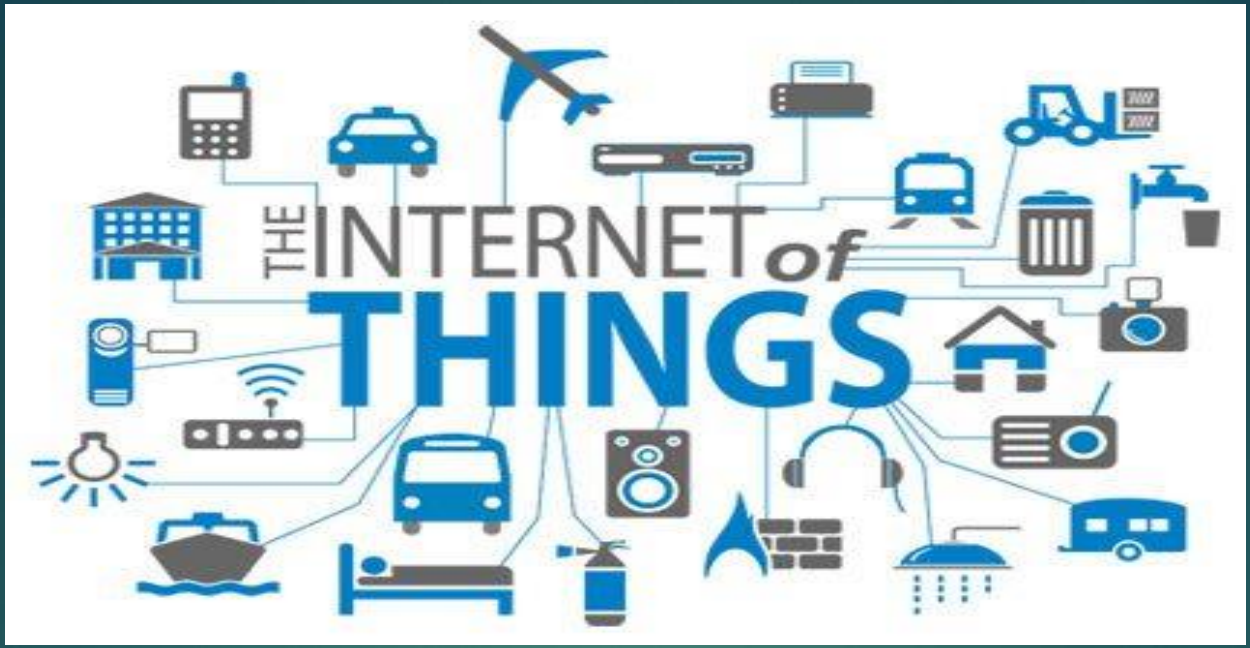



# Internet of Things

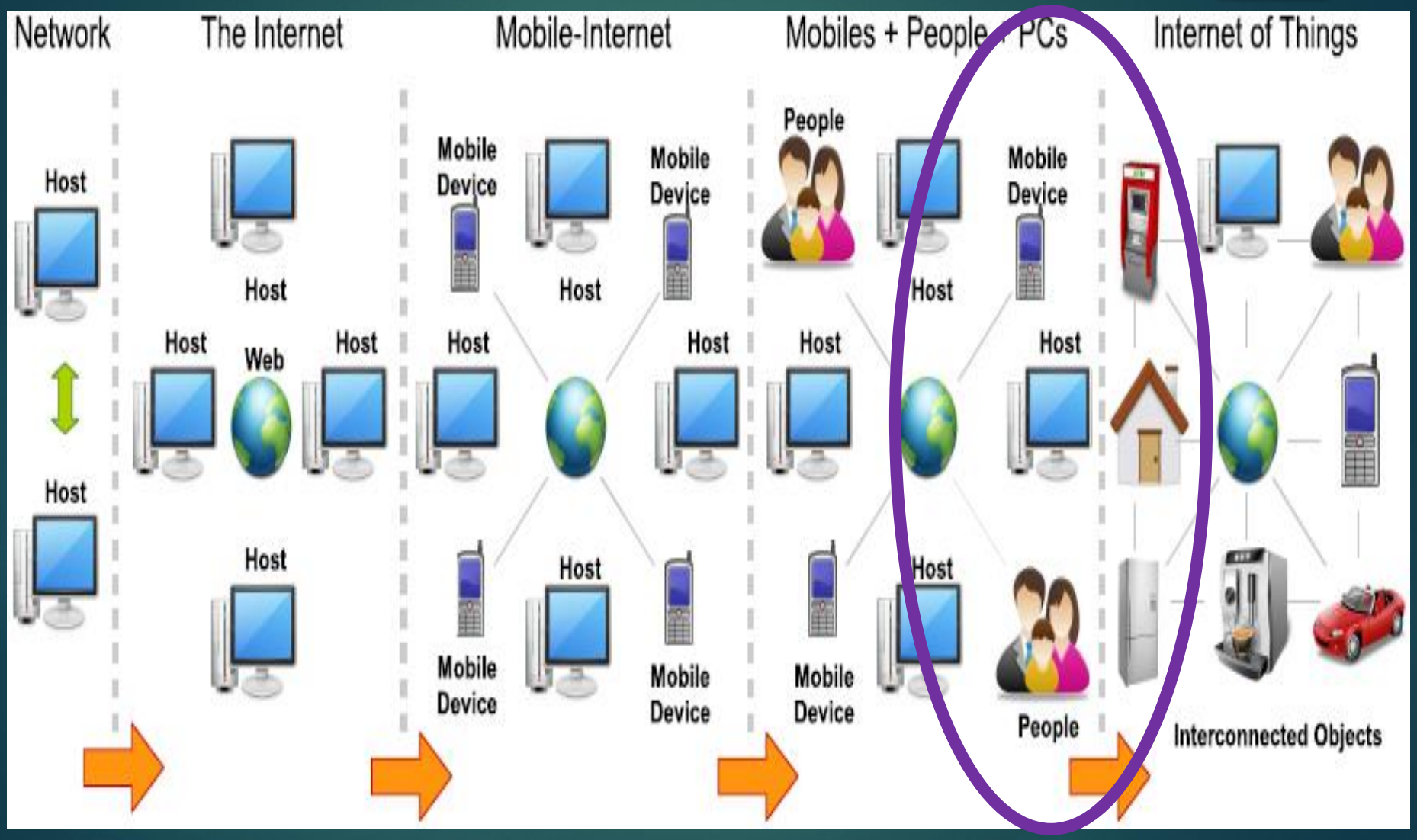
# What is IOT?



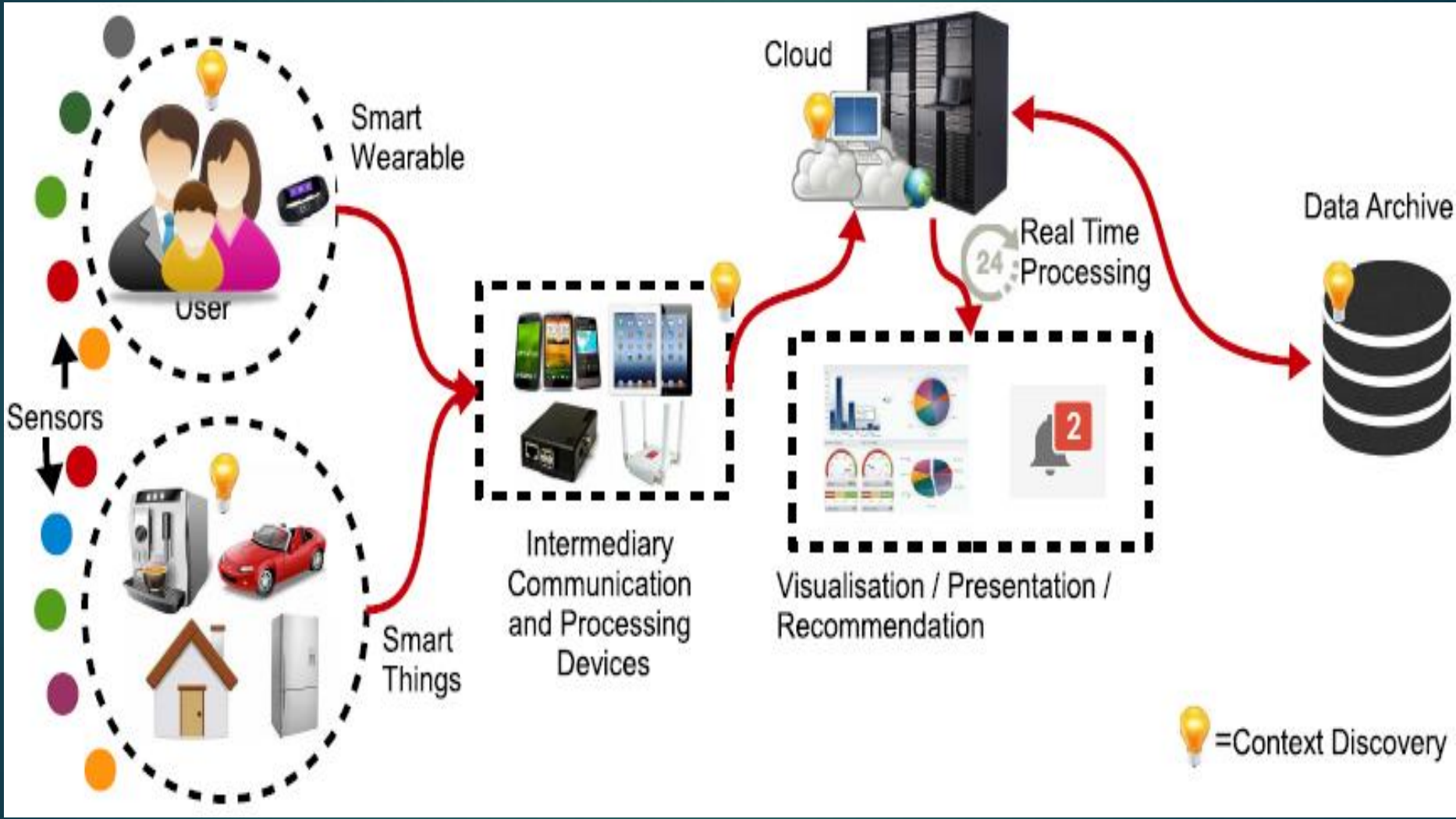
- **The Internet of Things is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.**
- **It allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.**

- "**Things**," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist fire-fighters in search and rescue operations.
- These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

# Where are we now in 2021



# IoT ecosystem



# Ecosystem components

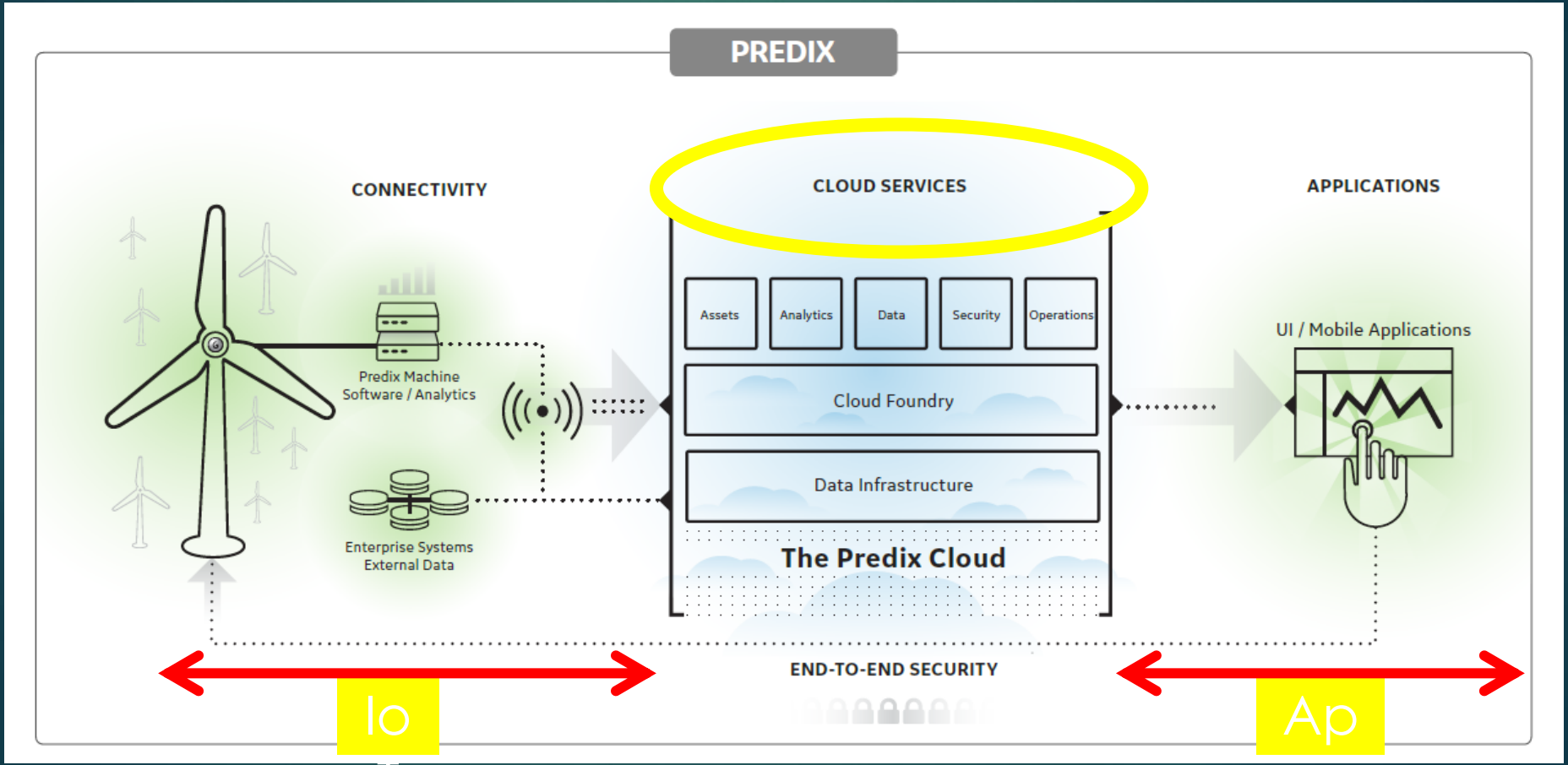
- Device manufacturers
  - Sensors/actuators, smart appliances
- Network service providers
  - Operators, NMS providers
- Cloud service providers
  - Data centres, dBase, dWarehouse
- Platform providers
  - Middleware providers, SDKs
- 3rd party application developers
  - Analytics providers, tools, APIs

IoT

App

# Example

- General Electric (GE) deploys sensors in its jet engines, turbines, and wind farms. By analyzing data in real time, GE saves time and money associated with predictive maintenance.




I p

# Broad research directions

| | Before 2010 | 2010–2015 | 2015–2020 | Beyond 2020 |
|---|---|---|---|---|
| Hardware | • RFID tags and some sensors<br>• Sensors built into mobile devices<br>• NFC in mobile phones<br>• Smaller and cheaper MEMs technology | • Multiprotocol, multistandards readers<br>• More sensors and actuators<br>• Secure, low-cost tags (e.g., Silent Tags) | • Smart sensors (biochemical)<br>• More sensors and actuators (tiny sensors) | • Nanotechnology and new materials |
| Data Processing | • Serial data processing<br>• Parallel data processing<br>• Quality of services | • Energy, frequency spectrum-aware data processing<br>• Data processing context adaptable | • Context-aware data processing and data responses | • Cognitive processing and optimization |

Source: Adapted from Sundmaeker, Guillemin, Friess, and Woelfflé (2010, p. 74)

# Research directions (contd.)

| | Before 2010 | 2010–2015 | 2015–2020 | Beyond 2020 |
|---|---|---|---|---|
| Network | • Sensor networks | • Self-aware and self-organizing networks<br>• Sensor network location transparency<br>• Delay-tolerant networks<br>• Storage networks and power networks<br>• Hybrid networking technologies | • Network context awareness | • Network cognition<br>• Self-learning, self-repairing networks |
| Software and Algorithms | • Relational database integration<br>• IoT-oriented RDBMS<br>• Event-based platforms<br>• Sensor middleware<br>• Sensor networks middleware<br>• Proximity/ Localization algorithms | • Large-scale, open semantic software modules<br>• Composable algorithms<br>• Next generation IoT-based social software<br>• Next generation IoT-based enterprise applications | • Goal-oriented software<br>• Distributed intelligence, problem solving<br>• Things-to-Things collaboration environments | • User-oriented software<br>• The invisible IoT<br>• Easy-to-deploy IoT software<br>• Things-to-Humans collaboration<br>• IoT 4 All |

# 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, blue-tooth, and digital watermarking.

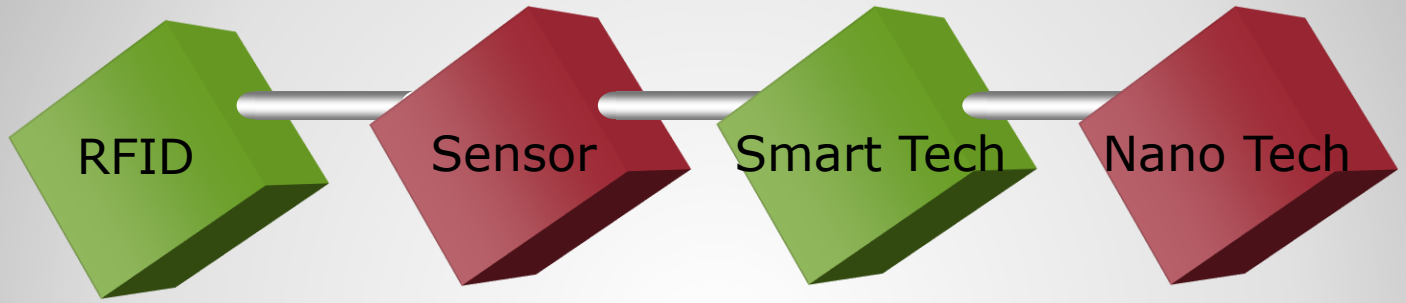
# How IOT Works?



Internet of Things is not the result of a single novel technology; instead, several complementary technical developments provide capabilities that taken together help to bridge the gap between the virtual and physical world. These capabilities include:

- ***Communication and cooperation***
- ***Addressability***
- ***Identification***
- ***Sensing***
- ***Actuation***
- ***Embedded information processing***
- ***Localization***
- ***User interfaces***

# How IoT Works?




| RFID | Sensor | Smart Tech | Nano Tech |
|---|---|---|---|
| To identify and track the data of things | To collect and process the data to detect the changes in the physical status of things | To enhance the power of the network by devolving processing capabilities to different part of the network. | To make the smaller and smaller things have the ability to connect and interact. |

# The Structure of IoT

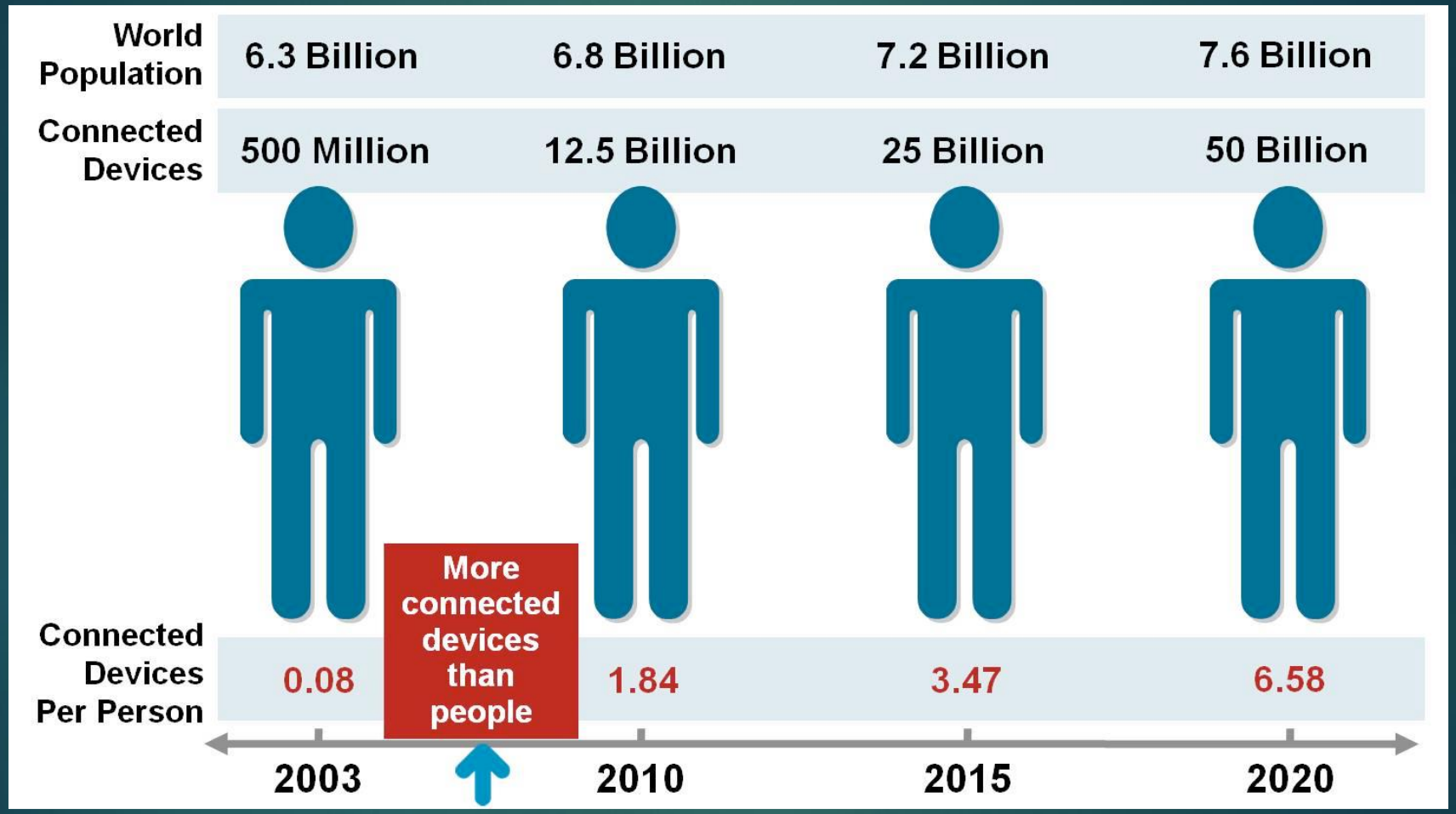


The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.

- ***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.

# Current Status & Future Prospect of IoT

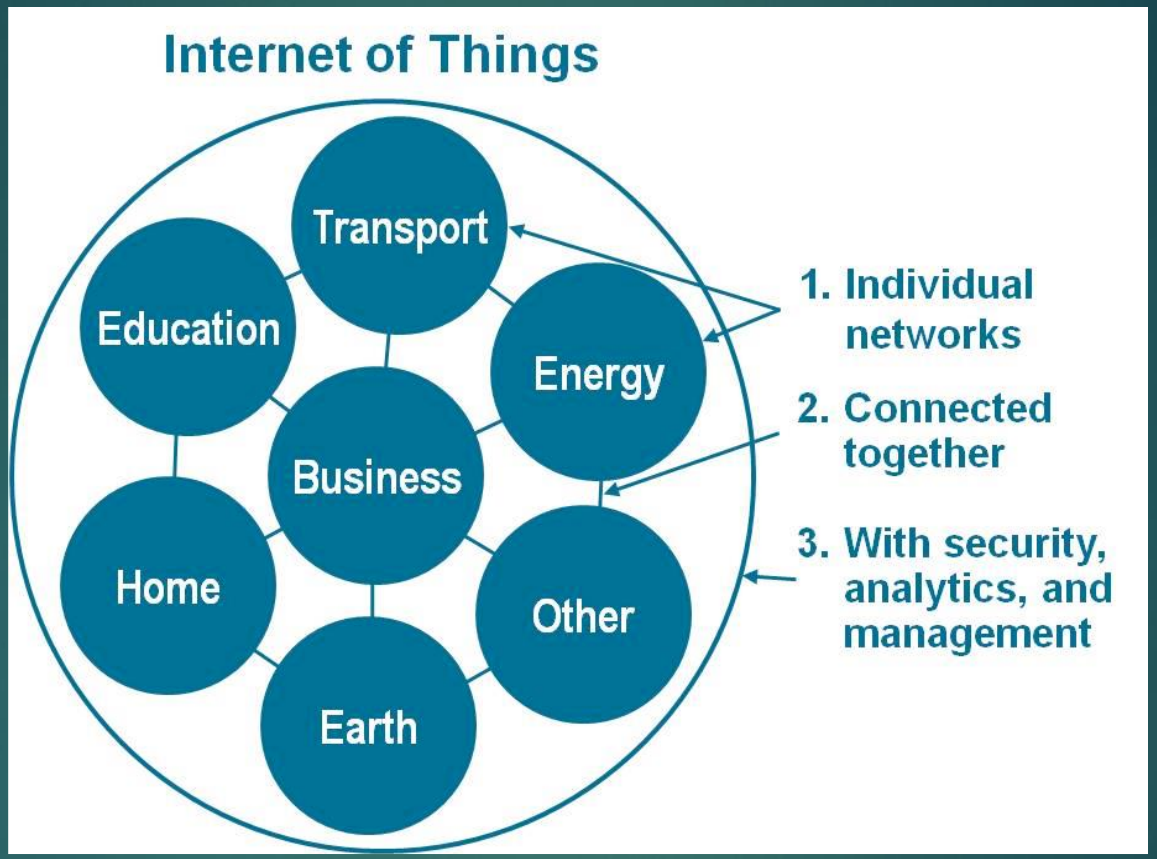





*"Change is the only thing permanent in this world"*

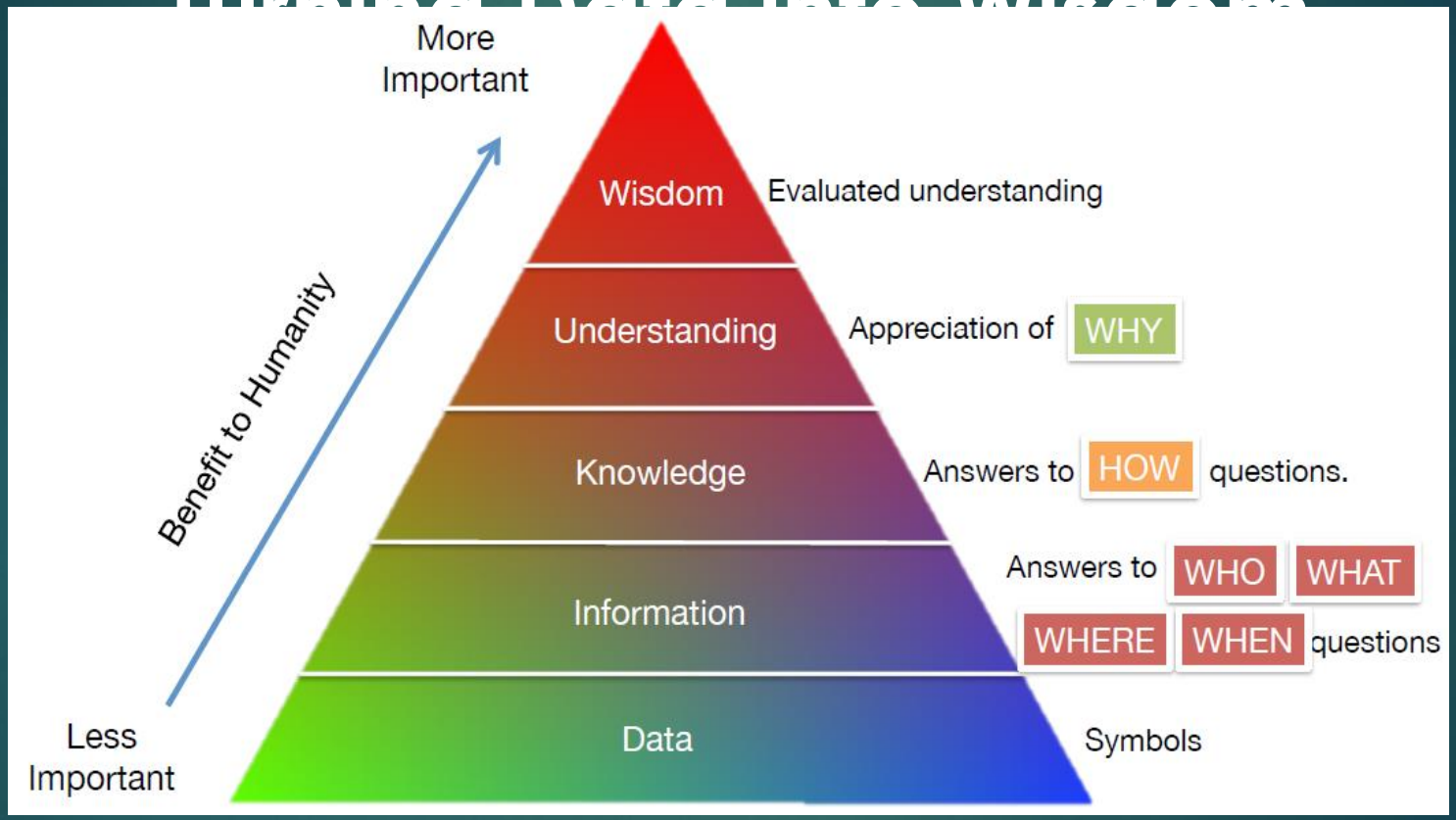
# IoT as a Network of Networks:






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.

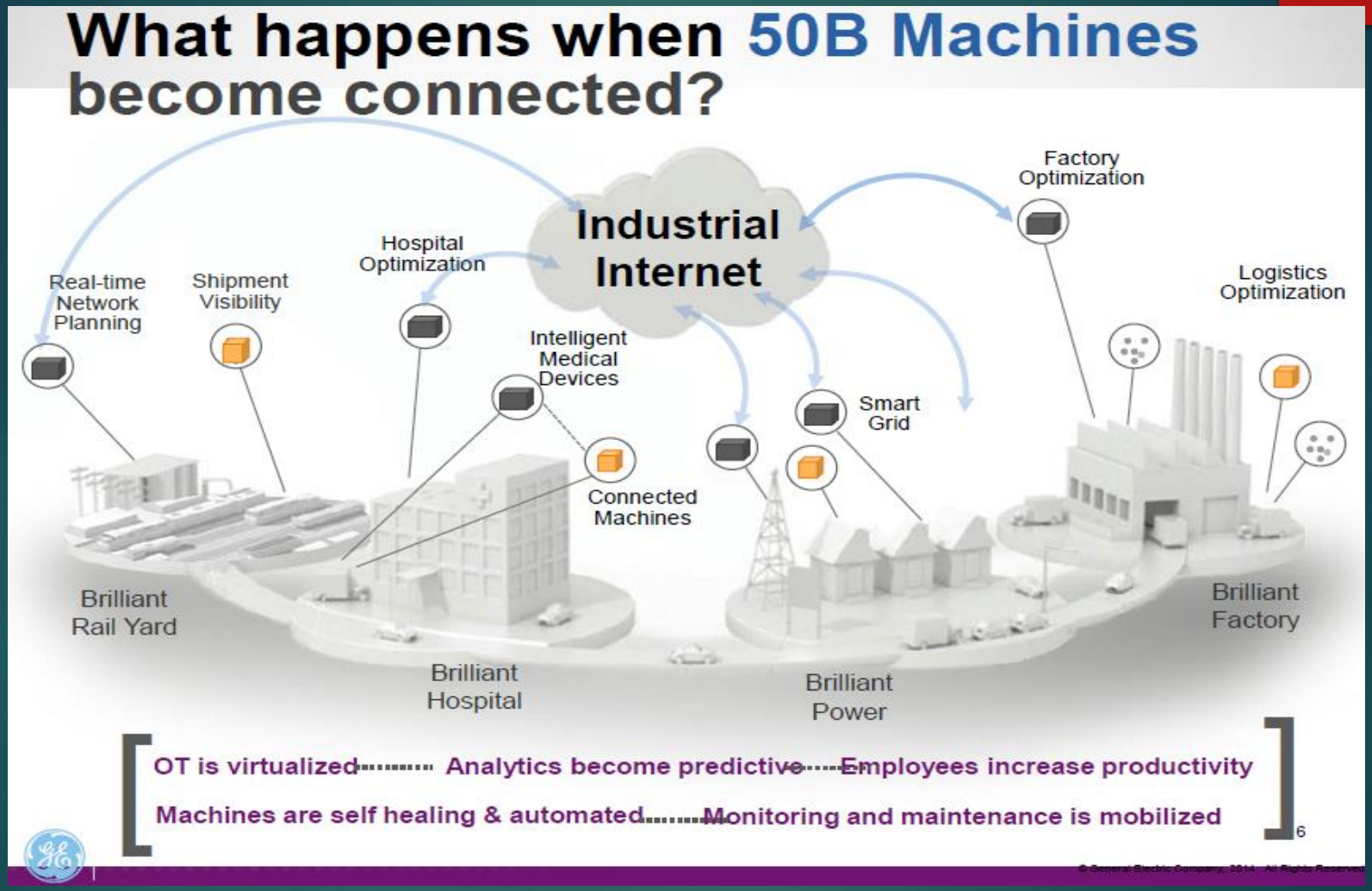
# Knowledge Management – Turning Data into Wisdom




The more data that is created, the better understanding and wisdom people can obtain.

# The Future of IoT






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

# The Potential of IoT



## Value of Industrial Internet is huge

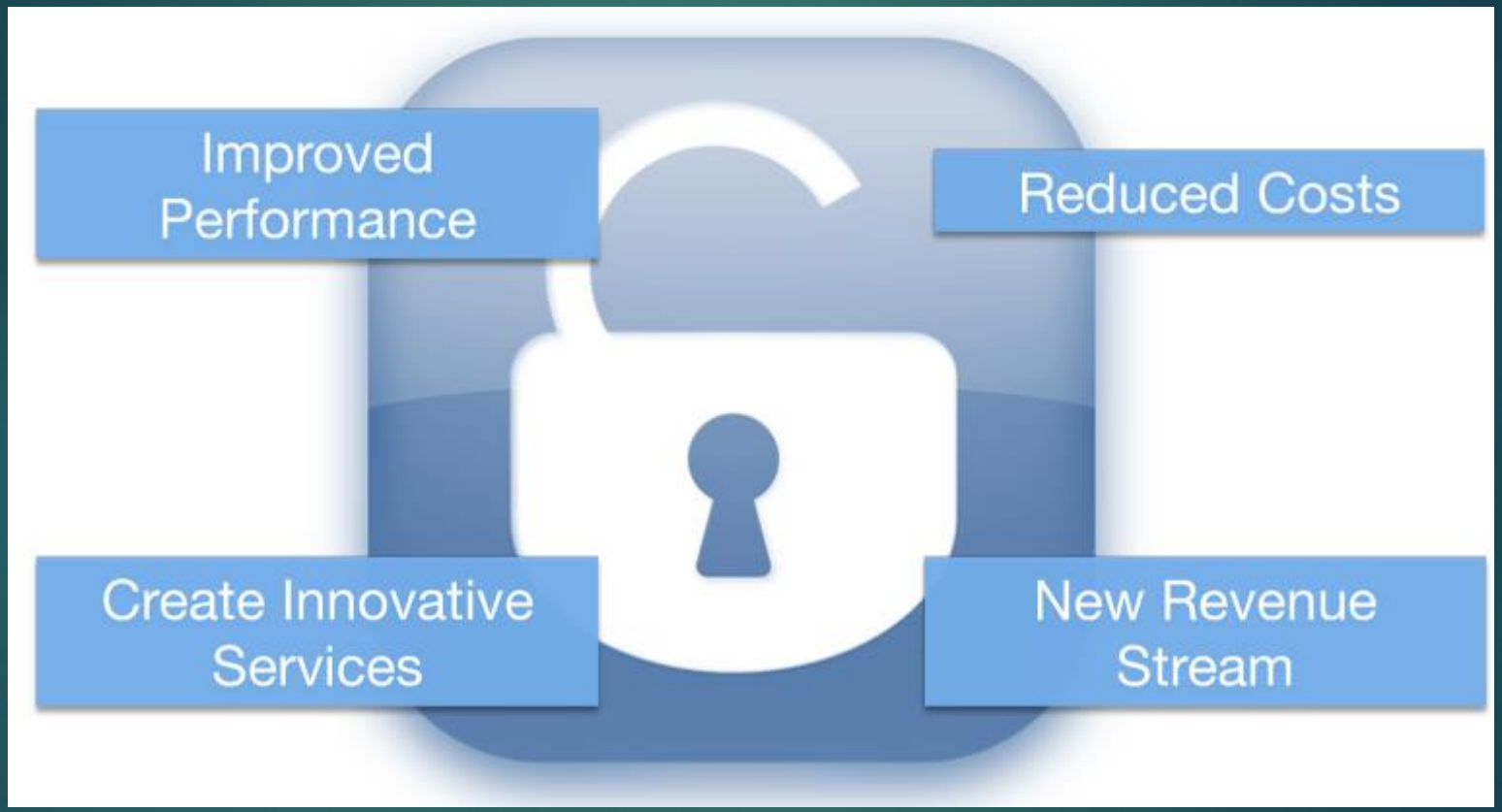
Connected machines and data could eliminate up to $150 billion in waste across industries

| Industry | Segment | Type of savings | Estimated value over 15 years (Billion nominal US dollars) |
|---|---|---|---|
| Aviation | Commercial | 1% fuel savings | $30B |
| Power | Gas-fired generation | 1% fuel savings | $66B |
| Healthcare | System-wide | 1% reduction in system inefficiency | $63B |
| Rail | Freight | 1% reduction in system inefficiency | $27B |
| Oil and Gas | Exploration and development | 1% reduction in capital expenditures | $90B |

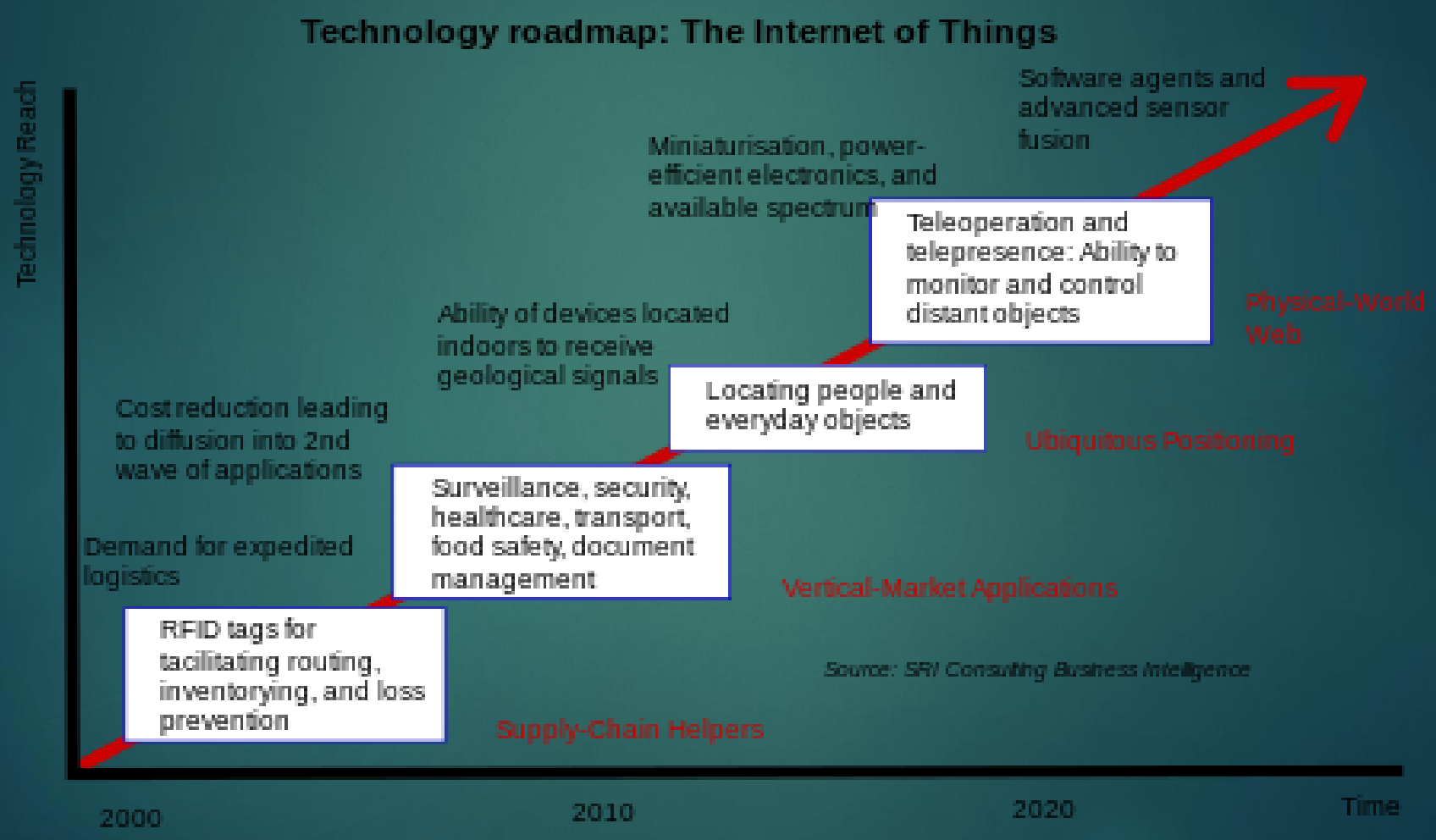
Note: Illustrative examples based on potential one percent savings applied across specific global industry sectors. Source: GE estimates

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

# Unlock the Massive potential of IoT

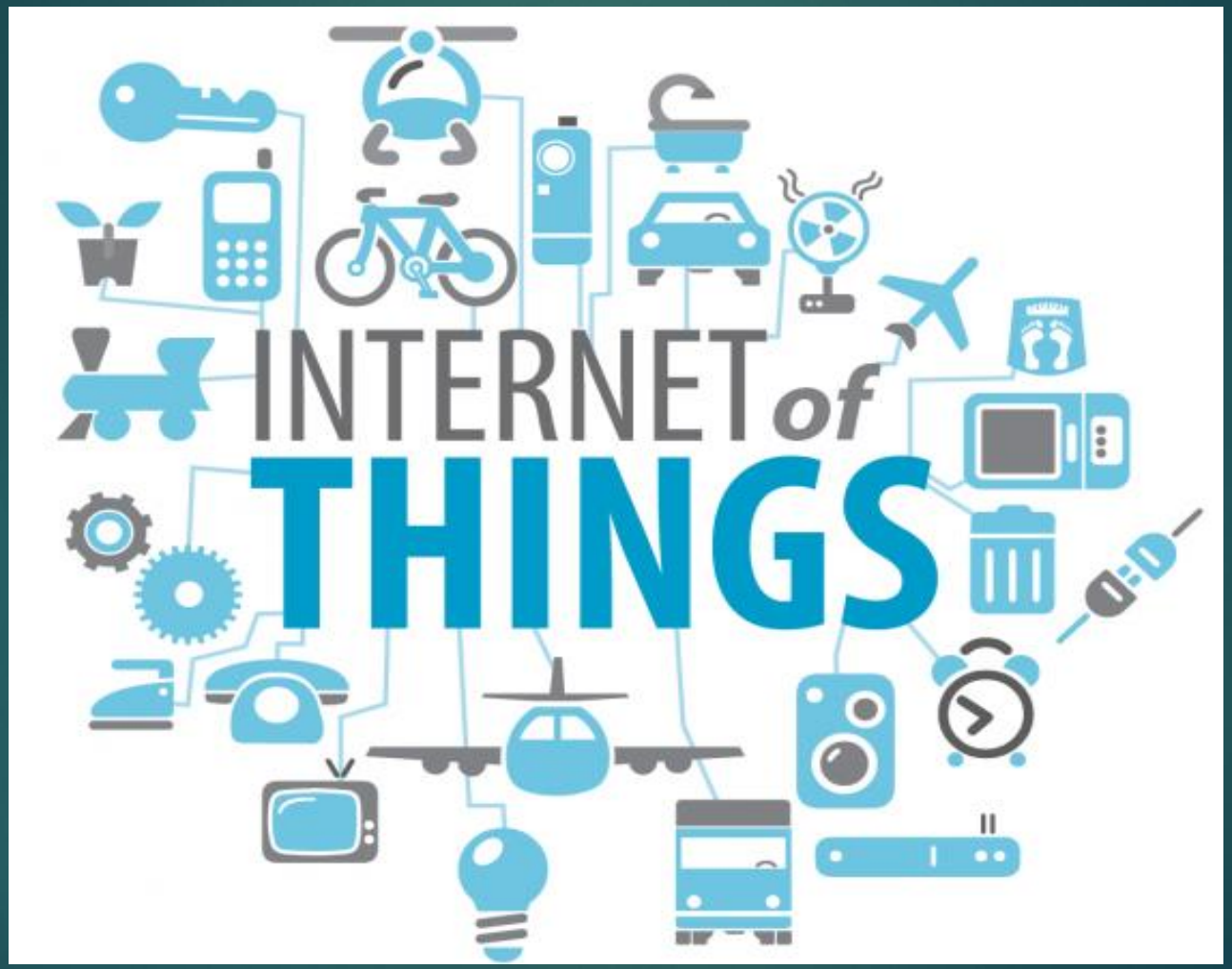


# Technology roadmap of IoT



# Applications of IoT






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

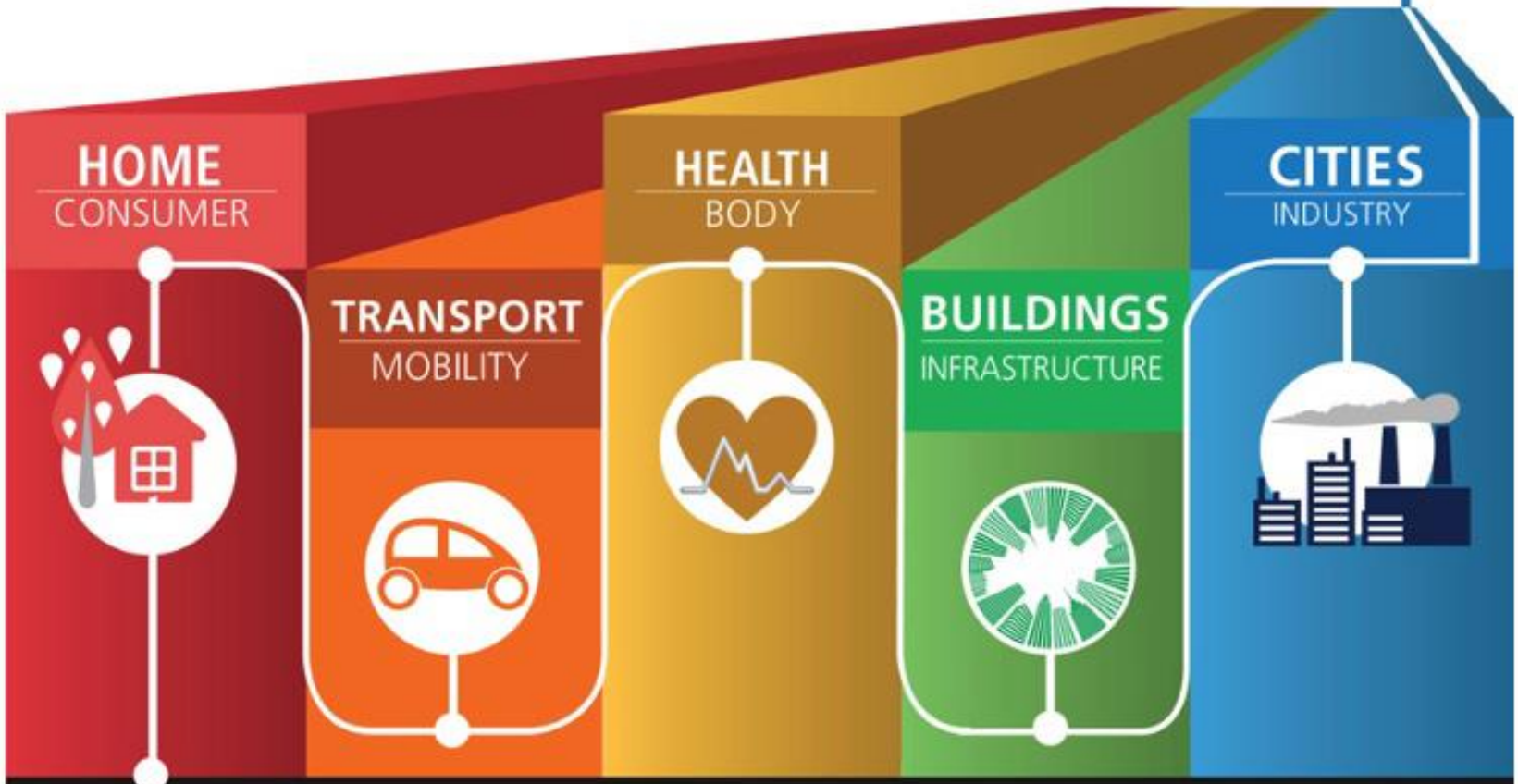
# Few Applications of IoT



- ✓ 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*

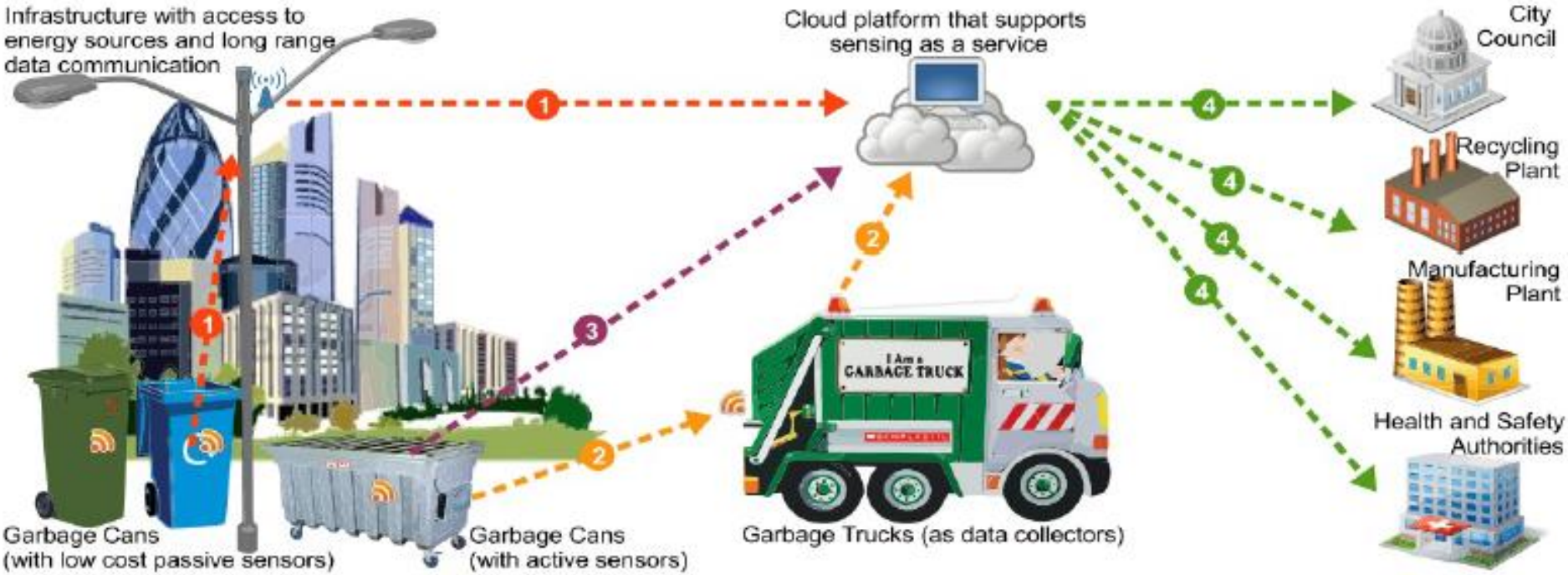
# Smart Parking

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

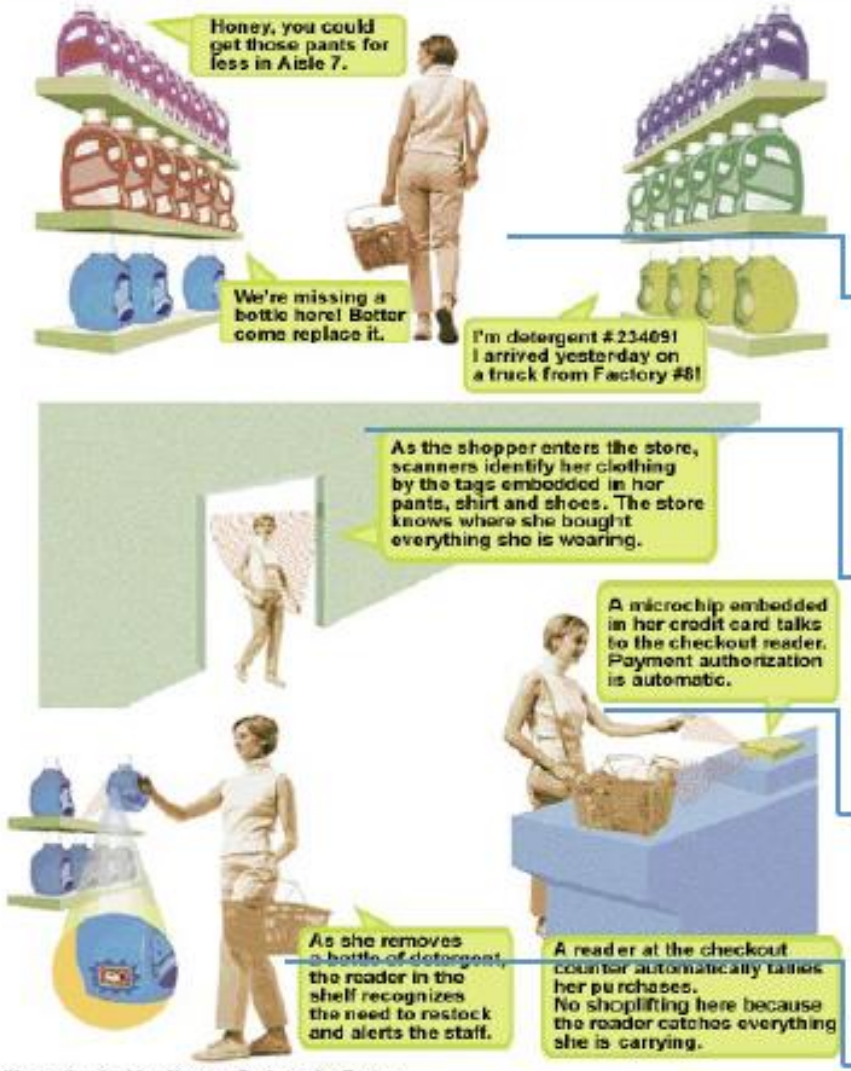



Illustration by Lisa Knouse Braiman for Forbes

(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.

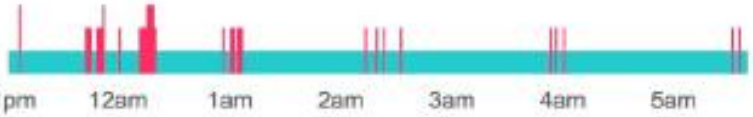
# How Well Do I Sleep?

## Sleep

zzzZ

YOUR SLEEP EFFICIENCY
92%

Your sleep pattern asleep awake




| 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

Time asleep over the past 30 days in hours

Times awoken over the past 30 days

**8 h 50 mins** asleep

1d 1w 1m 3m 1y

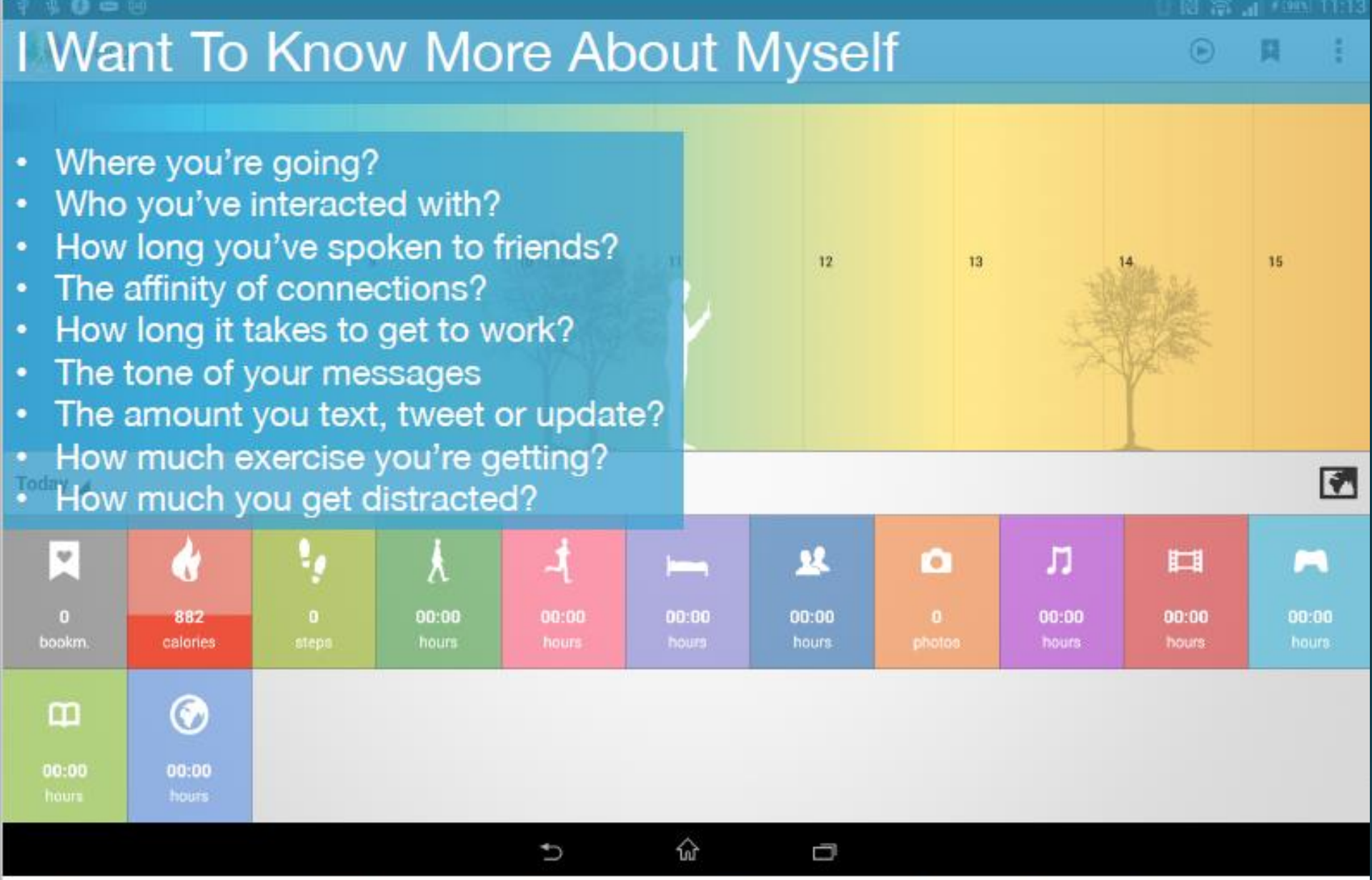
- Awake for 212 mins (81x)
- Restless for 278 mins (91x)

Thursday, February 27

fitbit flex
Wireless Activity + Sleep Wristband

# I Want To Know More About Myself

- Where you're going?
- Who you've interacted with?
- How long you've spoken to friends?
- The affinity of connections?
- How long it takes to get to work?
- The tone of your messages
- The amount you text, tweet or update?
- How much exercise you're getting?
- How much you get distracted?




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/ ]

# TECHNOLOGICAL CHALLENGES OF IOT

At present IoT is faced with many challenges, such as:

- Scalability
- Technological Standardization
- Inter operability
- Discovery
- Software complexity
- Data volumes and interpretation
- Power Supply
- Interaction and short range communication
- Wireless communication
- Fault tolerance

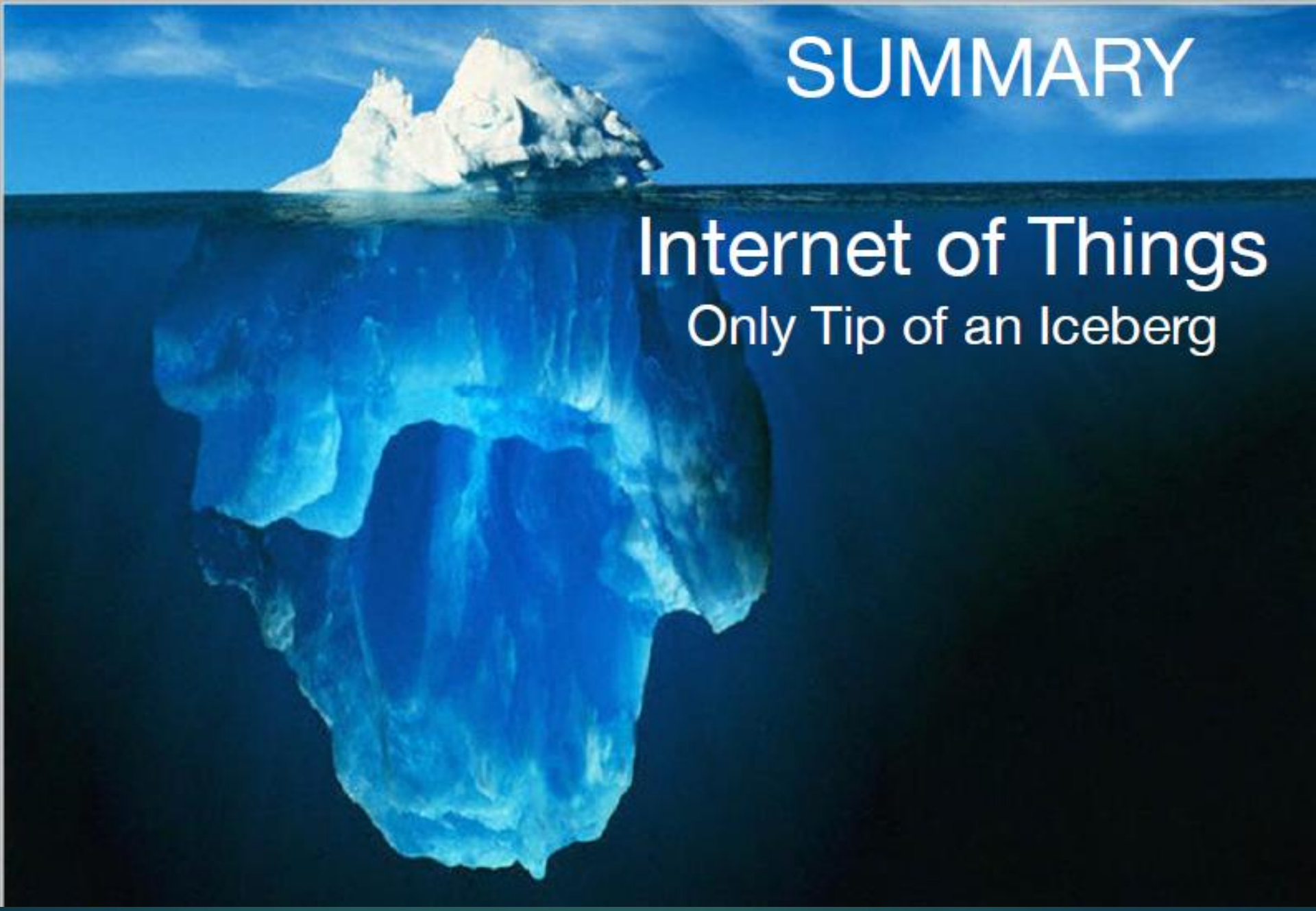
"Big Data is not magic. It doesn't matter how much data you have if you can't make sense of it."

# 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

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3. Cisco whitepaper, "The Internet of Things" - How the Next Evolution of the Internet Is Changing Everything, by Dave Evans, April 2011.
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# THANK YOU