Applications for the Internet of Things

Pierre Rust

\(^1\)MINES Saint-Étienne, CNRS
Lab Hubert Curien UMR 5516

\(^2\)Orange Labs
Presentation

- Pierre Rust
- Work for Orange
  - Software Developer
  - Research Engineer
  - ... and Phd Student
- Work on
  - Local Area Newtork and Protocols
  - End-user product and devices: Smart Home, Livebox, mobile apps, etc.
  - Now IoT!
Internet of Things Applications

- IoT vs M2M
- Wearables
- Smart Home
- Industrial IoT
- Energy
- Smart Agriculture
- Transportation
- Smart Cities
Internet of Things

- What is IoT?
- Is that really new?
Internet of Things vs M2M

- **M2M**: Machine to Machine Communications
- **Wikipedia**: "Machine to machine refers to direct communication between devices (...). M2M communication can include industrial instrumentation, enabling a sensor or meter to communicate the data it records (such as temperature, inventory level, etc.) to application software that can use it."
- **M2M exists for many years**: 1995!
- **What is the difference between M2M and IoT?**
Internet of Things vs M2M

Google trend for M2M and IoT search terms (last 10 years)
Internet of Things vs M2M

Is it different?

IoT =? M2M + Marketing + Hype

- Partly true ...
- Many M2M companies are now successfully re-branding them-self as IoT!
- But there is more to IoT!
Internet of Things vs M2M
So what are the differences?

IoT, the natural evolution of M2M

**M2M**
- Point-to-Point
- Vertical
- Closed
- Requires Commitment

**IoT**
- Multi-point
- Horizontal
- Open
- Allows Experimentation

Comparison from Aapo Markkanen, ABI Research, Principal Analyst for M2M and IOT.
Internet of Things vs M2M

is it different?

Another view: M2M is IoT at scale

- more connectivity
- more devices
- more competencies / developers
- more services and applications
Internet of Things vs M2M

IoT and connectivity

New connectivity options

- Cheaper: chipset designed for mass production and low cost
- More energy efficient: years on a battery, energy harvesting

Examples:

- Low-power Local-area connections: Bluetooth, Zibee, Z-Wave, EnOcean, etc.
- Low-power Wide-Area connection: SigFox, LoRa, etc.
- Next generation cellular technology: 5G (3GPP)

And of course GSM / 2G are still widely used.
Internet of Things vs M2M

IoT and devices

New hardware for building connected objects:

- Cheap and small sensors and actuators
- Cheap computing power
  - many micro-controllers available on the market
  - the mass production of smartphone made arm-based micro-processors cheap
- Energy efficiency
  - required in most use-cases!
Internet of Things vs M2M
is it different?

- hardware is hard ...
  “There is a reason they call it hardware — it is hard,”
  Tony Fadell, father of the iPod
- ... and so is M2M (and IoT)!
- But it’s getting easier!
  ▶ Lot’s of new tools, making life easier for developers
  ▶ Open-source boom in IoT area
  ▶ Platform and Saas are available (to avoid re-developing everything from scratch)
  ▶ Competencies are becoming "mainstream"
Internet of Things vs M2M
More applications and services

Thanks to the "Cloud"

- Storage is cheaper
- Computation is cheaper
- Scaling is easier (but still hard !)
Applications for the Internet of Things

- Consumer applications
- Business / Enterprise application
## IoT applications popularity

![IoT applications popularity chart](chart.png)

### IoT Analytics - Quantifying the connected world

<table>
<thead>
<tr>
<th>Applications</th>
<th>Overall popularity (and selected examples)</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Smart Home</td>
<td><img src="image1.png" alt="Smart thermostat" /> <img src="image2.png" alt="Connected lights" /> <img src="image3.png" alt="Smart fridge" /> <img src="image4.png" alt="Smart doorlock" /></td>
<td>100% 61k 3.3k 430</td>
</tr>
<tr>
<td><strong>2</strong> Wearables</td>
<td><img src="image5.png" alt="Smart watch" /> <img src="image6.png" alt="Activity tracker" /> <img src="image7.png" alt="Smart glass" /></td>
<td>63% 33k 2.0k 320</td>
</tr>
<tr>
<td><strong>3</strong> Smart City</td>
<td><img src="image8.png" alt="Smart parking" /> <img src="image9.png" alt="Smart waste collection" /></td>
<td>34% 41k 0.5k 80</td>
</tr>
<tr>
<td><strong>4</strong> Smart grid</td>
<td><img src="image10.png" alt="Smart metering" /></td>
<td>28% 41k 0.1k 60</td>
</tr>
<tr>
<td><strong>5</strong> Industrial internet</td>
<td><img src="image11.png" alt="Remote asset control" /></td>
<td>25% 10k 1.7k 30</td>
</tr>
<tr>
<td><strong>6</strong> Connected car</td>
<td><img src="image12.png" alt="Remote car control" /></td>
<td>19% 5k 1.2k 50</td>
</tr>
<tr>
<td><strong>7</strong> Connected Health</td>
<td><img src="image13.png" alt="Remote car control" /></td>
<td>6% 2k 0.5k 5</td>
</tr>
<tr>
<td><strong>8</strong> Smart retail</td>
<td><img src="image14.png" alt="Smart metering" /></td>
<td>2% 1k 0.2k 1</td>
</tr>
<tr>
<td><strong>9</strong> Smart supply chain</td>
<td><img src="image15.png" alt="Remote asset control" /></td>
<td>2% 0k 0.2k 0</td>
</tr>
<tr>
<td><strong>10</strong> Smart farming</td>
<td><img src="image16.png" alt="Smart metering" /></td>
<td>1% 1k 0.0k 1</td>
</tr>
</tbody>
</table>

1. Monthly worldwide Google searches for the application  
2. Monthly Tweets containing the application name and #IoT  
3. Monthly LinkedIn Posts that include the application name.  

Sources: Google, Twitter, LinkedIn, IoT Analytics


Represents popularity, not necessarily reality and deployments!
IoT consumer applications

IoT consumer applications have been enabled by the smartphone revolution.

Two examples:
- Wearables
- Smart-home
IoT wearables

The (big) tip of the iceberg

- Worldwide wearable device revenue of $28.7 billion (274.6 million units) in 2016, up 18.4% over 2015 (232 million units) - Gartner

- The most visible consumer oriented IoT devices
  - Activity & sleep trackers: Fitbit, Nike Fuelband, Garmin, Withings go, etc.
  - Smart-watch: Apple, Motorola, Samsung, Pebble, Withings, etc.
  - Connected jewelery and accessories
  - Smartglasses, contact lens : Google, Microsoft
  - Clothing
IoT Wearables Smart Home IoT Energy Smart Agriculture Transportation Smart Cities

IoT Applications

Rust
Wearables: What for?

Wearable functionalities:

- Fitness and tracking
- Quantified self
- Contactless payment
- Health (hopefully!), already some devices available for seniors and babies (alerting and sleep monitors)
- In the enterprise: identification, authentication, localization, etc.
Wearable: How do they work?

- Current wearables are mostly peripherals for a smartphone.
- With bluetooth (esp.BLE) the smartphone acts as a local gateway (aka ‘sensor hub’)
- A dedicated application runs on the smartphone and forward the data to a cloud platform
- "horizontal" data sharing is done on the cloud
Wearable : How do they work?

Smart Home

- Aka *Home automation*: control and automation of
  - lighting,
  - heating,
  - ventilation, air conditioning, etc.
  - appliances: washing machine, dishwasher, refrigerators, etc.

- Very old (geek) dream, but a limited market
  - too expensive: restricted to very costly installation
  - too complex to install and operate (KNX, etc.)

- Seems to take off today with IoT!
Smart Home

Three major kind of actors today

- Startups: stand-alone objects
- Big Internet company: platforms
- Telecommunication operators: local hubs
Smart Home: startups

Simple stand-alone objects, focused on one specific use:

- Thermostat
- Camera (with face recognition, activity detection, alerts & recording, etc.)
- Weather stations

These products are designed vertically:

- designed to work with their own platform
- no local communication!
- integration (if any) is done through the cloud and services like IFTTT
Smart Home: Startups

Examples: Withing, Netatmo
Smart Home: GAFA

Big Internet companies try to build platforms for smart-home

- Define their own architecture, protocols, platforms, ...
- Let other people build devices for their eco-system
- Make money either from data of from licenses

Examples:

- Apple: HomeKit,
- Google: Nest but also Brillo & Weave
- Amazon: Echo
Smart Home: Apple HomeKit

Apple framework to integrate for Smart Home devices into its existing iDevices ecosystem

- works with iPhone, iPad, iWatch & Apple TV
- based on existing technologies, with an ‘Apple twist’
- API for developers, to make application for their devices
- certification program for device manufacturer, licenses
- business model based on hardware, not data!
Google bought Nest in 2014: $3.2 billion!

- Nest was a startup, making stand-alone objects
- Now also promotes a "Work with Nest" program to integrate other objects and services

Since 2015, a platform approach based on Nest solutions:

- Brillo: Operating system for IoT
- Weave: protocol for smart-objects
Smart Home: Amazon Echo

Amazon Echo: intelligent, voice-controlled household appliance:

- an object, but mostly the door for a platform
- wants to be the main user interface of the Smart-Home
- allows integration of other services and objects
  - controlling the light, the heating systems, ...
  - ordering a pizza, calling a taxi, ...
  - cross-selling its own services!
- data, data & data!
Many telcos have launched Smart Home offers: Orange, SFR, Deutsch Telecom, AT&T, ...

- New offer for consumer
- Reduce churn and increase ARPU

Telco have an ‘hub’ approach:

- One box that coordinates everything in the house
- The "connection box" tradition (gateway - livebox)
- A set of low power basic sensors
- Implement existing standards to integrate other objects and services
Enterprise IoT projects

Excluding Consumer IoT: Wearable, Smart Home
from https://iot-analytics.com/top-10-iot-project-application-areas-q3-2016/
Industry is a long-time user of M2M, with IIoT it’s scaling up. Analysts expect IIoT to be so big that it is considered by many to be a specific subset of IoT now.

- Oil & Gas: one of the reason IIoT is so big!
- Smart Factories
IoT for Oil & Gas industry

Extremely capital-intensive and complex industry:

- Upstream: Exploration & Production (finding and drilling wells, etc.)
- Refining: convert crude oil into gasoline
- Distributing

The Oil & Gas industry is used to make huge investments, and expect a return!
Oil & Gas: Upstream

Five key insights from the 2016 Upstream Oil and Gas Digital Trends Survey

1. Digital technologies are recognized as adding value to upstream oil and gas companies by helping reduce costs, make faster and better decisions and increase workforce productivity.

2. Despite the low oil price environment, the majority of oil and gas companies will continue to invest at least the same amount or more in digital technologies over the next 3-5 years.

3. Digital investment today is focused on mobility and the Internet of Things (IoT) – with analytics and IoT predicted to lead the way over the next 3-5 years.

4. To realize the maximum benefits of digital, companies will need to rapidly improve their capabilities, including maturity in analytics.

5. Oil and gas companies are increasingly leveraging the cloud to more rapidly unlock the value of other digital technologies.

Source: Accenture
IoT: Oil & Gas

Improve operational efficiency

- Exploration: improve data acquisition (sensors & robots), processing and interpretation
- Reduce downtime: predictive maintenance vs. preventive maintenance
  - Very high cost maintenance: a single pump failure can cost $100,000 to $300,000 a day in lost production
- Reduce site visits: remote monitoring
- Increase productivity and reduce accident frequency with real time monitoring of assets
Oil & Gas: Upstream

Figure 1. IoT technologies, like data analytics, can significantly help increase well production.†

Figure 3. Conceptual architecture for upstream oil and gas

from Intel, "IoT solution for Upstream Gas and oil"
Oil & Gaz: Distribution

Distribution use case: Orange & Sensile.

- Sensile: Telemetry solution provider
- Remote monitoring gas and oil tank
- 25,000 SIM card with 2G, 3G and 4G connectivity in 60 countries
- Analytics and data visualization
- Optimize delivery schedules, saving 25% of logistics related costs

A Typical "M2M" scenario!

http://industrialiot5g.com/20160714/channels/use-cases/industrial-internet-things-case-study-tag23
Industrial IoT

- Oil & Gas
- Smart Factories
IloT: Smart Factories

Aka "Industry 4.0":

"Industry 4.0 is the trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things and cloud computing." (Wikipedia)

Supposed to be the fourth industrial revolution!

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1st
Mechanization, water power, steam power

2nd
Mass production, assembly line, electricity

3rd
Computer and automation

4th
Cyber Physical Systems
Smart Factories

Industry 4.0 (ambitious!) design principles:

- **Interoperability**: machines, devices, sensors, and people connect and communicate with each other via the IoT.

- **Information transparency**: information systems create a virtual copy of the physical world by enriching digital plant models with sensor data.

- **Technical assistance**: support human decision making (data aggregation and visualization). Avoid unpleasant, too exhausting, or unsafe tasks for humans.

- **Decentralized decisions**: cyber physical systems make decisions on their own and perform their tasks as autonomously as possible.
Smart Factories

Improve productivity in production system and supply chain:

- Still very new and prospective (2012), no real example available (yet!)
- Continuing trend of separating design from production
- Increase revenues by 23% and productivity by 26% (according to Mckinsey)
- Many companies are already working on some aspects:
  - (continue to) automate production
  - build metrics from sensors to optimize processes
  - predictive maintenance
  - tracking assets and production, supply chain integration
Smart Factories: use case example

Bosh hand-held industrial tools:

from Bosh: first-european-testbed-for-the-industrial-internet-consortium
Smart Factories: connected tools

Connected tools in manufacturing

In the international Track and Trace project, Bosch and its partners in the Industrial Internet Consortium are exploring the interconnection and management of industrial tools.

Tools send information about their position as well as measuring data to a central database. Software is then used to analyze this data. This analysis helps ensure manufacturing quality.

Depending on the specific location of each tool, the appropriate program for the task at hand is automatically deployed on the tool.

Source: Bosch
Smart Factories: connected tools

Connected screw driver: for aircraft, automotive, etc.

- located precisely on the factory floor
- knows who is using it, checks for training and certifications
- knows the current task
- identifies the kind of screw used
- knows exactly the right torque to apply for the current task
- records usage for regulations

For a single tool, imagine doing that at the full factory level!
IoT & Energy

- Many IoT activity on energy industries: oil, gas, etc.
- On specific case: electricity
  - Secondary source: always produced from other (primary) energy sources
  - Lots of different usages, and increasing
  - Lots of different production methods: coal, gaz, nuclear, hydropower, wind, solar, biomass, etc.

"An electrical grid is an interconnected network for delivering electricity from suppliers to consumers." (Wikipedia)
Smart Grid

New challenges with renewable sources:

- The grid is more distributed and decentralized:
  - many more small producers,
  - often consumer at the same time
- Production is not stable: depends on weather, etc.
- Consumption is not aligned with production
- Yet, generation and consumption must be **balanced** across the entire grid
Fig. 1. The IEEE's version of the Smart Grid involves distributed generation, information networks, and system coordination, a drastic change from the existing utility configurations.
Smart grid

- Smart metering
- Decentralizing operations: local production and consumption
- Asynchronous: organize energy storage
- Driving consumption
  - by automatic offloading
  - by varying price
Smart grid - Linky

First step in France: Linky smart meter, deployed by ERDF:

- real-time metering: every 2 seconds
- measure input **and output** energy: for prosumers
- connection: mesh PLC
- remote monitoring of failure
- designed for dynamic pricing

source: canardPC - dossier Linky
Smart agriculture

Challenges

- World population keeps increasing
- Resources depletion & pollution

Smart Agriculture:

- Producing more by optimizing crop yields
- Cheaper production by using less chemicals, fertilizers, etc.
- Better use of natural resources: water, etc.
Smart agriculture

- Improve rural area connectivity
- Add sensors in the fields and on machinery
- Analyse this data to make the right decision
- Direct command of watering and fertilizer distribution
Use case: Vineyard

**Fruition Science**: smart agriculture for vineyard

1. **COLLECT**
   Through innovative protocol, we help collect vineyard data that is not only useful but has the most informative value.

2. **MEASURE**
   Advanced yet easy-to-use analytics measure climate, as well as plant and fruit data, alongside GIS techniques in real-time.

3. **COMPARE**
   Our cloud and mobile software compares vineyard blocks and vintages, while delivering alerts and actionable insight.

4. **MAXIMIZE**
   Growers and winemakers maximize quality while optimizing yield and saving time, money and water.
Use case: Vineyard

**Fruition Science:** smart agriculture for vineyard

1. **HEATER**
   Held in place with Velcro, this orange sleeve applies heat to the stem.

2. **THERMOCOUPLES**
   These take temperature readings at the stem surface just before and after the heat is applied. The differential in the readings reflects how much water is pumping through the vine.

3. **ALUMINUM BUBBLE WRAP**
   Shields against external sources of heat (mostly sunshine) that

4. **UPLINK**
   This wire connects to a solar-powered data logger, which

Rust  IoT Applications

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Use case: Hostabee

**Hostabee**: French Startup (supported by Orange)
- remote monitoring of bees
- both in rural and urban area (e.g. to building)
- humidity, heat and activity sensors, connected with LoRa
- Avoid stealing
- Improve production, avoid visit
- Delegate the work to specialized workers
Intelligent Transportation Systems

Another sector that IoT is going to ‘disrupt’!

- Connected cars
- Connected infrastructure
- Traffic Data
- Autonomous vehicles
Connected cars

Connected cars are already a reality since 2010 (30% in the US)

- Smartphone integration: MirrorLink, CarPlay
- Entertainment,
- Navigation: with traffic and alerts
- Roadside assistance: contacting authorities and rescue workers
- Automotive system diagnosis
- Remote, wireless upgrade: Tesla
Intelligent Transportation

- Satellite Communications
- Terrestrial Broadcast
- Mobile Communications
- Navigation
- Intermodal Communications
- Vehicle-to-Vehicle
- Safety Systems
- Passenger Information
- Traffic Signs
- WLAN
- Adaptive Cruise Control
- Fleet Management
- Trip Planning
- Toll Collection

©ETSI 2008
Autonomous Vehicles

- Supposed to be commonplace in 2025
- Personal cars
- Taxis
- Trucks
SMART CITY
Smart city

New challenges for cities:

- Increase in urban population (70% in the world)
- Demographic changes: increase in the number of seniors
- Lifestyle changes: new habits in work, mobility, new family patterns
- Environmental pressure: pollution, resources depletion, climate change, etc.

**Smart City**: use Information Technologies and IoT to improve the quality of life, efficiency and economic competitiveness of the city, while ensuring an sustainable growth and protecting the environment.
SMART CITY CONCEPTS

Smart Governance and Smart Education

Smart Citizen
Smart Healthcare

Smart Energy
Smart Building

Smart Technology
Smart Mobility

Smart Infrastructure
Smart city: a perfect use-case for IoT!

Many different activities:

- Transportation: cars, parking, public transports, merchandise, ...
- Utilities: water, gaz, electricity,
- Waste management,
- Street lighting,
- Public services,
- Building management,
- etc.

All these activities:

- are managed by different companies, public & private sector
- take place (roughly) at the same time, in the same place,
- depends on each other,
- can and should be optimized together!
Smart city

The smart city technical requirement:

- Sensor and data sharing
- Interconnection & interoperability
- A common shared infrastructure

Here we really see the difference between IOT and M2M!

- Sharing means reduced costs but also increased complexity!
- Applications and services are built by using and aggregating data from different domains (aka ‘verticals’).

A converged approach to break silos that lowers TCO and unlocks new use cases.
Smart Street Lighting: Benefits

- Energy savings from:
  - Lighting levels adjusted to traffic density
  - Dimming and extending life of luminaires

- Central monitoring and reporting for individual street lights, enabling more effective maintenance

- Every light can be tagged and tracked, improving accuracy and simplification of asset management

- Reduction in carbon emissions plus energy saving of up to 50%, rising to 80% with the introduction of Smart Control

- Improved emergency services: Emergency operators can flash nearby lights to speed first responders arriving at the scene
City Lighting Network with Multi-Sensing Nodes

The NetSense platform turns LED light fixtures into sensor-equipped, smart devices capable of capturing and transmitting data near real-time, enabling new applications and services (lighting, parking management, safety and security, location-based etc.)
Smart+Connected City Parking: How It Works

Solution Components
1. Sensors on parking spots
2. New generation of parking meters
3. Video camera with analytics

Data Flow
1. Sensors detect parking events
2. Correlation of sensor and meter events to generate meter violations
3. Cameras detect no-parking and loading zone violation events
La métropole intelligente lyonnaise est fondée sur le principe d'innovation et de collaboration pour construire des projets pérennes. L'année 2015 est marquée par le déploiement de services novateurs et la poursuite d'expérimentations dans les secteurs clés.

**GESTION DE L’EAU EN VILLE**

› HUBLO

La plateforme de supervision HUBLO entre en action pour répondre aux fortes exigences du service d’eau potable : qualité, sécurité, anticipation, réactivité, service, information.

**MOBILITÉ**

› OPTIMOD’LYON

Trois ans de recherches partenariales ont donné naissance à un outil de prédiction du trafic et des interfaces intermodales uniques au service des usagers, entreprises et collectivités. L’aventure se poursuit avec OPTICITIES.

**ÉNERGIE ET SMART GRID**

› LYON SMART COMMUNITY

L’inauguration du premier îlot à énergie positive couronne le projet d’expérimentations énergétiques à l’échelle du quartier de la Confluence : auto-partage de véhicules électriques, contrôle de la demande en énergie, rénovation énergétique, pilotage centralisé…

**NOUVEAUX SERVICES NUMÉRIQUES**

› TUBÀ

Laboratoire urbain et incubateur de services de la ville de demain, le TUBÀ, depuis un an, stimulate l’écosystème du territoire et suscite la création de valeur sociale, environnementale et économique à partir du croisement des données publiques et privées.
Smart cities use case - Lyon

- New Mobilities
- Digital services
- Energy smart grid
- Innovation and initiative
Questions ?