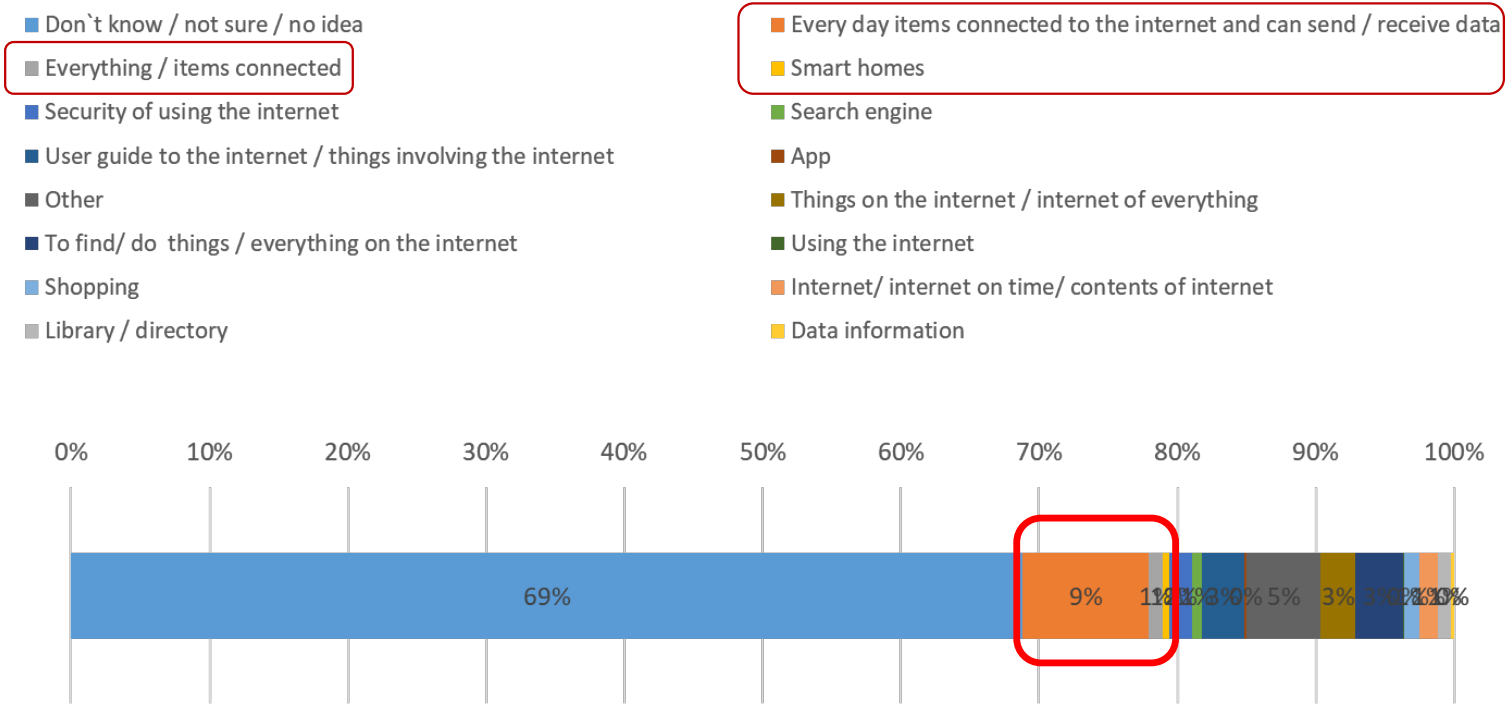
Internet of Things

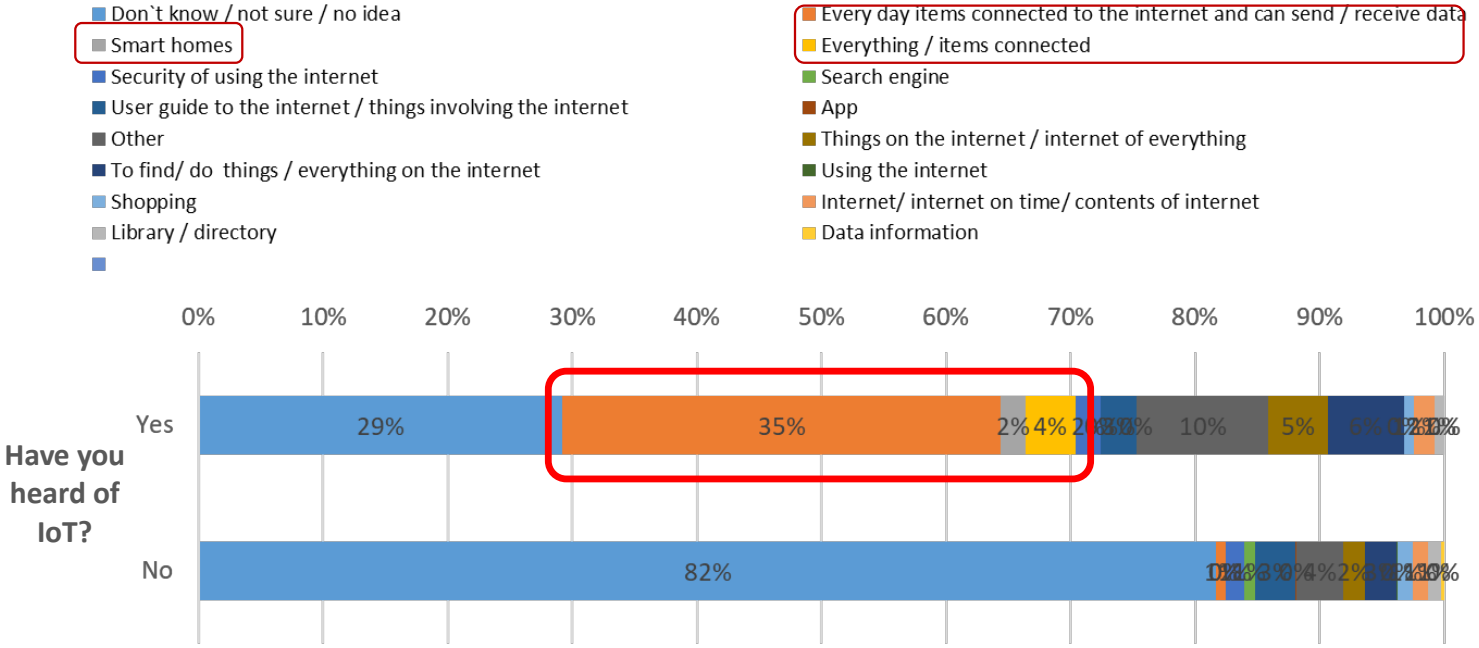
What is the IOT?



Taking in a couple of other descriptions which just about make sense, we hit around 11%.

N = 1000

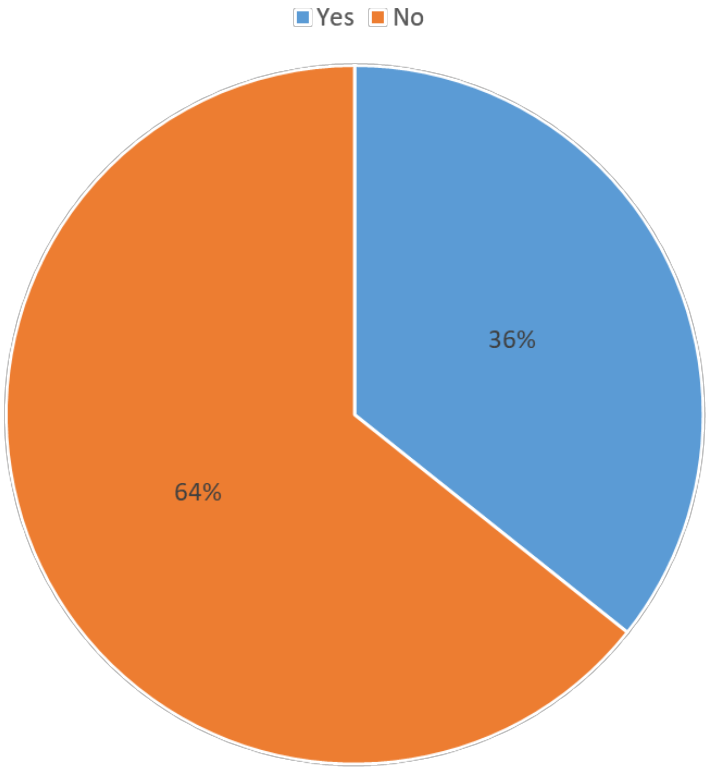
A whole IoT of headlines



- Whilst tech writers are easing off the subject, there is a whole lot of consumer noise around the subject.
- Even those who claim to have already heard of IoT are likely to either get it wrong, or be blinded by the question.

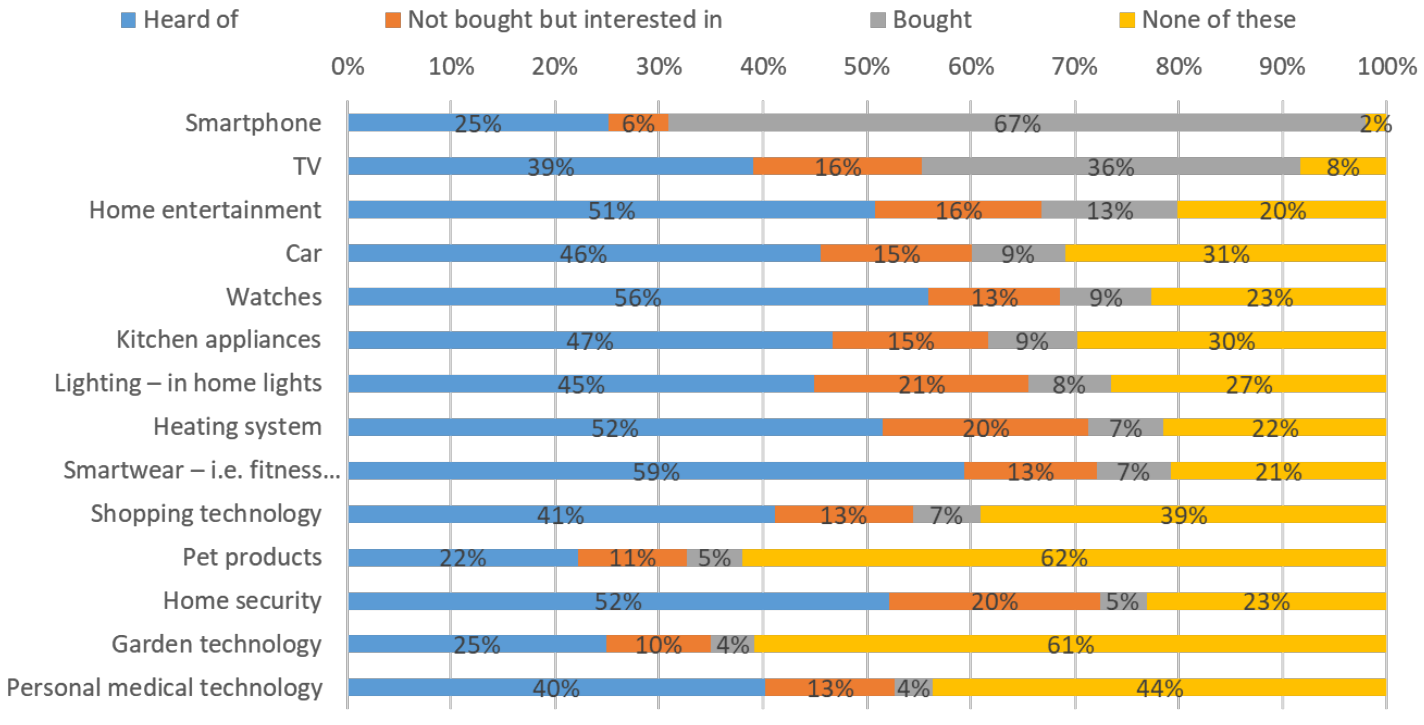
N = 1000

Have you bought any items that are ‘smart’?



N = 1000

Smart phones no longer smart?



But there is plenty of headroom in the market.

N = 1000

What is IoT?

- Latest development in the long and continuing revolution of computing and communications
- The term refers to:
  - expanding interconnection of smart devices
  - ranging from appliances to tiny sensors
  - Interconnection of billions of industrial and personal objects, usually through cloud systems
- What devices are in the IoT:
  - Personal computers
  - Smartphones
  - ….
  - But above all embedded devices
    - Low-bandwidth,
    - low-repetition data capture
    - low-bandwidth data-usage

History of IoT

The concept of the Internet of Things first became popular in 1999, through the Auto-ID Center at MIT and related market-analysis publications.

Radio-frequency identification (RFID) was seen as a prerequisite for the IoT at that point.

If all objects and people in daily life were equipped with identifiers, computers could manage and inventory them.

Besides using RFID, the tagging of things may be achieved through such technologies as Near Field Communication, barcodes, QR codes, bluetooth, and digital watermarking.

Evolution

1. **Information technology (IT)**:
   - PCs, servers, routers, firewalls, and so on
   - bought as IT devices by enterprise IT people, primarily using wired connectivity.
2. **Operational technology (OT)**:
   - Machines/appliances with embedded IT built by non-IT companies, such as medical machinery, SCADA (supervisory control and data acquisition), process control, and kiosks
   - bought as appliances by enterprise OT people, primarily using wired connectivity.
3. **Personal technology**:
   - Smartphones, tablets, and eBook readers bought as IT devices by consumers (employees)
   - exclusively using wireless connectivity and often multiple forms of wireless connectivity.
4. **Sensor/actuator technology**:
   - Single-purpose devices bought by consumers, IT, and OT people
   - exclusively using wireless connectivity, generally of a single form, as part of larger systems

Components

- **Sensor**
  - A sensor measures some parameter of a physical, chemical, or biological entity and delivers an electronic signal proportional to the observed characteristic, either in the form of an analog voltage level or a digital signal.
  - In both cases, the sensor output is typically input to a microcontroller or other management element.
- **Actuator**
  - An actuator receives an electronic signal from a controller and responds by interacting with its environment to produce an effect on some parameter of a physical, chemical, or biological entity.
- **Microcontroller**
  - The “smart” in a smart device is provided by a deeply embedded microcontroller.

Components

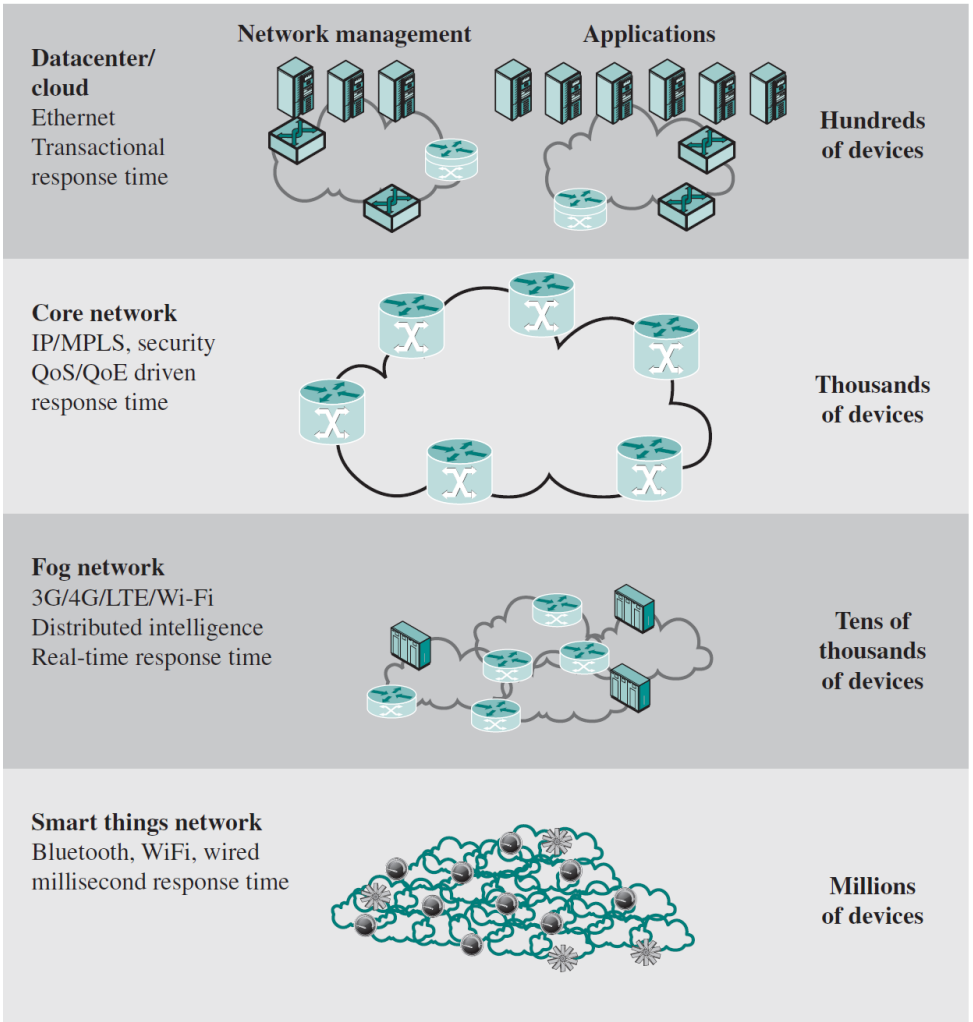
- **Transceiver**
  - A transceiver contains the electronics needed to transmit and receive data.
  - Most IoT devices contain a wireless transceiver, capable of communication using Wi-Fi, ZigBee, or some other wireless scheme.
- **Radio-Frequency Identification (RFID)**
  - Technology that uses radio waves to identify items, is increasingly becoming an enabling technology for IoT.
  - The main elements of an RFID system are tags and readers.
  - RFID tags are small programmable devices used for object, animal, and human tracking.
  - They come in a variety of shapes, sizes, functionalities, and costs.

The Structure of IoT

The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.

- ***Tagging Things :*** Real-time item traceability and addressability by ***RFID***s.
- ***Feeling Things : Sensors*** act as primary devices to collect data from the environment.
- ***Shrinking Things :*** Miniaturization and ***Nanotechnology*** has provoked the ability of smaller things to interact and connect within the “things” or “smart devices.”
- ***Thinking Things : Embedded intelligence*** in devices through sensors has formed the network connection to the Internet. It can make the “things” realizing the intelligent control.

IoT in the context of complete enterprise network



IoT operating systems

- Constrained devices
  - very limited resources including limited RAM (kbytes) and ROM,
  - low-power requirements (batteries),
  - no memory management unit,
  - limited processor performance.

- We need ad-hoc operating systems
  - TinyOS
  - RIOT (open source)
  - µClinux

IoT OS requirements

- **Small memory footprint**
  - Few available memory
  - We need to place both OS and applications
  - need for libraries optimized in terms of both size and performance, and space-efficient data structures.
- **Support for heterogeneous hardware**
  - For the largest systems, such as servers, PCs, and laptops, the Intel x86 processor architecture dominates.
  - For smaller systems, such as smartphones and a number of classes of IoT devices, the ARM architecture dominates.
  - Constrained devices are based on various microcontroller architectures and families, especially 8-bit and 16-bit processors.
  - A wide variety of communications technologies are also deployed on constrained devices.

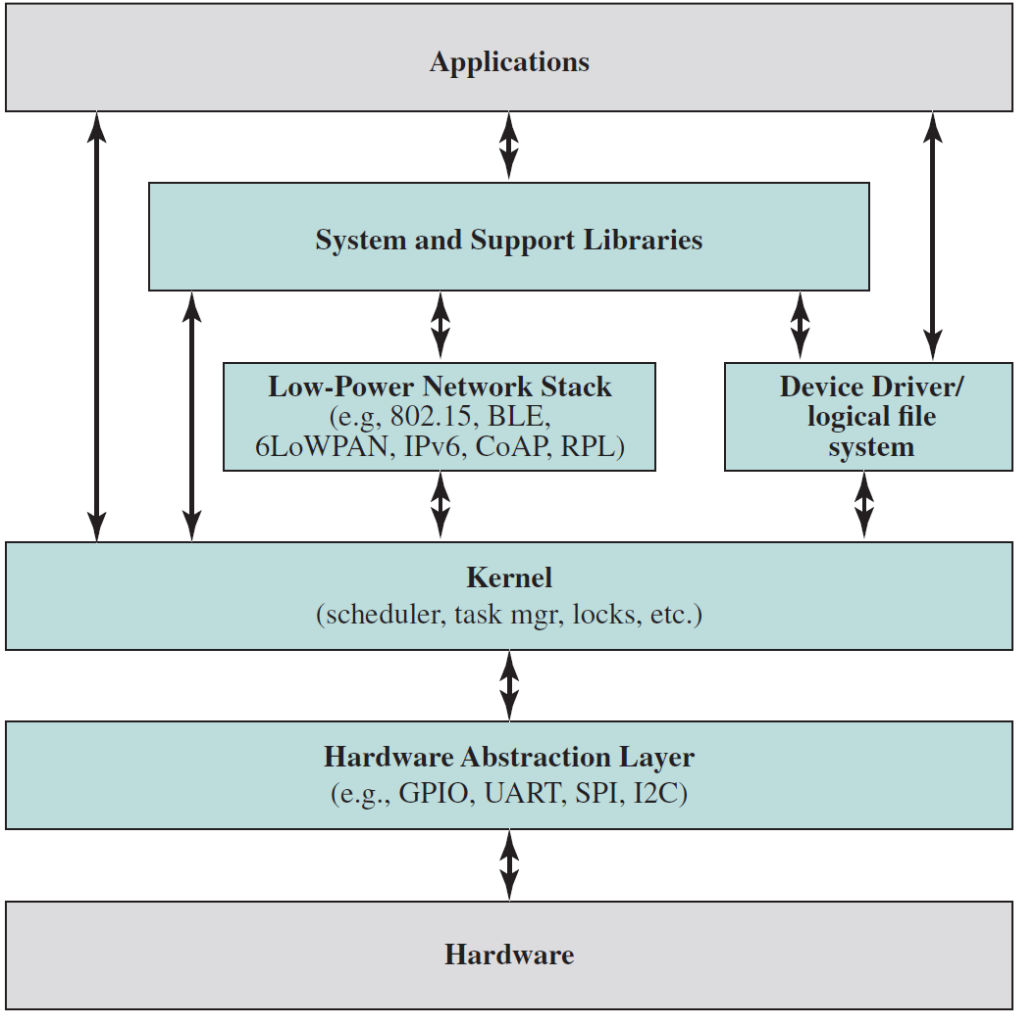
IoT OS requirements

- **Network connectivity**
  - IEEE 802.15.4 [low-rate wireless personal area network (WPAN)]
    - ZigBee
  - Bluetooth Low Energy (BLE)
  - 6LoWPAN (IPv6 over Low-power Wireless Personal Area Networks)
  - CoAP (Constrained Application Protocol)
  - RPL (Routing Protocol for Low power and Lossy Networks)
  - LoRaWAN (low-power Long-Range network technology)
- **Energy efficiency**
  - Need to work for years with a single battery
  - making the processor as energy efficient as possible
  - Wireless transmission schemes that minimize energy consumption
  - OS must provide energy consumption facilities
    - Provide them to higher level
    - Use them

IoT OS requirements

- **Real-time capabilities**
  - Several devices must support real-time applications
    - Surveillance
    - Smart cars
  - OS must fulfill timely execution reuirements
- **Security**
  - At application layer
    - Authorization, Authentication
    - Data confidentiality
    - Anti-virus
    - Privacy
  - At network layer
    - Authorization, Authentication
    - Data confidentiality
    - Data integrity protection
  - At device layer
    - Authorization, Authentication
    - Device integrity validation
    - Access control

Typical structure for IoT OS

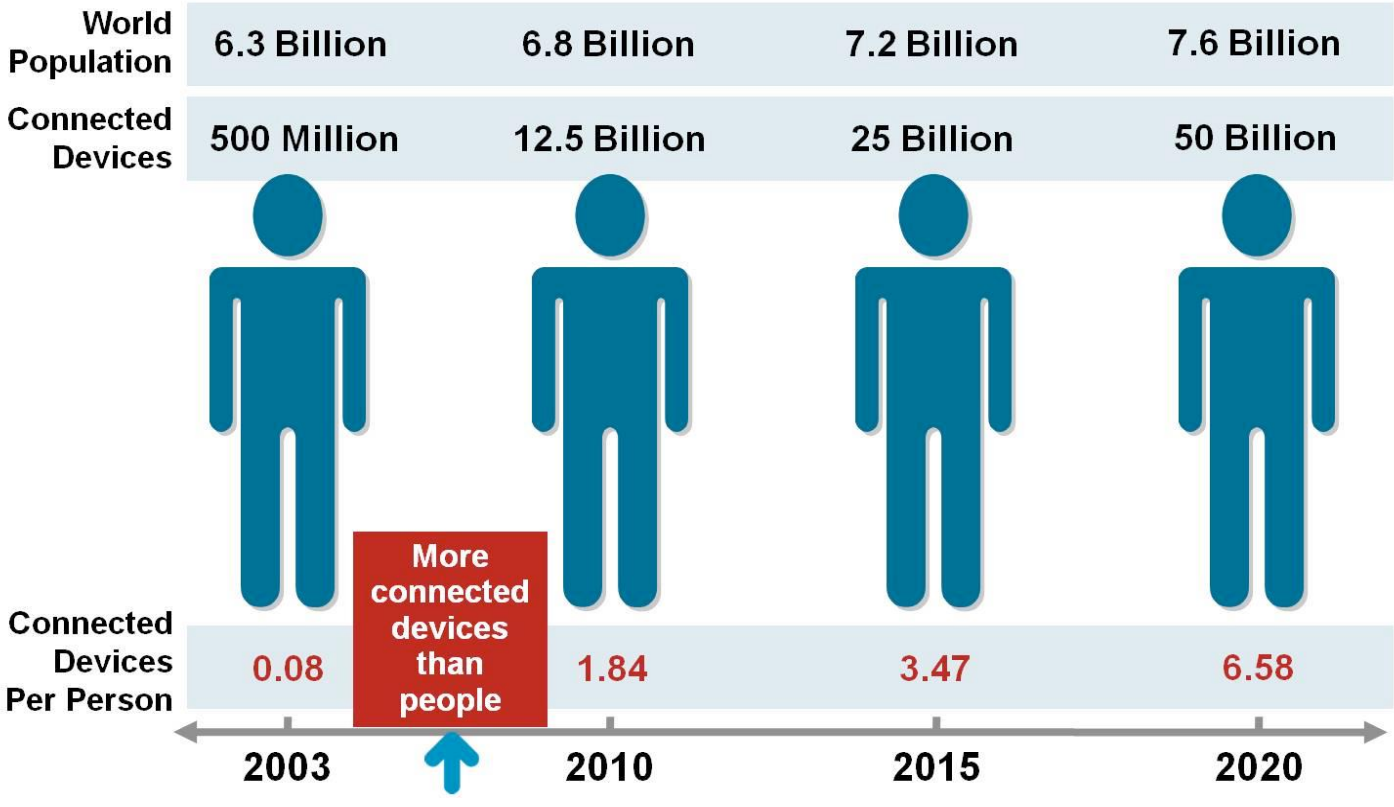


Characteristics of famous IoT OS

	μClinux	TinyOS	RIOT
Minimum RAM	< 32 MB	< 1 kB	~1.5 kB
Minimum ROM	< 2 MB	< 4 kB	~5 kB
C Support	✓	✗	✓
C++ Support	✓	✗	✓
Multithreading	✓	○	✓
Microcontrollers without MMU	✓	✓	✓
Modularity	○	✗	✓
Real time	○	✗	✓

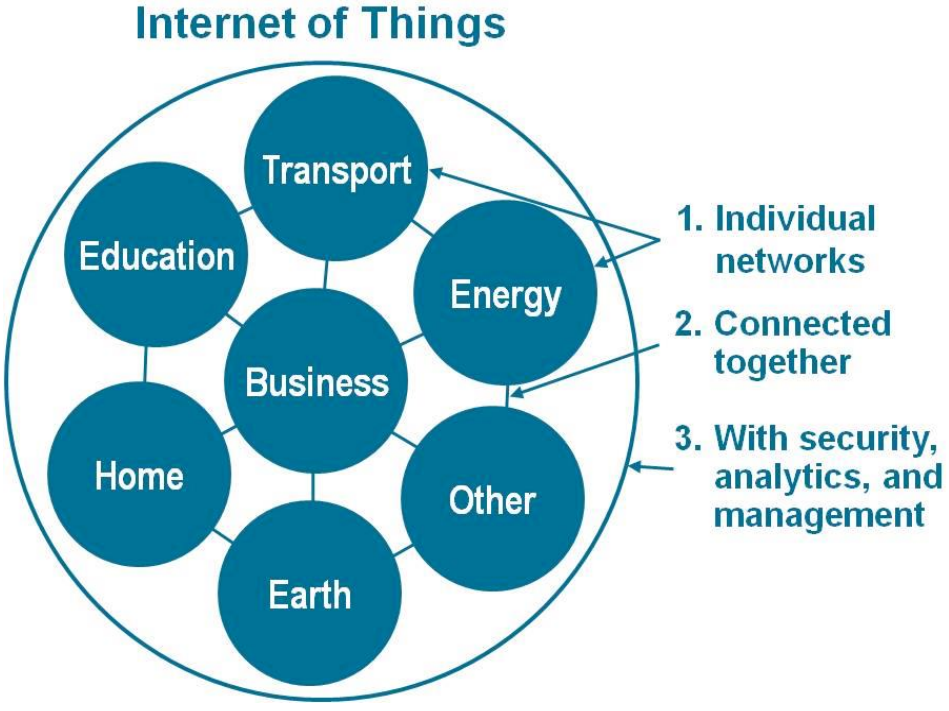
✓ = full support
○ = partial support
✗ = no support

Current Status & Future Prospect of IoT



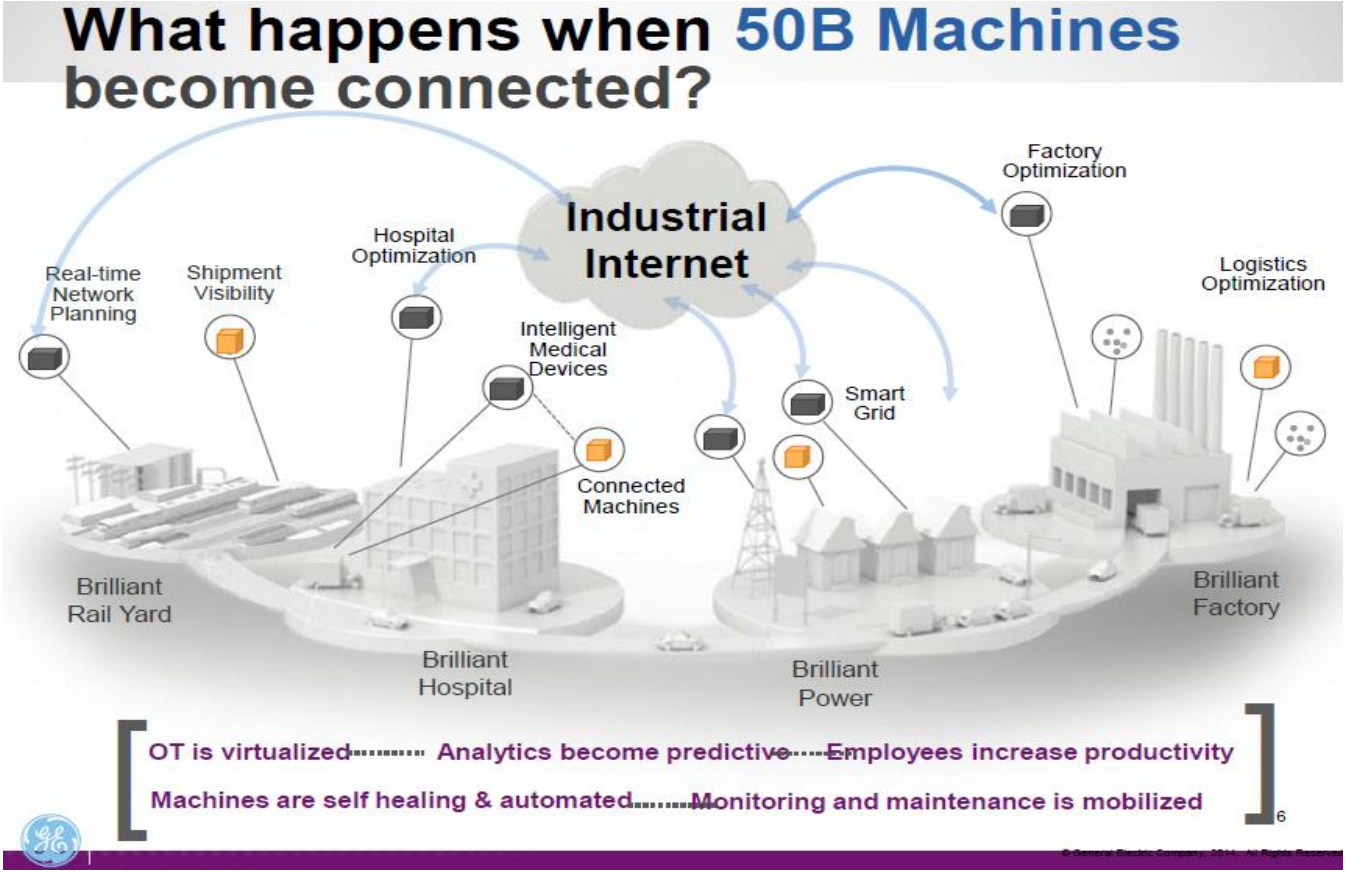
"Change is the only thing permanent in this world"

IoT as a Network of Networks:



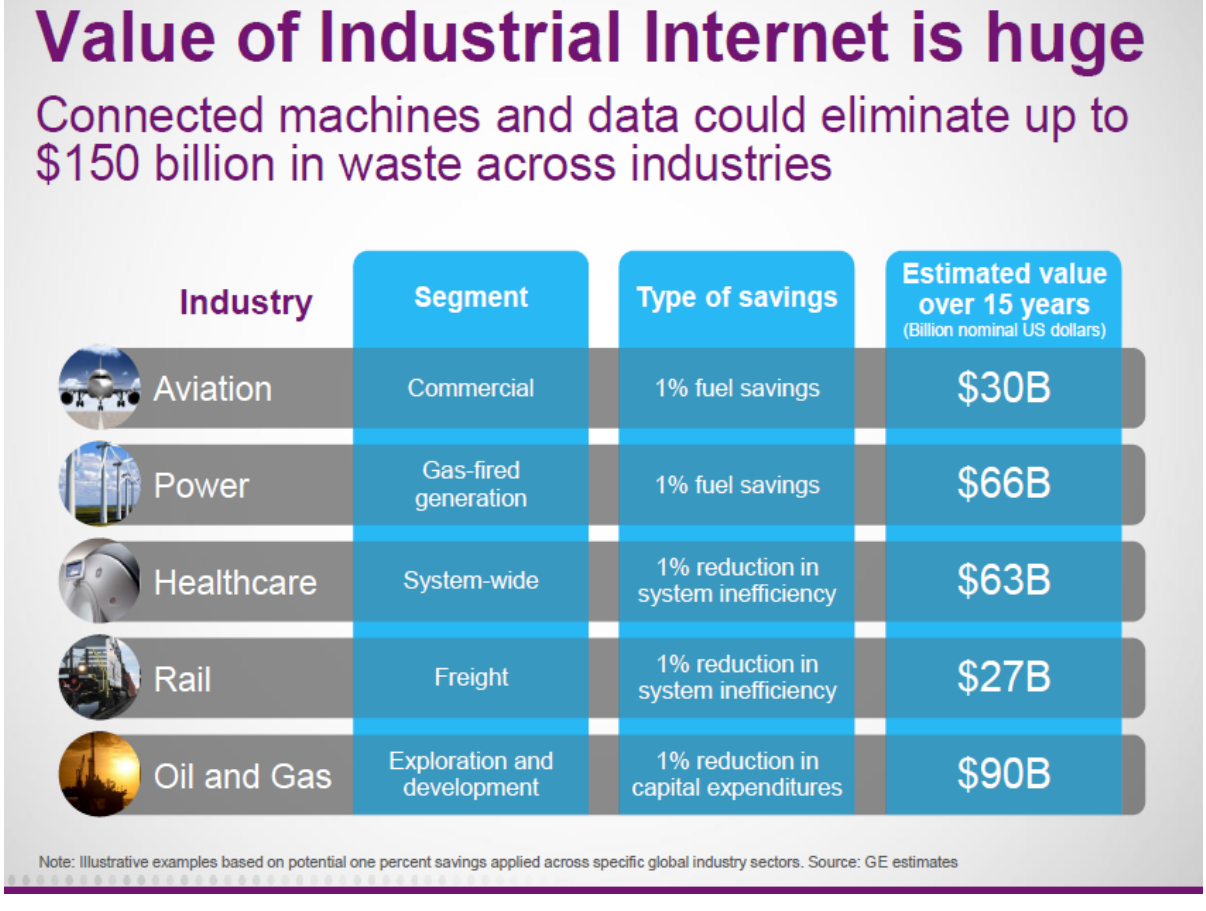
These networks connected with added security, analytics, and management capabilities. This will allow IoT to become even more powerful in what it can help people achieve.

The Future of IoT



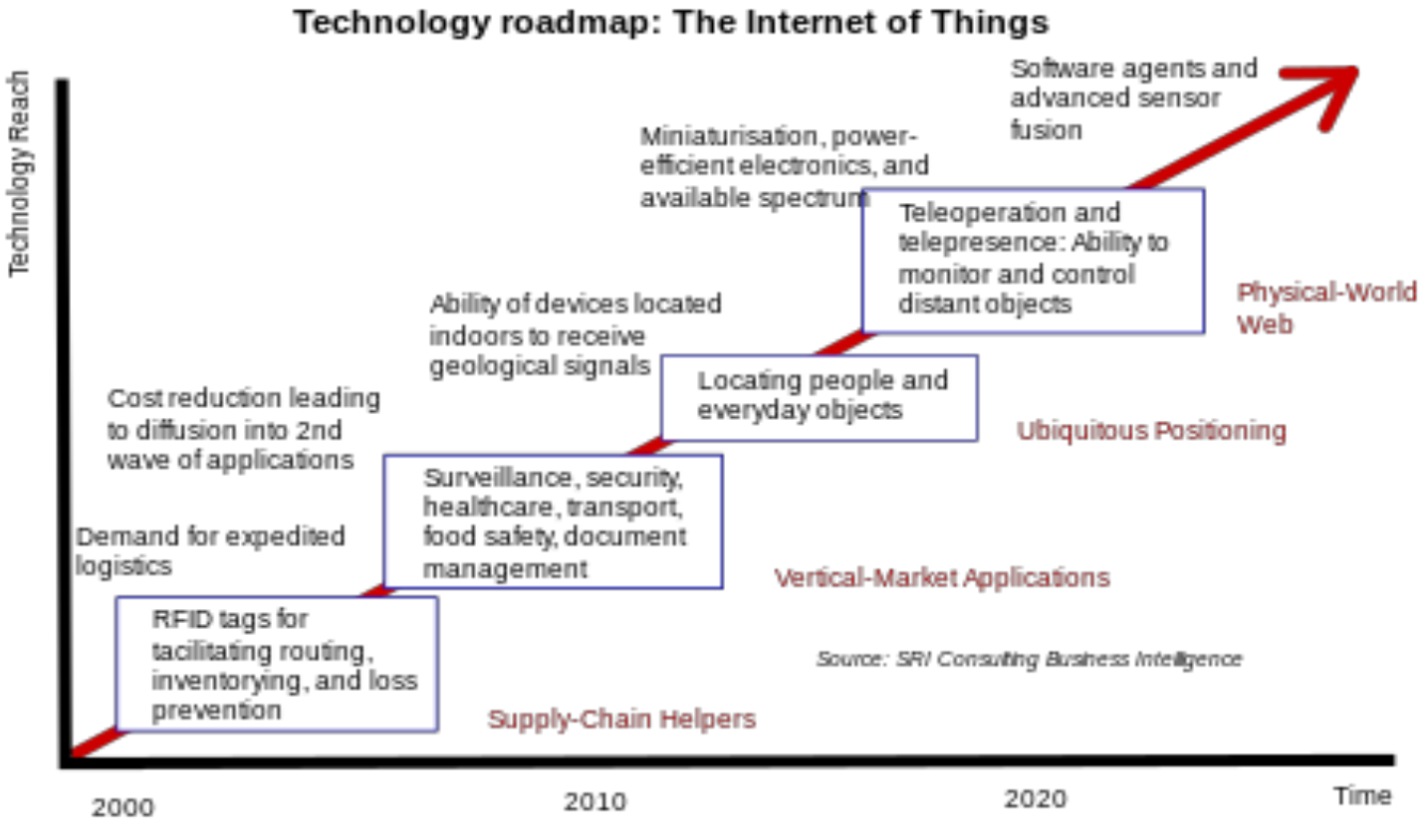
"The Sky's not the limit. It's only the beginning with IoT."

The Potential of IoT

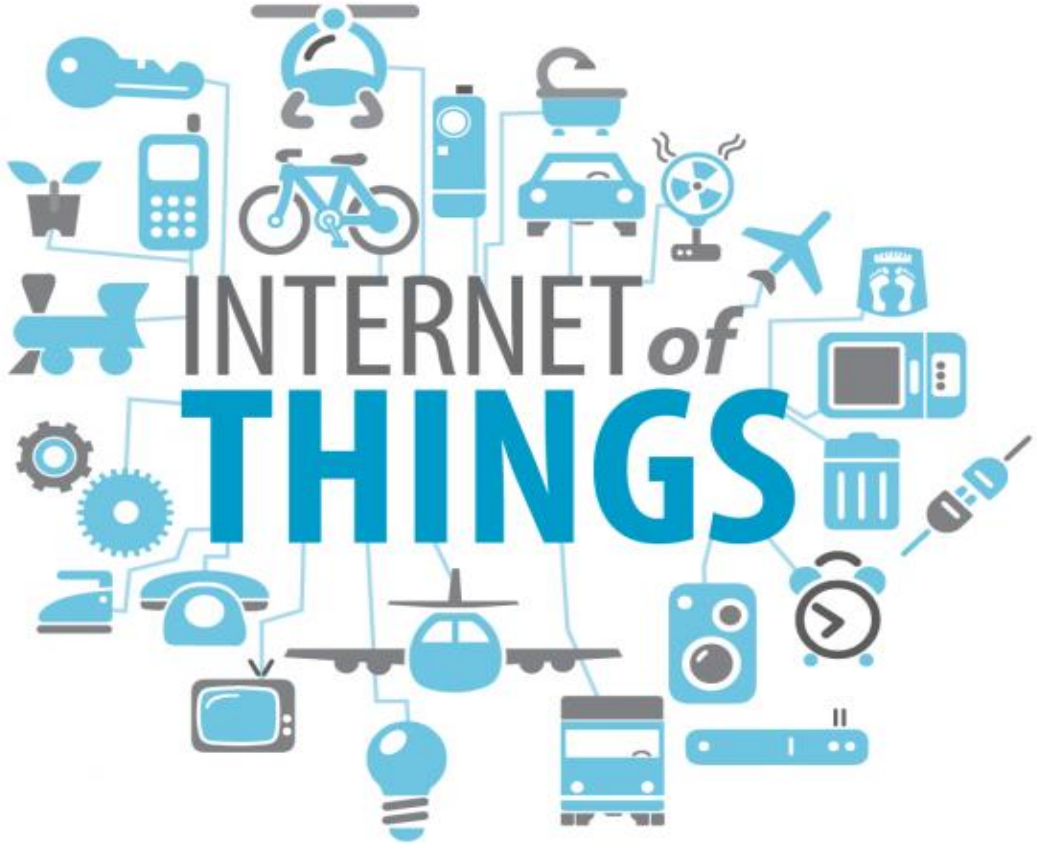


GE's estimates on potential of just ONE percent savings applied using IoT across global industry sectors.

Technology roadmap of IoT



Applications of IoT



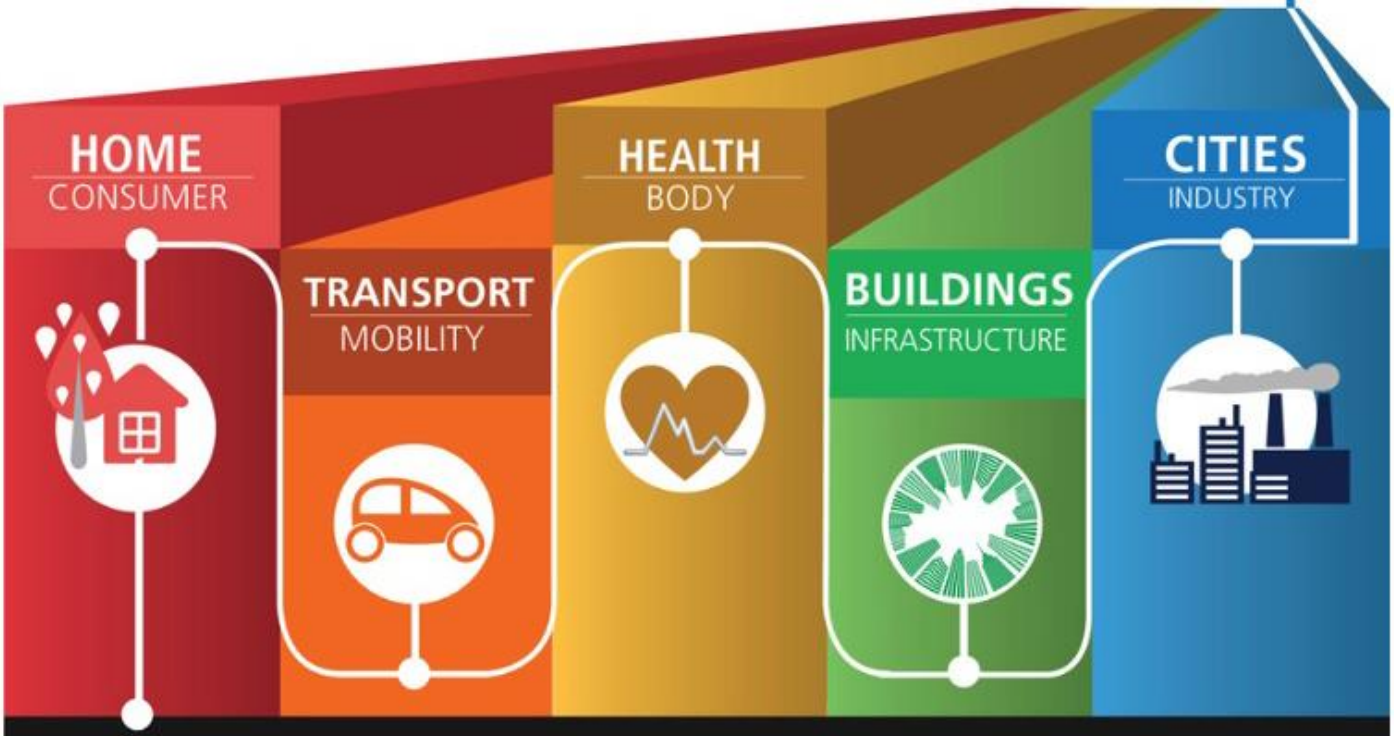
"The Ultimate Goal of IOT is to Automate Human Life."

Few Applications of IoT

- ✓Building and Home automation
- ✓Manufacturing
- ✓Medical and Healthcare systems
- ✓Media
- ✓Environmental monitoring
- ✓Infrastructure management
- ✓Energy management
- ✓Transportation
- ✓Better quality of life for elderly
- ✓… … …

You name it, and you will have it in IoT!

TO ➡ DIVERSE APPLICATIONS



Light bulbs
Security
Pet Feeding
Irrigation Controller
Smoke Alarm
Refrigerator
Infotainment
Washer / Dryer
Stove
Energy Monitoring

Traffic routing
Telematics
Package Monitoring
Smart Parking
Insurance Adjustments
Supply Chain
Shipping
Public Transport
Airlines
Trains

Patient Care
Elderly Monitoring
Remote Diagnostic
Equipment Monitoring
Hospital Hygiene
Bio Wearables
Food sensors

HVAC
Security
Lighting
Electrical
Transit
Emergency Alerts
Structural Integrity
Occupancy
Energy Credits

Electrical Distribution
Maintenance
Surveillance
Signage
Utilities / Smart Grid
Emergency Services
Waste Management

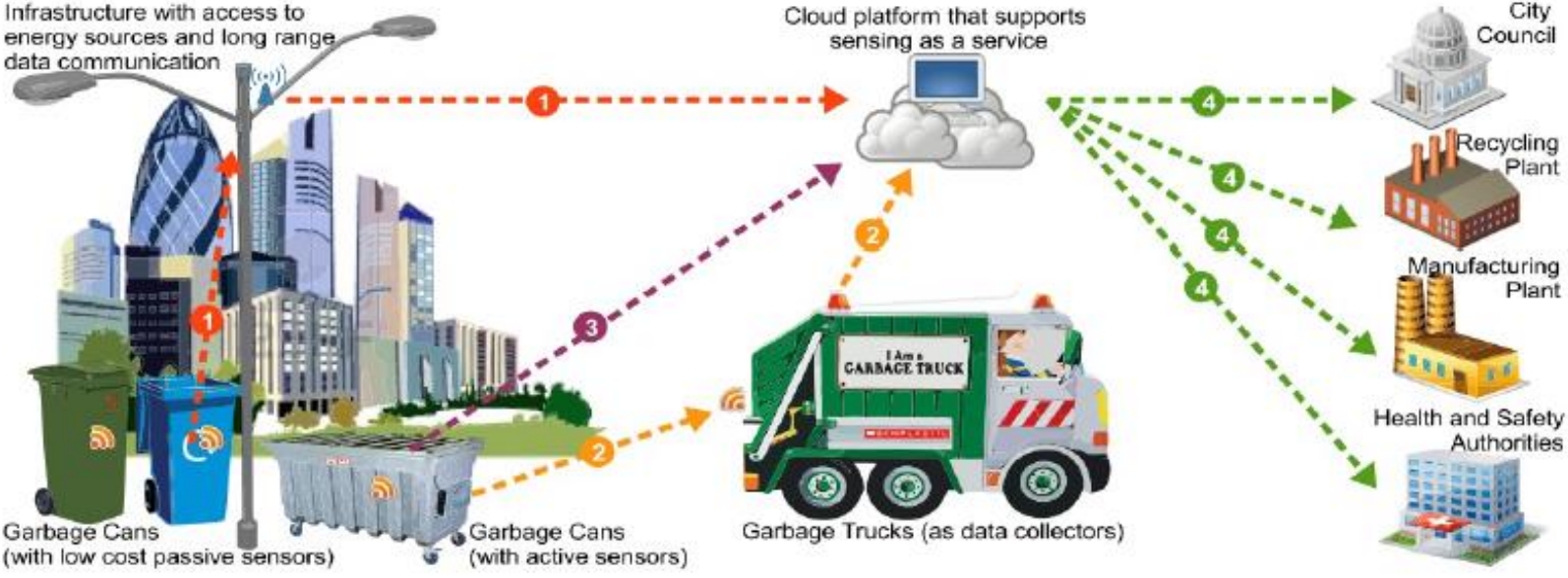
Smart Parking

Create **USD 41Billion** by providing visibility into the availability of parking spaces across the city.

Residents can identify and reserve the closest available space, traffic wardens can identify non-compliant usage, and municipalities can introduce demand-based pricing.

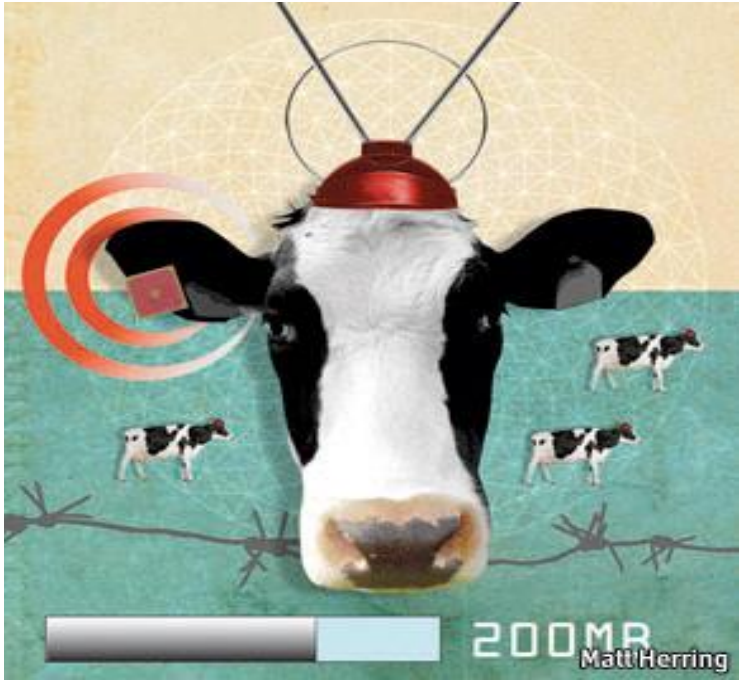
[Source: http://www.telecomreseller.com/2014/01/11/cisco-study-says-ioe-can-create-savings/]

Efficient Waste Management in Smart Cities Supported by the Sensing-as-a-Service



[Source: "Sensing as a Service Model for Smart Cities Supported by Internet of Things", Charith Perera et. al., Transactions on Emerging Telecommunications Technology, 2014]

Sensors in even the holy cow!



In the world of IoT, even the cows will be connected and monitored. Sensors are implanted in the ears of cattle. This allows farmers to monitor cows' health and track their movements, ensuring a healthier, more plentiful supply of milk and meat for people to consume. On average, each cow generates about 200 MB of information per year.

IOT Application Scenario - Shopping

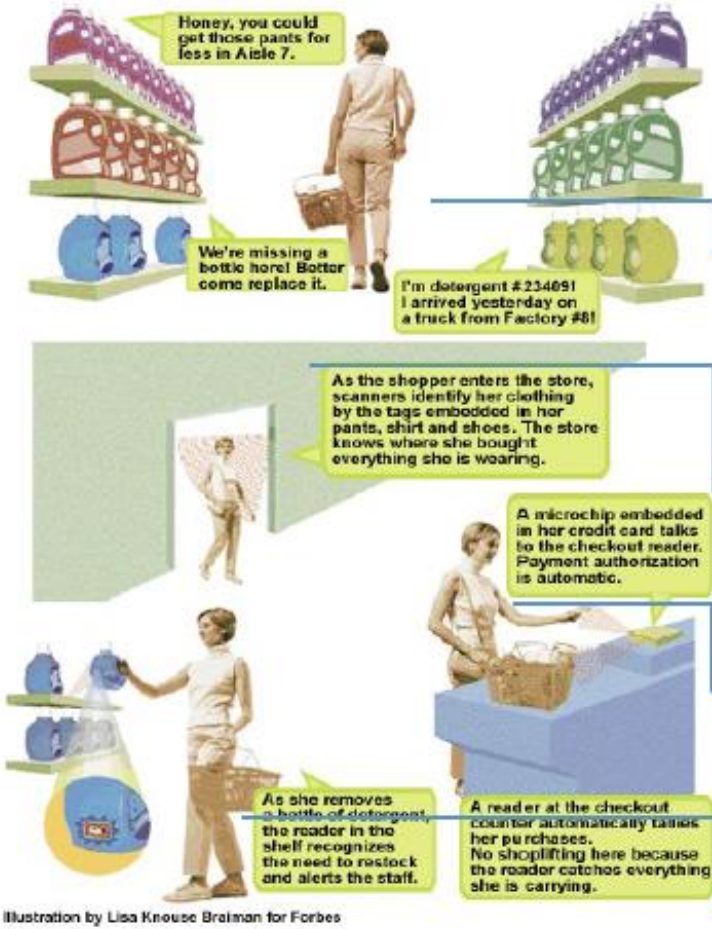


Illustration by Lisa Kreuse Breiman for Forbes

(2) When shopping in the market, the goods will introduce themselves.

(1) When entering the doors, scanners will identify the tags on her clothing.

(4) When paying for the goods, the microchip of the credit card will communicate with checkout reader.

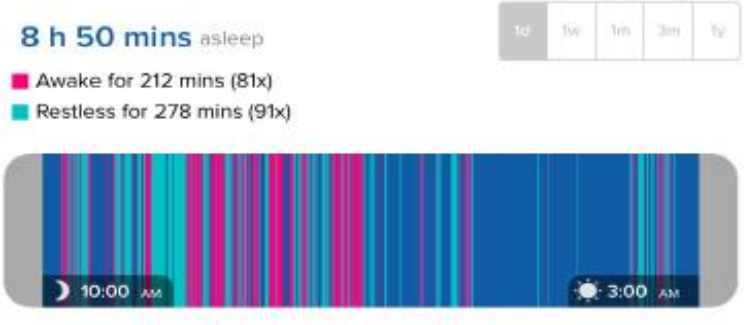
(3) When moving the goods, the reader will tell the staff to put a new one.


HOW MANY STEPS
HAVE YOU
WALKED TODAY?

How Well Do I Sleep?

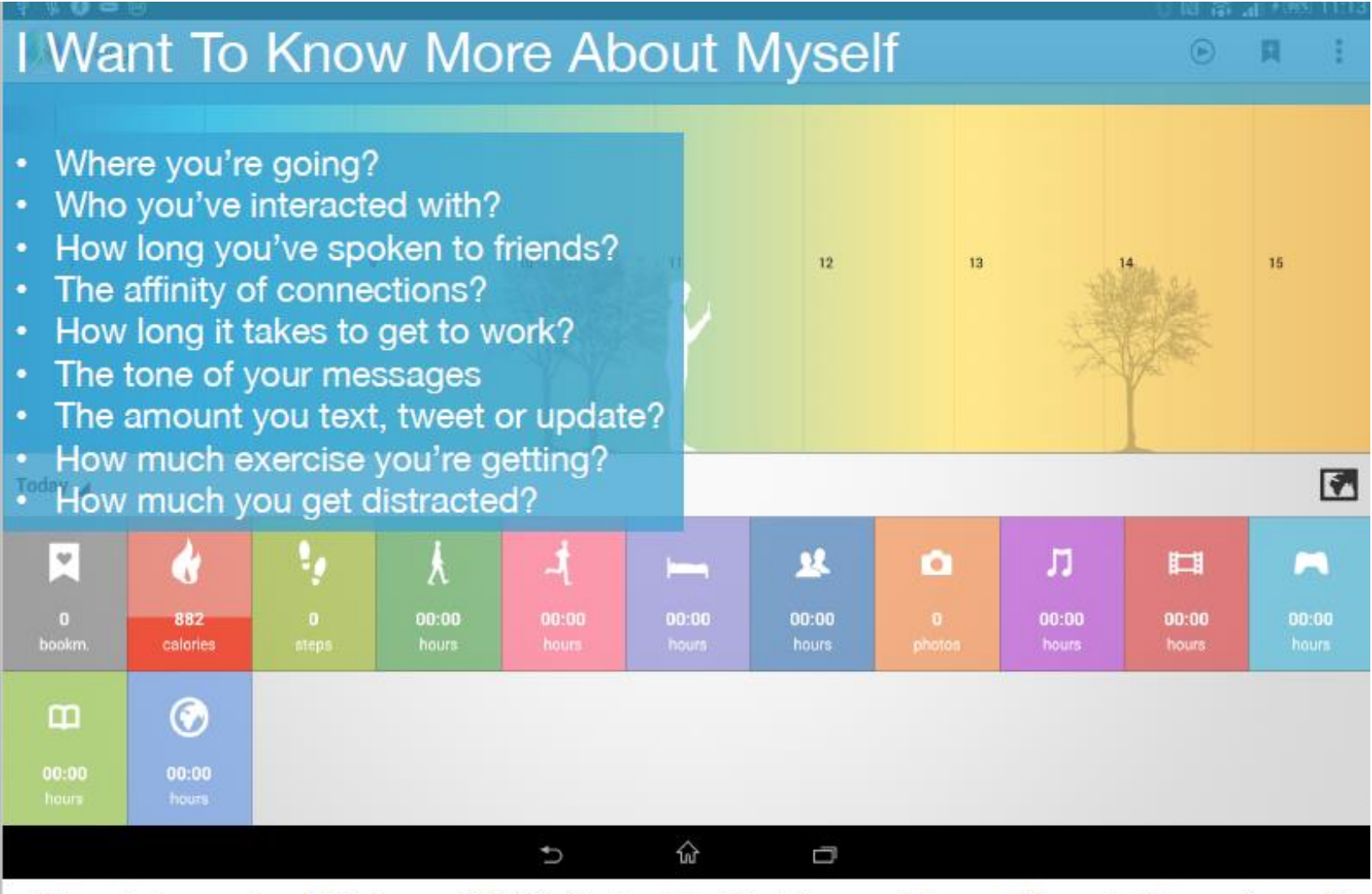
Sleep

You went to bed at	Time to fall asleep	Times awakened	You were in bed for	Actual sleep time
11:00PM	0min	20	6hrs 40min	6hrs 6min



Sleep Stats

fitbit flex
Wireless Activity + Sleep Wristband



Can Internet of Things (IOT) Help Us To Know More About Ourselves?

IoT helps you in LIFE LOGGING

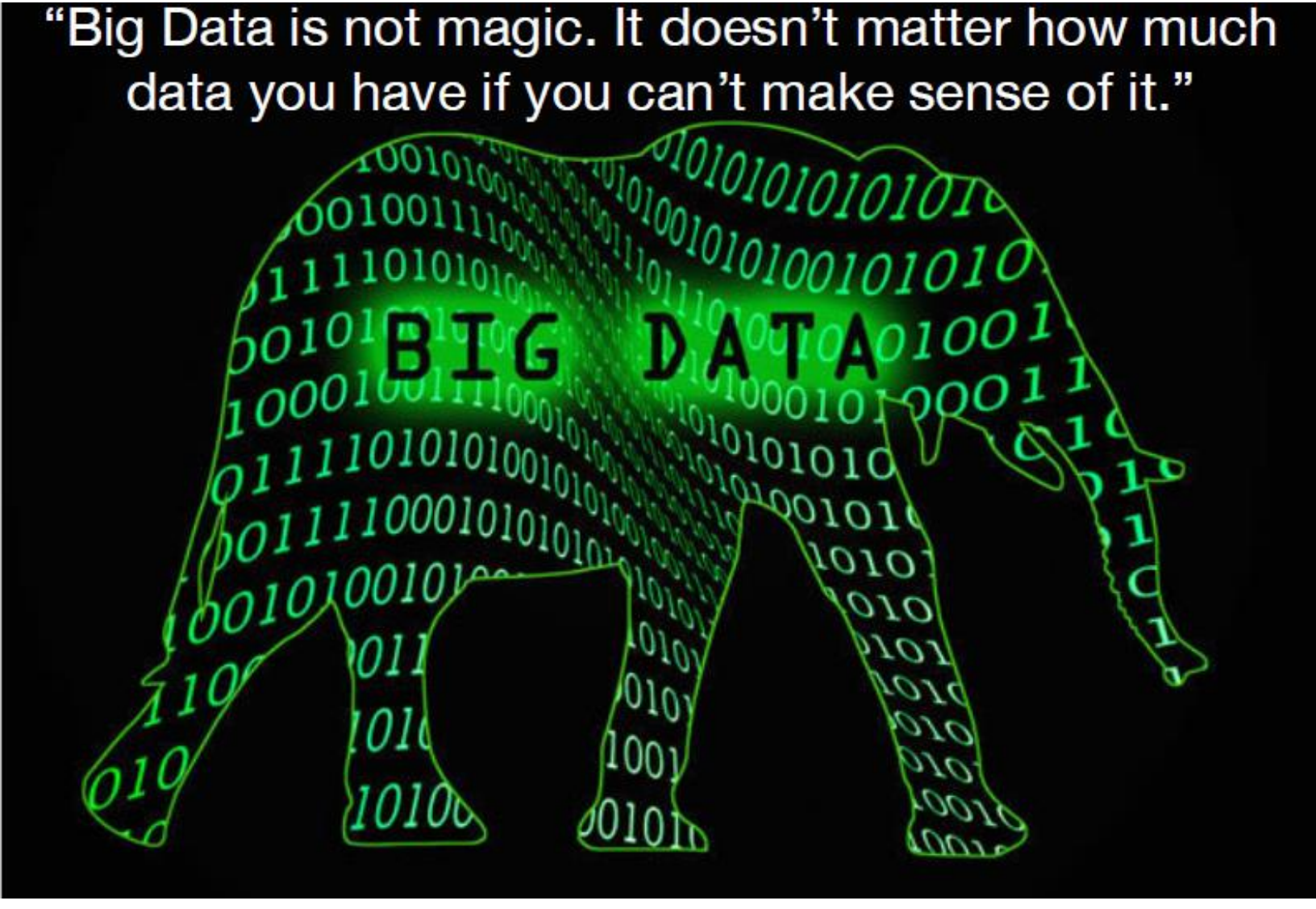
Thought Controlled Computing

The flagship product, MindWave, is a headset that can log into your computer using just your thoughts. Researchers recently used the EEG headset to develop a toy car that can be driven forward with thought.

NeuroSky's smart sensors can also track your heart rate and other bodily metrics and can be embedded in the next generation of wearable devices.

"We make it possible for millions of consumers to capture and quantify critical health and wellness data," Yang (CEO of Softbank) said. Softbank is the funder.

[Source: http://venturebeat.com/2013/11/04/next-step-for-wearables-neurosky-brings-its-smart-sensors-to-health-fitness/]


"Big Data is not magic. It doesn't matter how much data you have if you can't make sense of it."
BIG DATA

Criticisms and Controversies of IoT

Scholars and social observers and pessimists have doubts about the promises of the ubiquitous computing revolution, in the areas as:

- Privacy
- Security
- Autonomy and Control
- Social control
- Political manipulation
- Design
- Environmental impact
- Influences human moral decision making


SUMMARY
Internet of Things
Only Tip of an Iceberg