The Internet of Things – Challenges and Opportunities beyond the hype

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Since 1999 we have served clients in 80 countries from our bases in the US, UK, Germany and Japan
Cisco view

Source: Cisco
Internet of People is already established and it has huge immediate potential

Internet of Things is unclear

Connected sensing things with IP addresses. Smart things that collaborate for the benefit of humans but without human involvement at the time – a tiny business today

Or is it all networks including RFID or perhaps all networks with at least internet-enabled backhaul? Problem: these have little in common and very few of them are valid targets for conversion to systems with all nodes IP addressed
### Internet of People

Internet-enabled personal electronics such as phones, tablets and computers

### Internet of Things with IP address

Ubiquitous smart objects sense and communicate over the internet with no human interaction.

### Other ID and Sensor systems (Internet of Things without IP address)

Dedicated systems for connected things. Proprietary or standardized RFID, Active RFID, Real Time Location Systems, Mesh Sensor Networks

### Driver: Governments or specific niche problems

- Infrastructure monitoring/ smart cities
- Lighting
- Transportation monitoring
- Energy monitoring/smart grid
- Process automation
- Security
- Agriculture

### Consumer Applications

**Driver:** Consumer needs, usually new business models

- Wearable technology
- Home automation
- Healthcare, fitness, assisted living
- Consumer services and infotainment
- Vehicles

**Key**

- High Market Value
- Mid Market Value
- Larger circle size indicates larger unit volume potential (not to scale)

**Component**

- Value/ Margin

**System Supply**

- Gateway
- Software
- System Supply

**Device**

- IC
- Gateway
- Software

**Trends**

- IC - low power
- Device - open source hardware
- Gateway - hardware agnostic
- Software - proprietary
- System Supply - targeted to a need

**Potential**

For lot to high volume proprietary sensor systems

**Stand alone systems or internet connection by backhaul**

**Value/ Margin**

Other ID and Sensor systems (Internet of Things without IP address)

- Larger circle size indicates larger unit volume potential (not to scale)
Why most of the existing RFID and sensor networks will not convert to IoT IP-addressed microcontrollers with sensors

• The $9 billion RFID business consists mainly of passive RFID with disposable dumb tags, very price critical eg 6 cents. RFID is mainly closed systems for security and simplicity. Owners rarely have the budget or the business case to change. However, many RFID networks have internet backhaul.

• Legacy systems that work well – why change? ZigBee networks “IP addresses are just one of many choices of node identity. We do not envisage using them.” Telegesis

• Wireless sensors. Owners rarely have the budget or the business case to change. However, many wireless networks have internet backhaul.
IoT today is essentially about internet-enabled smart objects

“At Freescale, we see the Internet of Things (IoT) as billions of intelligent connections that will encompass every aspect of our lives and make our world smarter, greener and safer. We believe that the biggest opportunities within the IoT will be in the transformational shift from the computing nexus to highly intelligent nodes - when intelligence massively scales, and the nodes have the power to learn, adapt and communicate”.

“After file transfer, e-commerce and social media, connecting things is the next generation of the internet: the Internet of Things (IoT). Connected things can range from sensors and security cameras to vehicles and production machines – Bosch Software Innovations expects that there will be 14 billion connected devices by 2022.”

“A pre-requisite is extremely low cost microcontrollers with sensors” Cisco
Internet of Things

Internet-enabled microcontrollers sense, learn, adapt, communicate and co-operate without human intervention at the time.
Internet of Things

Microcontrollers with up to ten sensors
Something new vs Renamed world of mobile phones

**Internet of Things**
Machines can sense, process, exchange information and take action independent of human intervention
*Key: Collaboration between smart devices*

**Internet of People**
People can communicate and access information anywhere
*Key: Ubiquity, mobility*

**Industrial, commercial, medical etc with devices rarely bought on their own? Euphoria**
Small, new, paybacks little understood, sometimes done for safety or security but mostly likely to be payback driven, not clear where the added value is in the value chain, value chain unclear

**Mainly consumer & office electronics with devices usually bought on their own. Sober reality**
Large, mature, usually bought for personal convenience/essential tool not payback, clear where the added value is in the value chain, value chain well understood
Example: London taxis always point to nearest McDonalds
IoT Why now?

- Low-priced microcontrollers with sensors
- Consumers have something to read/control them – smart phones, tablets etc
- IP addresses now effectively infinite – IPv6
- Internet access more widespread. 900MHz 80211ah WiFi for reliable M2M
- Investors and hungry wealthy suppliers eg Cisco, Google, Samsung.
- GE investing $1.5 billion in “industrial internet”
- Large government investment in smart cities in China. Funding increasing from other governments e.g. UK
- Business cases established by suppliers (though few potential users in evidence)
IoT disagreements

Over 400 standards. Which of the new over-arching standards will win? Some compete with each other

Which applicational sector is most promising?

Which organisation will place the large orders?

Is this mainly a business for node makers, services, or what else?

Will almost all the processing be done by the nodes or be Big Data managed centrally by IBM, Oracle etc
Silly season?

Cisco predicts $14 trillion IoT opportunity increasing global GDP by several percent.

Suppliers and analysts predict up to 200 billion in place in 2020 against a few million now, but…

…no one can name a company budgeting or even discussing a large order.
Google has bought Nest for $3.2 billion
Wearable IoT?

Blood glucose in real time or enhanced virtual reality from contact lens, artificial pancreas skin patch, gaming suit for realistic sensations
## Impediments to mass rollout of IoT

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Security

- Cyber attacks on infrastructure could become a risk to society
- Nodes may last for more than ten years. Need to be protected from threats now and in the future. Upgradeable software? How do you regain control of a node that has been taken over? Bin and replace is not an option.

- Vendors and some users implementing own security but a holistic approach is needed
- Effort from groups such as Allseen Alliance, Open Internet Consortium, Thread Group
- However, for high volume controllers will users pay the extra for security (which they assume anyway)? Who is taking leadership? Users have substantially different needs.
Energy harvesting will be a key enabling IoT technology but it receives little attention as yet.

- Long life single use batteries such as lithium thionyl chloride or rechargeable lithium-ion where practicable
- Rechargeable battery with one form of energy harvesting: Spansion
- Multiple energy harvesting no battery: EnOcean
  - Spansion
The Value Chain: EH powered WS/IOT

No “one fit all” solution – feedback needed
Strategies for Success: Wireless Sensor Networks

Horizontal Players
EH, ES, Electronics Components

Vertical Players
Hardware Integration/Software

Applications

- EnOcean and EnOcean Alliance, MicroStrain, KCF
- Perpetuum Partner with GE, Emerson, Honeywell... Micropelt device used by Schneider Electric etc
- Savi Ubisense, Wherenet/Zeba
- Nest/Google, GE, ABB, Emerson...

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Problems that are Opportunities: EH

- End Users are told “We will sell you an energy harvester/ battery/ supercapacitor/ low power IC but you are on your own for the rest”. A component is not a product: Few full solutions to buy – not an easy attraction for end users

- High level of customisation is needed – opportunity for services, design and benchmarking

- New forms factors are not yet being exploited e.g. flexible PV, flexible/embeddable thin film batteries. These new possibilities could command premium pricing and move away from competing on cost – create new markets instead.

- Cost of an energy harvesting component is typically very high and more case studies are needed to prove the ROI. Possible room for new models e.g. leasing approach rather than high upfront cost compared to a conventional battery?
Problems that are Opportunities: IoT

• In enterprise, end users have a large choice of different protocols to choose from that may or may not become obsolete. So called interoperable systems are sometimes not. Standards may not be optimal. The successes are typically in small, closed loop installations with proven ROI rolled out in a “cookie cutter” approach.

• Some even want lock-in!

• Start-ups that became successful tend to have a strong software and hardware offering, provide a complete solution, and do some integration. Service proposition is lacking and is mostly anecdotal.
Lessons/observations

• Governments have been huge driver of wireless sensors/tagging
  - Animal tracking, ePassports, $2Bn military orders for RTLS, Transit systems – ticketing, ZigBee in smart meters
  - **Emerging IoT sectors: energy, transport, cities, agriculture**

• Industry/enterprise seeks ROI, needs to fix a problem and have low appetite for payback experiments
  - Passive RFID “tag everything” scenario failed – sharing cost vs payback with many partners did not work
  - Industry adoption of WSN and RTLS has been much lower than anticipated
  - **Emerging IoT: smart lighting, process/manufacturing control**

• Consumer markets have huge potential for rapid growth by creating benefits that consumers are willing to pay for
  - Remote car access control, toys etc.
  - Need a “next big thing” as phones and tablets saturate – and money behind them
  - Only very few get the product concept right. E.g. NFC has been a failure. Can Apple turn it around? Can they create a smart watch that will be successful? Samsung and SAMI?
  - **Emerging IoT: home automation, connected vehicles**
Examples of IoT opportunities

- **High energy density lithium-ion batteries** - Samsung, Panasonic
- **Small memory** – Samsung, Thinfilm Electronics
- **Low power, ultra small microprocessors** - Intel, Texas Instruments, Samsung, ARM
- **Microcontroller sensor platforms, small, low power** - Intel, Texas Instruments, Samsung, Arduino
- **Sensor nodes** - Intel, Samsung, Arduino
- **Sensor systems** - Intel, Samsung, Marlow
- **Real time data logging solutions** - Xively
- **Software development environments to create the software to work with the hardware used in the Internet of Things** - ThingWorx, Raco Wireless, nPhase, Carriots
- **Converting legacy networks on proprietary protocols to IP-based networks** - Cisco
- **System integration and facilities management** - IBM, Cisco
- **Asset Management** - MASH
- **Healthcare systems** - Intel, Qualcomm, Johnson & Johnson, Roche
IDTechEx position on IoT

IoT will be big but later than most people predict. Consumer applications will be biggest – particularly where completely new markets are created, followed by Government applications. Enterprise needs a problem to fix.

8 billion mainly Chinese microcontrollers with sensors @ $6 sold in 2025 + big systems business?

Easy to talk about the application visions in the future but getting there is a huge challenge. These take time for standards, collaboration, technology development and large sums of money.
IDTechEx forecast for IoT based on IP addressed sensing nodes

Source: www.IDTechEx.com/IoT
For more on IoT and IoP see...

**Internet of Things (IoT): Business Opportunities 2015-2025**

Concerning ‘things’ not ‘people’ - with companies, technologies, hidden challenges, forecasts and timelines

By Dr Peter Harrop, Dr Jon Harrop and Raghu Das

[www.IDTechEx.com/IoT](http://www.IDTechEx.com/IoT)

**Internet of People: Technology 2015-2025**

Wearable, P2M, future mobile phones etc – flexible, printable, invisible, new systems

Dr Peter Harrop and Raghu Das

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