1

IoT promise

Connected objects in a numerical world
$2^{128} = \approx 3.402 \times 10^{38}$
IoT Acceleration Dashboard 2012-2014

Industry Environment

- Sensors Shipped: 23.64B
- Total Connections: 14.4B+
- M2M Connections: 4.1B
- Total IP Traffic: 62.47EB
- 51.10EB Traffic EB/Month
- 195M Identities Exposed (in Millions)
- 551M High Profile Security Break-ins

Business Sentiment

- Standards Bodies: 7
- Media Coverage: 45,032+
- Google Search Trends (based on index): 4x
- # of Companies Participating Consortia: 260

Opportunity Size

- IoT Revenue: $97B
- M2M Services Revenue: $79B
- 99.07%
- 99.25%
- 99.40%
- Predictive Maintenance: $400M

Investments

- IoT Developers (est.): 300K
- IoT Start Ups: 189 as of Sept 2014
- VC Investments: $960M as of Sept 2014
- Acquisitions: $1,100M
- YTD: $5.3B
- 17$302M
- 27$2.9B

Source: CBI Insights, Cisco Consulting Services Analysis
First takeaways

1. IoT Is Here. Now. And It’s Big
2. IoT Dashboard: IoT is Accelerating
3. IoT... Huge Opportunity for Ecosystem
Deploying real applications
Build new protocols / applications
  Specification / Design
  Simulation
  Deployment / Experimentation
  Standardization / IETF / ETSI

Large scale experimentation is real nightmare
Fastidious for a dozen of nodes
Manual handling / time consuming / boring

Needs for large scale scientific tools

Scientific & Reproductible experiment
FIT IoT-LAB in the IoT Context

WHAT / WHERE / WHY / HOW
FIT IoT LAB Objectives

- Target and challenge:
  - M2M / scaling
  - IoT (heterogenous)
  - Designing / Testing / Deploying / Monitoring

Use Cases:
- Home Gateway
- Cloud service monitoring
- IPv6 from sensors to the Cloud
- Mobile nodes
What/Where is FIT IoT LAB?

- More than 2700+ wireless nodes
- IMS band
- IEEE 802.15.4
- Low Power and Lossy Networks
- Total Remote Access
- Total Open Access
- Mobile Nodes/Richots
IoT LAB Nodes

- A8 node: TI-SITARA AM3505
  - Ethernet, USB
  - Linux/Android
  - Indoor GPS for highly accurate synchronisation

- M3 node: STM32
  - Radio Atmel AT86RF231
  - Ambient light, Temp, IMU, Pressure

- WSN430 node: TI MSP430
  - Radio TI CC1101 / CC2420
  - Ambient light, Temp
Embedded User Software

- IoT-LAB offers full support for embedded software development:
  - Direct access to node HW
  - OS-level features
- Developers can leverage the different APIs to build applications.
### Several Operating Systems

<table>
<thead>
<tr>
<th></th>
<th>WSN430</th>
<th>M3 NODE</th>
<th>A8 NODE</th>
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<tr>
<td>freeRTOS</td>
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<td>Linux</td>
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</tbody>
</table>
More than just an isolated testbed

- An Internet of Testbeds
  - A Facility – A playground for the future Internet
  - Wide-variety of eco-systems and develop openness

- Benefits from FIT / OneLAB.eu
  - An architecture for federation
  - Fundamental components for testbed federation

- SFA (Slice-Based Facility Architecture) aims to provide a secure common API with the minimum possible functionality to enable
The issue with testbed isolation
Experimenters

compliant to SFA (Slice-Based Facility Architecture)

Common API

A secure and distributed thin waist

Testbed resources
How to run an experiment

1) Experiment configuration

2) Experiment results

Open systems with IETF protocols (RPL/COAP/6TiSCH/...)

Eric Fleury ENS de Lyon / Inria

Juin 2015
How to run an experiment

- Open a user account
- Resources reservation
  - Geographical sites
  - WSN430/M3/A8 nodes
- Experimentation description
  - Firmware/nodes association
- Monitoring tuning
- Experimentation launching
- Monitoring data analysis
3

IoT-LAB Inria Grenoble
IoT LAB Strasbourg Site

Demo
IoT LAB Inria Grenoble

- 256 WSN nodes
- 200/384 M3 nodes
- 256 A8 nodes
- 32 Open nodes
Several demos / experiments

- Experiment on FIT IoT-LAB platform on Contiki/RPL using Foren6 for visualization:
  - https://www.youtube.com/watch?v=oSuWG7ixkJU

- Demonstration of using tiles equipped with IoT-LAB nodes detecting a mobile node (turtlebot2) or human steps. The detection is done using accelerometers (for human detection) or magnetometers (for robot detection) on IoT-LAB node tiles.
  - https://www.youtube.com/watch?v=IPxTfgNBjsI

- Use a Turtlebot2 mobile node in FIT IoT-LAB
  - https://www.youtube.com/watch?v=4uqjI89k81E
IoT LAB Strasbourg

- 256 WSN nodes
- 120 M3 nodes
- 25 A8 nodes
- 40 mobile nodes
Several demos / experiments

- Multi robots:
  - https://clarinet.u-strasbg.fr/owncloud/index.php/s/0kTW4v49fJMV7yx
Conclusions
Time to use it!

- Statistiques
  - more than 400 users registered
  - in more than 45 countries
  - 11K experiments launched
  - Masters / Tutorials

- Futur development
  - Open robots

- H2020 calls on IoT
  - 10 proposals submitted

https://www.iot-lab.info
Huge collaborative and collective work

- Strasbourg
  - Guillaume Schreiner
  - Erkan Valentin
- Rocquencourt
  - Ala-eddin Weslati
  - Ichrak Amdouni
  - Vincent Ladeveze
- Lille
  - Julien Vandaele
  - Loic Schmidt
  - Anne-Sophie Tonneau
  - Raymond Borenstein
- Grenoble
  - Frédéric Saint-Marcel
  - Roger Pissard-Gibollet
  - Nicolas Turro
  - Gaetan Harter
  - Olivier Fambon
  - Sandrine Avakian
  - Fabien Vauvilliers
  - Jean-Francois Cuniberto

C. Chaudet, N. Mitton, T. Noel, C. Adjih, E. Baccelli
For more information

- **IoT-lab**
  - [https://www.iot-lab.info](https://www.iot-lab.info)
  - **Wiki**: [https://github.com/iot-lab/iot-lab/wiki](https://github.com/iot-lab/iot-lab/wiki)
  - **Sources**: [https://github.com/iot-lab/](https://github.com/iot-lab/)
  - **Issues**: [https://github.com/iot-lab/iot-lab/issues](https://github.com/iot-lab/iot-lab/issues)
  - **Mailing-list**: users@iot-lab.info

- **OneLab**
  - [https://onelab.eu](https://onelab.eu)

- **HIKOB**
  - [http://www.hikob.com](http://www.hikob.com)