A perspective of the Network of the Future: Smart Computing & Internet of Things

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Outline of Presentation

- Introduction
- What is Internet of Things (IoT)
- Examples of IoT
- Context of IoT
- Challenges in IoT
- Future of IoT

Introduction

- **First our phones got smarter.**
- **Now our homes are getting smarter too.**
- **Moving towards a Smart World –IoT**

Connected *Anytime, Anyplace,* with *Anything* and *Anyone*
Ideally using *Any Path*, Any Network and *Any Service.*

Connected! All the time! Everywhere!

Connecting............ Places ➜ People ➜ Things

Mix of many technology domains:
- **Embedded computing + intelligent computing = >Smart computing**
- **Application software => Smart Devices to create Smart Spaces**
- **Telecom + Data communications => connectivity to Internet => ubiquitous computing**

Shift in people-computing power Ratio
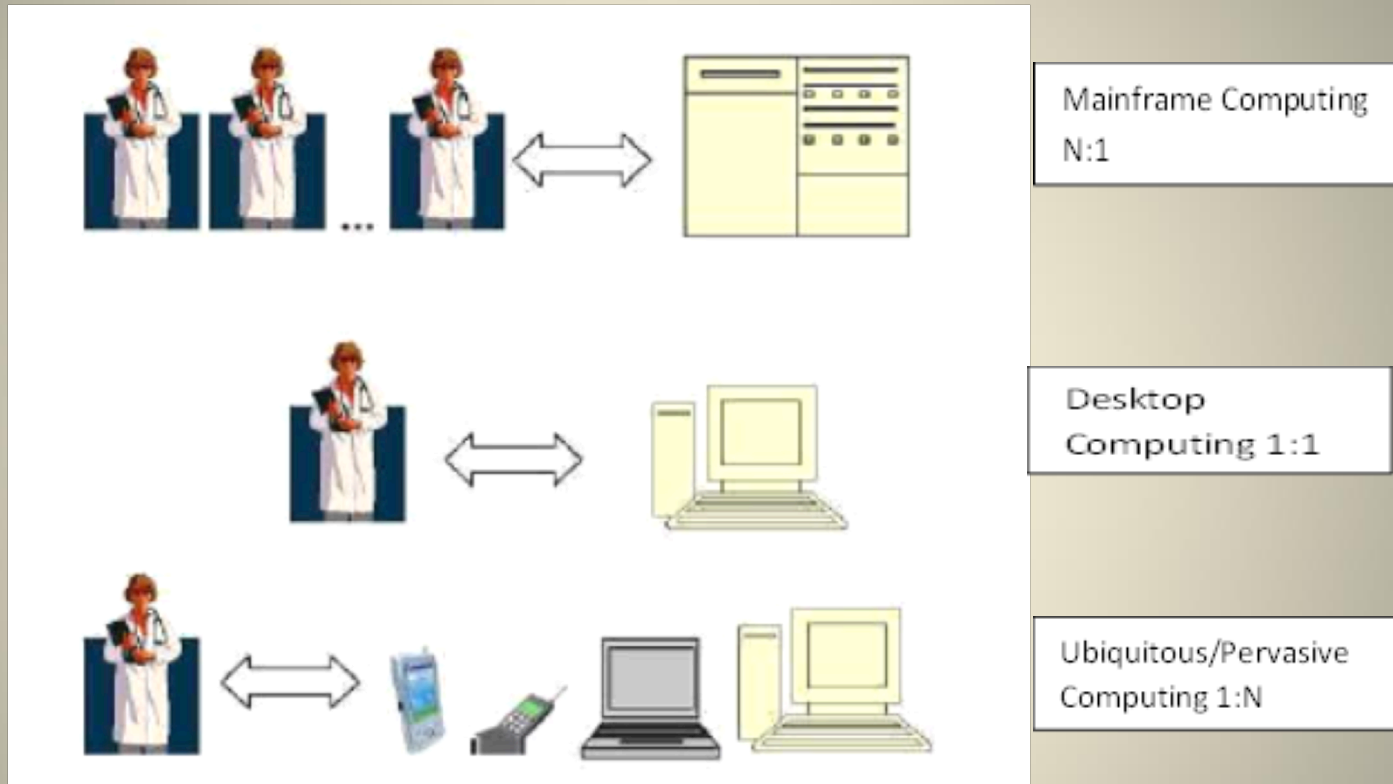
Pervasive Computing = Ubiquitous Computing???

Source: Lyytinen (2003)

Pervasive Computing has <u>Low Mobility</u> (a fridge with embedded functions, is hardly mobile).

Ambient Intelligence(AmI)

"Exciting new paradigm in Information Technology"

An intelligent service system in which technologies are able to automate a platform embedding the required devices for powering context aware, personalized, adaptive and anticipatory services.

AmI and Context Aware Computing related?

Ambient Intelligence deploys new forms of user interactions, CA computing relies on information captured by sensors to predict users' intentions and act on their behalf.

Smart Objects/things posses Ambient Intelligence

Smart Objects
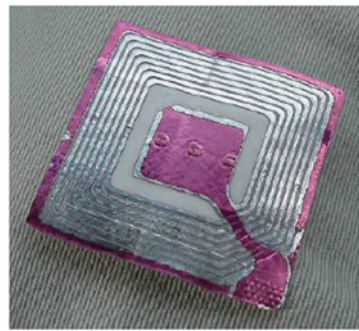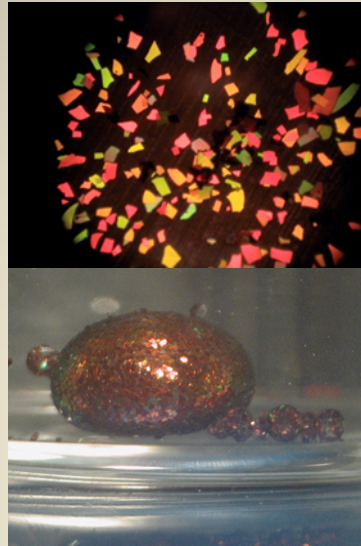
Smart Objects contd…

Nursery 2.0 (powered by Edison , a system-on-a-chip) smart plastic turtle that is attached to infants clothing and which monitors the baby's temperature, heart rate. MIT

Smart earbuds, which not only track the user's fitness but can also switch to more motivational music .

Smartwatch that incorporates geo-fencing technology to pinpoint the wearer's location

Smart charging bowl that powers multiple devices that have just been dropped inside.

Sensors and Smart Phones not only play a significant role and act as an effective interface between physical and Cyber Worlds but also bring in human social aspects.
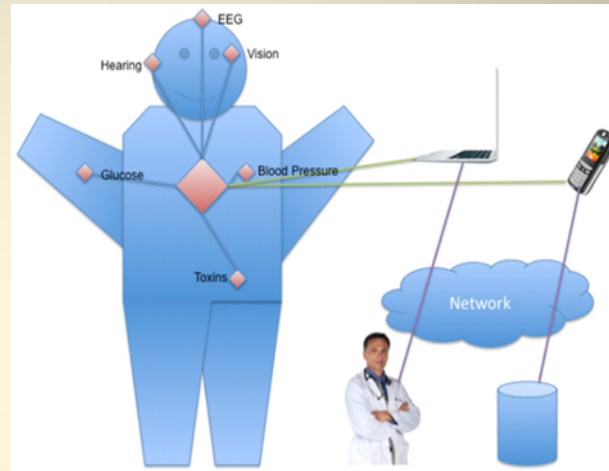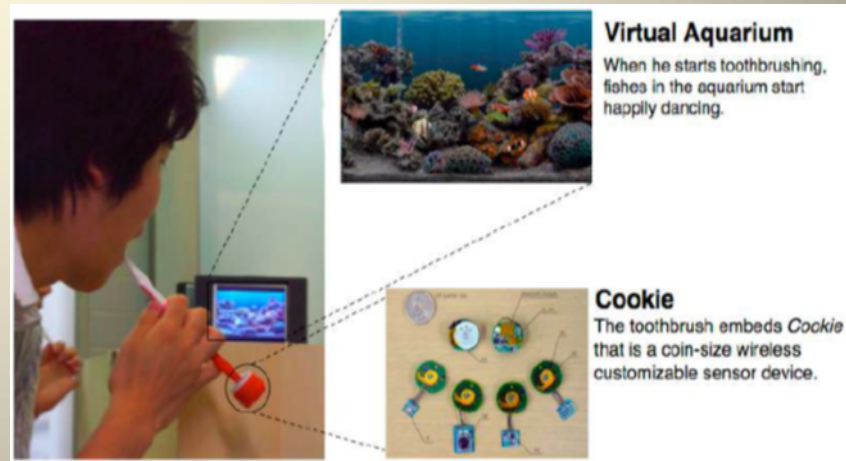
Smart Appliances

Smart Systems

Augmented Mirror

Body Area Network

*Virtual Aquarium System*

Virtual Aquarium
When he starts toothbrushing, fishes in the aquarium start happily dancing.

Cookie
The toothbrush embeds *Cookie* that is a coin-size wireless customizable sensor device.

Home Networking

Rooms will become "intelligent" and objects will communicate with one another. The refrigerator will talk with the notebook, the chair with the stereo, the sweater with the cleaning robot, and so on
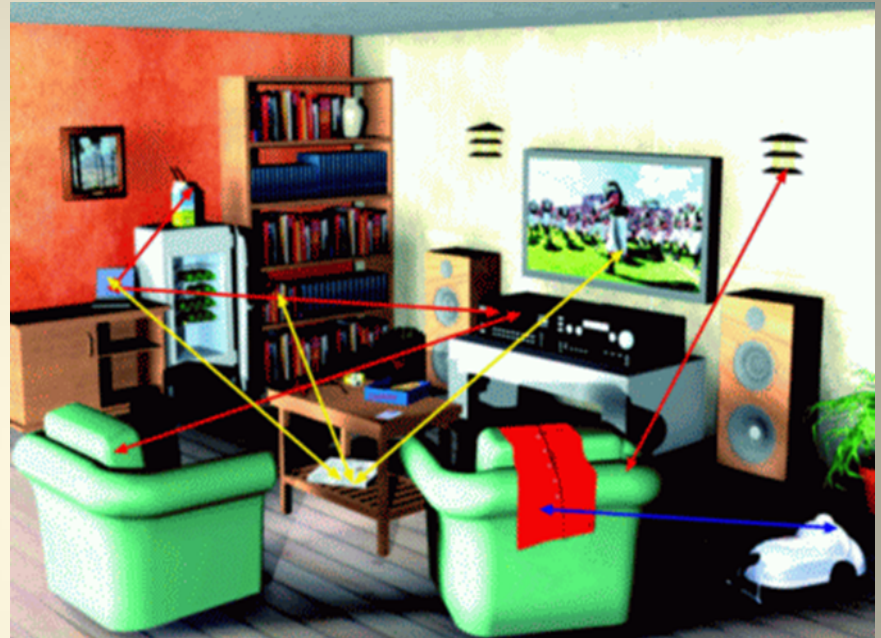
Networking Technologies: Multiple wireless network protocols participate in smart home applications, including Bluetooth LE (Low Energy), IEEE 802.11 (Wi-Fi), cellular, ZigBee (a low-power wireless technology), RFID, and near field communications (NFC), Z-wave , Powerline etc.

Wi-Fi, received a booster shot with the IEEE's approval of standard 802.11ad, commonly referred to as "WiGig."

The Bluetooth Special Interest Group is preparing for the IoT era, too

Home Automation

When you're not home, nagging little doubts can start to crowd your mind.

- Did I turn the coffee maker off?

- Did I set the security alarm?

- Are the kids doing their homework or watching television?

With a smart home, you could quiet all of these worries with a quick glance at your smartphone or tablet.

- Smart Home Entertainment
- Smart Home Monitoring & Control
- Smart Home Health: Remotely monitored individuals
- Smart Home Computing Devices: Gateways and Smart Appliances

The concept of the "Internet of Things" has tied in closely with the popularization of home automation. The IoT is the current revolution following the www.

Internet of Things (IoT)

- The term Internet of Things (IoT) refers to when real-world objects are connected to the Internet

- Internet has become a ubiquitous communications medium: Connected people and Smart things/objects

- Internet of Things (IoT) is a networking infrastructure for cyber-physical systems

- IoT aims to not only connect people to their devices, but also these devices to each other, enabling large numbers of "things" to exchange information with other connected assets, and then make decisions or otherwise act upon the available information without human intervention.

- Revolution in Machine-to Machine (M2M) and Machine-to-Machine to-Human (M2M2H) communications.

- Computing and communications will then become ubiquitous, indivisible and invisible.
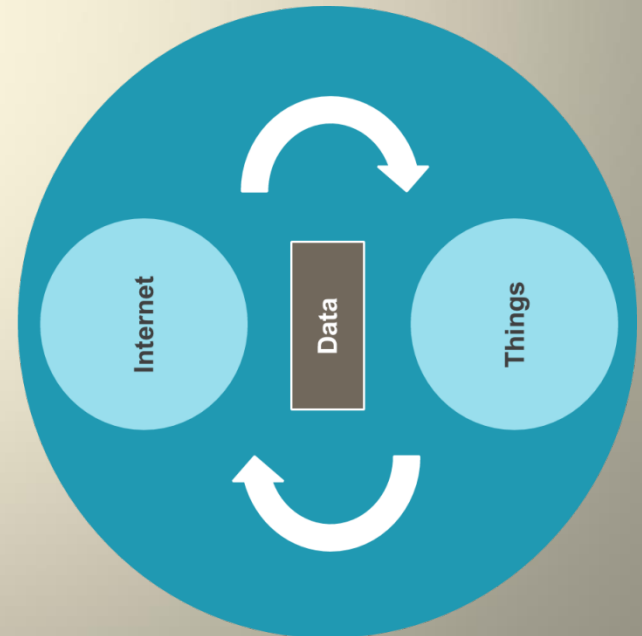
Internet of Things (IoT)

A term with so many different definitions 🙂

What is real is:
- user needs
- technologies to be used to fulfill those needs

The IoT is about the **interaction** between **Internet, Things and Data**

IoT: Smart Living and Beyond

Samsung Smart Home : a service enabling users to control and manage their home devices through a single application

Smart Home also offers a voice command function on all the controller devices. **Eg:** GALAXY Gear device
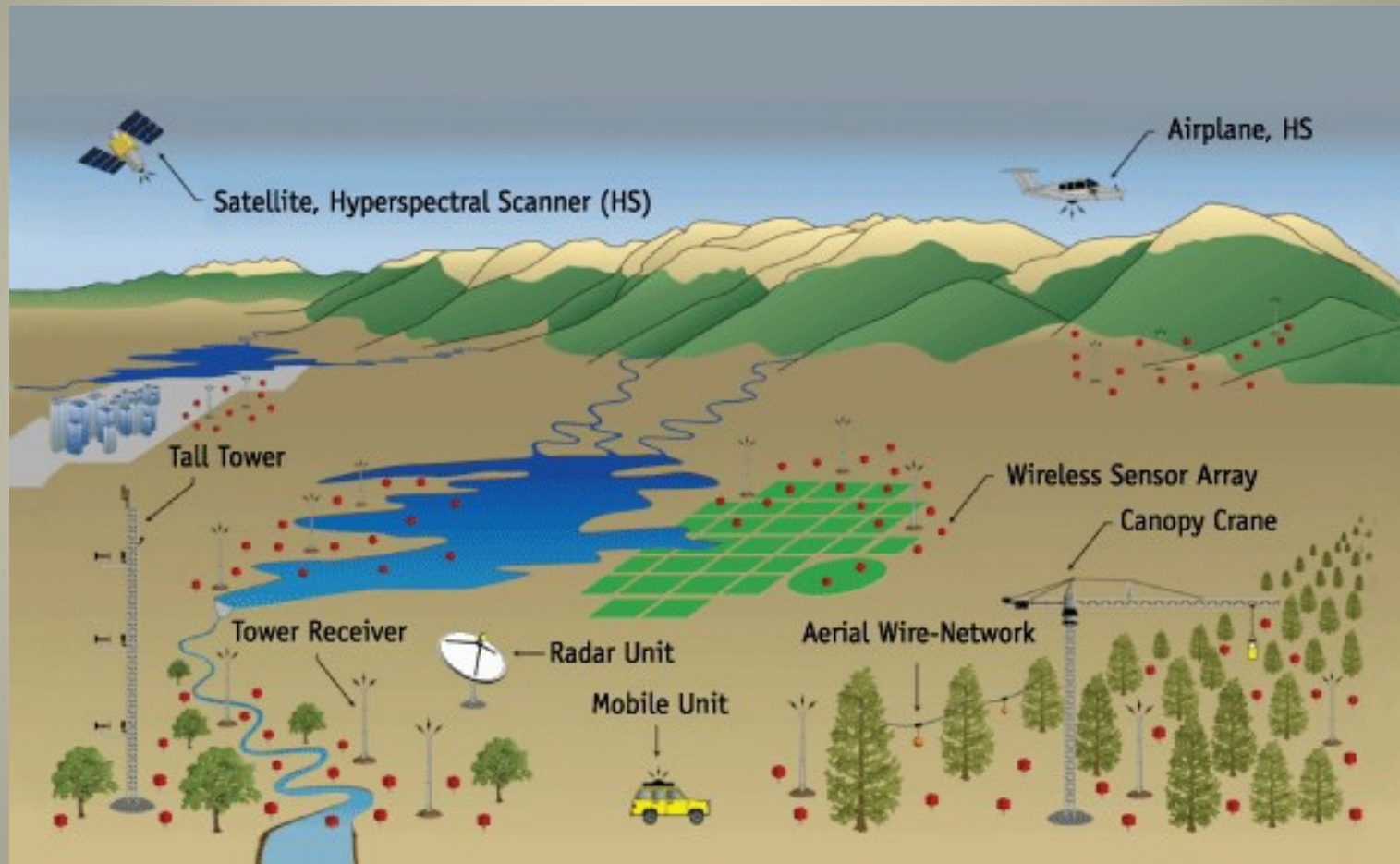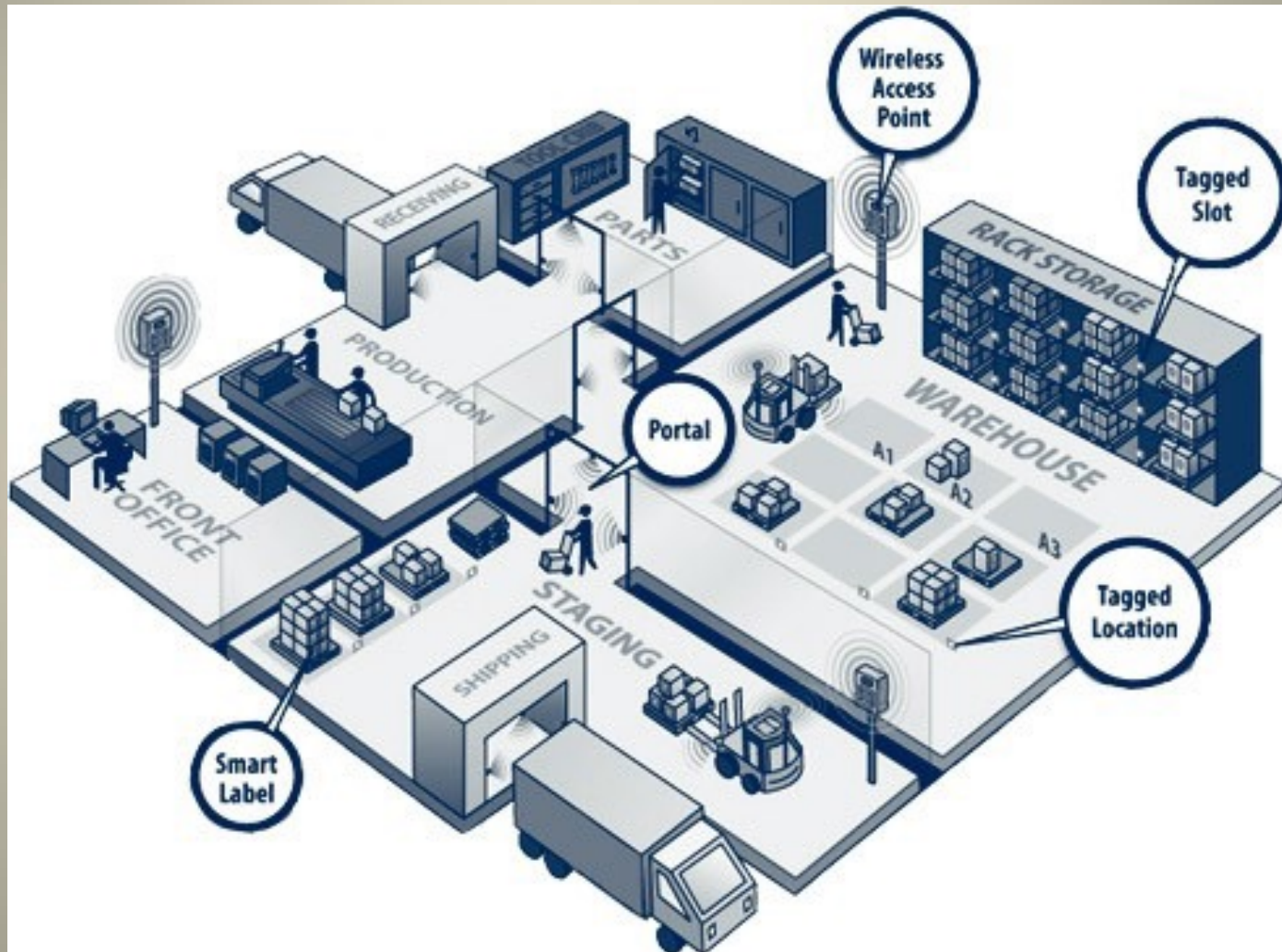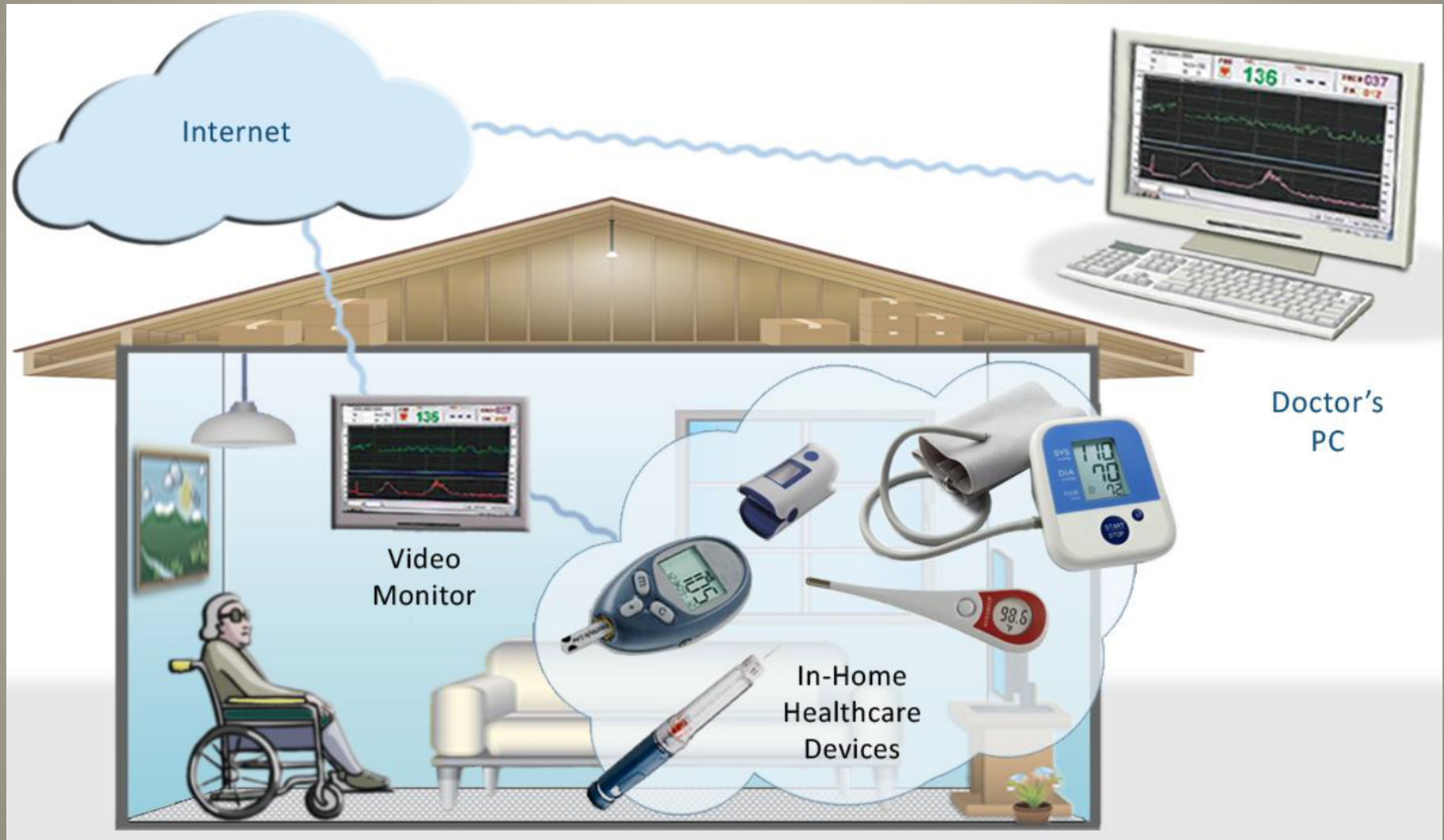
Other examples - container tracking

Other examples – environment monitoring

http://www.environment.ucla.edu/reportcard/article.asp?parentid=1506
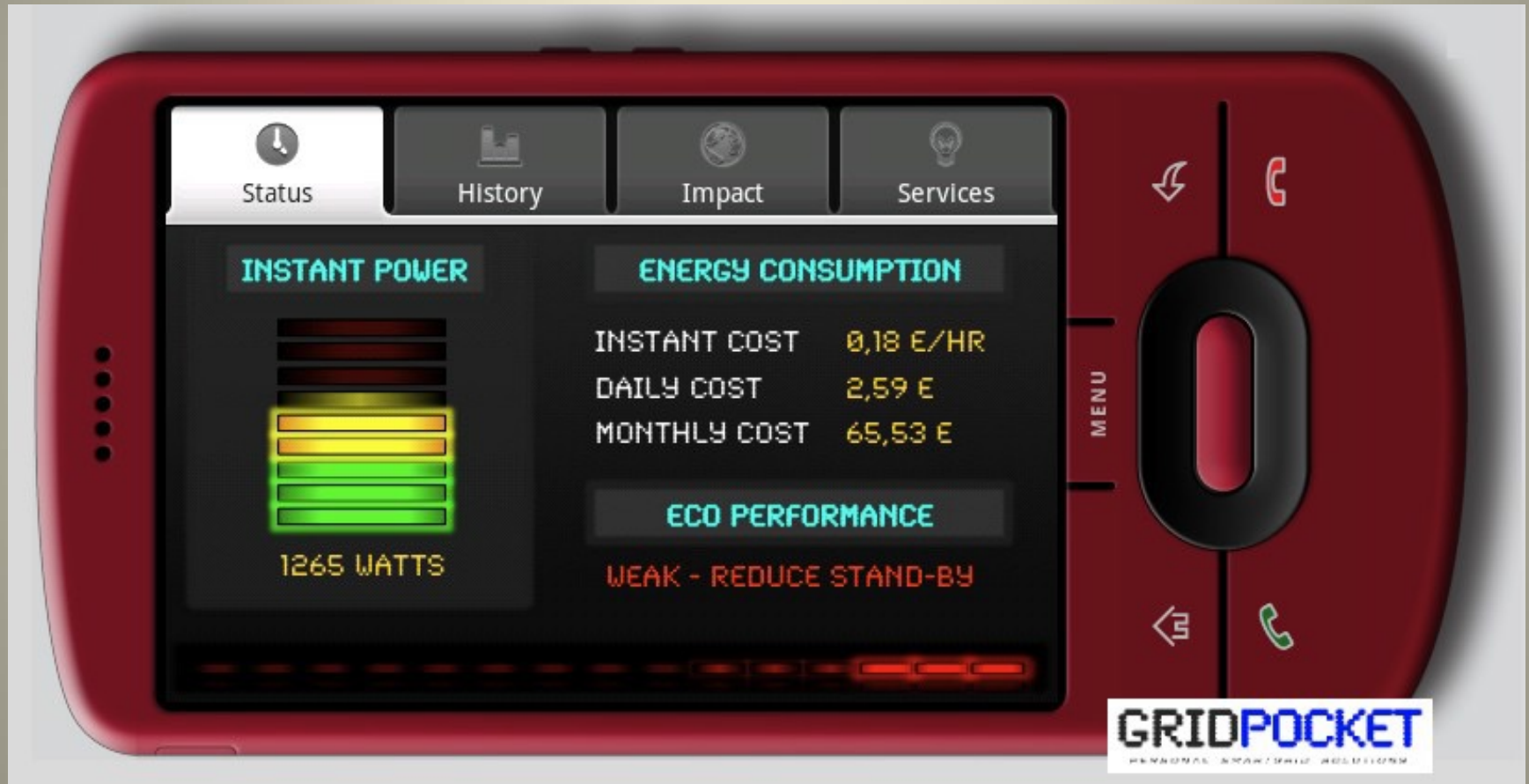
Other examples – logistics

Other examples – e-healthcare

Other examples – Smart Grid

A scenario

These **things** are starting to talk to each other and develop their own intelligence. Imagine a scenario where...

...your **meeting** was pushed back 45 minutes.

This is communicated to your **alarm clock,** which allows you 5 extra minutes of sleep.

...your **car** knows it will need gas to make it to the train station. Fill-ups usually take 5 minutes.

...there was an accident on your **driving route** causing a 15 minute detour.

...your **train** is running 20 minutes behind schedule.

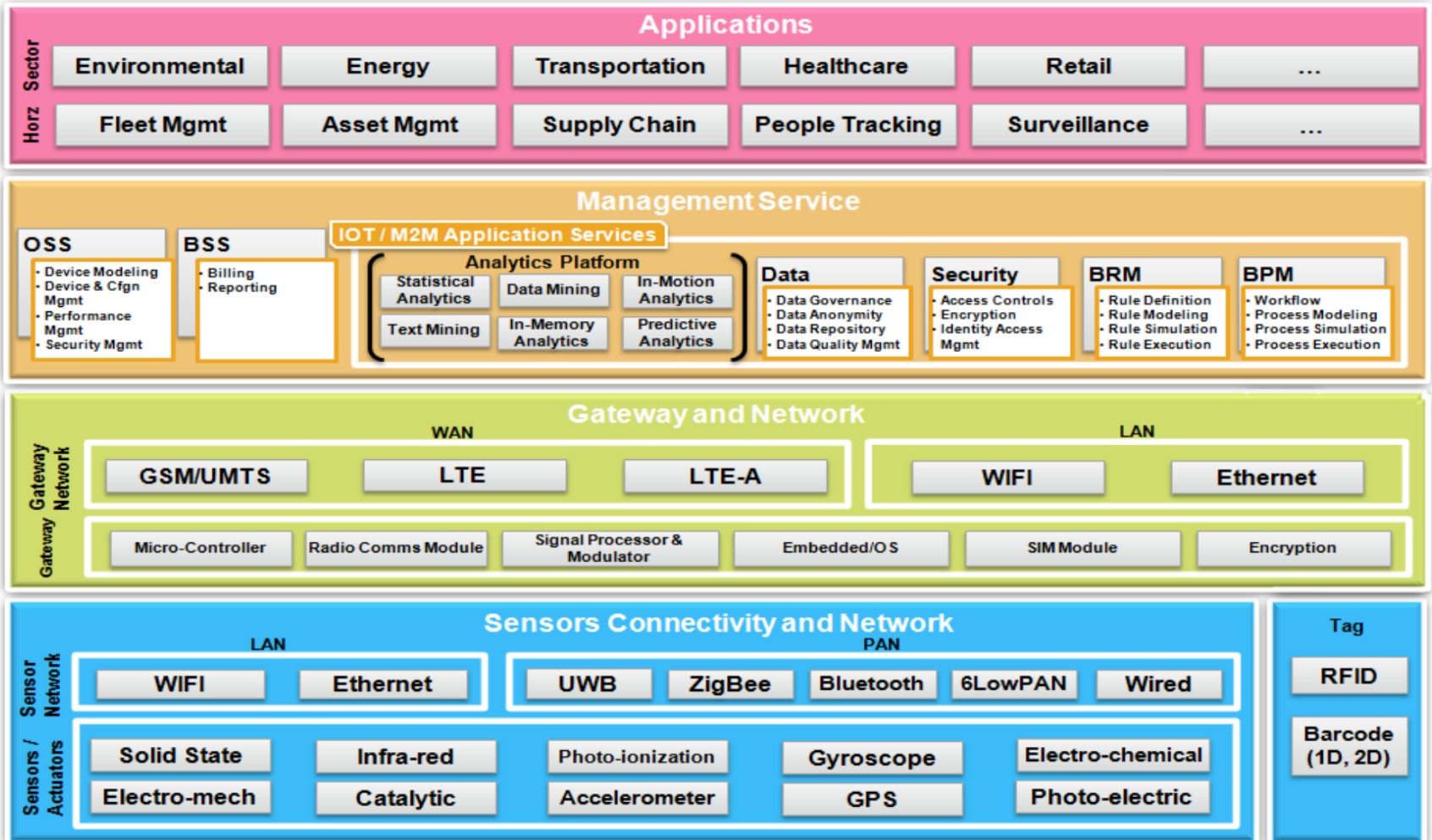And signals your **car** to start in 5 minutes to melt the ice accumulated in overnight snow storms.

And signals your **coffee maker** to turn on 5 minutes late as well.

IoT: Smart Environment

Smart Planet
Green Environment
- Environmental sensors
- Water, power leak detection
- Pollution, weather monitoring

Smart Cities
Connected Communities
- Lighting, water management
- Monitoring & security
- Traffic control

Smart Energy
Electric Grid
- Voltage and power sensors
- Meters and breakers
- Fault detection

Future Internet

Internet of Things

Smart Transport
ITS, HEVs, EVs
- Electric Mobility, EVs and HEVs
- High Speed Trains
- Infrastructure, V2I, V2V, V2I+I

Smart Buildings
Buildings, Smart Homes
- Thermostats, HVAC, lighting
- Presence sensors, lockers, actuators
- Meters, smart-plugs, HEC

Smart Industry
Industrial Environments
- Lightning, security, actuators
- Production control
- Robotics

Smart Health
Healthcare System
- People monitoring
- Bio sensors, probes
- Remote health

Smart Living
Entertaining, Leisure
- Independence through technology
- Information when you need it
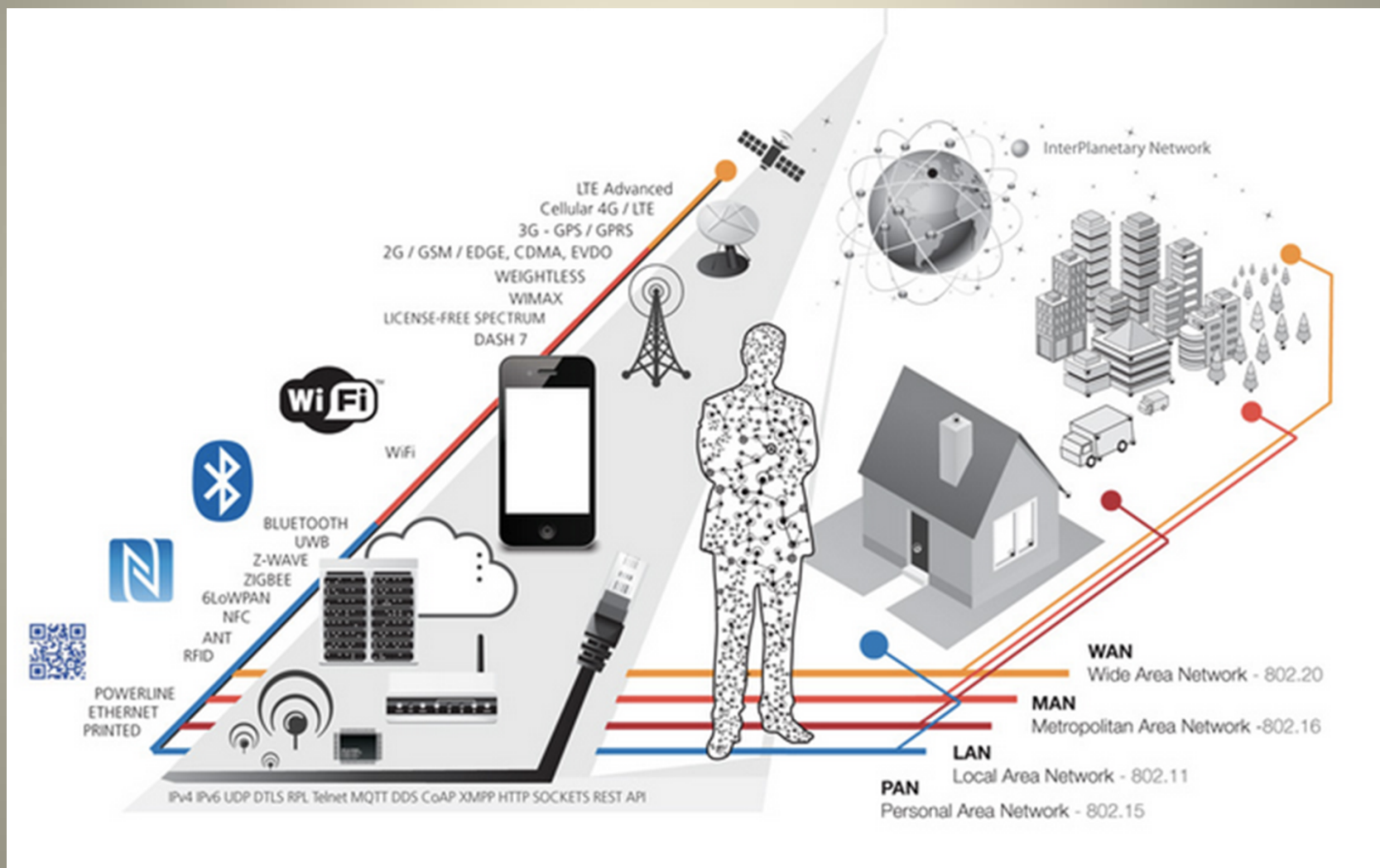- Connected when you need it

Architecture of IoT

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IoT-Enabling Technologies

IoT Networking Technologies

IoT: Context

- Today, there are nine billion devices connected to the internet.

- By 2020, this will have increased to 24 billion although some estimates place the number at 100 billion.

- Cisco predicts that the number of connected devices will reach 50 billion by 2020 – though overwhelming ,but reasonable
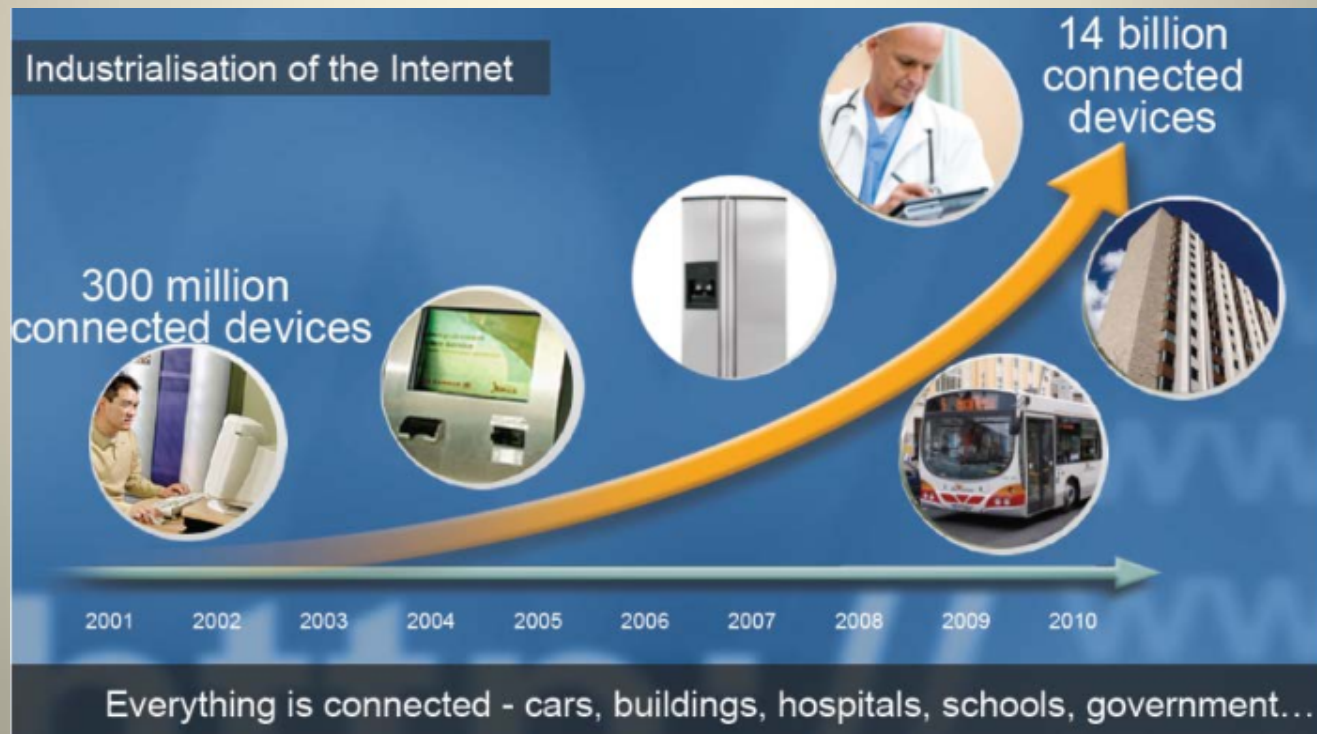
IoT: Context contd...

Adding up the potential devices that can be remotely accessed in a given home including entertainment devices, appliances, windows, thermostats, security control panels, utility meters, electrical outlets, and even coffee makers that can start brewing in advance of your arrival etc. etc..

It is expected that a range of sensors in a "body area network" will record parameters such as blood pressure, respiration and heart rate, then processed and transmitted to a control station .
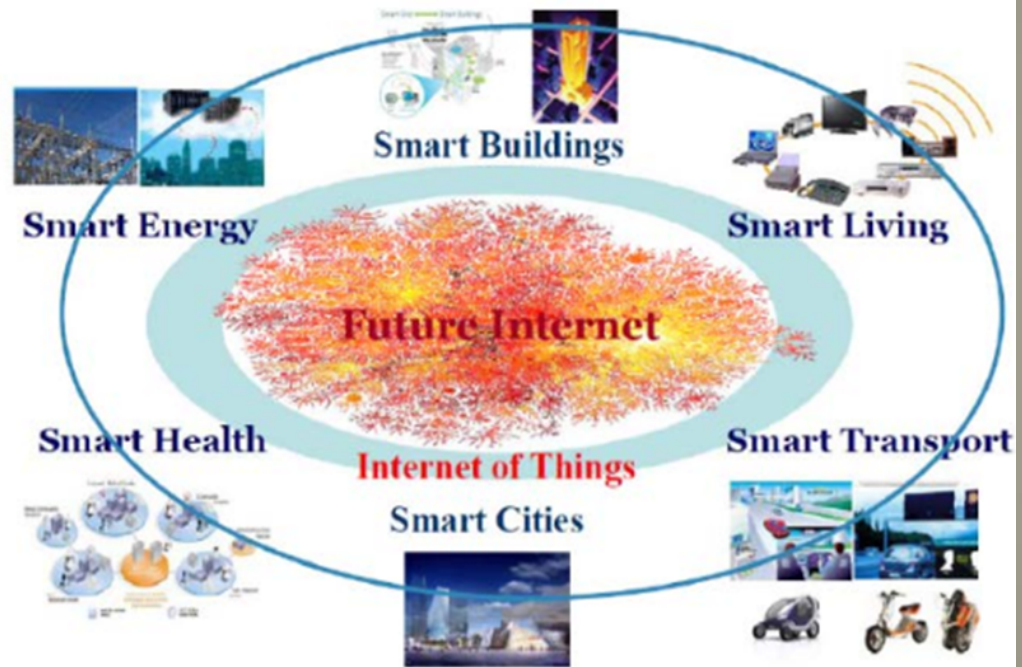

IoT and smart environments creation.

Challenges in IoT

➢ How do you construct a digital network throughout a home or any environment and connected to Internet and ensure its privacy?

➢ How do you connect the myriad devices (Myriads of different requirements and consequently, myriads of different systems)?

➢ The distinction between online and offline would fade to insignificance: How can effective identification and authentication be achieved without compromising privacy?

➢ How to protect against threats when it comes to Internet-connected gadgets? Even if something like a smart stereo or coffee maker has been hacked into, it can be trickier to tell than with a laptop or a smartphone. These devices often have no visual display, and if they're participating in an attack ……

➢ Machine-to-Machine communication (M2M) standardization

Challenges contd… : IoT-Communications

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Universal network, availability alone is not enough. Equally important is support for the various data streams across the boundaries of individual technologies and providers.
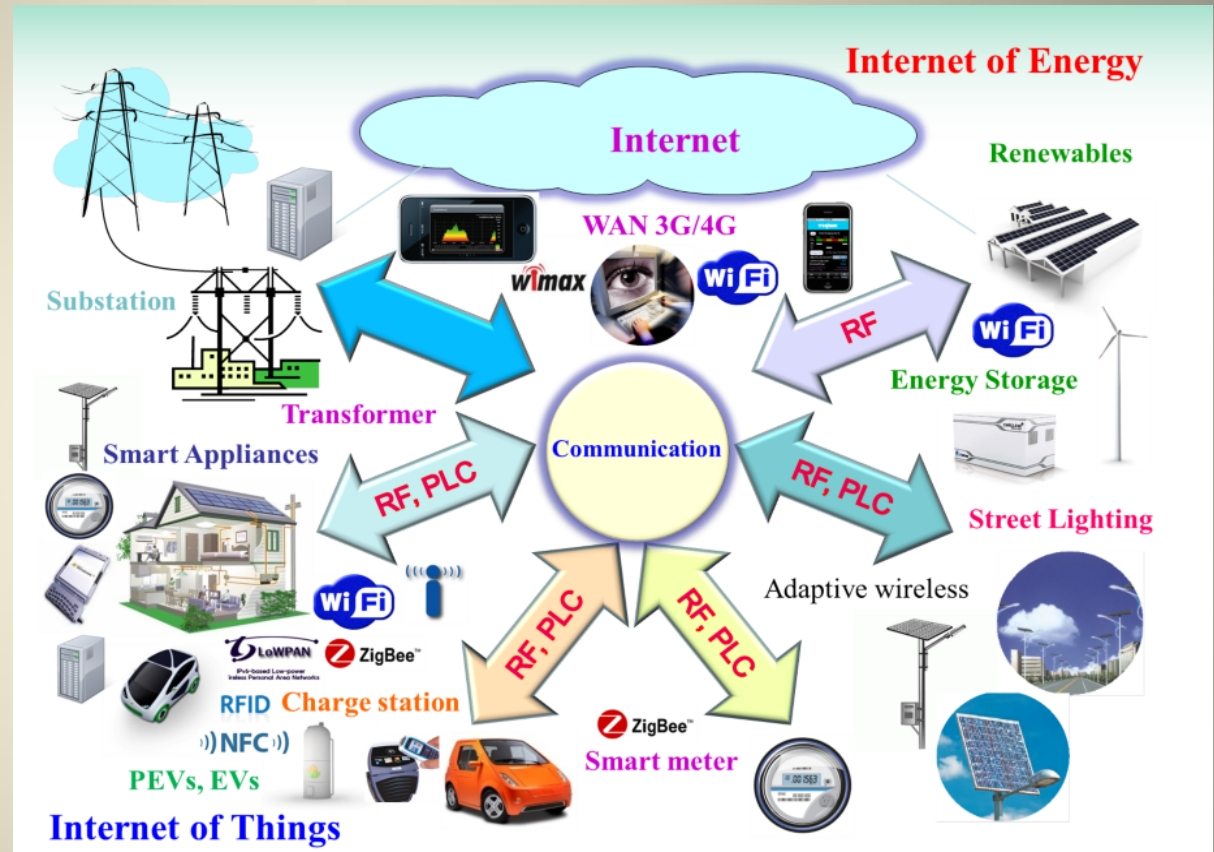
The future technical standards (ITU-T Recommendations) will be fundamental to the smooth operation of networks potentially supporting billions of interconnected devices.

Challenges contd... : Growth in Data

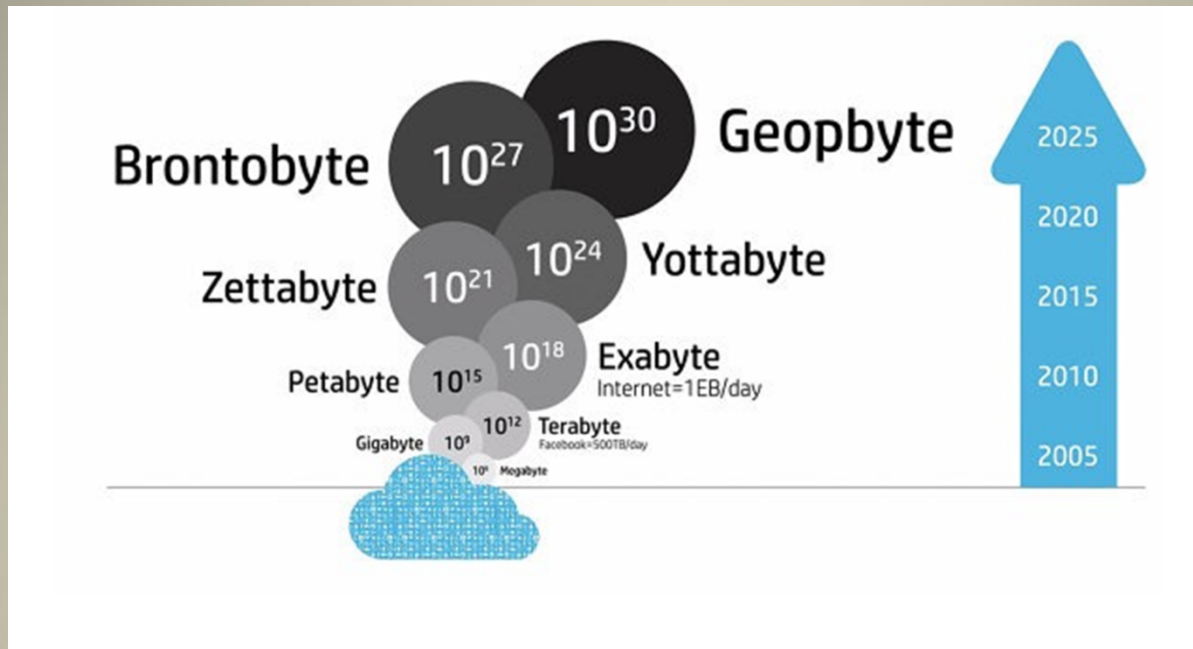**Exponential growth of Intelligent Interactions**

Smart Objects will add tens of billions of additional devices

There is no scope for IPv4 to support Smart Object Networks

IPv6 is the only viable way forward

Big Data Explosion

- It's "big" when we have to rethink:
  - How we store that much data
  - How we move that much data
  - How we extract, load & transform that much data
  - How we explore and analyze that much data
  - How we process and get meaningful insights from that much data

Some Interesting updates

- The term "Internet of Things" was added in oxford dictionary in August, 2013.

- The term has been defined as : "A proposed development of the internet in which everyday objects have network connectivity, allowing them to send and receive data."

- National Intelligence Council (NIC) U.S. listed IoT in the six technologies with potential impacts on U.S. interests out to 2025.

- "Shodan", World's first search engine that finds connected 'Things'.
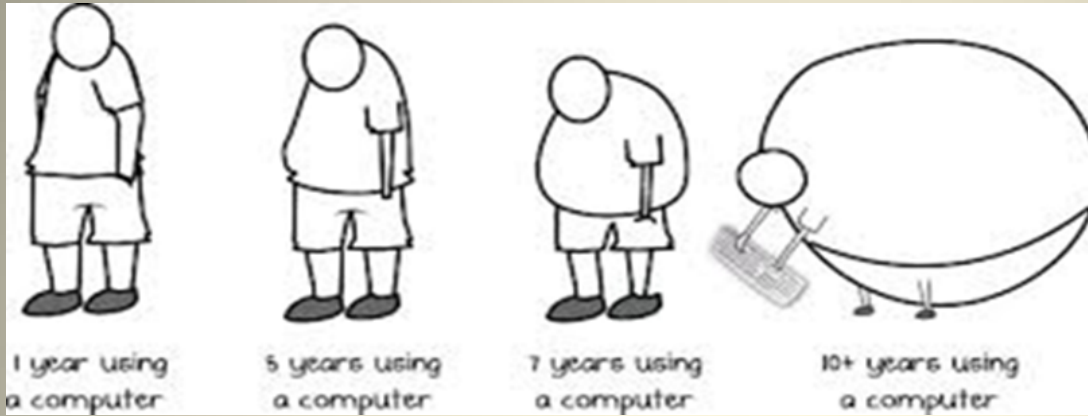
- For more : www.shodanhq.com

Conclusion

IoT will simplify our lives in the future. It won't come all at once, though. Instead, many small developments will lead us there.

"Without change there is no innovation, creativity, or incentive for improvement. Those who initiate change will have a better opportunity to manage the change that is inevitable."

William Pollard

Thank You