12. SMART TECHNOLOGY

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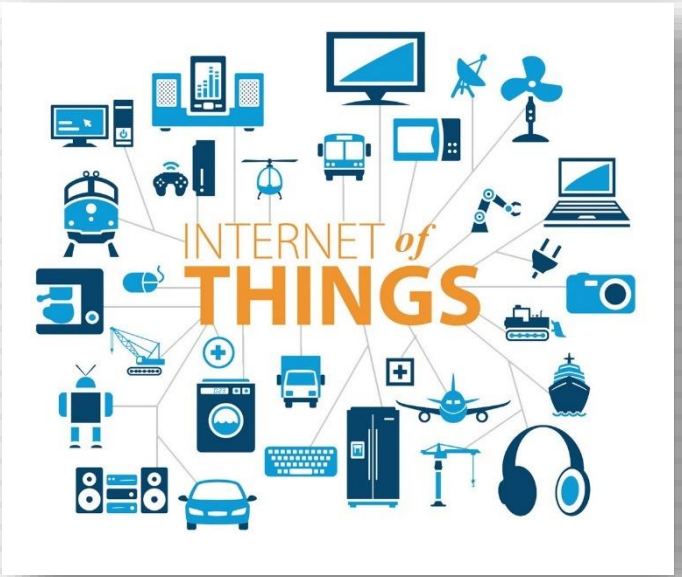
12.1. IoT (Internet of Things)

12.1. IoT

12.2. Smart Home

12.3. Smart Grid



Internet of Things (IoT)

- The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity—that enables these objects to collect and exchange data.

History (1)

- As of 2016, the vision of the Internet of things has evolved due to a convergence of multiple technologies, including ubiquitous wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems.

History (2)

- The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at Carnegie Mellon University becoming the first Internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold.

History (3)

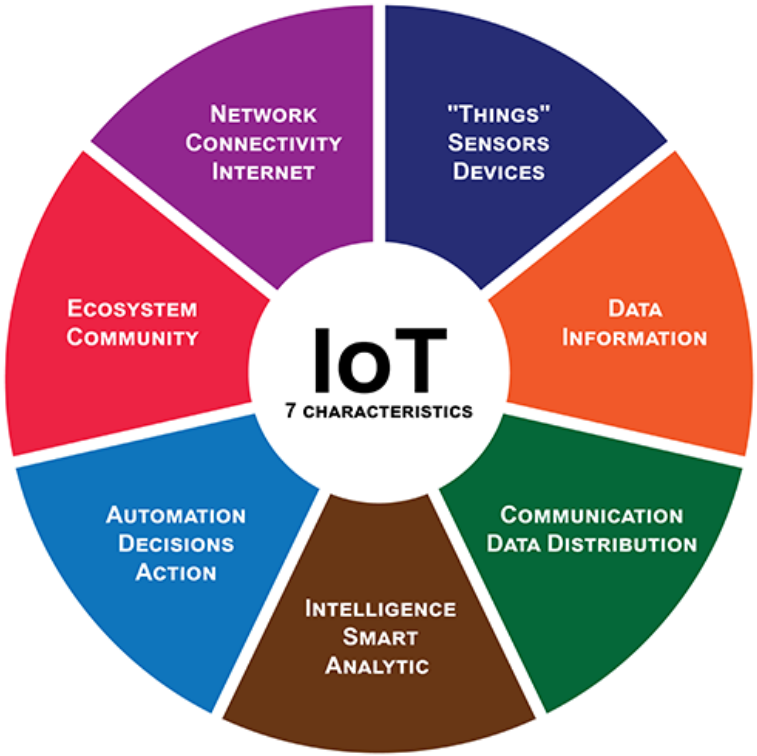
- Mark Weiser's seminal 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of IoT.
- In 1994 Reza Raji described the concept in IEEE Spectrum as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories".

History (4)

- Between 1993 and 1996, several companies proposed solutions like Microsoft's at Work or Novell's NEST. However, only in 1999 did the field start gathering momentum. Bill Joy envisioned Device to Device (D2D) communication as part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.
- The concept of the Internet of things became popular in 1999, through the Auto-ID Center at MIT and related market analysis publications.

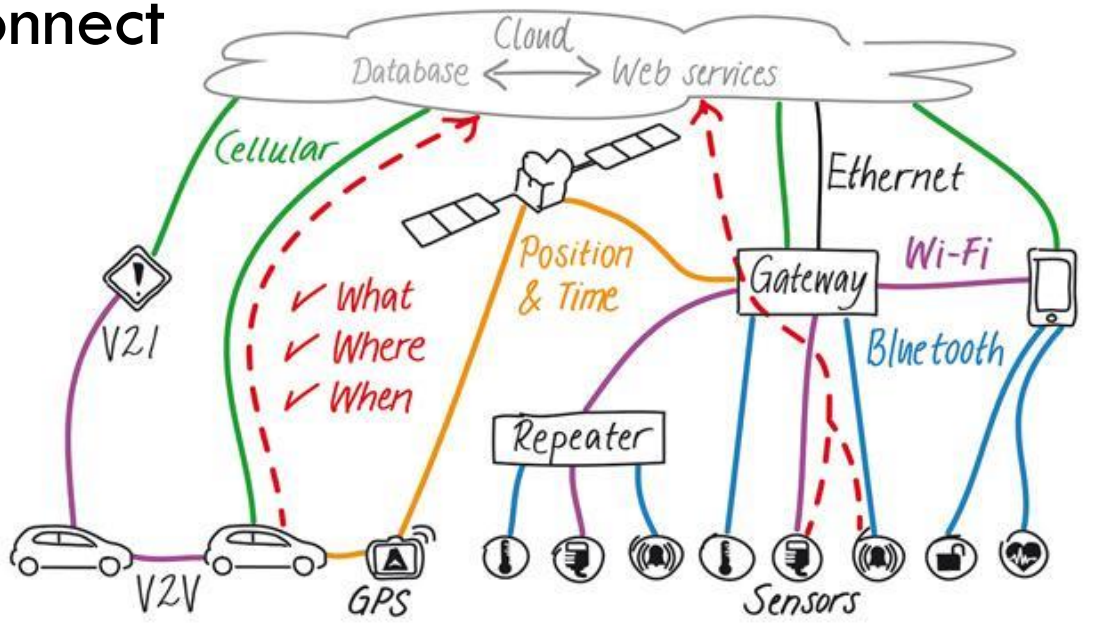
Internet of Things Characteristics

- Connectivity
- Things
- Data
- Communication
- Intelligence
- Action
- Ecosystem



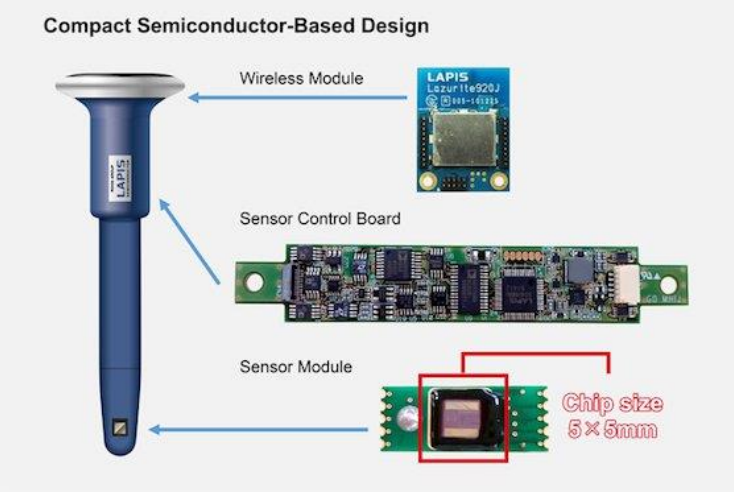
Characteristics (1): Connectivity

- Devices need to connect to each other, to a network, or to the internet
- Many use cloud computing



Characteristics (2): Things

- Anything that is designed to be connected
  - Complex devices that contain sensors
  - Simple sensors that communicate
  - Sensing materials can be attached to devices, items, humans, or animals

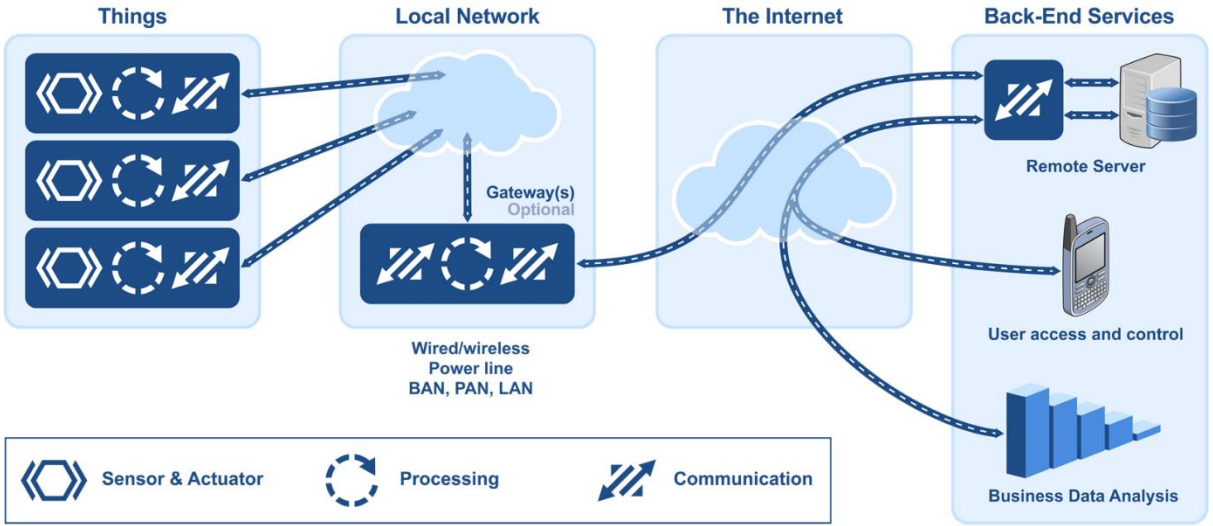


Characteristics (3): Data

- Data is the glue of the Internet of Things, the first step towards action and intelligence.

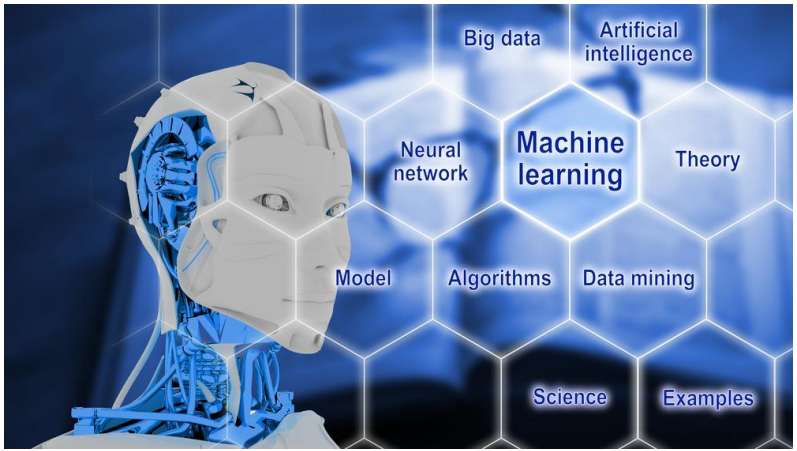
Characteristics (4): Communication

- Devices get connected so they can communicate data and this data can be analyzed.



Characteristics (5): Intelligence

- Two types of intelligence
  - Intelligence as in the sensing capabilities in IoT devices
  - Intelligence gathered from data analytics (also artificial intelligence)

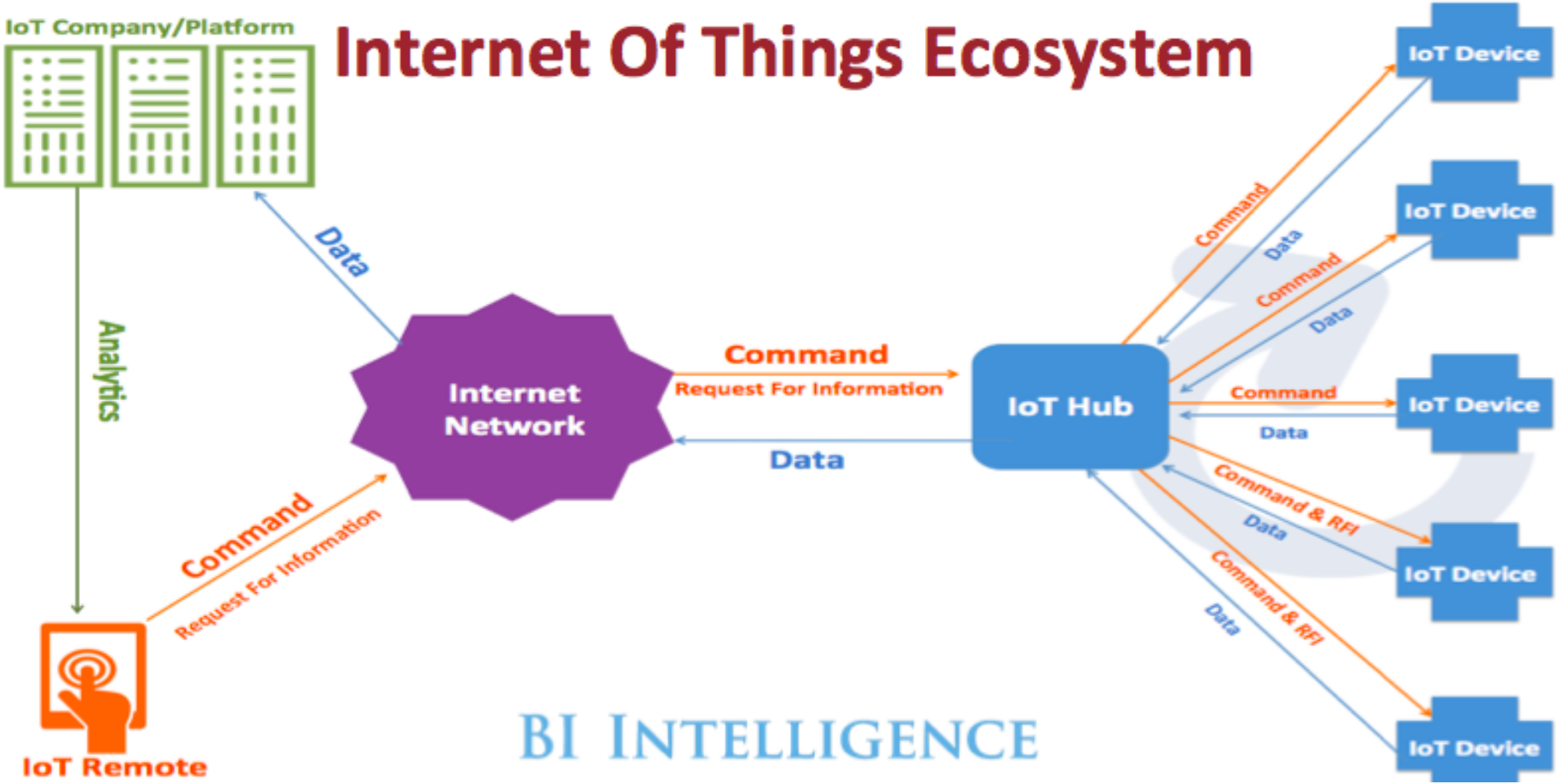


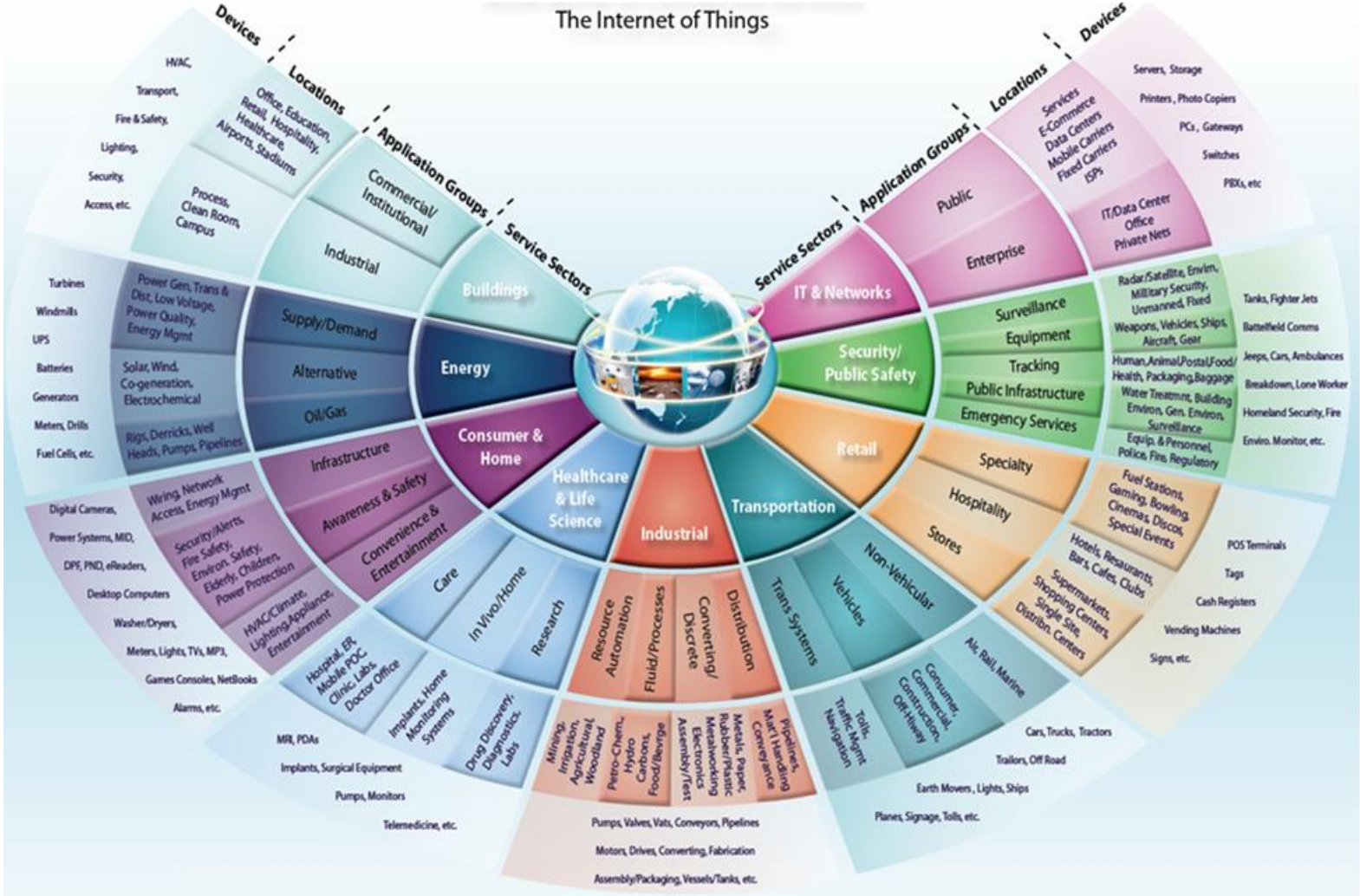
Characteristics (6): Action

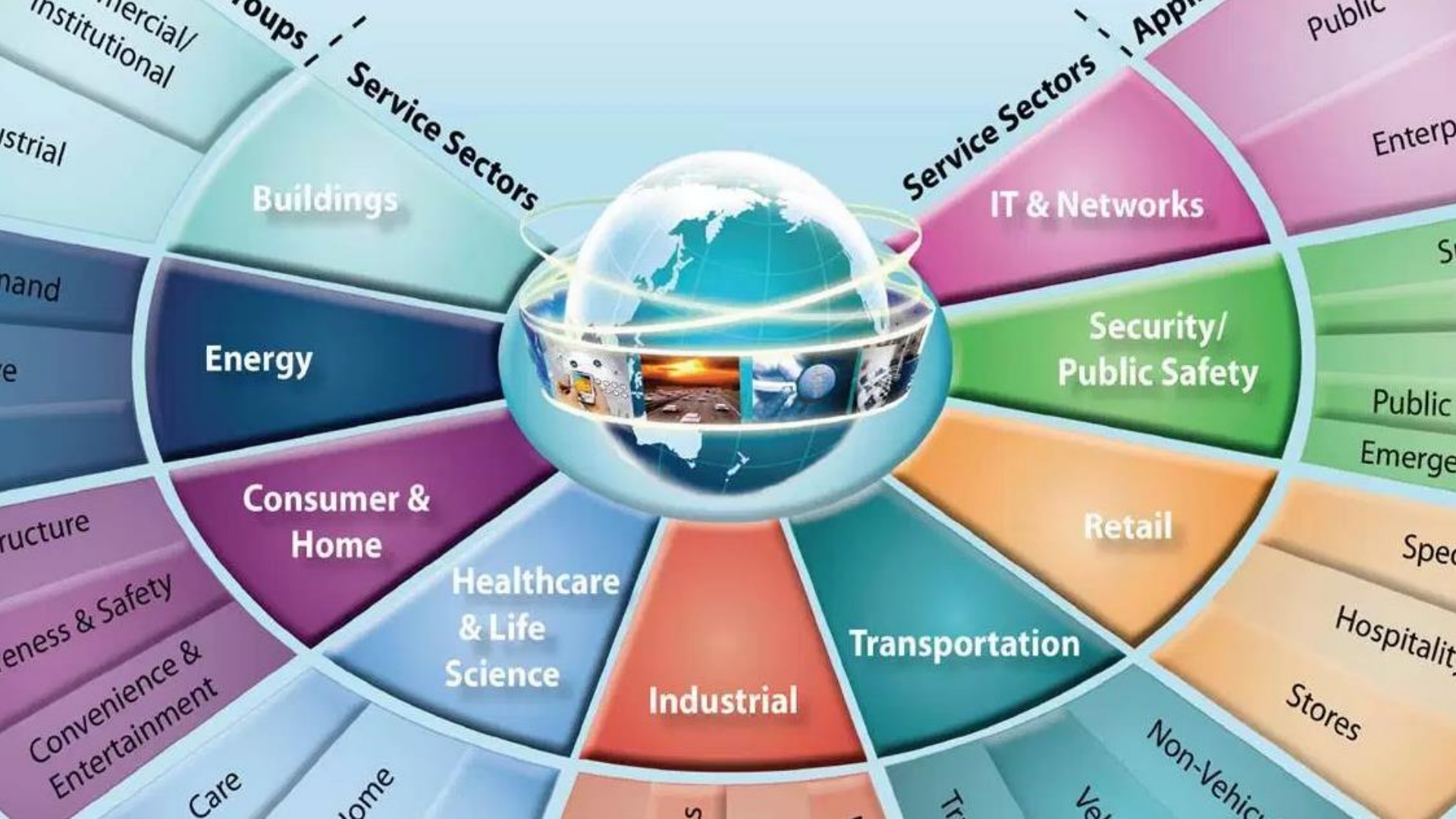
- The consequence of intelligence.
- This can be a manual action, action based upon debates regarding phenomena (for instance in climate change decisions) and automation, often the most important piece.

Characteristics (7): Ecosystem

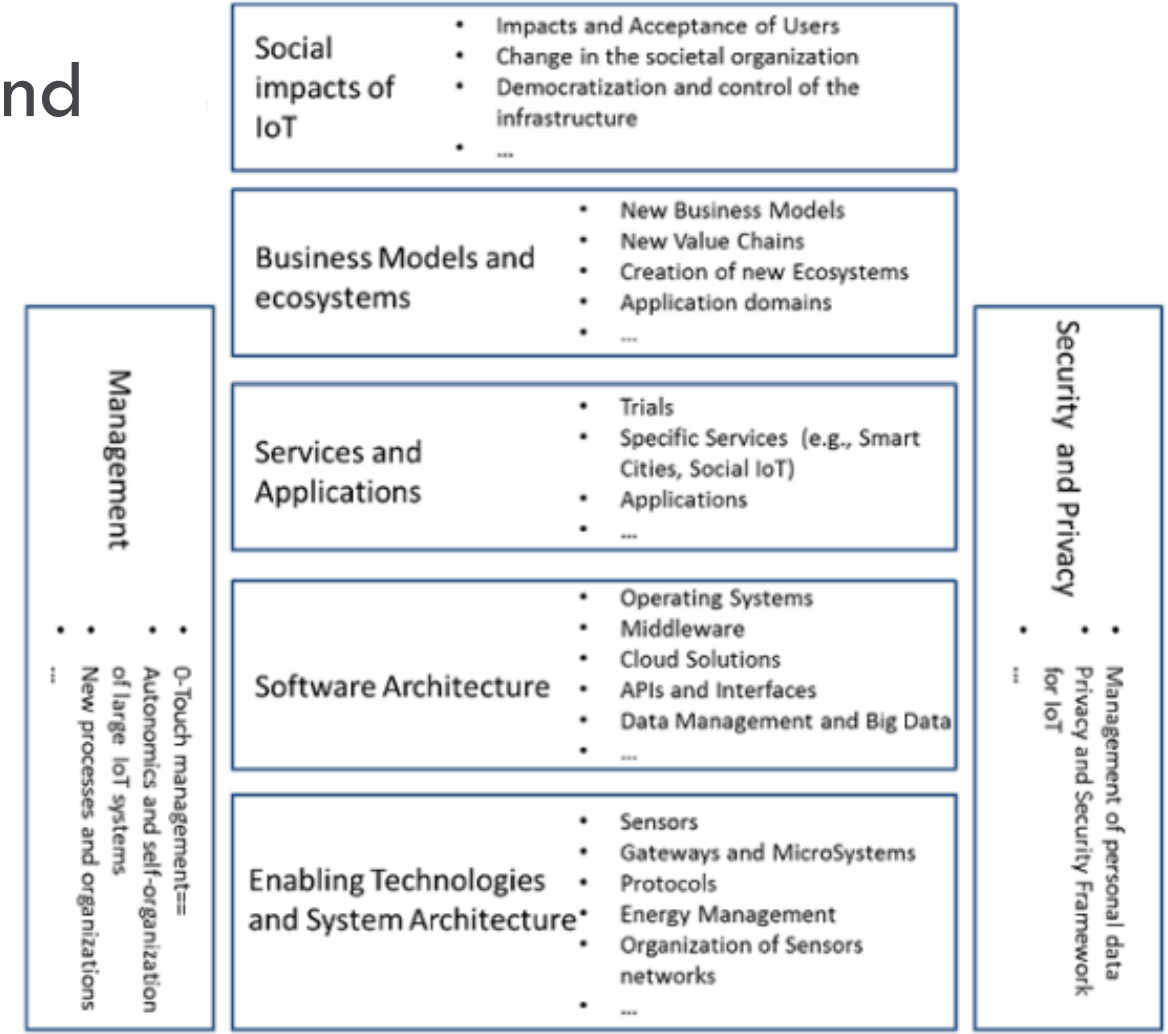
- The place of the Internet of Things from a perspective of other technologies, communities, goals and the picture in which the Internet of Things fits.
- The Internet of Everything dimension, the platform dimension and the need for solid partnerships.


IoT Company/Platform
Internet Of Things Ecosystem
IoT Device
IoT Device
IoT Device
IoT Device
IoT Device
Data
Analytics
Internet Network
Command
Request For Information
Data
IoT Hub
Command
Data
Command
Data
Command
Data
Command & RFI
Data
Command & RFI
Data
Command
Request For Information
IoT Remote
BI INTELLIGENCE


The Internet of Things
Devices
Locations
Application Groups
Service Sectors
HVAC,
Transport,
Fire & Safety,
Lighting,
Security,
Access, etc.
Office, Education, Retail, Hospitality, Healthcare, Airports, Stadiums
Process, Clean Room, Campus
Commercial/ Institutional
Industrial
Buildings
Energy
Supply/Demand
Alternative
Oil/Gas
Power Gen, Trans & Dist, Low Voltage, Power Quality, Energy Mgmt
Solar, Wind, Co-generation, Electrochemical
Rigs, Derricks, Well Heads, Pumps, Pipelines
Turbines
Windmills
UPS
Batteries
Generators
Meters, Drills
Fuel Cells, etc.
Consumer & Home
Infrastructure
Awareness & Safety
Convenience & Entertainment
Wiring, Network Access, Energy Mgmt
Security/Alerts, Fire Safety, Environ. Safety, Elderly, Children, Power Protection
HVAC/Climate, Lighting,Appliance, Entertainment
Digital Cameras,
Power Systems, MID,
DPF, PND, eReaders,
Desktop Computers
Washer/Dryers,
Meters, Lights, TVs, MP3,
Games Consoles, NetBooks
Alarms, etc.
Healthcare & Life Science
Care
In Vivo/Home
Research
Hospital, ER, Mobile POC, Clinic, Labs, Doctor Office
Implants, Home Monitoring Systems
Drug Discovery, Diagnostics, Labs
MR, PDAs
Implants, Surgical Equipment
Pumps, Monitors
Telemedicine, etc.
Industrial
Resource Automation
Fluid/Processes
Converting/ Discrete
Distribution
Mining, Irrigation, Agricultural, Woodland
Petro-Chem, Hydro Carbons, Food/Bevrge
Metals, Paper, Rubber/Plastic Metalworking Electronics Assembly/Test
Pipelines, Mat'l Handling Conveyance
Pumps, Valves, Vats, Conveyors, Pipelines
Motors, Drives, Converting, Fabrication
Assembly/Packaging, Vessels/Tanks, etc.
Transportation
Trans Systems
Vehicles
Non-Vehicular
Tolls, Traffic Mgmt, Navigation
Consumer, Commercial, Construction, Off-Hiway
Air, Rail, Marine
Cars, Trucks, Tractors
Trailors, Off Road
Earth Movers , Lights, Ships
Planes, Signage, Tolls, etc.
Retail
Specialty
Hospitality
Stores
Hotels, Resaurants, Bars, Cafes, Clubs
Supermarkets, Shopping Centers, Single Site, Distribn. Centers
Fuel Stations, Gaming, Bowling, Cinemas, Discos, Special Events
POS Terminals
Tags
Cash Registers
Vending Machines
Signs, etc.
Security/ Public Safety
Surveillance
Equipment
Tracking
Public Infrastructure
Emergency Services
Radar/Satellite, Envirn, Military Security, Unmanned, Fixed
Weapons, Vehicles, Ships, Aircraft, Gear
Human,Animal,Postal,Food/ Health, Packaging,Baggage
Water Treatmnt, Building Environ, Gen. Environ, Surveillance
Equip. & Personnel, Police, Fire, Regulatory
Tanks, Fighter Jets
Battelfield Comms
Jeeps, Cars, Ambulances
Breakdown, Lone Worker
Homeland Security, Fire
Enviro. Monitor, etc.
IT & Networks
Public
Enterprise
Services
E-Commerce
Data Centers
Mobile Carriers
Fixed Carriers
ISPs
IT/Data Center
Office
Private Nets
Servers, Storage
Printers , Photo Copiers
PCs , Gateways
Switches
PBXs, etc


Service Sectors
Buildings
Energy
Consumer & Home
Healthcare & Life Science
Industrial
Transportation
Retail
Security/ Public Safety
IT & Networks
Service Sectors
Convenience & Entertainment
Stores

Technological and social aspects related to IoT



12.2. Smart Home

12.1. IoT

12.2. Smart Home

12.3. Smart Grid

Smart technology – Definition 1

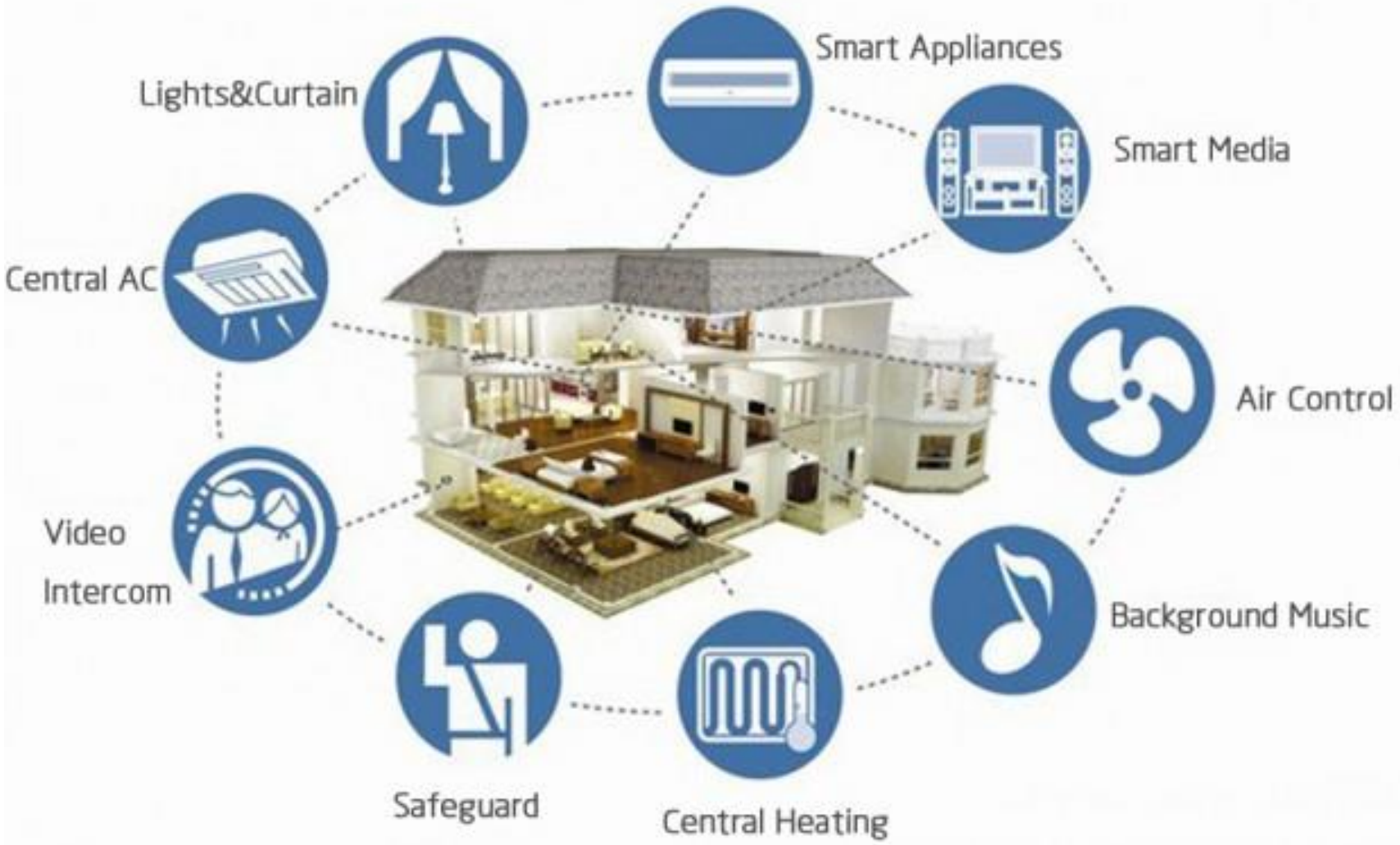
- Smart technology (includes physical and logical applications in all formats) that is capable of adapting automatically to modify its behavior to fit the environment.
- The technology senses things using sensors to collect and analyze data to perform some action.
- The technology is also capable of learning, which is using its experience to improve performance, anticipating, thinking and reasoning about what to do next.

Smart technology – Definition 2

- Technology that has sensors, data storage, and wireless access to collect and transmit data about the environment
- These smart devices provide data to the user
- More data collection and less automation

Smart Home

- A smart home involves the control and automation of lighting, heating, ventilation, air conditioning, appliances, and security.
- Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface.
  - A wall-mounted terminal, mobile phone software, tablet computer, or a web interface.


Lights&Curtain
Smart Appliances
Smart Media
Central AC
Air Control
Video
Intercom
Background Music
Safeguard
Central Heating

History (1)

- Early home automation began with labor-saving machines. Self-contained electric or gas-powered home appliances became viable in the 1900s with the introduction of electric power distribution and led to the introduction of washing machines (1904), water heaters (1889), refrigerators, sewing machines, dishwashers, and clothes dryers.

History (2)

- In 1975, the first general purpose home automation network technology, X10, was developed.
- By 1978, X10 products included a 16-channel command console, a lamp module, and an appliance module. Soon after came the wall switch module and the first X10 timer.
- By 2012, in the United States, according to ABI Research, 1.5 million home automation systems were installed.

Generations of home automation

- First generation
  - wireless technology with proxy server, e.g., Zigbee automation
- Second generation
  - artificial intelligence controls electrical devices, e.g., Amazon Echo;
- Third generation
  - robot buddy who interacts with humans, e.g., Robot Rovio, Roomba.

source: www.jdnet.gr.jp

Applications and Technologies

- Heating, ventilation and air conditioning (HVAC)
- Lighting control system
- Occupancy-aware control system
- Smart grid integration
- Security
- Leak detection
- Indoor positioning systems
- Home automation for the elderly and disabled
- Pet Care

Occupancy Sensor

- A key aspect to smart homes is occupancy sensors
- An **occupancy sensor** is an indoor motion detecting devices used to detect the presence of a person to automatically control lights or temperature or ventilation systems.
- Infrared sensors
  - Heat difference detection, measuring infrared radiation
- Environmental sensors
  - Temperature, humidity and CO2 sensors

Heating, ventilation and air conditioning (HVAC)

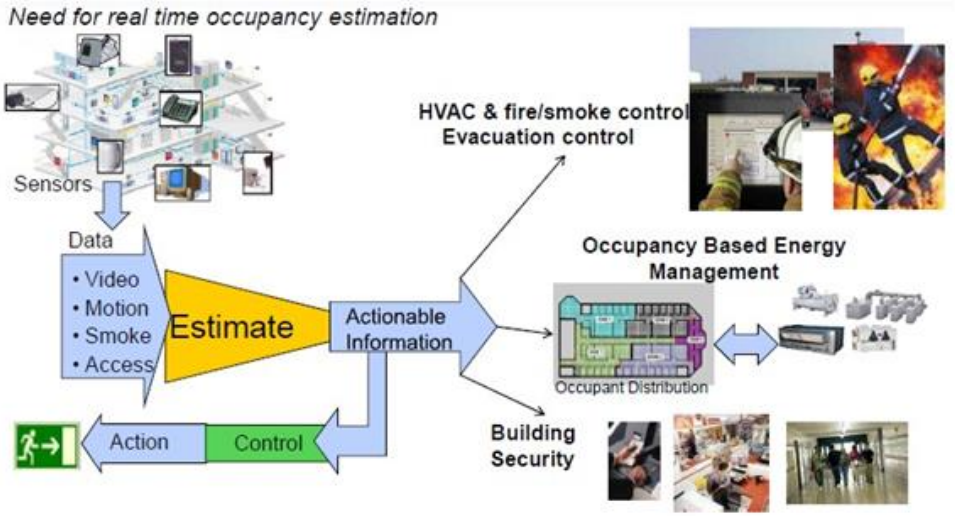
- Simple and friendly user interface to monitor and control home HVAC systems over the internet
  - Temperature reporting
  - Humidity control

Lighting Control System

- A system for controlling all of the home's lighting from a single panel or user interface
  - Voice commands
  - Motion sensors

Occupancy-Aware Control System

- A system that monitors and controls the environment based on changes
  - Motion and sound
  - Temperature, humidity
  - Air quality
    - (CO, gas leaks, mold spores, smoke)



Smart Grid Integration

- **Appliance control** and **integration** with the smart grid
  - For example, using power from the solar panel output in the middle of the day to run washing machines.

Security

- A household security system integrated with a home automation system can provide additional services
  - Remote surveillance of security cameras over the Internet
  - Central locking of all perimeter doors and windows

Leak Detection System

- Real-time alerts to harmful gasses in the home to a device
  - Smoke
  - CO gas
  - Natural gas

Indoor positioning systems

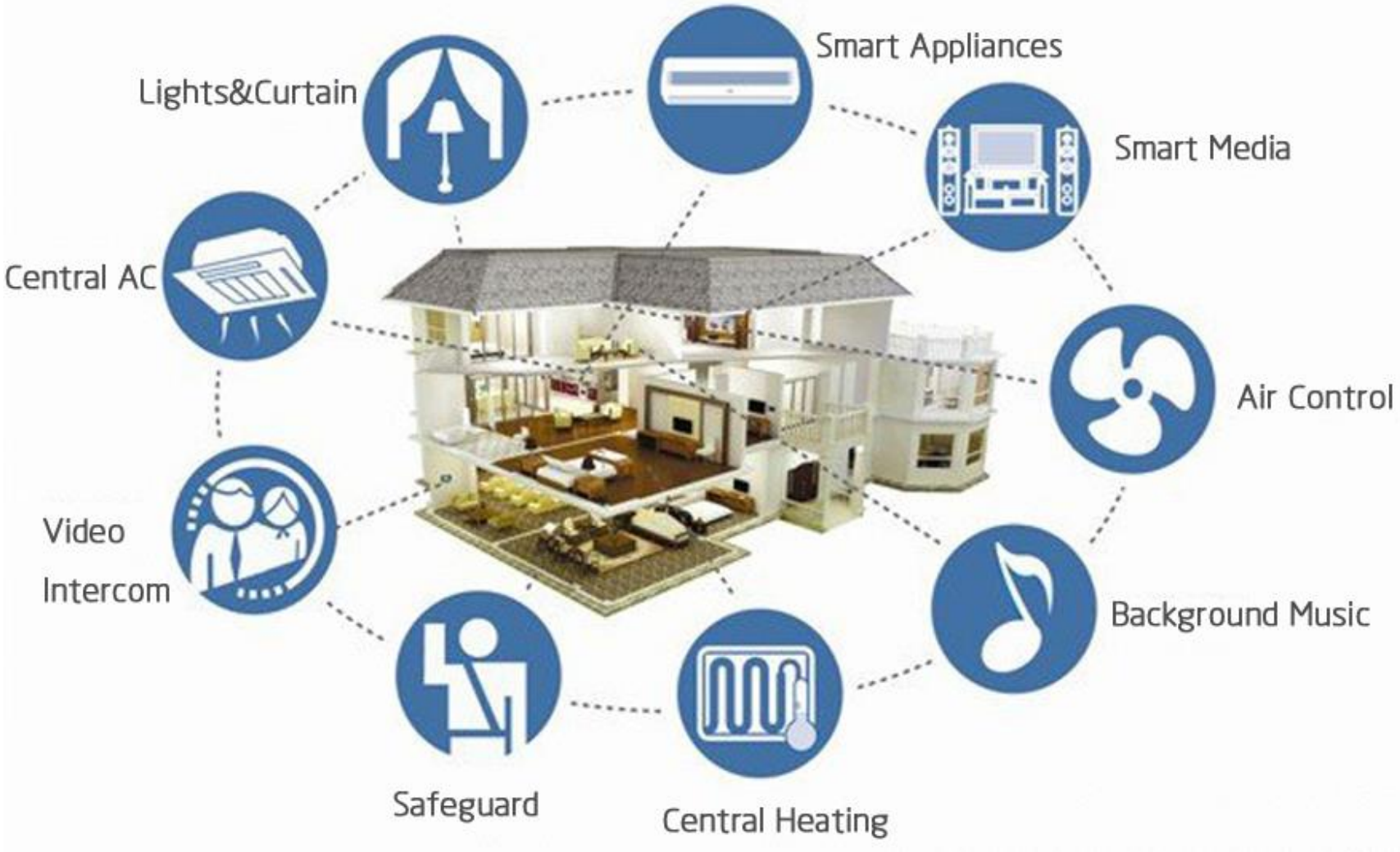
- Locate objects or people inside a building using radio waves, magnetic fields, acoustic signals, or other sensory information collected by mobile devices
  - Precisely determine someone's position based on their mobile device

Home Automation for the Elderly and Disabled

- Remote Monitoring
- Medication reminders
- Daily medical testing
- Remote medical consultation
- Security

Pet Care

- Tracking the pets movements and controlling access rights


Smart Appliances
Lights&Curtain
Smart Media
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Intercom
Background Music
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12.3. Smart Grid

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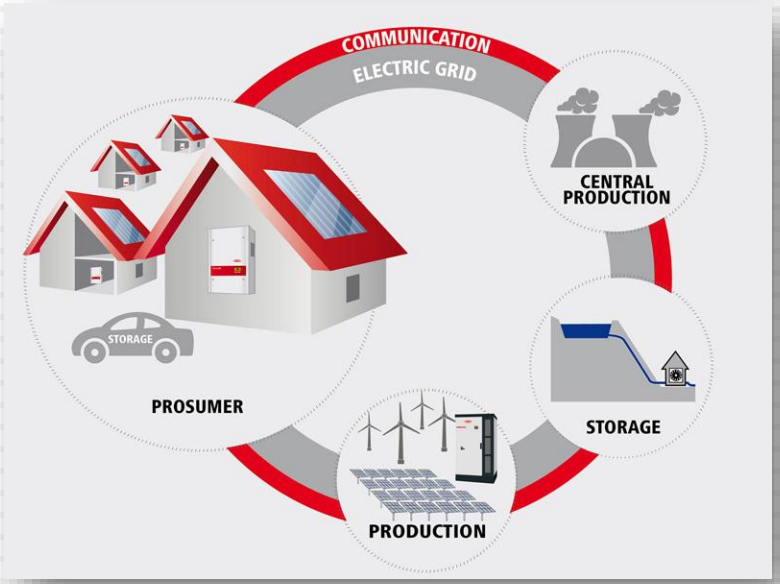
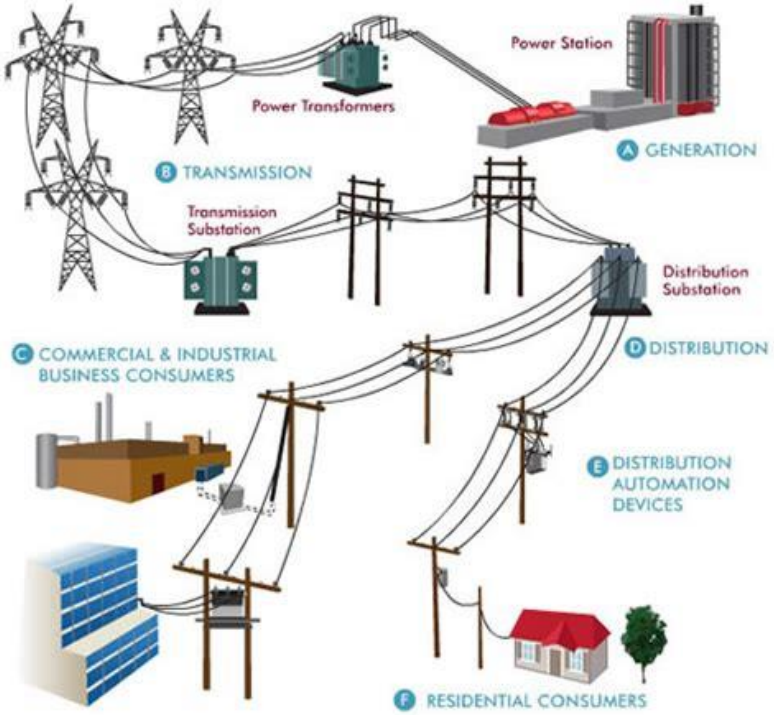


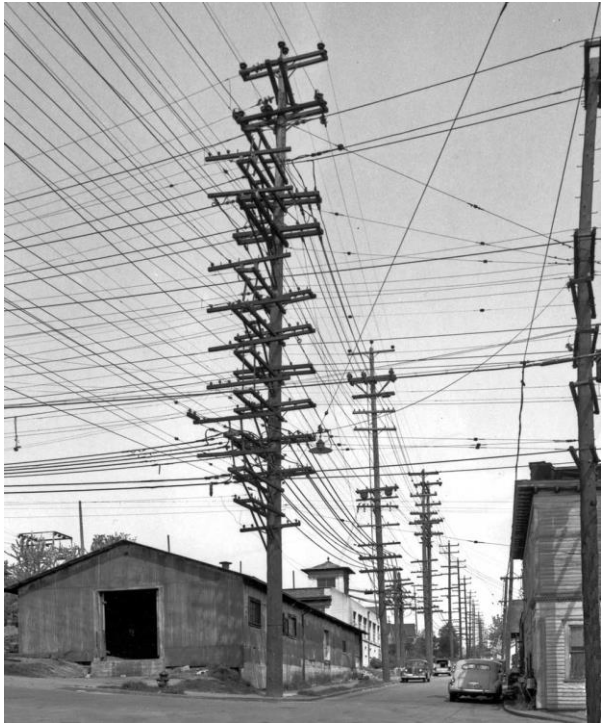
The Power Grid (1)

- **The grid** refers to the electric grid, a network of transmission lines, substations, transformers and more that deliver electricity from the power plant to your home or business.



The Power Grid (2)

- Our current electric grid was built in the 1890s
- Improvements were made with new technology
- However, it is based on the distribution model using centralized power generation



A New Type of Grid (1)

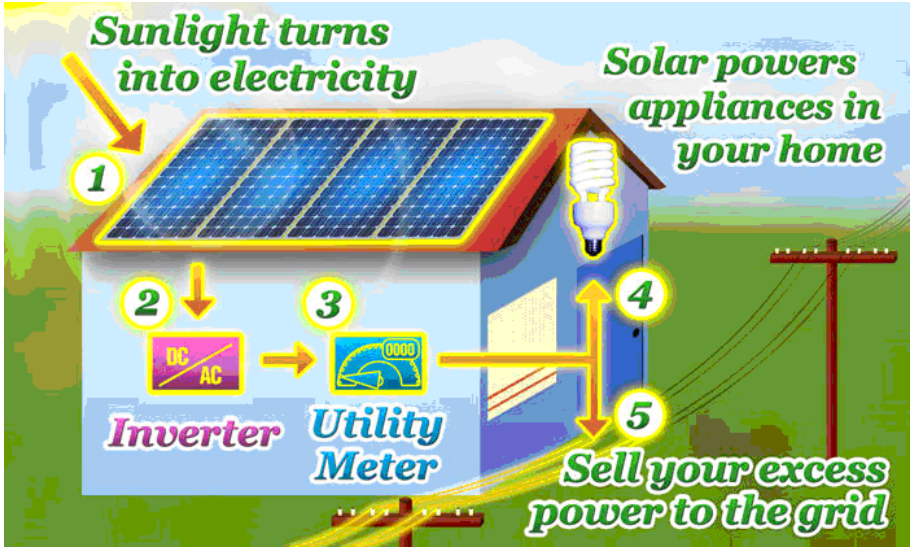
- To move forward, we need a new kind of electric grid to address growing needs
  - Fossil fuels are limited
  - Much energy is wasted
  - Large scale power generation stations are not sustainable

A New Type of Grid (2)

- The smart grid allows someone to buy (use) or sell (contribute) electricity to the grid
- Customer use micro-power generation
  - Solar panels
  - Windmills
  - Waterwheels

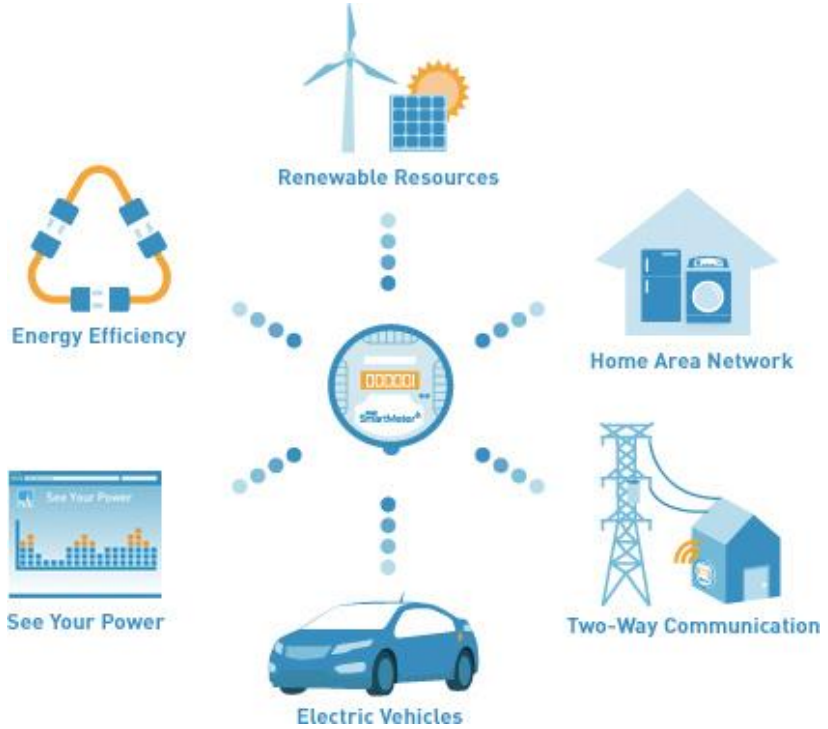
A New Type of Grid (2)

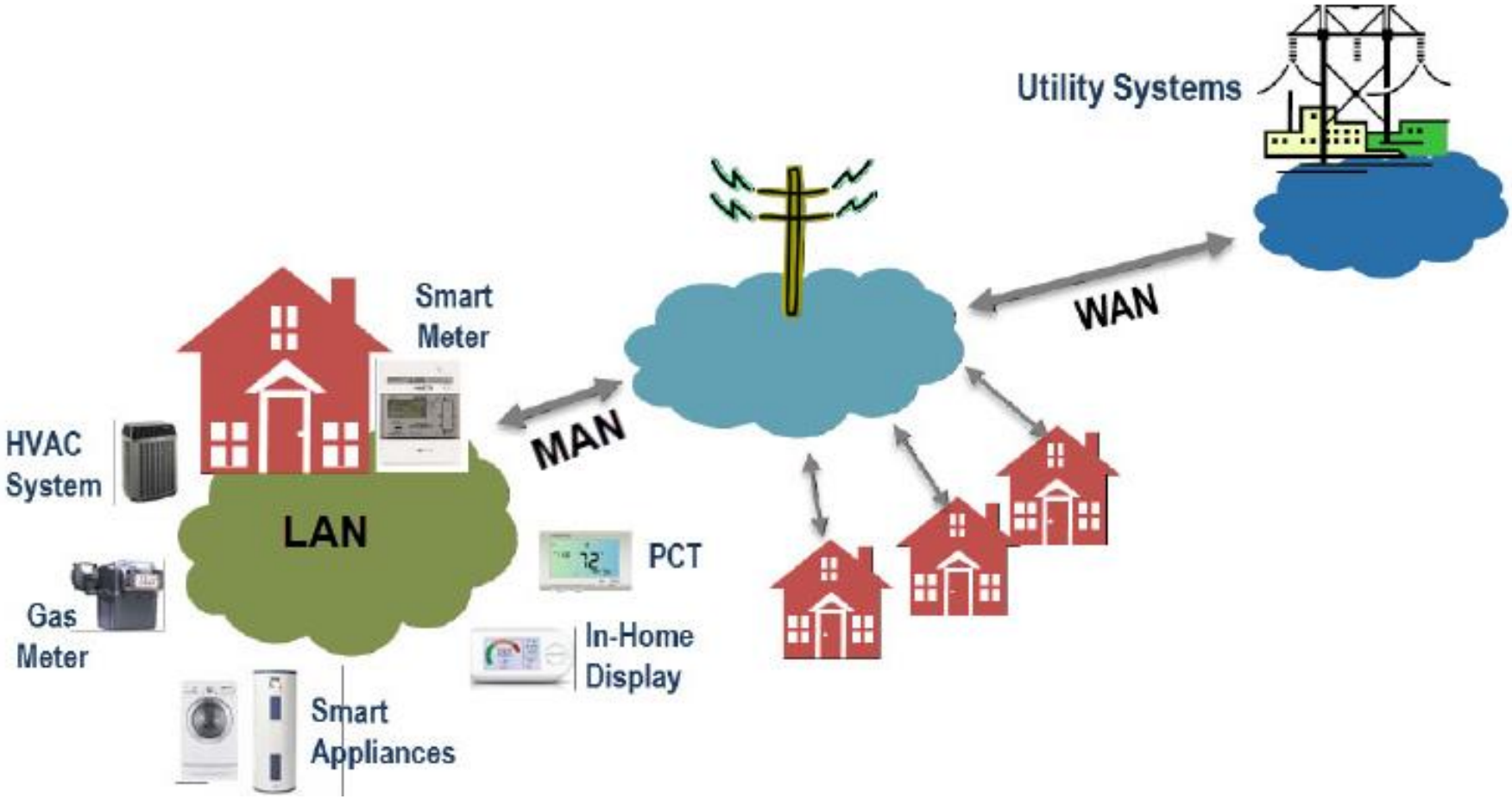
- A homeowner uses their own generated electricity first, then electricity from the grid
- They sell excess electricity back to the grid

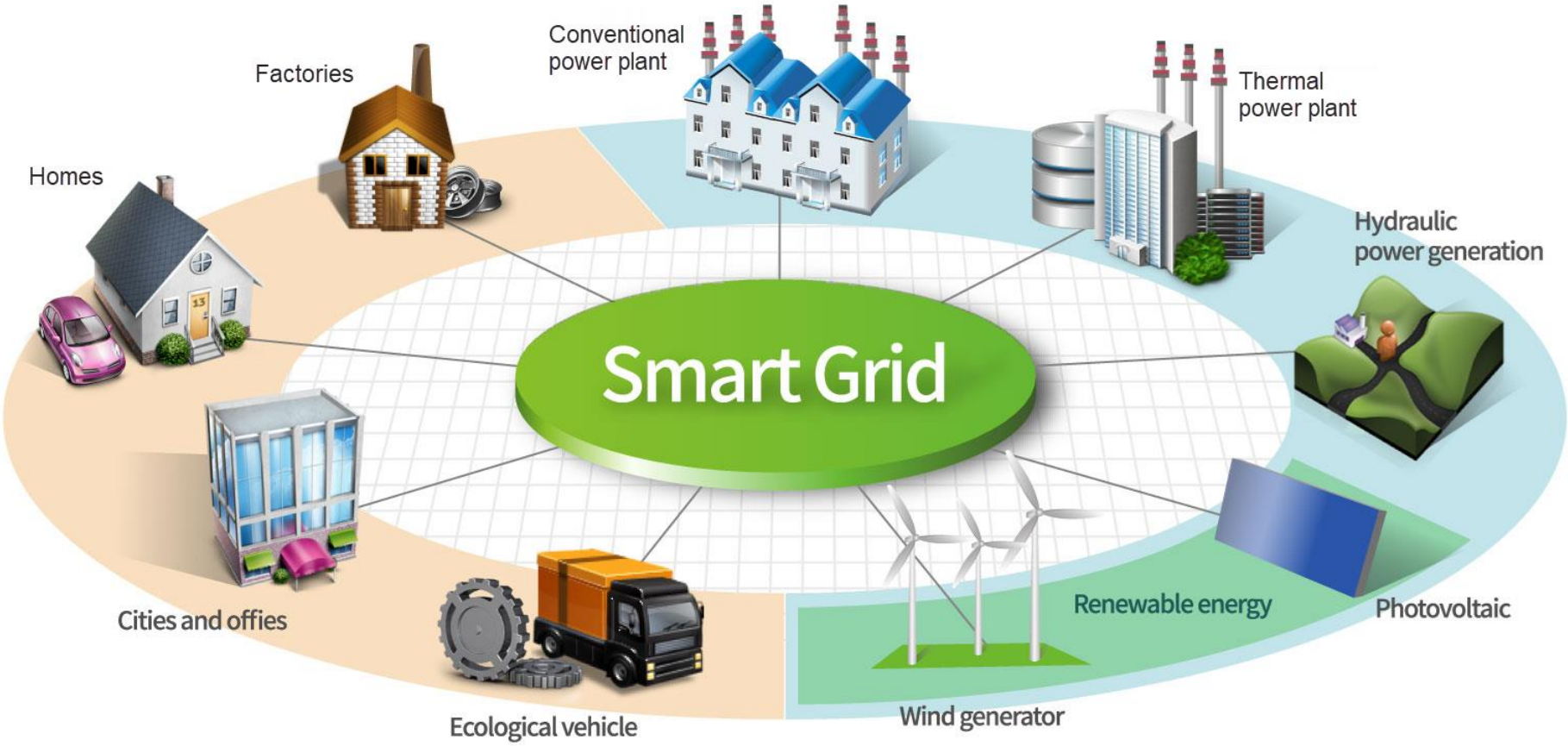


Smart Grids (1)

- A smart grid is an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources

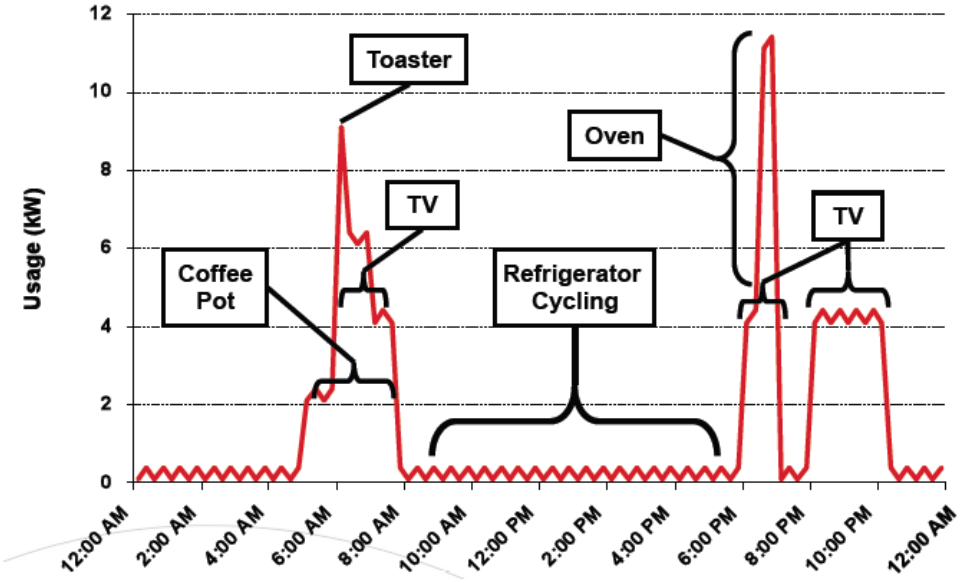



Utility Systems
WAN
MAN
Smart
Meter
HVAC
System
LAN
PCT
Gas
Meter
In-Home
Display
Smart
Appliances


Factories
Conventional
power plant
Thermal
power plant
Homes
Hydraulic
power generation
Smart Grid
Cities and offies
Renewable energy
Photovoltaic
Ecological vehicle
Wind generator

Smart Grids (2)

- Electronic power monitoring and control of the production and distribution of electricity are important aspects of the smart grid.



Smart Grids (3)

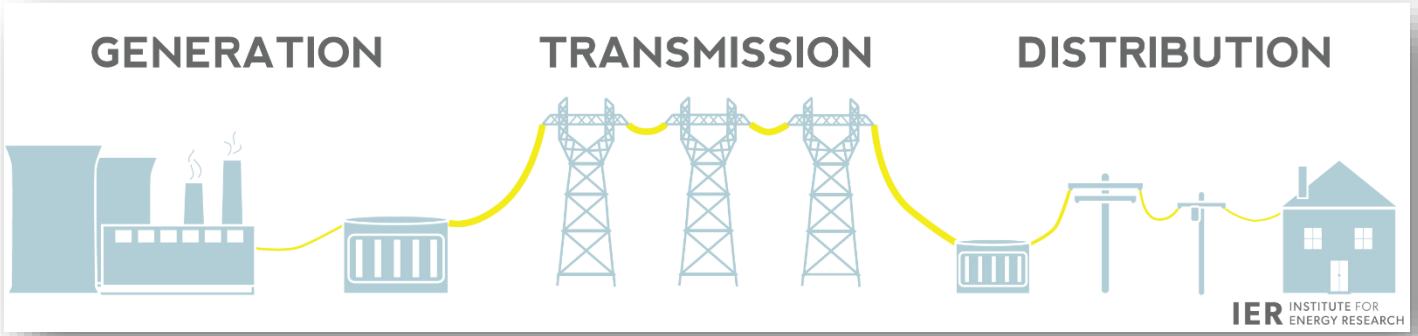
- Rolling out smart grid technology requires a fundamental re-engineering of the electricity services industry
  - Resource intensive (time and finance)

Smart Grids (4)

- The Smart grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to our economic and environmental health.

Smart Grid Benefits (1)

- More efficient transmission of electricity
- Quicker restoration of electricity after power outages
- Reduced operations and management costs for utilities, which will lower power costs for consumers



Smart Grid Benefits (2)

- Reduced peak demand, which will also help lower electricity rates
- Increased integration of large-scale renewable energy systems
- Better integration of customer-owner power generation systems, including renewable energy systems

Resiliency

- Today, an electricity disruption such as a blackout can have a domino effect—a series of failures that can affect banking, communications, traffic, and security.
- A smarter grid will add resiliency to our electric power system and make it better prepared to address emergencies such as
  - Severe storms
  - Earthquakes
  - Large solar flares
  - Terrorist attacks
  - Human error

Smart Grid History (1)

- Smart grid technologies emerged from earlier attempts at using electronic control, metering, and monitoring.
- In the 1980s, automatic meter reading was used for monitoring loads from large customers, and evolved into the Advanced Metering Infrastructure of the 1990s, whose meters could store how electricity was used at different times of the day.

Smart Grid History (2)

- Beginning in 2000, Italy's Telegestore Project was the first to network large numbers (27 million) of homes using smart meters connected via low bandwidth power line communication.
- Monitoring and synchronization of wide area networks were revolutionized in the early 1990s when the Bonneville Power Administration expanded its smart grid research with prototype sensors that are capable of very rapid analysis of anomalies in electricity quality over very large geographic areas.

Smart Grid History (3)

- Other countries are rapidly integrating this technology — China started having a comprehensive national WAMS when the past 5-year economic plan completed in 2012.
- The earliest deployments of smart grids include the Italian system Telegestore (2005), the mesh network of Austin, Texas (since 2003), and the smart grid in Boulder, Colorado (2008).

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