

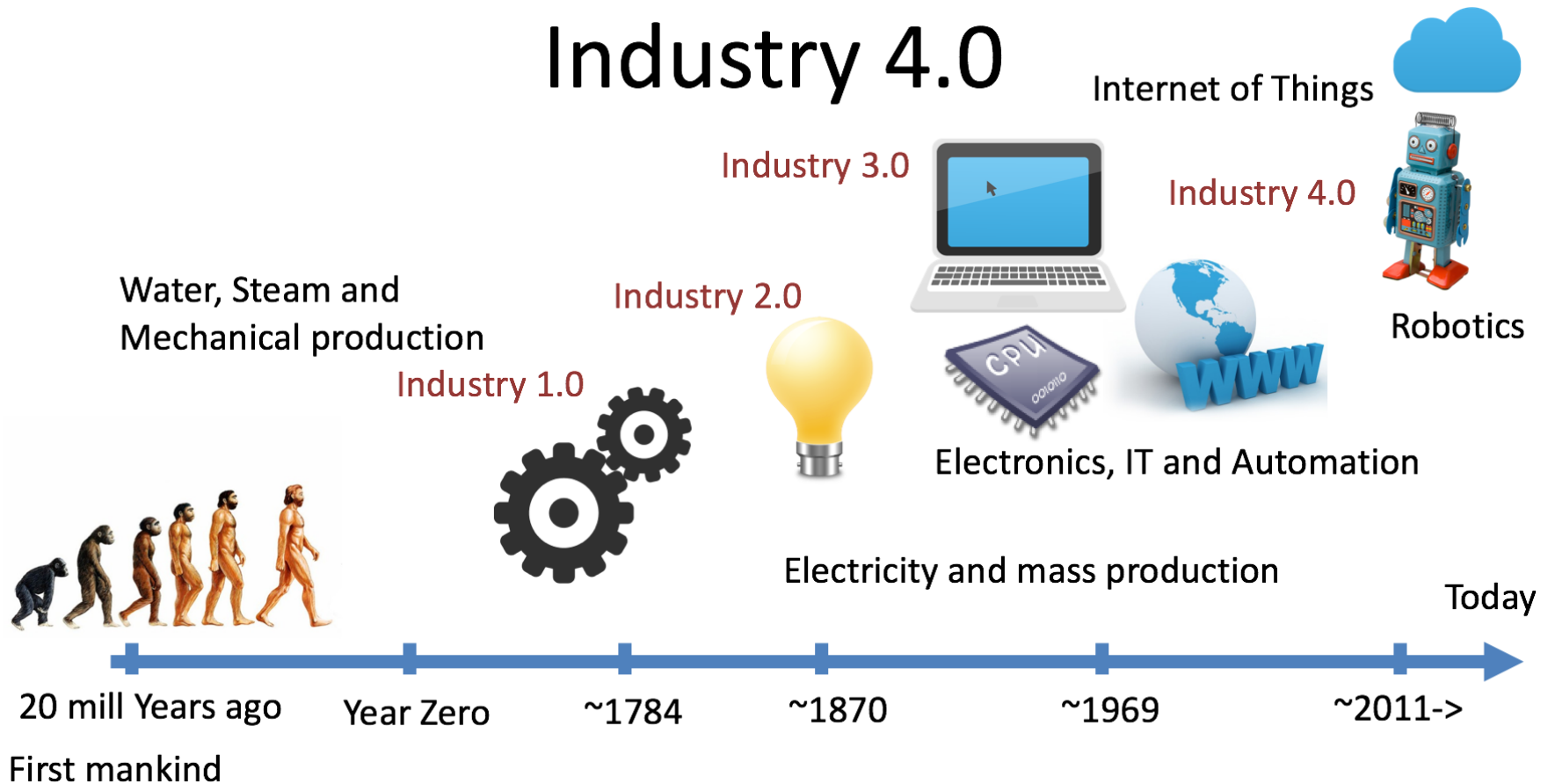
IFA511 Komunikasi Antar Perangkat (Internet of Things - IoT)

Introduction of Internet of Things (IoT)


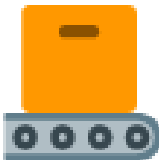


Nur Uddin, PhD.

**Program Studi Informatika
Universitas Pembangunan Jaya
Tangerang Selatan**

Industrial Revolutions (#1)



Industrial Revolutions (#2)

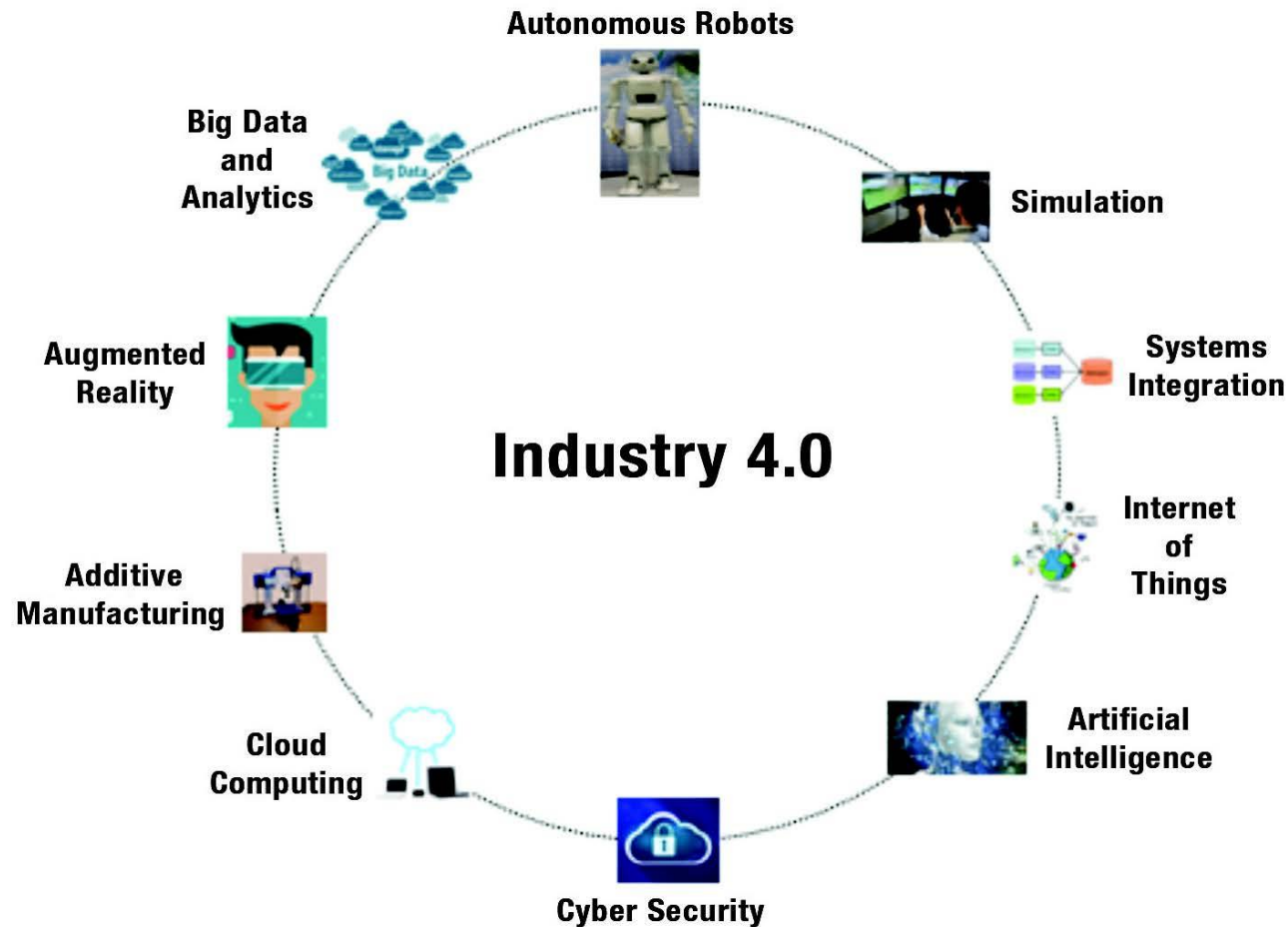
			
INDUSTRY 1.0	INDUSTRY 2.0	INDUSTRY 3.0	INDUSTRY 4.0
18th century	19th century	Mid 20th century	Today
Steam power	Electricity	ICTs Electronics	Advanced robotics 3D printing Internet of Things Artificial Intelligence Big data
Mechanical production, moving away from cottage industry	Mass production and assembly line	Automated and networked production	Intelligent, flexible and distributed production

Keywords of Industrial Revolutions

- Industrial revolution 1: Mechanisation
- Industrial revolution 2: Electrification
- Industrial revolution 3: Digitalisation
- Industrial revolution 4: Cyber-physical systems (intelligence & connectivity)

Cybernetics: the science of control and communications in the animal and machine

Industry 4.0



Graphic inspired by Boston Consulting Group discussion on Industry 4.0

Internet of Things (IoT)

- The Internet of Things (IoT) describes the network of physical objects—“things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.
- By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention.



What technologies have made IoT possible?

While the idea of IoT has been in existence for a long time, a collection of recent advances in a number of different technologies has made it practical:

- Access to low-cost, low-power sensor technology.
- Connectivity.
- Cloud computing platforms.
- Machine learning and analytics.
- Conversational artificial intelligence (AI)



<https://www.oracle.com/internet-of-things/what-is-iot/>



What is the Internet-of-Things?



How Does My Fridge Do That?

- You are leaving the home (sense user)
- There's no milk in fridge (sense object)
- Use this information to make a decision (process)
- Inform user of decision (communicate)

How Does My Fridge Do That?

- **You are leaving the home (sense user)**
 - What type of sensor?
 - Distinguish between parent and child
 - Identify reason for leaving home
 - Identify other contexts (e.g., store hours)
- There's no milk in fridge (sense object)
- Use this information to make a decision (process)
- Inform user of decision (notify)

How Does My Fridge Do That?

- You are leaving the home (sense user)
- **There's no milk in fridge (sense object)**
 - What type of sensor?
 - Is milk needed?
 - No milk or "little" milk? (prediction)
- Use this information to make a decision (process)
- Inform user of decision (notify)

How Does My Fridge Do That?

- You are leaving the home (sense user)
- There's no milk in fridge (sense object)
- **Use this information to make a decision (process)**
 - Where is processor?
 - What are the rules?
 - Fixed rules versus dynamic rules (learning)
- Inform user of decision (notify)

How Does My Fridge Do That?

- You are leaving the home (sense user)
- There's no milk in fridge (sense object)
- Use this information to make a decision (process)
- **Inform user of decision (notify)**
 - How?
 - When?
 - Privacy?
 - Subtleness?
 - Information overflow?

Internet-of-Things (IoT)

Physical object (“thing”)

+

Controller (“brain”)

+

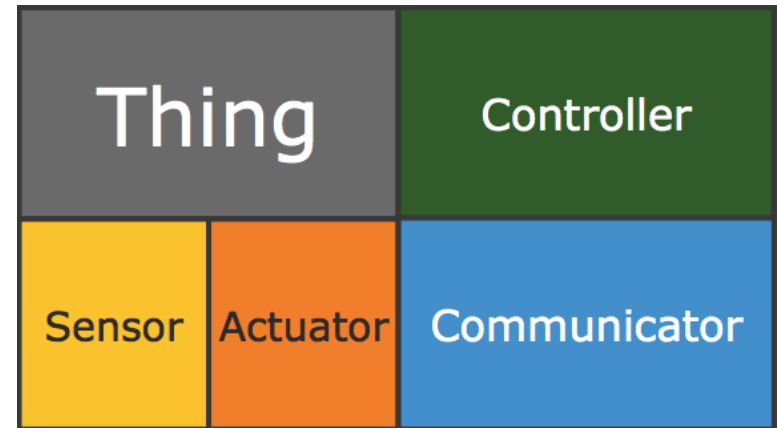
Sensors

+

Actuators

+

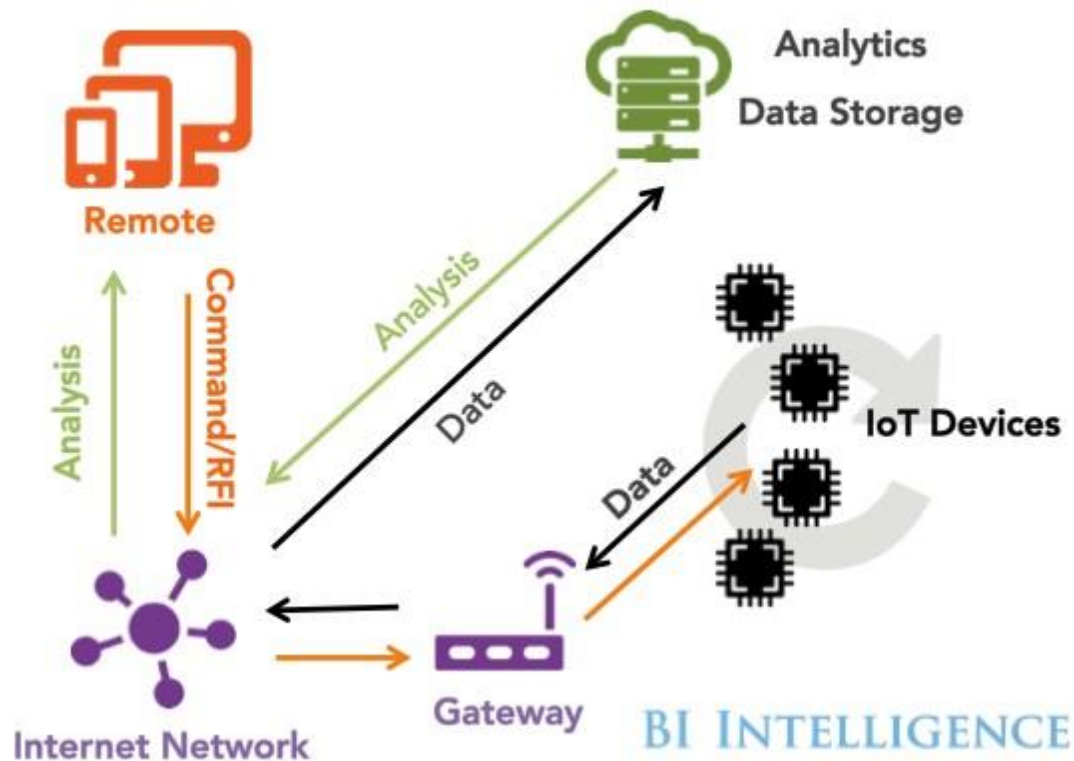
Networks (Internet)





Internet-of-Things (IoT)

The Internet of Things Ecosystem

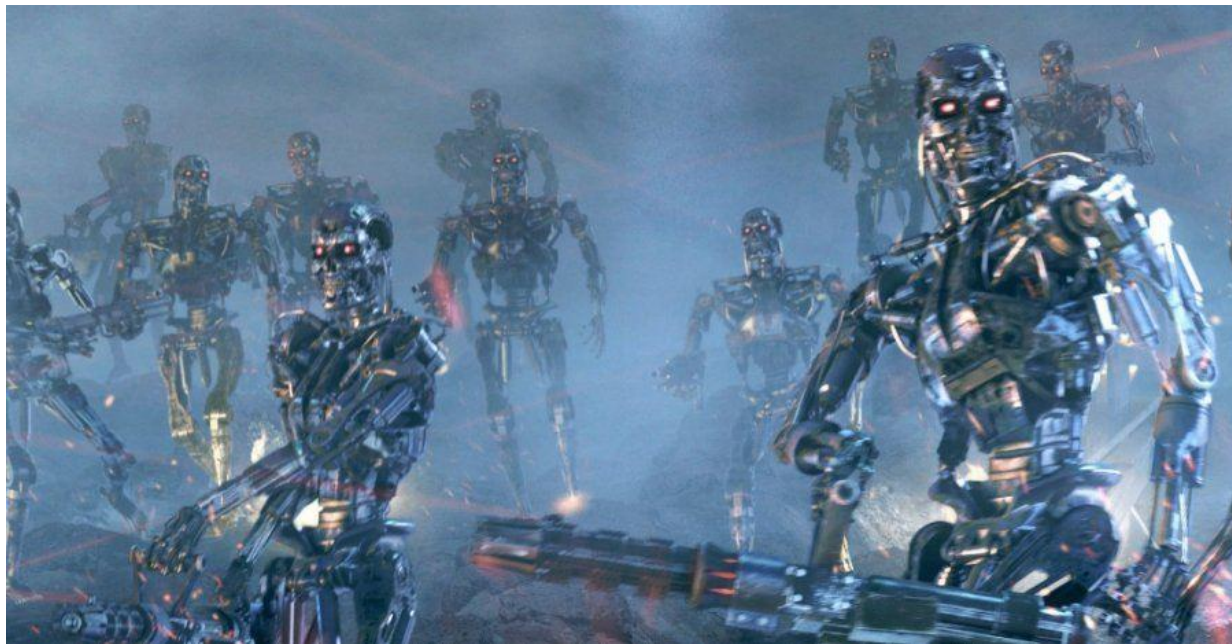


Related Areas/Terminology

- **Embedded systems:** not necessarily connected
- **Sensor networks:** collection of sensor devices connected through wireless channels
- **Cyber-physical systems:** focus on interaction between physical and cyber systems. A cyber system is an integration of computation and networking.
- **Real-time systems:** focus on time constraints
- **Pervasive/ubiquitous computing:** focus on anytime/anywhere computing

Related Areas

- Machine-to-machine (M2M) communications
- Internet of Everything (Cisco Systems)
- “Skynet” (Terminator movie)



“Internet-of-Things”

- Term coined by British entrepreneur Kevin Ashton, while working at MIT Auto-ID Labs
- Referred to (and envisioning) a future global network of objects connected specifically by RFID (radio-frequency identification)
- Complete automation of data collection
- First article about IoT in 2004 from MIT; called “Internet 0”

Internet-of-Things Vision & Growth

THE INTERNET OF THINGS

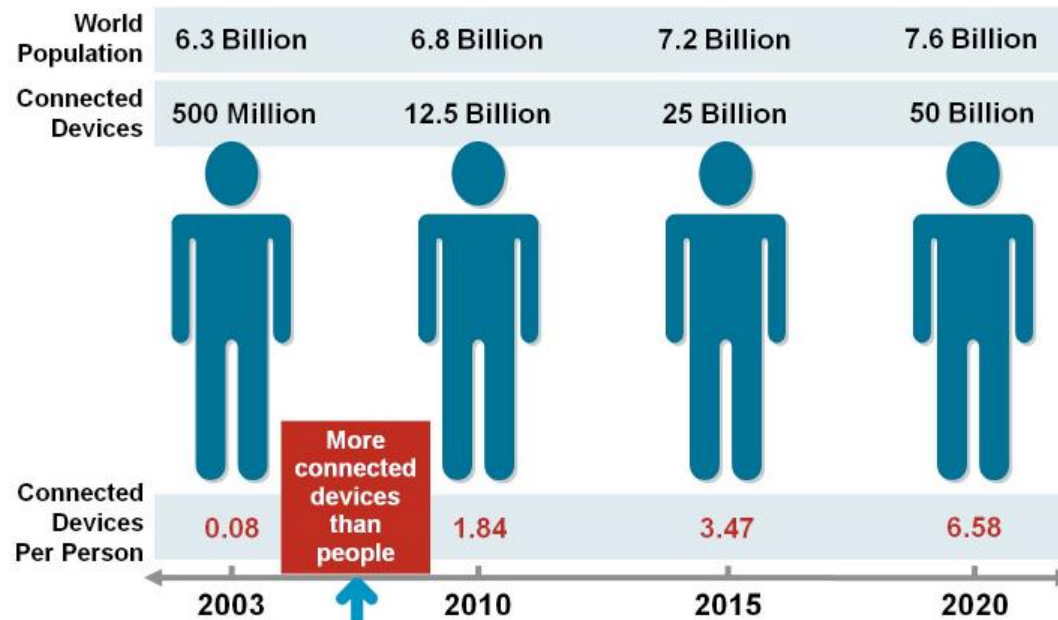
Connected devices (billions)



	15 billion	28 billion	CAGR 2015–2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/laptop/tablet	1.7	1.8	1%
Mobile phones	7.1	8.6	3%
Fixed phones	1.3	1.4	0%
	2015	2021	

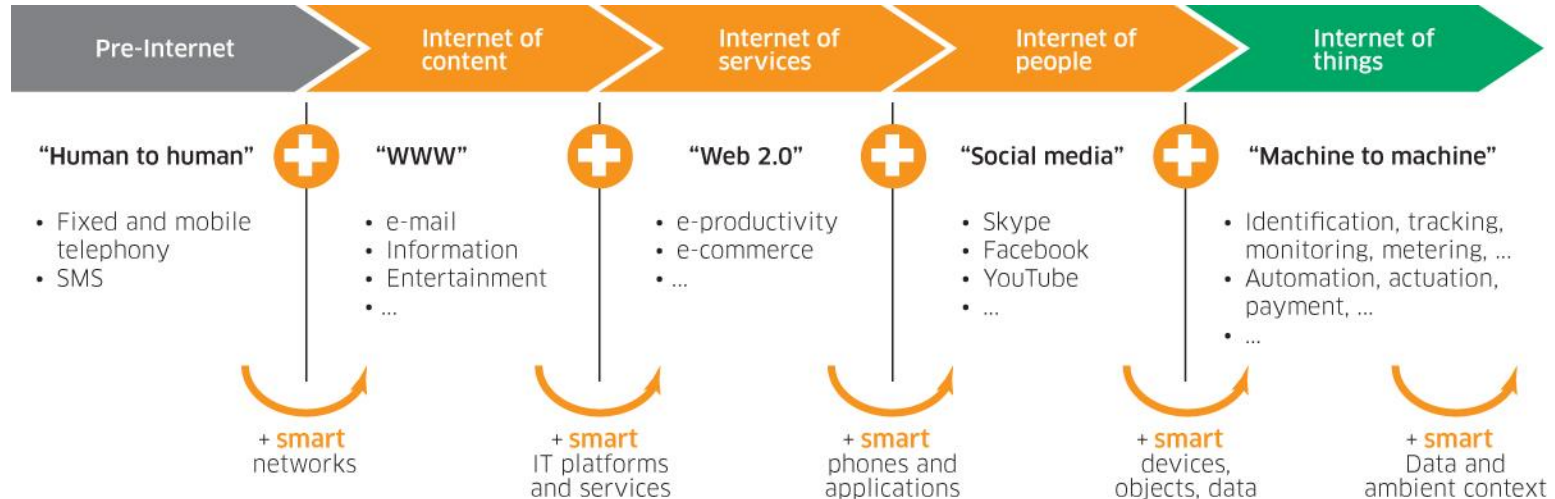
Internet-of-Things Vision & Growth

Figure 1. The Internet of Things Was "Born" Between 2008 and 2009

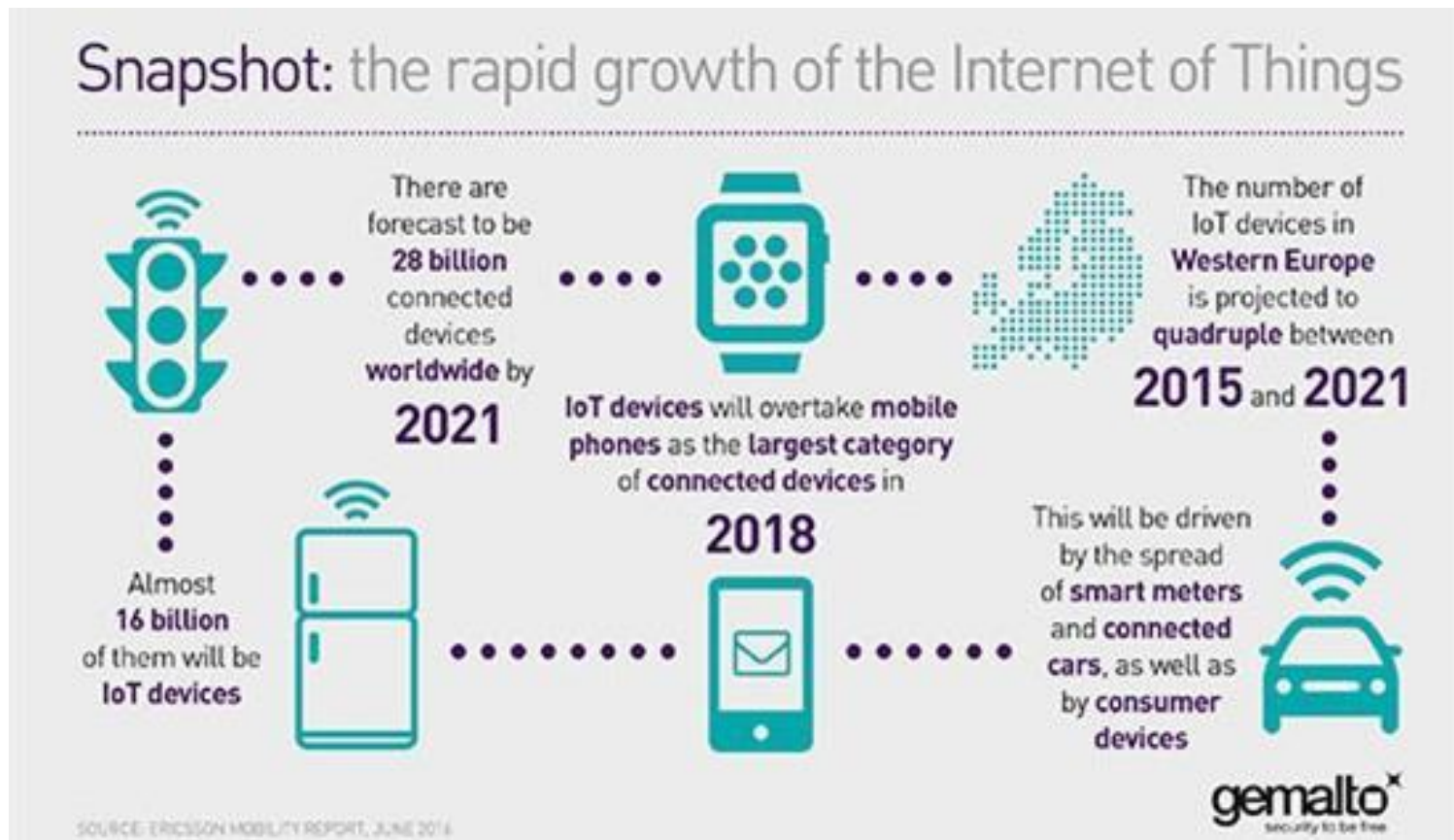


Source: Cisco IBSG, April 2011

Internet-of-Things Vision & Growth

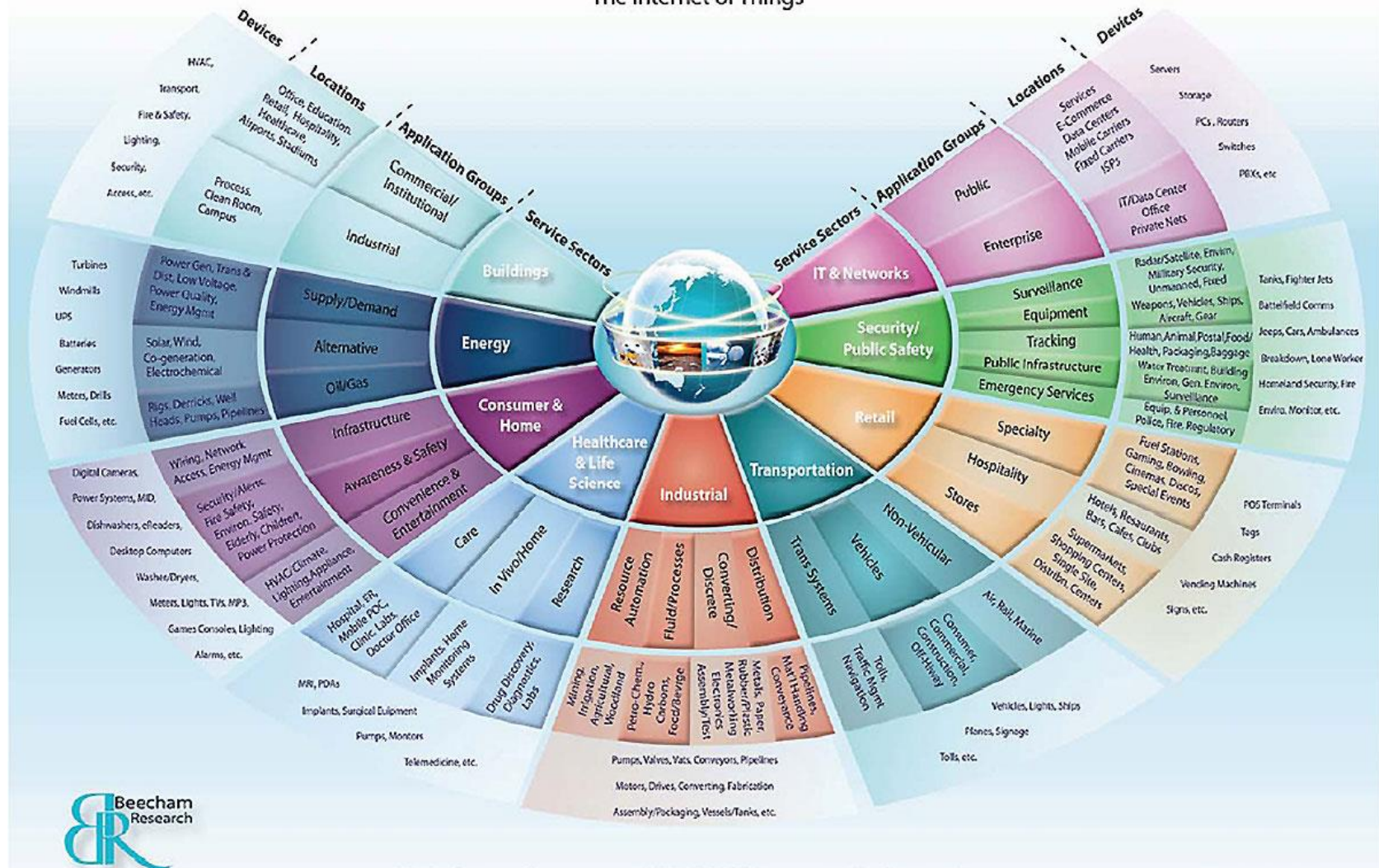


Internet-of-Things Vision & Growth



Internet-of-Things Vision & Growth

The Internet of Things



Augment Existing Things



Augmenting Life With New Things

- Smart City
- Smart Car
- Smart Me (healthcare, fitness, wellness)



Example: Connected Roadways

- US DoT Statistics for 2012:
 - 5.6million crashes
 - About 31,000 fatalities (26,500 in EU)
 - Over 1.6M injuries
- 1trillion USD in economic loss
- 5.5billion hours of travel delays per year
- CO2 emissions

Example: Connected Roadways

Under the bonnet

How a self-driving car works

Signals from **GPS (global positioning system)** satellites are combined with readings from tachometers, altimeters and gyroscopes to provide more accurate positioning than is possible with GPS alone

Lidar (light detection and ranging) sensors bounce pulses of light off the surroundings. These are analysed to identify lane markings and the edges of roads

Video cameras detect traffic lights, read road signs, keep track of the position of other vehicles and look out for pedestrians and obstacles on the road

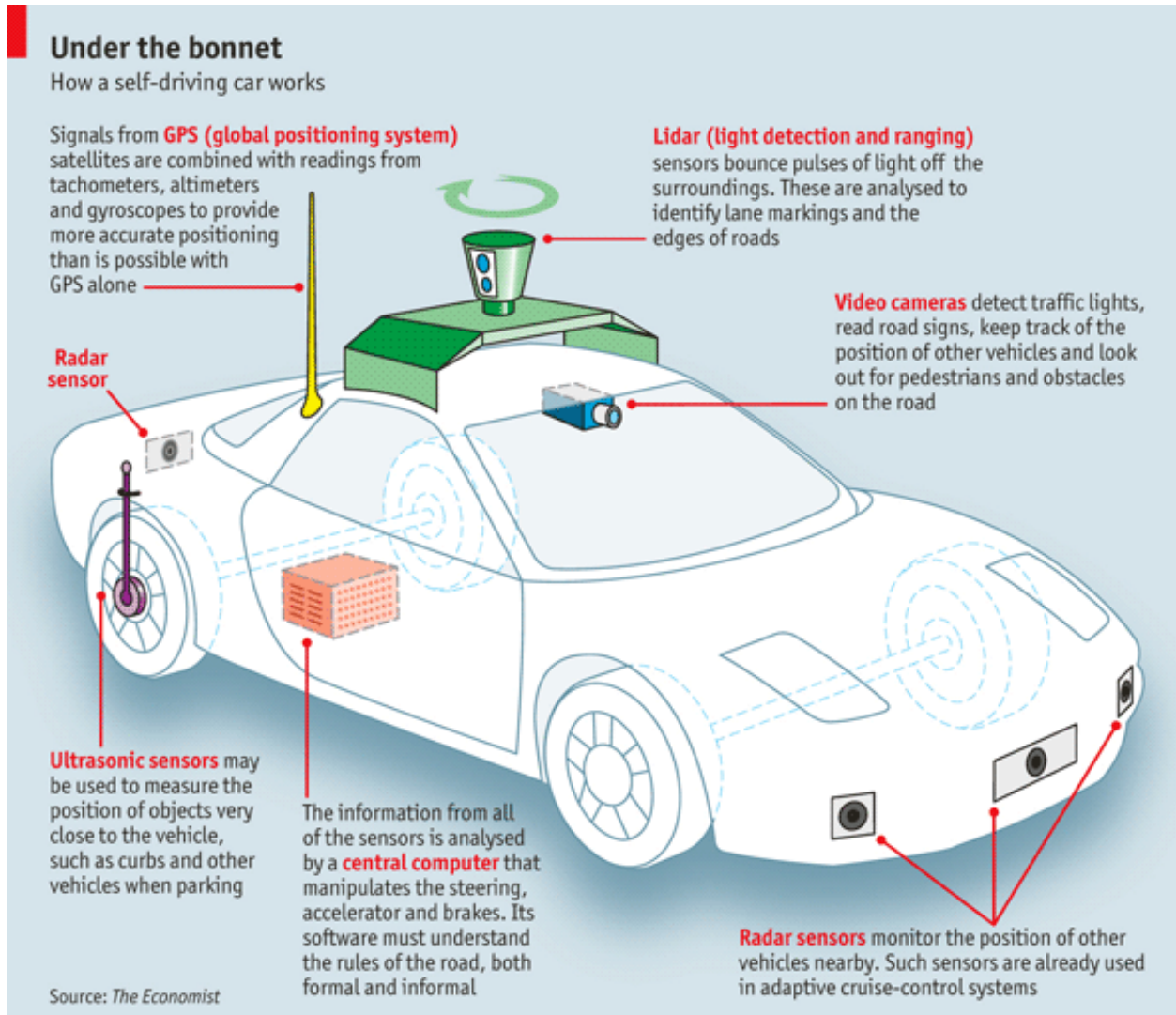
Radar sensor

Ultrasonic sensors may be used to measure the position of objects very close to the vehicle, such as curbs and other vehicles when parking

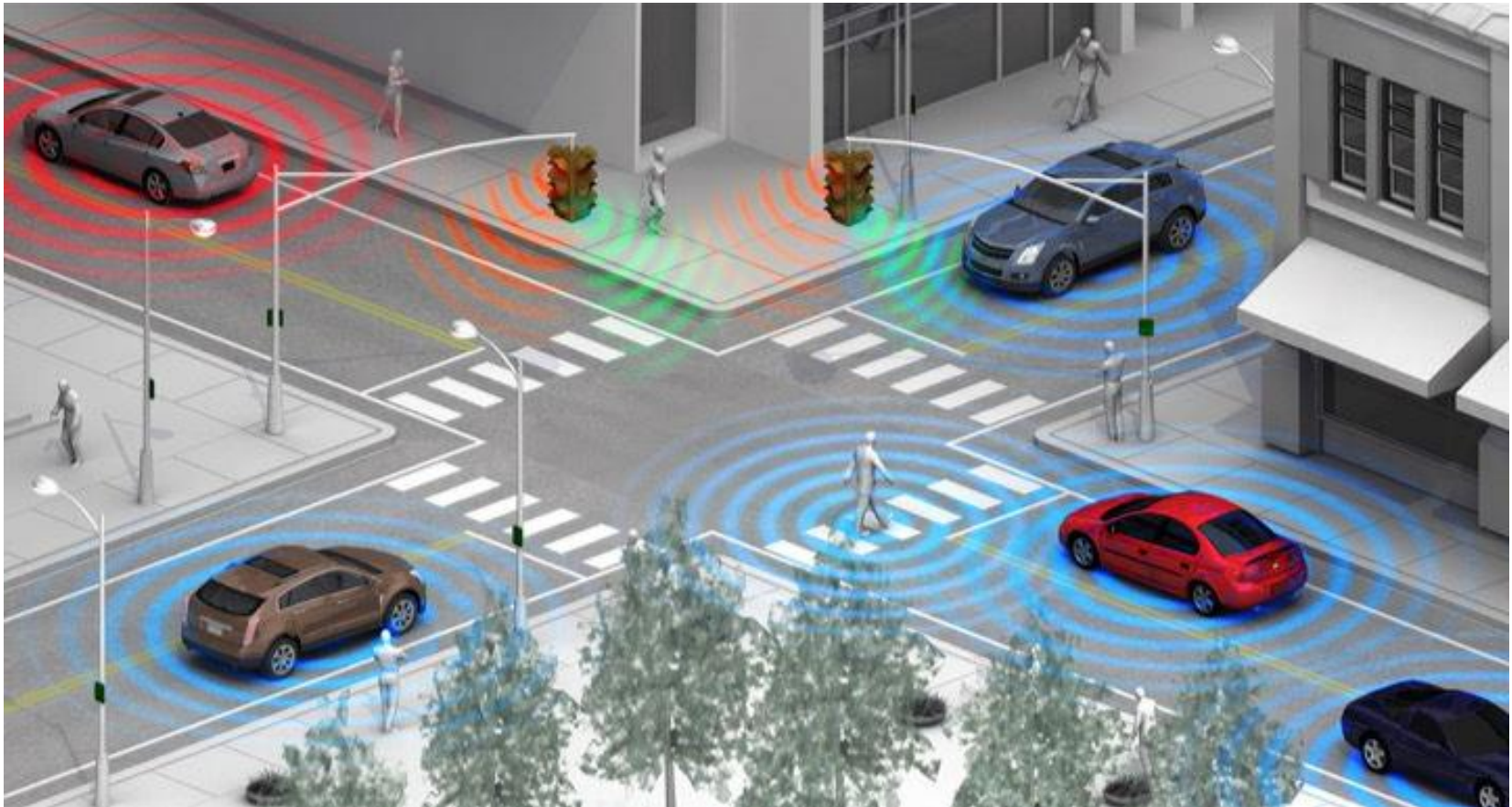
The information from all of the sensors is analysed by a **central computer** that manipulates the steering, accelerator and brakes. Its software must understand the rules of the road, both formal and informal

Radar sensors monitor the position of other vehicles nearby. Such sensors are already used in adaptive cruise-control systems

Source: *The Economist*



Example: Connected Roadways



[State of Self-Driving Car](#)

Example: Connected Factory

The Connected Factory in Action



INNOVATION

TAP COMMERCIAL INNOVATION

Mobile employees and supervisors to move across the factory floor and access data wherever they are. The iPad and other like devices are making their way into industrial settings – along with an expectation that much of the commercial innovation it brings will also apply to industrial activities.

CONNECT ENGINEERS WITH MACHINES (M2M)

Apply predictive maintenance. Gain early warnings when production, machinery or network performance is about to degrade.



EFFICIENCY

LINK INFORMATION & OPERATIONAL TECHNOLOGY

Bridge the gap from data center to control room to collaborate and share best practices and common goals between manufacturing and IT.

OPTIMIZE ASSETS

Identify where your people, equipment, works in process and finished goods are in real-time. Adjust the schedule and inventory on the fly.



"I see the flat!"



AGILITY

CONNECT & COLLABORATE EXTERNALLY

Extend visibility beyond your four walls. Link the extended supply chain and distribution to create dynamic workflows. Help and expertise are available in an instant.

EXPANDABLE INFRASTRUCTURE

Design and build an Industrial Ethernet infrastructure to minimize cost and effort to expand or improve processes. One infrastructure for safety, control, SCADA, Physical Security, and IAN.



RISK

SECURE PHYSICAL & CYBER ASSETS

Traditional security devices, like keypad entry systems, call boxes and security cameras, need power from Industrial Ethernet cables, with secure networks, to protect your processes, people, and plants from cyber sabotage.

MAXIMIZE UPTIME

Design ruggedized industrial networking infrastructure that will endure in harsh environments with redundant communications, power and configuration backup – especially for business processes under extreme conditions.

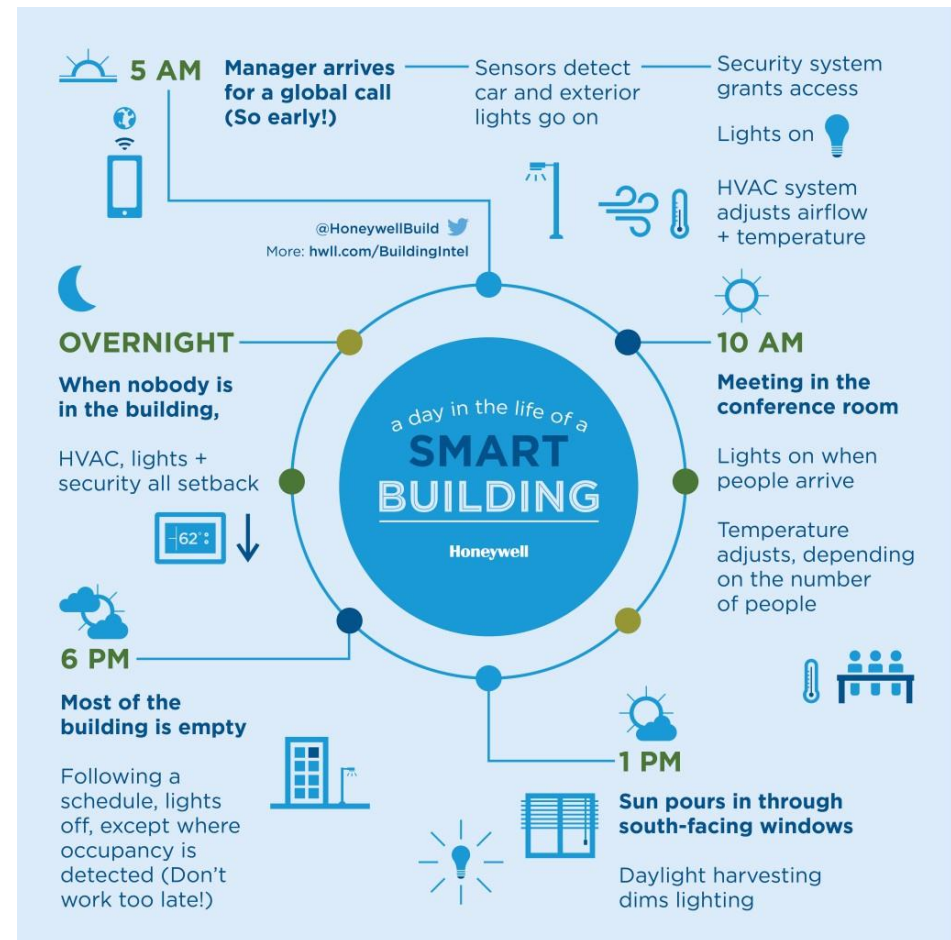


Example: Connected Factory

- New product and service introductions faster
- Increasing production, quality, uptime
- Mitigating unplanned downtime
- Protecting from cyber threats
- Worker productivity and safety

Example: Smart & Connected Buildings

- Energy management
- Lighting
- Safety
- HVAC
- Building automation
- Smart spaces



Example: Smart Creatures

The connected cow

Necklace

Connecterra, a Dutch company, makes Fitbit-style necklaces that monitor a cow's movement and feeding habits. The sensor can be used to detect health problems and to tell when the cow is in heat, so that insemination can happen at an optimum time.

Acid monitor

Well Cow, a British company, has developed a bolus that is inserted into the cow's rumen to monitor acidity levels. This helps detect digestive problems.

Tail movements

Moocall, an Irish company, makes a birthing sensor that attaches to the tail. It measures tail movements triggered by labour contractions, and sends a farmer an SMS alert approximately one hour before a cow is due to calve.

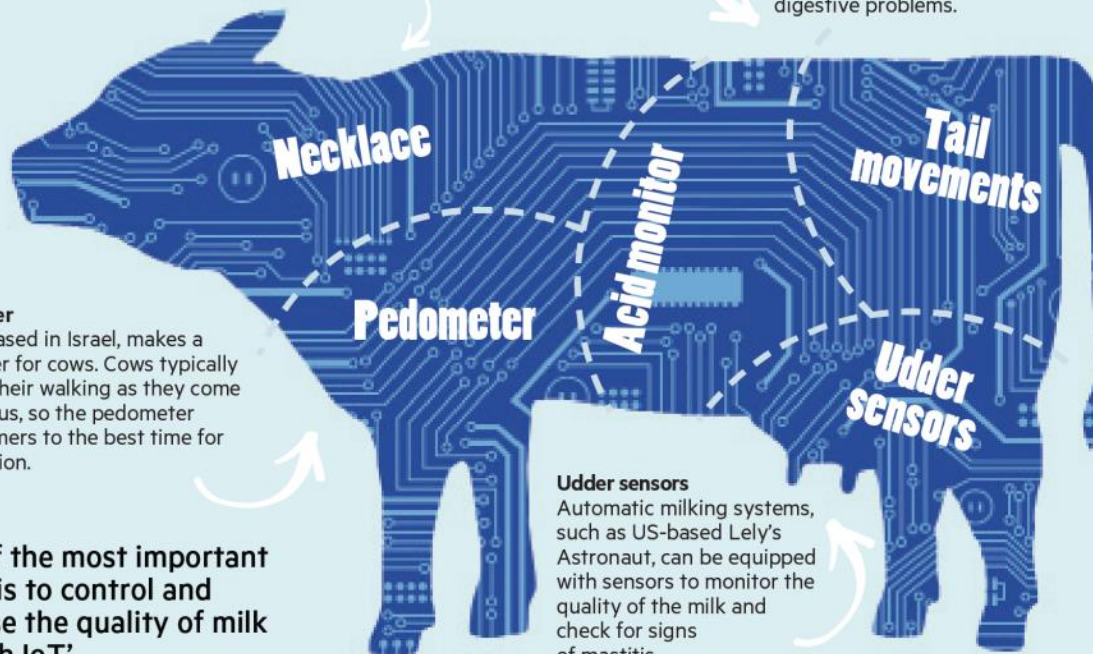
Pedometer

Afimilk, based in Israel, makes a pedometer for cows. Cows typically increase their walking as they come into oestrus, so the pedometer alerts farmers to the best time for insemination.

'One of the most important issues is to control and increase the quality of milk through IoT'

Udder sensors

Automatic milking systems, such as US-based Lely's Astronaut, can be equipped with sensors to monitor the quality of the milk and check for signs of mastitis.



Example: Fight Poverty

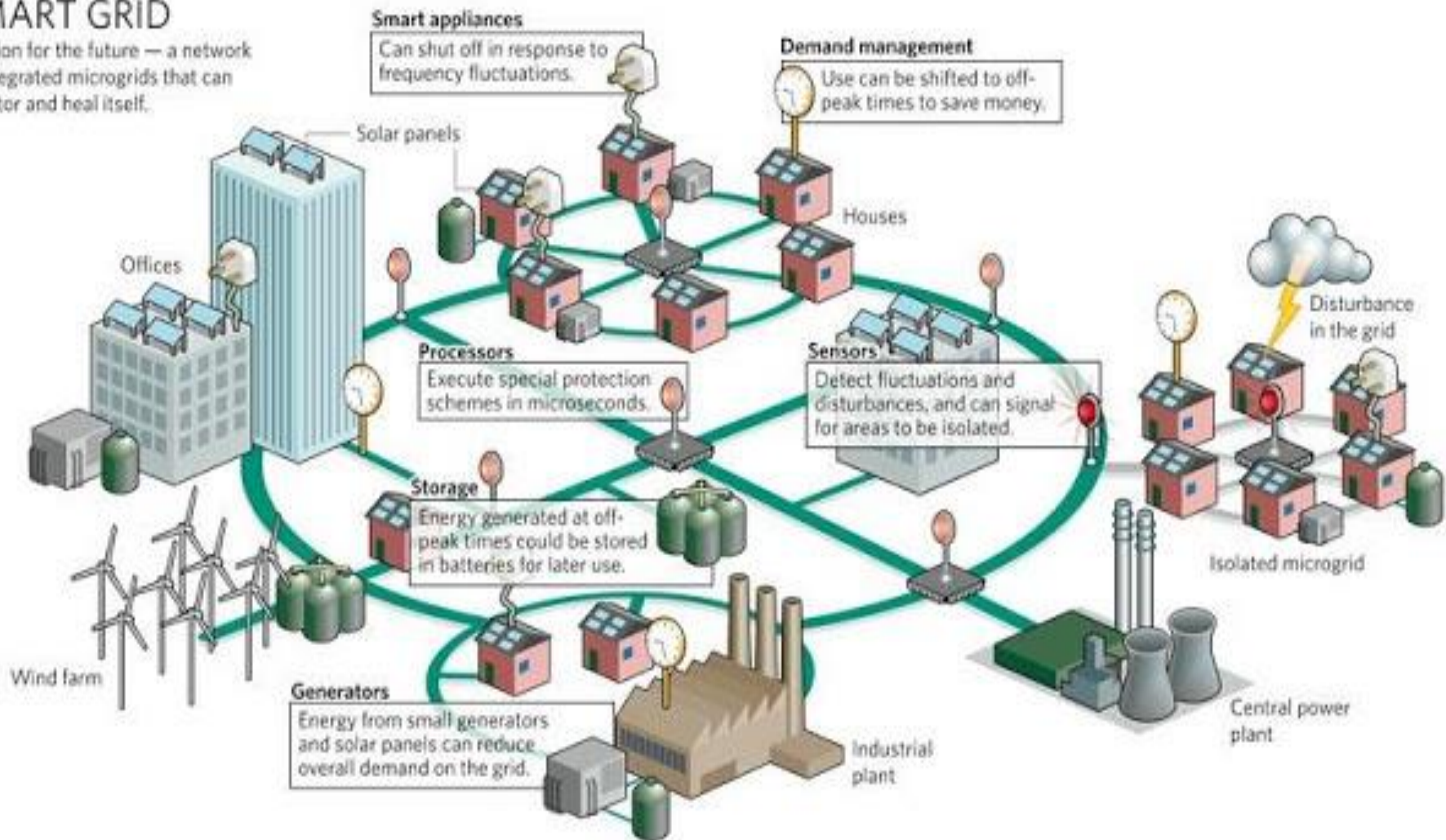
- Try to get more shoppers from Warden Road to Dharavi in Mumbai



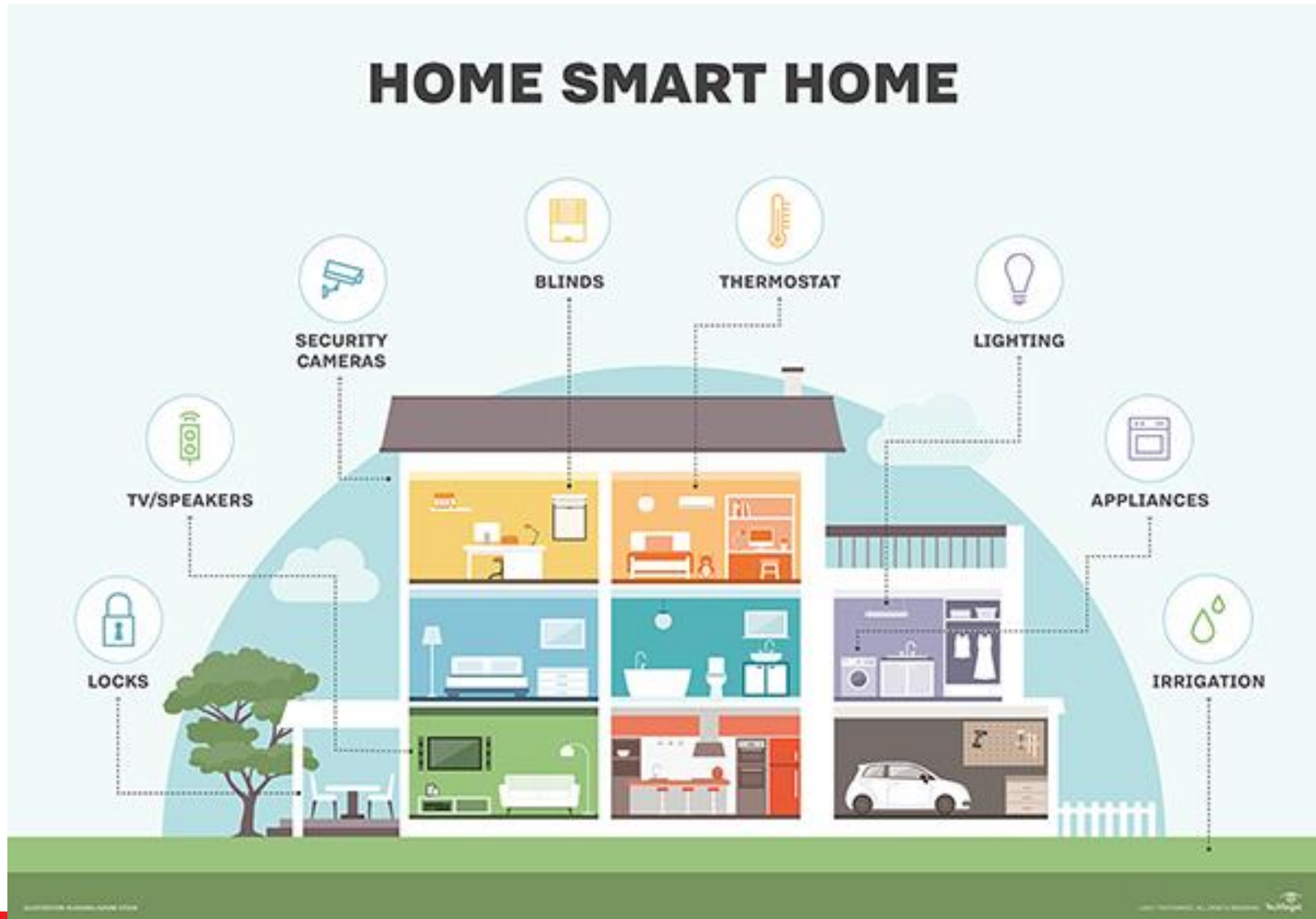
Example: Smart Grid

SMART GRID

A vision for the future — a network of integrated microgrids that can monitor and heal itself.



Example: Smart Homes



Example: Smart Lighting

- Tunable light, 16 million colors
- Activated by smartphone or over Zigbee wireless
- Can serve as alarm clock
- Can synch colors to movies or possibly music



Philips never anticipated the demand - sold out in 3 months at Apple stores!

More Smarts

- Smart bathroom cabinet for medicine
- Smart refrigerator
- Smart toilet
- Smart history (in museums)
- Smart health (sensors in running shoes)
- Smart buying (beacons)
- Smart shirt (seal wounds)
- Smart helmet (detect concussion)
- ...

Enablers: Portability

- Reducing the size of hardware to enable the creation of computers that could be physically moved around relatively easily



Enablers: Miniaturization

- Creating new and significantly smaller mobile form factors that allowed the use of personal mobile devices while on the move



50mm x 50mm



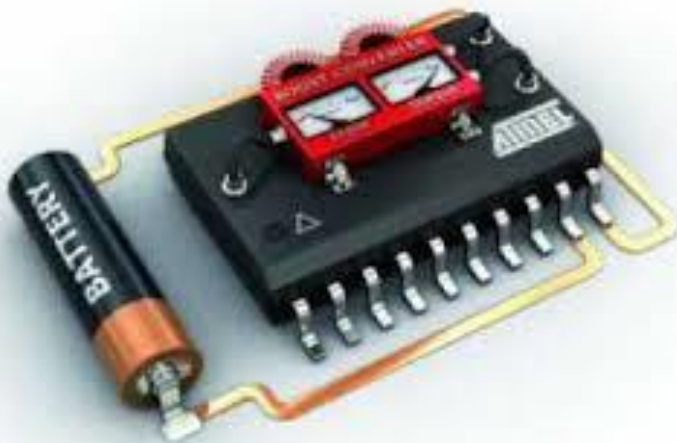
35mm x 35mm



15mm x 15mm

Enablers: Low Power and Low Heat

- Low power architectures
- Low power radios
- Sleep modes
- Energy harvesting



Enablers: Connectivity

- Developing devices and applications that allowed users to be online and communicate via wireless data networks while on the move



Bluetooth®

Enablers: Convergence

- Integrating emerging types of digital mobile devices, such as Personal Digital Assistants (PDAs), mobile phones, music players, cameras, games, etc., into hybrid devices



Enablers: Divergence

- Opposite approach to interaction design by promoting information appliances with specialized functionality rather than generalized ones



Enablers: Ecosystems

- The emerging wave of *digital ecosystems* is about the larger wholes of pervasive and interrelated technologies that interactive mobile systems are increasingly becoming a part of



Example: Smartphone

- Portability: carry it anywhere you want
- Miniaturization: make it possible to build device to fit in your pocket
- Connectivity: Wi-Fi, LTE/4G, cellular, Bluetooth
- Convergence: phone, camera, gaming device, movie streaming, music player, ...
- Digital Ecosystem: cloud, social networks, software development kits, app stores, big data, standardization ...

IoT Issues & Challenges

