</td>
</tr>
<tr>
<td>24.25-29.5 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, KT, SK Telecom, LG Uplus, Etsalat, Orange, Verizon, T-mobile, Telecom Italia, British Telecom, Deutsche Telekom</td>
</tr>
<tr>
<td>31.8-33.4GHz</td>
<td>Orange, Telecom Italia, British Telecom</td>
</tr>
<tr>
<td>37-40 GHz</td>
<td>AT&amp;T, Verizon, T-mobile</td>
</tr>
<tr>
<td>1.427-1.518G</td>
<td>Etisalat</td>
</tr>
<tr>
<td>1710-1785MHz/1805-1880MHz (Band 3)</td>
<td>CMCC, China Telecom</td>
</tr>
<tr>
<td>2500-2570MHz/2620-2690MHz (Band 7)</td>
<td>CHTTL, British Telecom</td>
</tr>
<tr>
<td>880-915MHz/925-960MHz (Band 8)</td>
<td>CMCC</td>
</tr>
<tr>
<td>832-862MHz/791-821MHz (Band 20)</td>
<td>Orange</td>
</tr>
<tr>
<td>703-748MHz/758-803MHz (Band 28)</td>
<td>Orange</td>
</tr>
<tr>
<td>2496-2690MHz (Band 41)</td>
<td>Sprint, China Telecom, C-Spire, China Unicom</td>
</tr>
<tr>
<td>1710-1780MHz/2110-2200MHz (band 66)</td>
<td>T-mobile</td>
</tr>
<tr>
<td>1920-1980MHz/2110-2170MHz (Band 1)</td>
<td>China Unicom, China Telecom</td>
</tr>
</tbody>
</table>
5G Network Slicing

Mobile Broadband
~ 20 Gbps

Massive IoT/LPWA
Millions per km²

Industrial/Critical IoT
1ms/ 99.999%

eMBB Slice

Massive IoT Slice

Critical IoT Slice

Device

Industry

Communications, Internet

Sensors, Tracking, Metering

Robotics, Factory, Industrial
Recent and future events – on the field
IoT for Mobility: not only in the car, from the train...

https://tinyurl.com/iot-sncf-challenge
IoT for Mobility: ... to connected bikes and scooters

LTE-M Launch Workshop
November 22nd 2018

www.velocate.com
www.knotcity.com
Open Connected Car Challenge – Coming up soon

Location: Paris

Kickoff: 19th February 2019
Duration: 1.5 month March-April 2019

Fabrique des mobilités
http://lafabriquedesmobilites.fr/

Contact Sierra Wireless if interested!

Prizes of 1000, 2000 and 5000 EUR
5G in France with Orange

https://challenge5g.orange.com/fr/challenges/startup
Merci

ndamour@sierrawireless.com