Laboratorio di Cloud Computing

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Mi presento…

Riccardo Rosati

- Postdoctoral Researcher @ VRAI, DII, UNIVPM
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- Teaching assistant @ LUISS
- Visiting Researcher @ University of Cordoba
- Research collaborator @ Sinergia Consulenze srl, Revolt srl

Course Outline and Organization

- IoT Technologies
- Big Data & Databases
- Introduction to Cloud Computing
- Cloud Computing basic concepts
- Cloud architectures
- High Peformance Computing
- Real Applications & Examples
- Lab Session

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vision robotics
artificial
intelligence

Laboratorio di Cloud Computing

Lecture 1 - IoT Technologies

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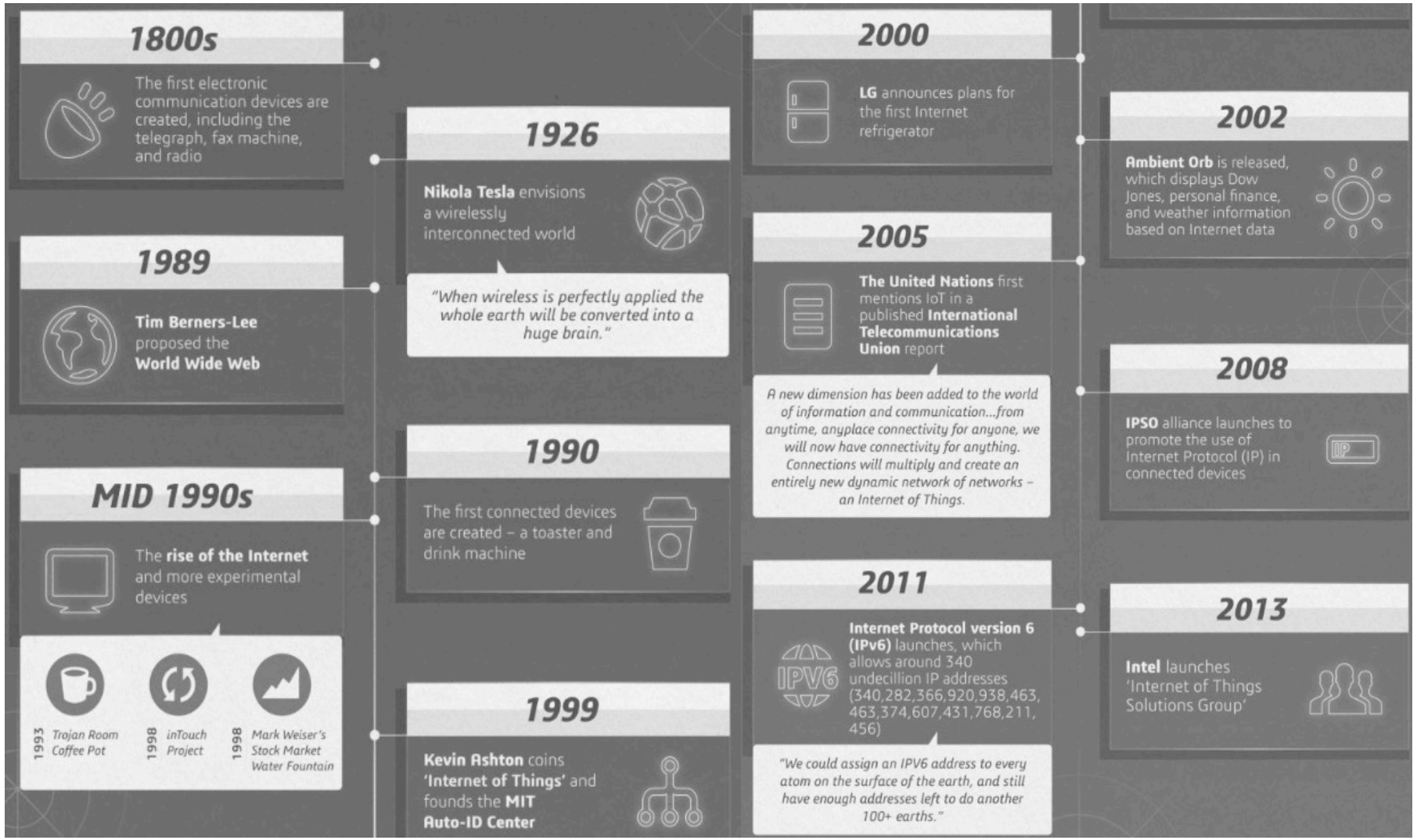
Today's Lesson

- Knowledge assessment
- Introduction
- What is IoT?
- Why IoT?
- Applications
- Question Time

The vision

"When **wireless** is perfectly applied the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole. We shall be able to communicate with one another instantly, irrespective of distance. Not only this, but through television and telephony we shall see and hear one another as perfectly as though we were face to face, despite intervening distances of thousands of miles; and the instruments through which we shall be able to do his will be amazingly simple compared with our present telephone. A man will be able to carry one in his vest pocket." - **Nikola Tesla**, 1926

IoT History

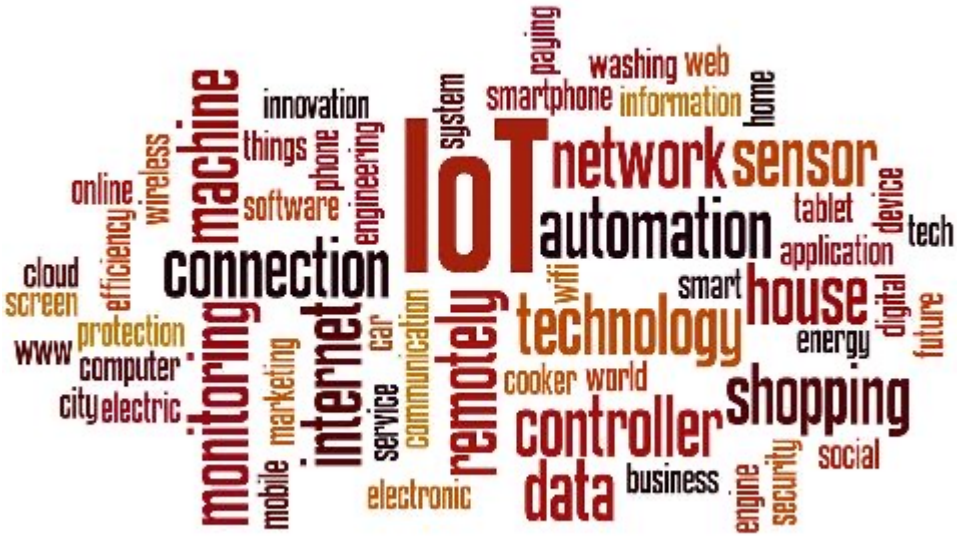

1800s
The first electronic communication devices are created, including the telegraph, fax machine, and radio
1926
Nikola Tesla envisions a wirelessly interconnected world
"When wireless is perfectly applied the whole earth will be converted into a huge brain."
1989
Tim Berners-Lee proposed the World Wide Web
1990
The first connected devices are created – a toaster and drink machine
MID 1990s
The rise of the Internet and more experimental devices
1993 Trojan Room Coffee Pot
1998 inTouch Project
1998 Mark Weiser's Stock Market Water Fountain
1999
Kevin Ashton coins 'Internet of Things' and founds the MIT Auto-ID Center
2000
LG announces plans for the first Internet refrigerator
2005
The United Nations first mentions IoT in a published International Telecommunications Union report
A new dimension has been added to the world of information and communication...from anytime, anyplace connectivity for anyone, we will now have connectivity for anything. Connections will multiply and create an entirely new dynamic network of networks – an Internet of Things.
2011
IPV6
Internet Protocol version 6 (IPv6) launches, which allows around 340 undecillion IP addresses (340,282,366,920,938,463,463,374,607,431,768,211,456)
"We could assign an IPV6 address to every atom on the surface of the earth, and still have enough addresses left to do another 100+ earths."
2002
Ambient Orb is released, which displays Dow Jones, personal finance, and weather information based on Internet data
2008
IPSO alliance launches to promote the use of Internet Protocol (IP) in connected devices
IP
2013
Intel launches 'Internet of Things Solutions Group'

What is IoT ?

- The *Internet of Things (IoT)* refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

- In simple words, *Internet of Things (IoT)* is an ecosystem of connected physical objects that are accessible through the internet.

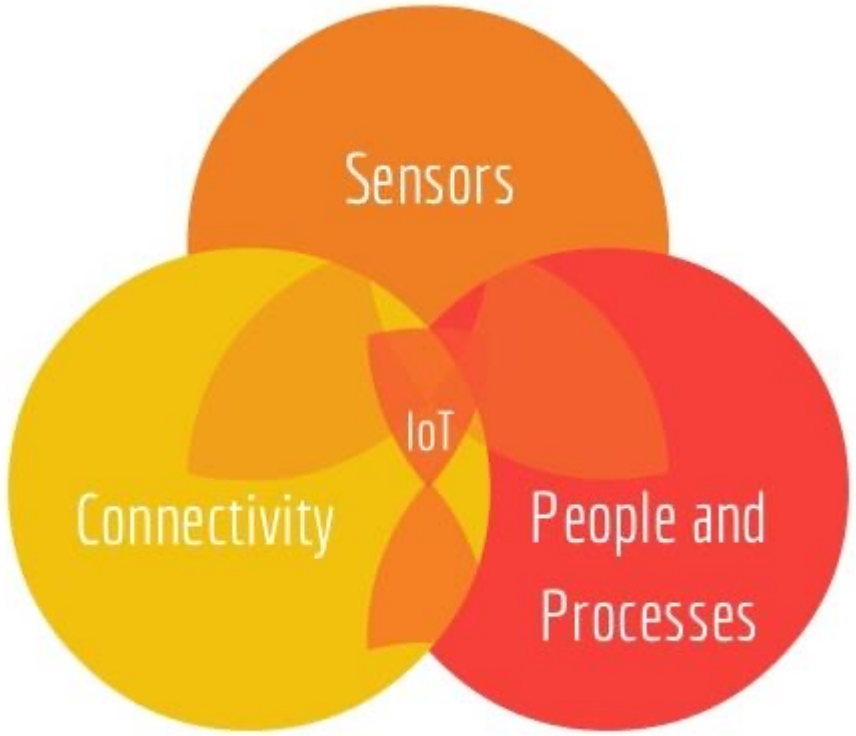
- It is also referred to as *Machine-to-Machine (M2M*), *Skynet* or *Internet of Everything*.



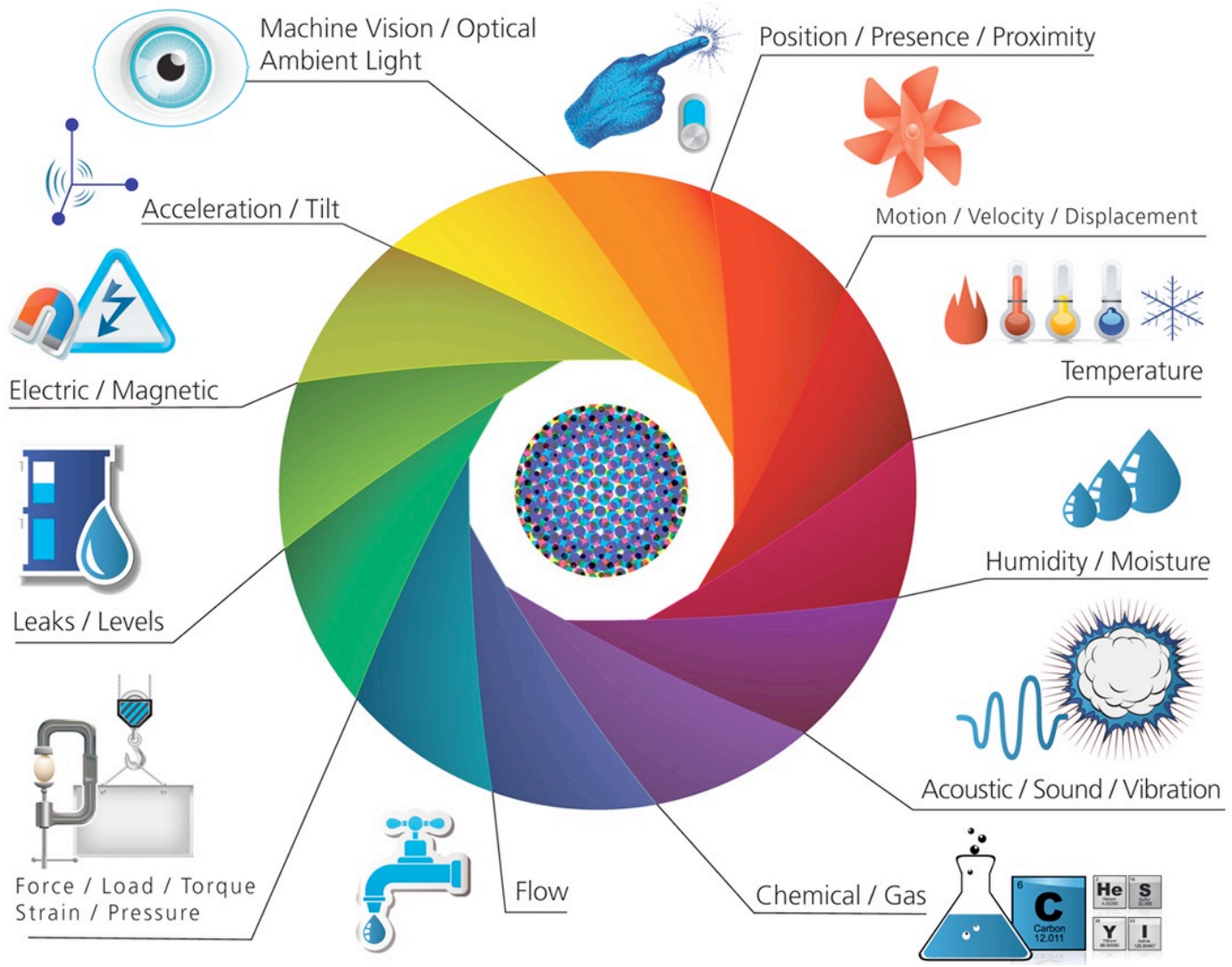
Why IoT ?

Smart Systems and Internet of Things are driven by a combination of:

1) Sensors
2) Connectivity
3) People & Processes

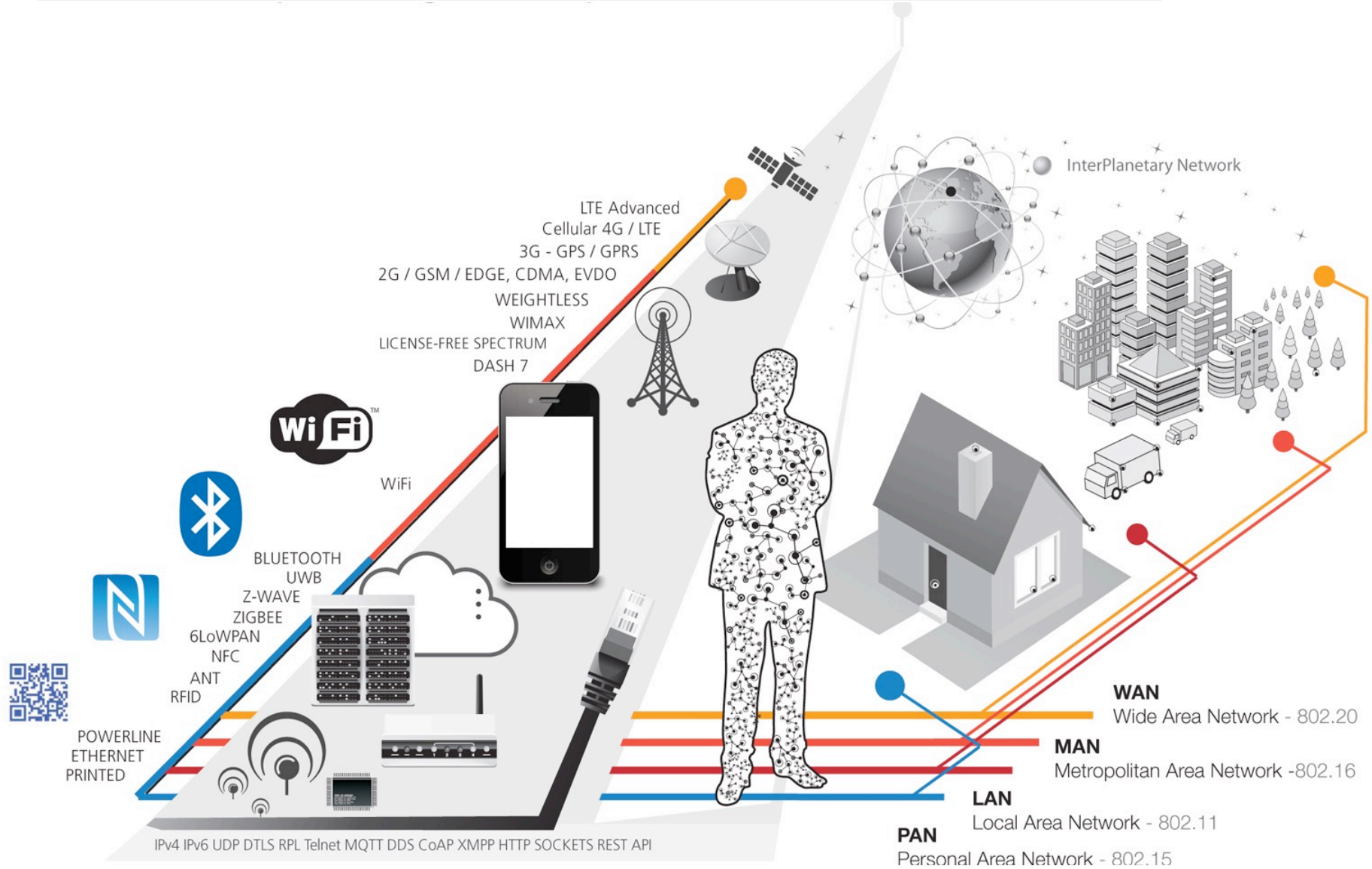


Sensors



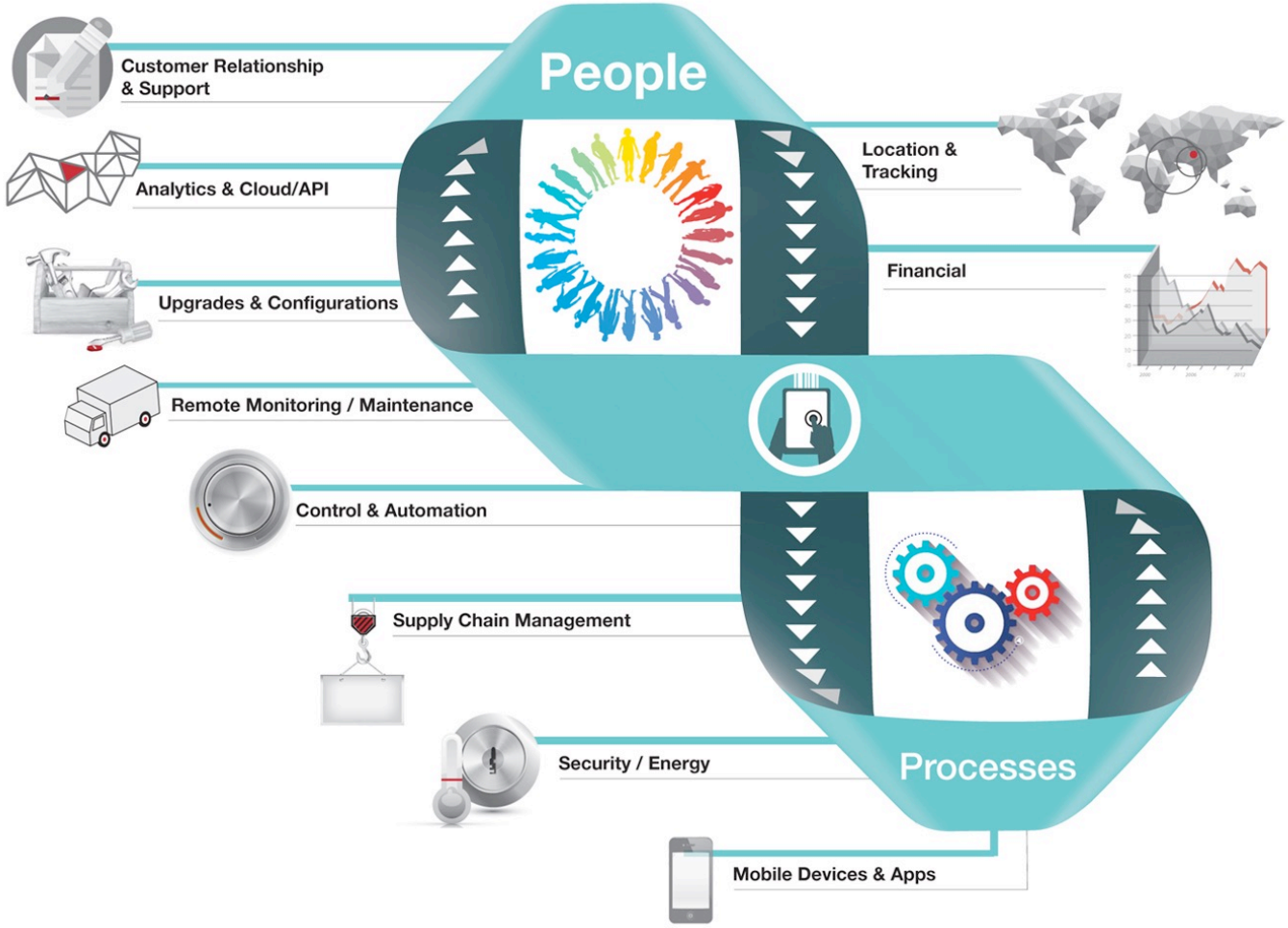
We are giving our world a digital nervous system. Think about GPS for location systems, eyes and ears using cameras and microphones, along with sensory organs that can measure everything from temperature to pressure changes.

Connectivity



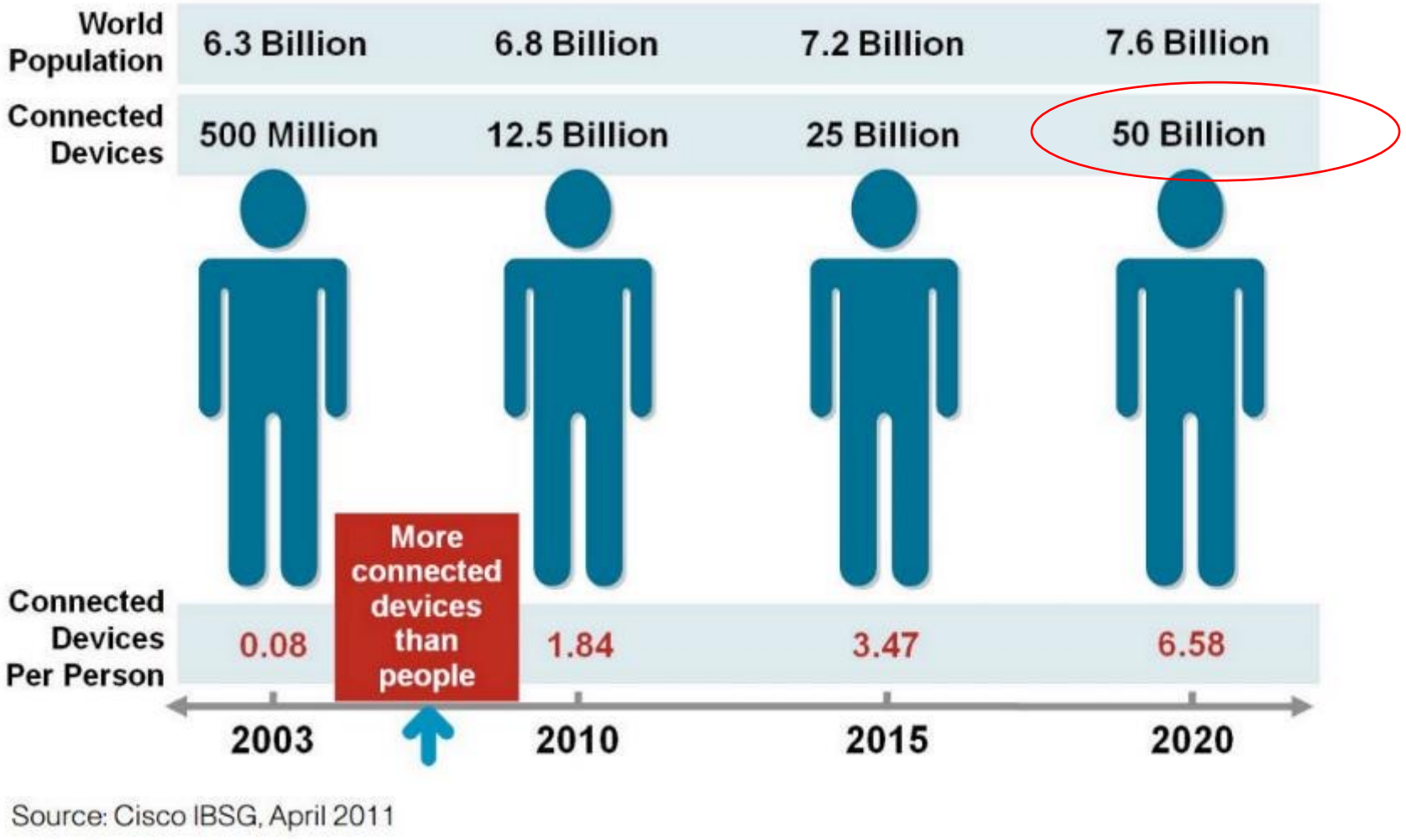
These inputs are digitized and placed onto networks…

People and Processes



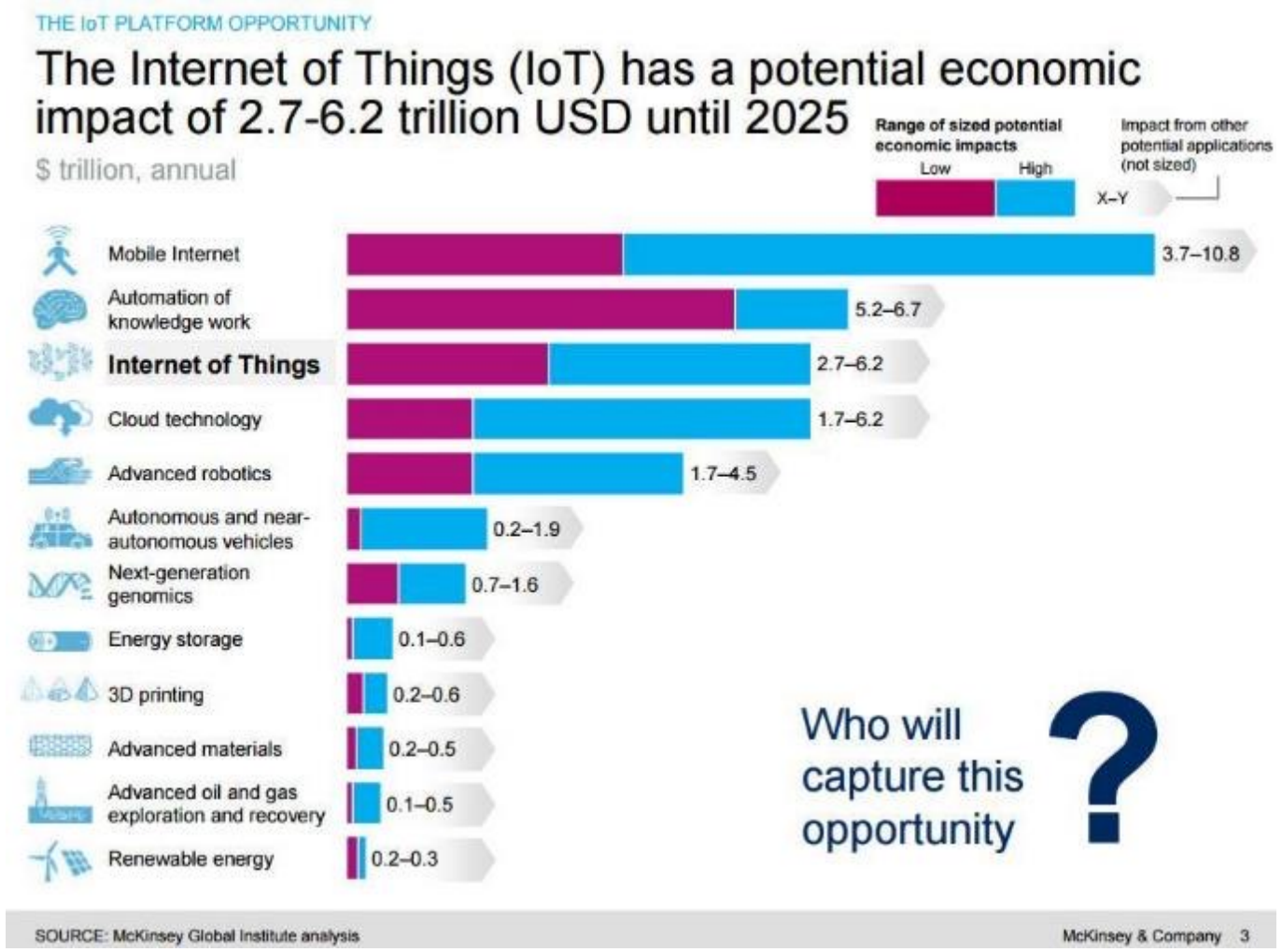
These networked input can then be combined into bi-directional systems that integrate data, people, processes and systems for better decision making. The interactions between these entities are creating new types of smart applications and services.

Why IoT ?

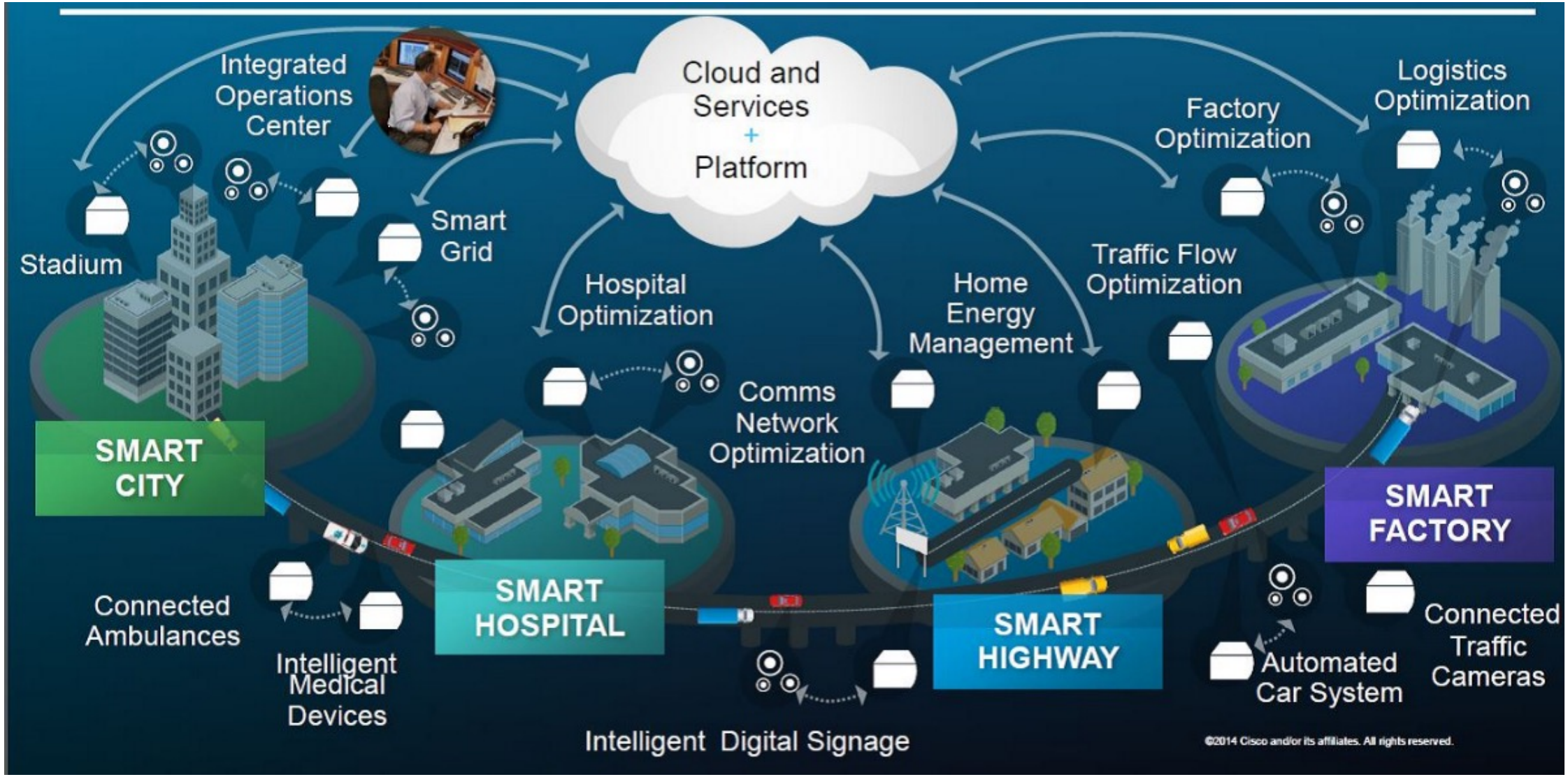


Source: Cisco IBSG, April 2011

Why IoT ?


THE IoT PLATFORM OPPORTUNITY
The Internet of Things (IoT) has a potential economic impact of 2.7-6.2 trillion USD until 2025
$ trillion, annual
Range of sized potential economic impacts
Low
High
Impact from other potential applications (not sized)
X–Y
Mobile Internet
3.7–10.8
Automation of knowledge work
5.2–6.7
Internet of Things
2.7–6.2
Cloud technology
1.7–6.2
Advanced robotics
1.7–4.5
Autonomous and near-autonomous vehicles
0.2–1.9
Next-generation genomics
0.7–1.6
Energy storage
0.1–0.6
3D printing
0.2–0.6
Advanced materials
0.2–0.5
Advanced oil and gas exploration and recovery
0.1–0.5
Renewable energy
0.2–0.3
Who will capture this opportunity ?
SOURCE: McKinsey Global Institute analysis
McKinsey & Company 3

Why IoT ?


Integrated Operations Center
Cloud and Services + Platform
Logistics Optimization
Factory Optimization
Smart Grid
Stadium
Traffic Flow Optimization
Hospital Optimization
Home Energy Management
Comms Network Optimization
SMART CITY
SMART FACTORY
SMART HOSPITAL
SMART HIGHWAY
Connected Ambulances
Intelligent Medical Devices
Automated Car System
Connected Traffic Cameras
Intelligent Digital Signage
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Why IoT ?

Dynamic control of industry and daily life

- Improves the resource utilization ratio
- Integrating human society and physical systems
- Flexible configuration
- Acts as technology integrator
- Universal inter-networking

Why IoT ?

Internet of Things can connect devices embedded in various systems to the internet. When devices/objects can represent themselves digitally, they can be controlled from anywhere. The connectivity then helps us capture more data from more places, ensuring more ways of increasing efficiency.

IoT is a transformational force that can help companies improve performance through **IoT analytics** and **IoT Security** to deliver better results. Businesses in the utilities, oil & gas, insurance, manufacturing, transportation, infrastructure and retail sectors can reap the benefits of IoT by making more informed decisions, aided by the torrent of interactional and transactional data at their disposal.

Why IoT ?

- IoT platforms can help organizations reduce cost through improved process efficiency, asset utilization and productivity.
- The growth and convergence of data, processes and things on the internet would make such connections more relevant and important, creating more opportunities for people, businesses and industries.

Some examples..

https://www.youtube.com/watch?v=xKYABI-dGEA

Not everything makes the cut…

https://www.youtube.com/watch?v=8y-1h_C8ad8

IoT technologies

Starting with popular connected devices already on the market

SMART THERMOSTATS

Save resources and money on your heating bills by adapting to your usage patterns and turning the temperature down when you're away from home.

CONNECTED CARS

Tracked and rented using a smartphone. Car2Go also handles billing, parking and insurance automatically.

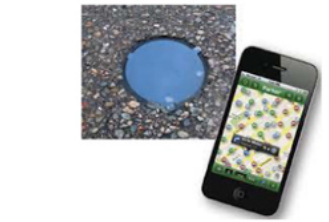
ACTIVITY TRACKERS

Continuously capture heart rate patterns, activity levels, calorie expenditure and skin temperature on your wrist 24/7.

SMART OUTLETS

Remotely turn any device or appliance on or off. Track a device's energy usage and receive personalized notifications from your smartphone.

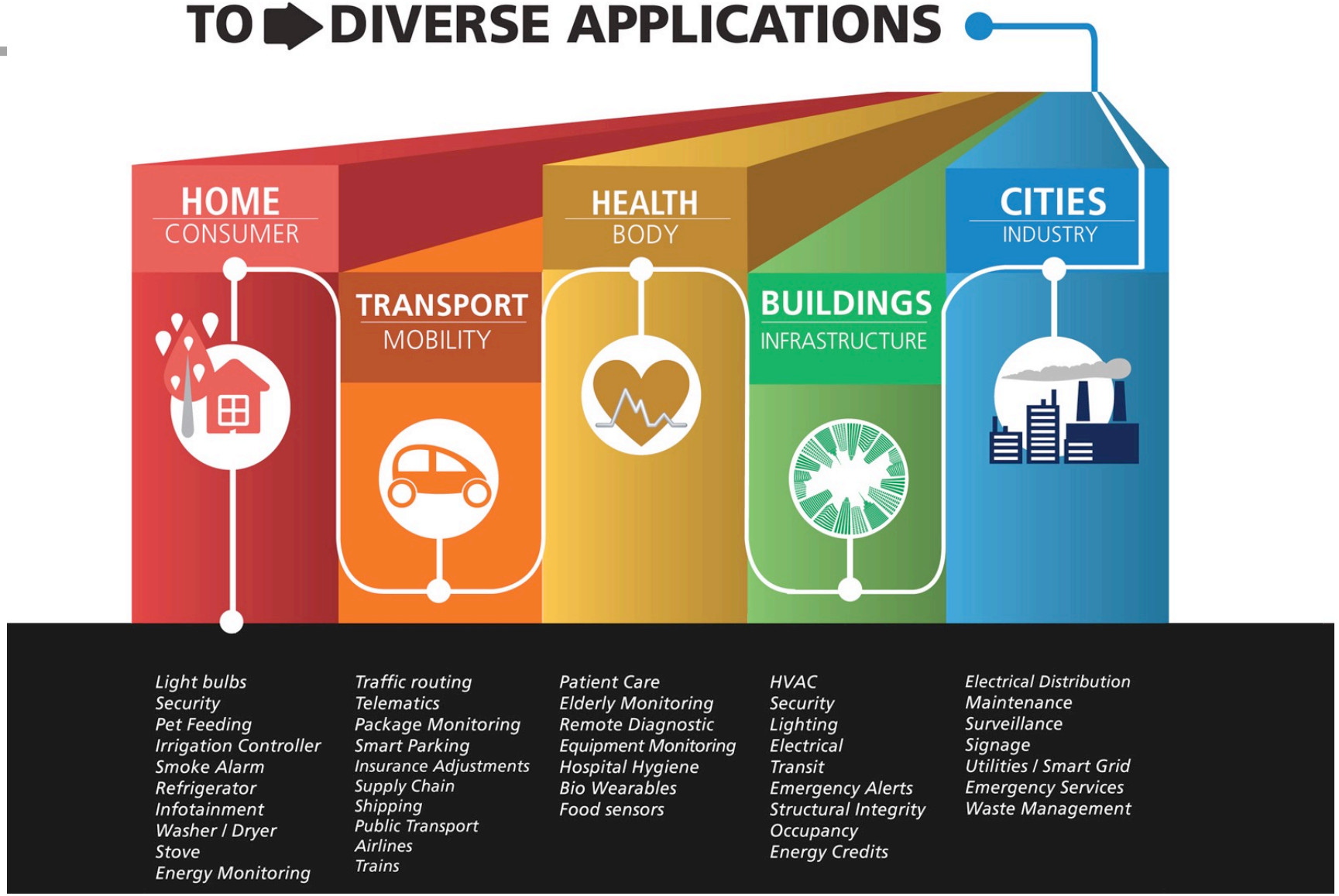
PARKING SENSORS



Using embedded street sensors, users can identify real-time availability of parking spaces on their phone. City officials can manage and price their resources based on actual use.

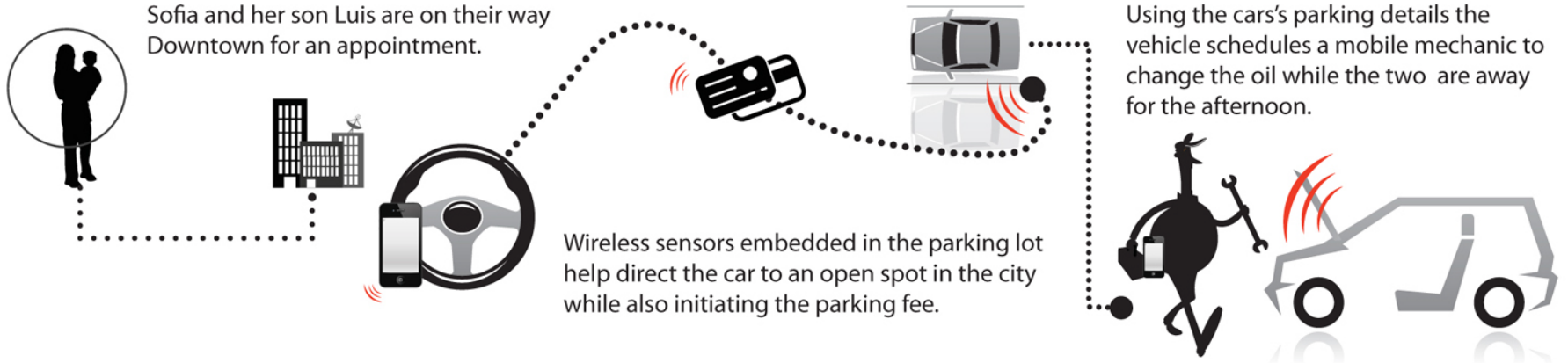
And quickly advancing

TO ➡ DIVERSE APPLICATIONS



IoT technologies

TRANSPORTATION + SMART CITIES

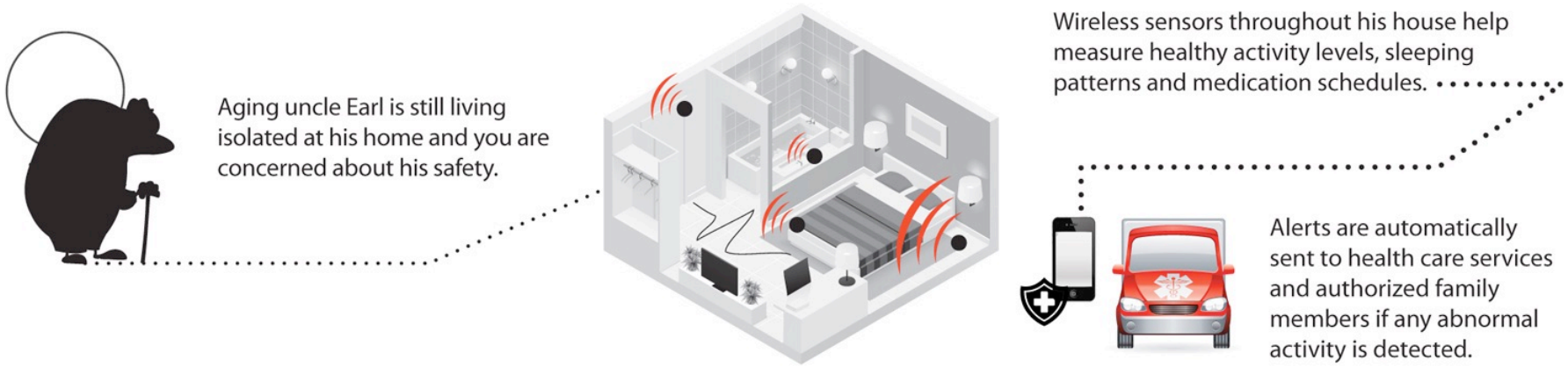


In Downtown San Francisco 20-30% of all traffic congestion is caused by people hunting for a parking spot.

- San Francisco Municipal Transportation Agency (SFMTA)

IoT technologies

HEALTHCARE + SMART HOME

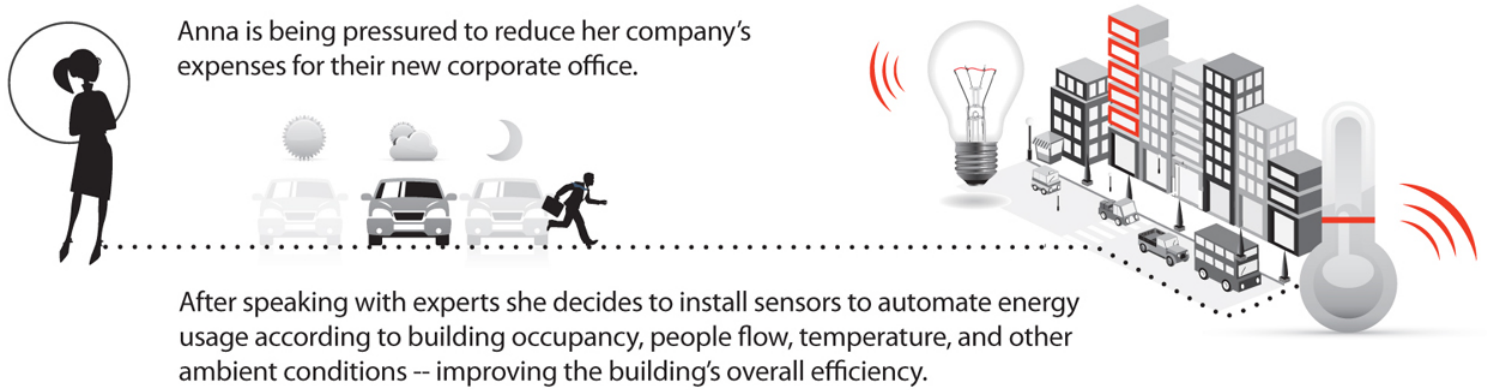


40 million adults age 65 and over will be living alone in the U.S, Canada and Europe.

- U.S. Department of Health and Human Services: Administration for Community Living (ACL)

IoT technologies

SMART BUILDINGS + MOBILITY



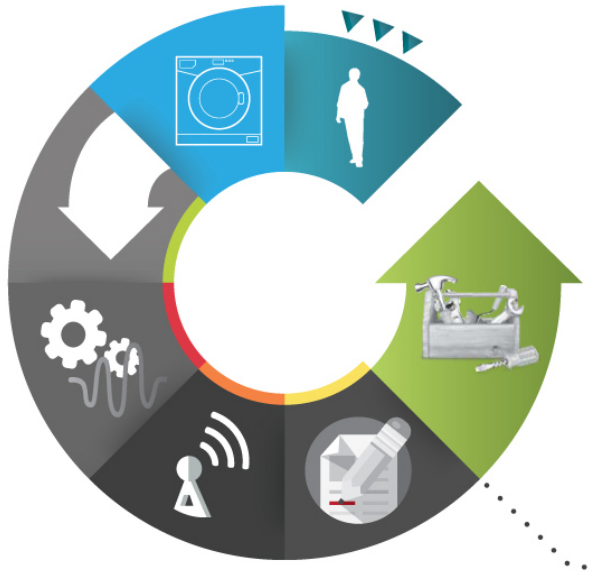
Energy used by commercial and industrial buildings in the US creates nearly 50% of our national emissions of greenhouse gases.

- United States Environmental Protection Agency

IoT technologies

REAL-TIME SERVICE NETWORKS

- Appliance Monitoring
- Predictive Maintenance
- Service Technician / CRM
- Waste Management / Recycling



R Hotel Denver,
Industrial Washer #GHS40-2608

Location: ID: *FC-RM #00243*
Manufacturer: *Appliance Park Louisville, KY* ID: *#45205343*
Materials: *FC / SUS*
Sensor: *Vibration*
Connectivity: *Wireless LAN*

Connor, the Lead Maintenance Manager at the R Hotel in Denver, receives a sensor notification that the pump body O-ring #6 on washing machine #230243 is starting to fail in the housekeeping laundry room.

On his mobile, Connor prompts the machine to order a new part. This action triggers a bidding opportunity for local service technicians within the product's authorized maintenance network.

The request lays out:
- *Pricing parameters*
- *Timing requirements*
- *Machine history*
- *Part specs*
- *Predictive sensor measurements & alerts*

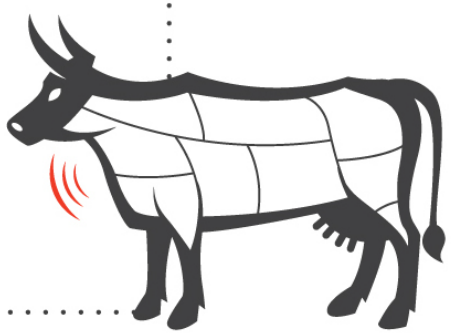
Tom from IA Appliances bids on the service request and receives a notification a few moments later that his bid was accepted.

Within 1.5 hours, a service technician from IA Appliances is on site (Using a temporary facility access code for the wireless door lock) to replace the water pump. Connor sends a brief note on the service quality and IA Appliances releases a bid request for the part's raw materials to local recycling centers.

IoT technologies

DIGITAL FARM TO TABLE

- Farm & Livestock ID & Sensors
- Food packaging sensors
- Retail Supply Chain Monitoring
- Health Services



Cattle
AIN: 840 003 123 456 789

Location: ID: Braymeadow Farm *FR #00285453543*
Slaughterhouse ID: *#45205343*
Sensor: *Temperature, Accelerometer*
Connectivity: *RFID, NFC, WAN*

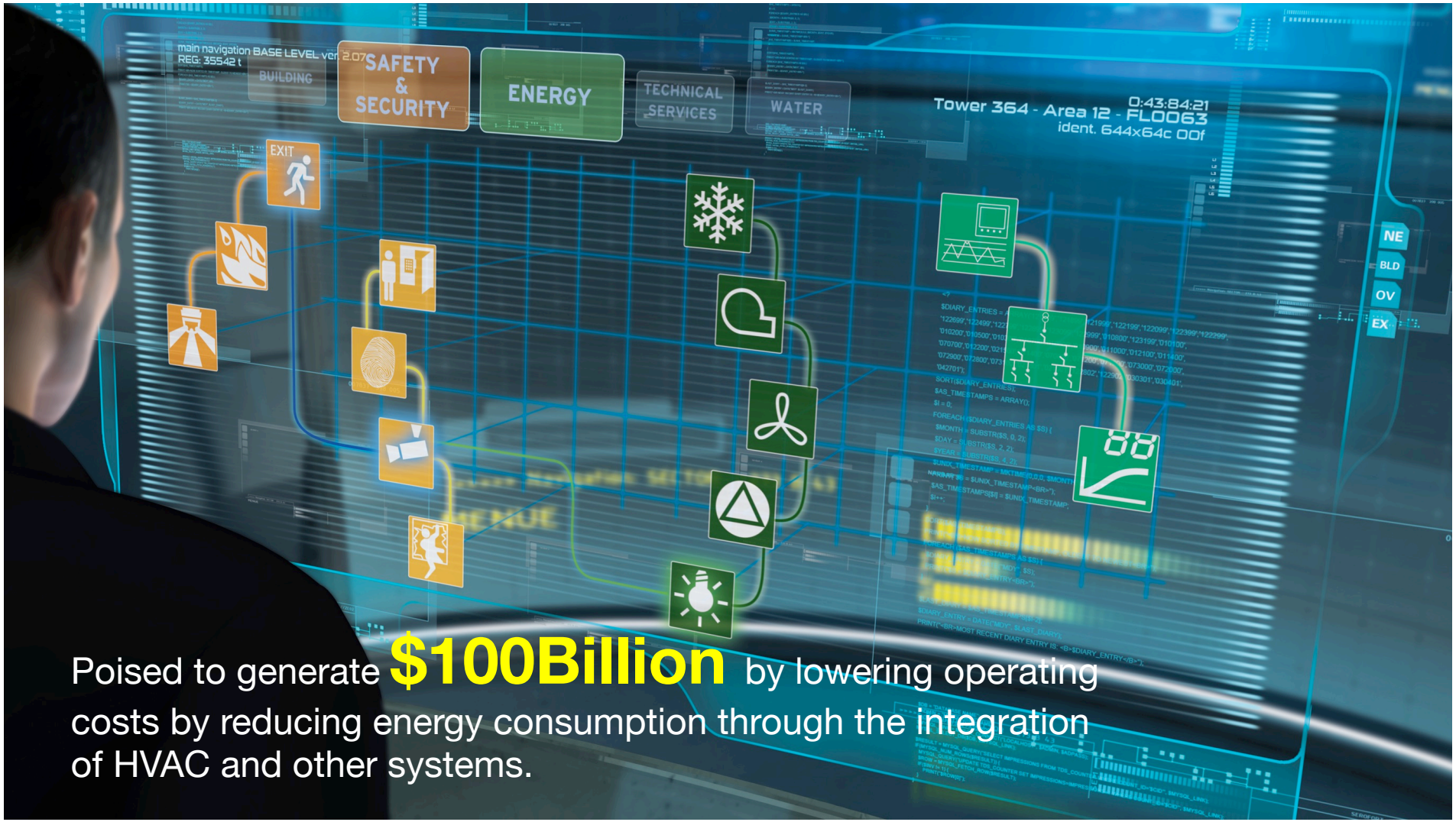
Maria and her daughter are picking up groceries for the week. Using packaging with printed sensors, the two can make sure the ground beef they are purchasing has never reached unsafe temperature levels while on the shelf or being transported.

The packaging also contains a QR code which they can use to query the cow's RFID tag and bring up its history:

- *Where it was raised*
- *What it was fed*
- *Where it was slaughtered*
- *How it was transported*
- *Where it was packaged*
- *The last time it was inspected.*

A week later the U.S. Department of Agriculture's Food Safety Service determines ground beef from originating from a regional packing company and sold at a neighboring store is contaminated with E. coli O157:H7. All packages from this distributer change their alert color and notification messages are sent to those shoppers that may have been impacted.

Smart Building



IoT technologies

Gas Monitoring

Generate **USD 69Billion** by reducing meter-reading costs and increasing the accuracy of readings for citizens and municipal utility agencies.

IoT technologies

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.

IoT technologies

Water Management

Could generate **USD 39Billion** by connecting the household water meter over an IP network to provide remote information on use and status

A Retail application

https://www.youtube.com/watch?v=qz3qbQoJbOg

IoT issues


WHAT WOULD CONCERN YOU ABOUT A WORLD OF CONNECTED DEVICES?
PRIVACY 62%
SECURITY 54%
PHYSICAL SAFETY 27%
UNABLE TO REPAIR 24%
MACHINES TAKING OVER THE EARTH 21%
NOT KNOWING HOW TO USE THEM 17%
NO TANGIBLE BENEFITS 11%

Security Issues

- For the IT department, the IoT will create a need to manage large numbers of different types of devices, many of which may not be able to ask a user for login credentials or run traditional security software. For hackers, the sheer quantity and diversity of these devices will increase the potential attack surface. Gartner estimates that by 2020, more than 25 percent of all enterprise attackers will make use of the IoT. The challenge of preventing attacks will be compounded by IoT deployments in settings where there is an absence of technical expertise, such as homes and small enterprises.

- From an operational technology perspective, the Industrial IoT (IIoT) makes industrial control systems more autonomous and connected. Cyber physical systems affect the physical world and, when compromised, significant material damage may be caused, safety may be jeopardized, and the environment may be harmed. Hence a successful attack on an IIoT system has the potential to be as serious as the worst industrial accidents to date.

Where are we going? An example: Amazon Go

https://www.youtube.com/watch?v=NrmMk1Myrxc