Internet of Things

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Why IoT is Important?

It is first necessary to understand the differences between the Internet and the World Wide Web (or web).

The Internet is the physical layer or network made up of switches, routers, and other equipment. Its primary function is to transport information from one point to another quickly, reliably, and securely

The web, on the other hand, is an application layer that operates on top of the Internet. Its primary role is to provide an interface that makes the information flowing across the Internet usable.

IoT represents the next evolution of the Internet

Early history

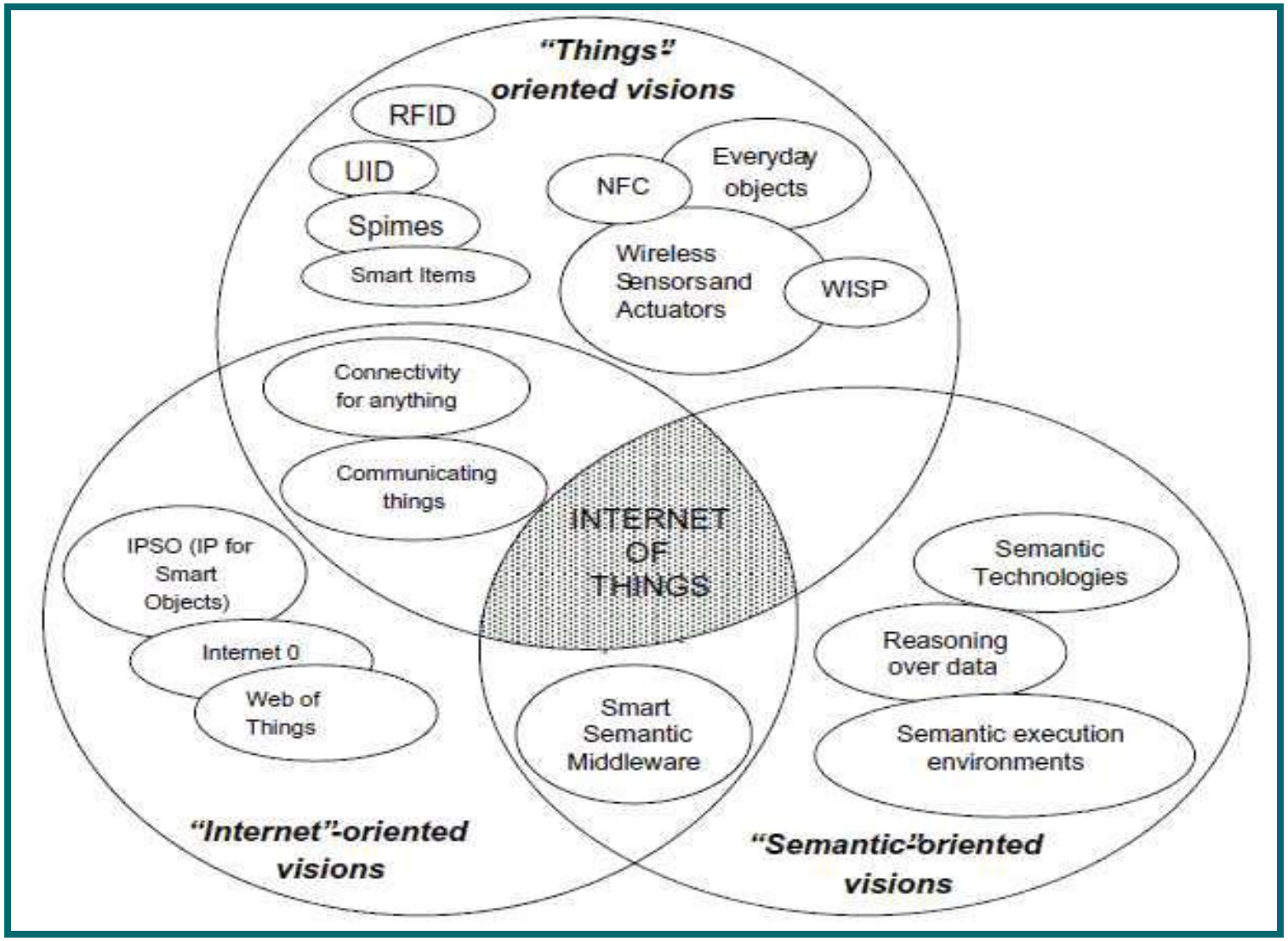
- As of 2014 the vision of the Internet of Things has evolved due to a convergence of multiple technologies, ranging from wireless communication to the Internet and from embedded systems to micro-electromechanical systems (MEMS).

- This means that the traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others, all have contributions to enable the Internet of Things (IoT).

What Exactly Is The "Internet of Things“?

- Internet of Things can be realized in three paradigms:
  - (i) internet-oriented (middleware)
  - (ii) things oriented (sensors)
  - (iii) semantic-oriented (knowledge).
- Internet of Things is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure.
- Internet of Things today consists of many different sensor networks and protocols, connected to dedicated cloud services, providing access through smartphone and browser apps.

Convergence of different visions of IoT



IOT Elements

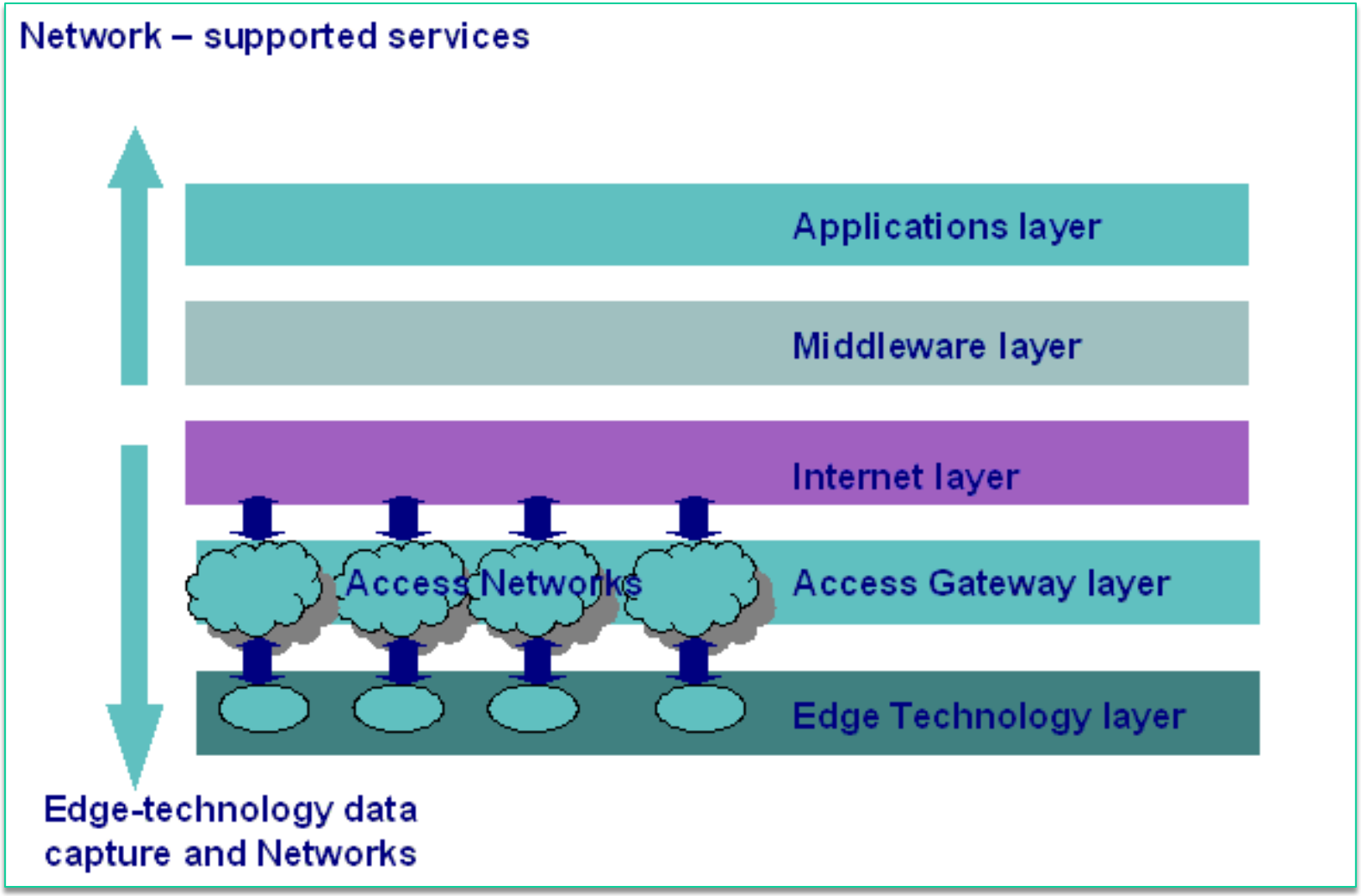
There are three IoT components:

(a) Hardware: Made up of Sensors, Actuators and Embedded communication hardware.

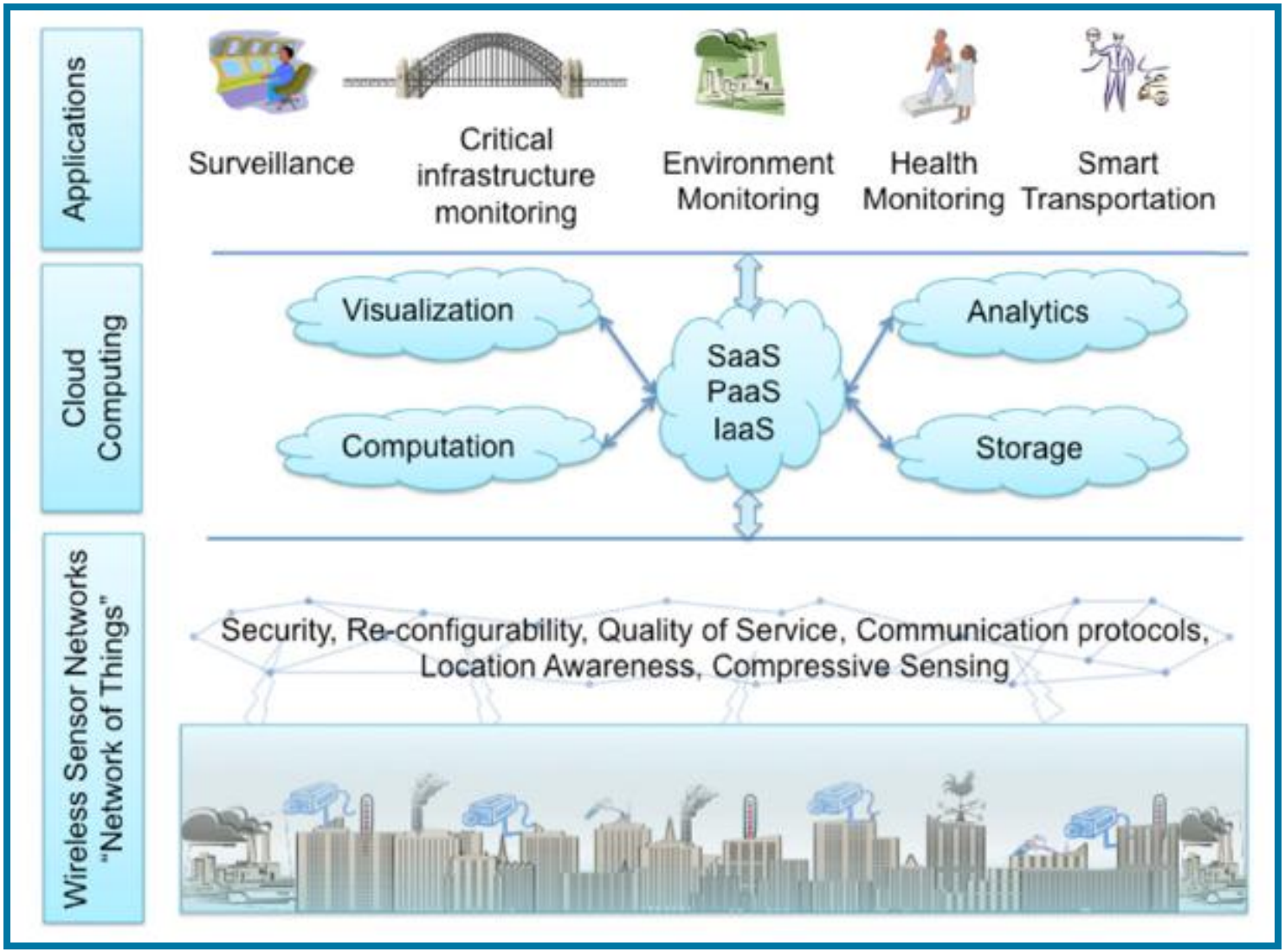
(b) Middleware: on demand for storage and computing tools for data analytics

(c) Presentation: To understand visualization and interpretation tools which can be widely accessed on different platforms and which can be designed for different applications.

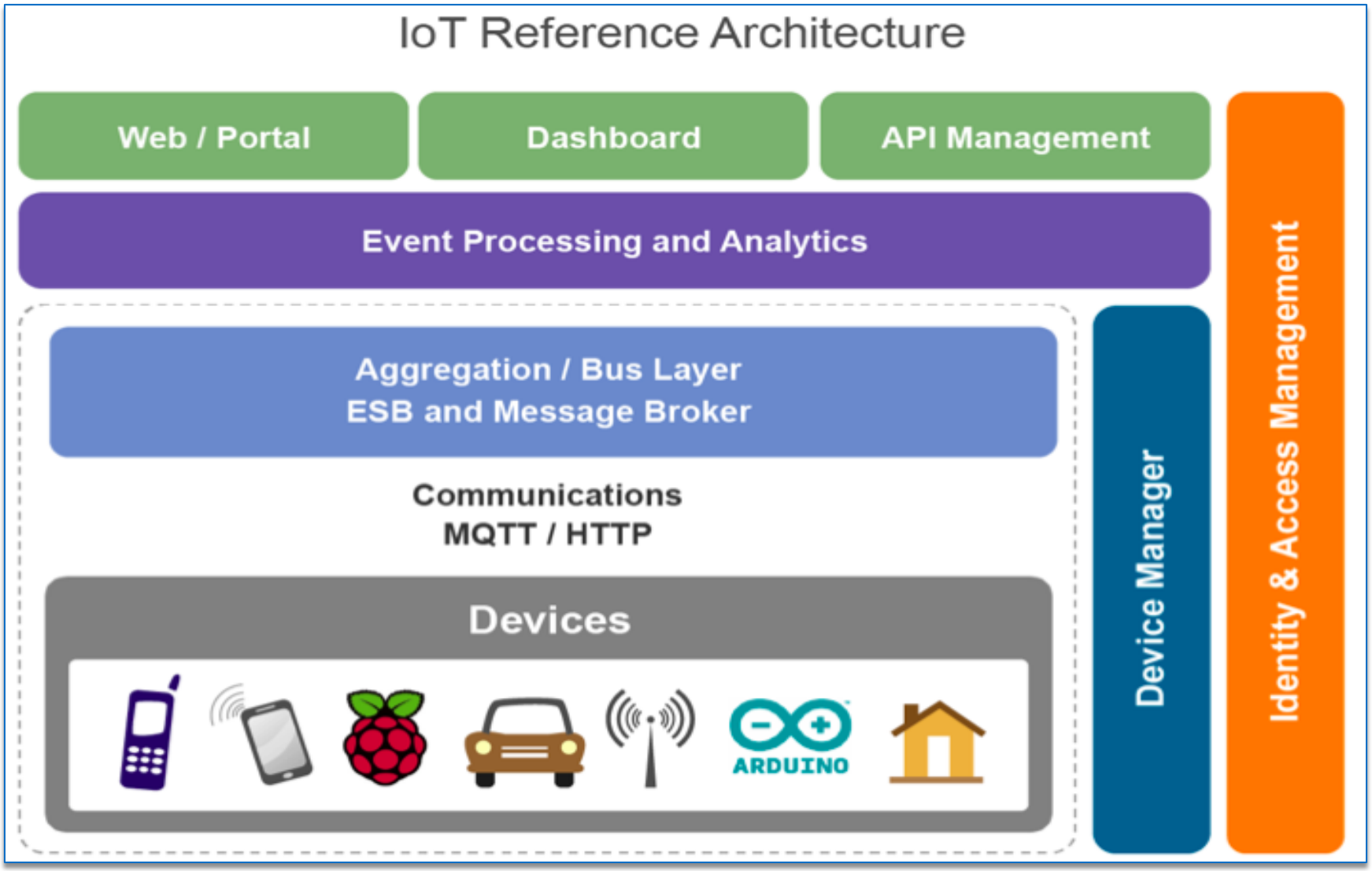
Layered Architecture of Internet of Things



Conceptual IoT framework with Cloud Computing



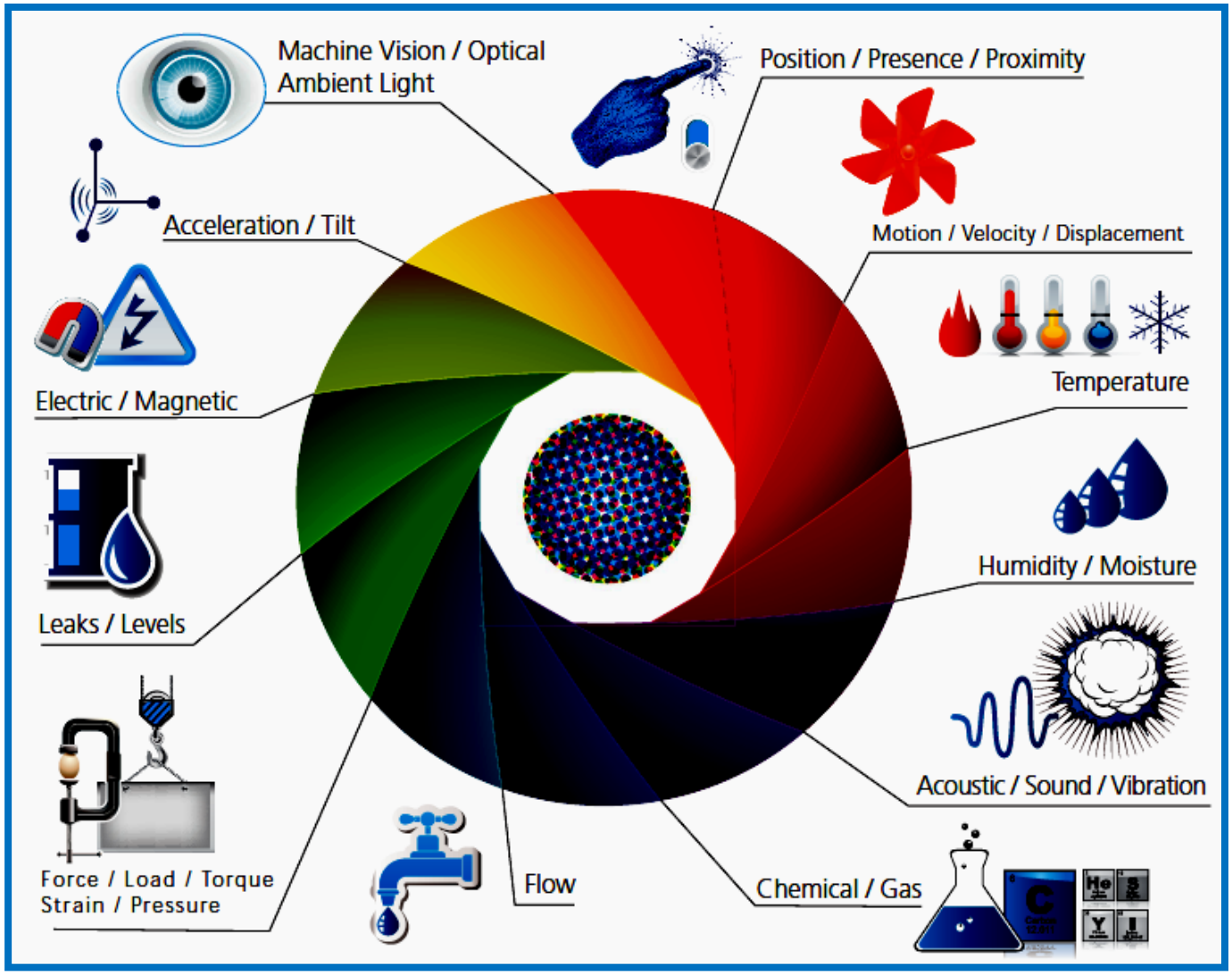
Internet of Things architecture



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

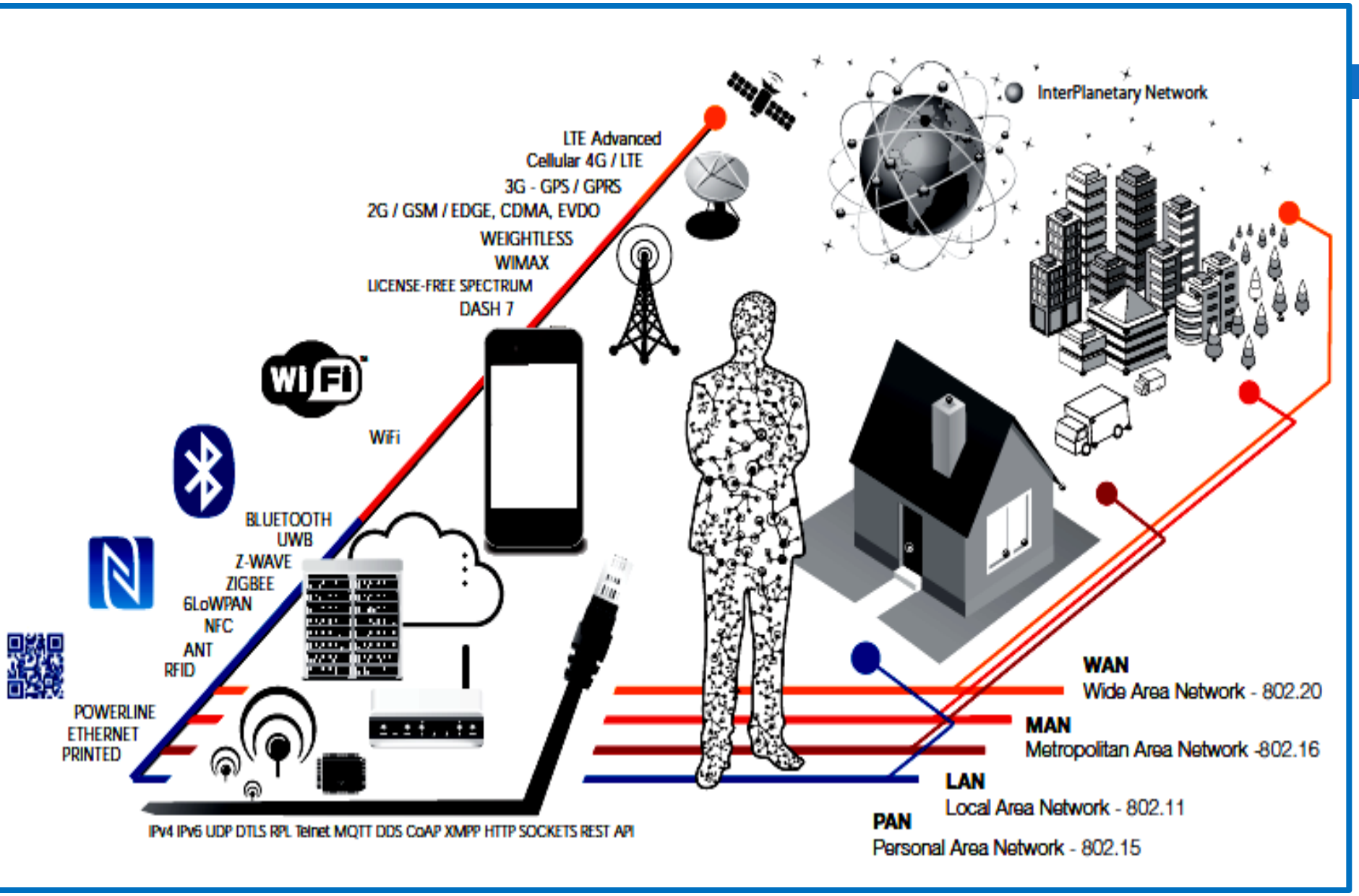
SENSORS & ACTUATORS

We are giving our world a digital nervous system. Location data using GPS sensors. Eyes and ears using cameras and microphones, along with sensory organs that can measure everything from temperature to pressure changes.



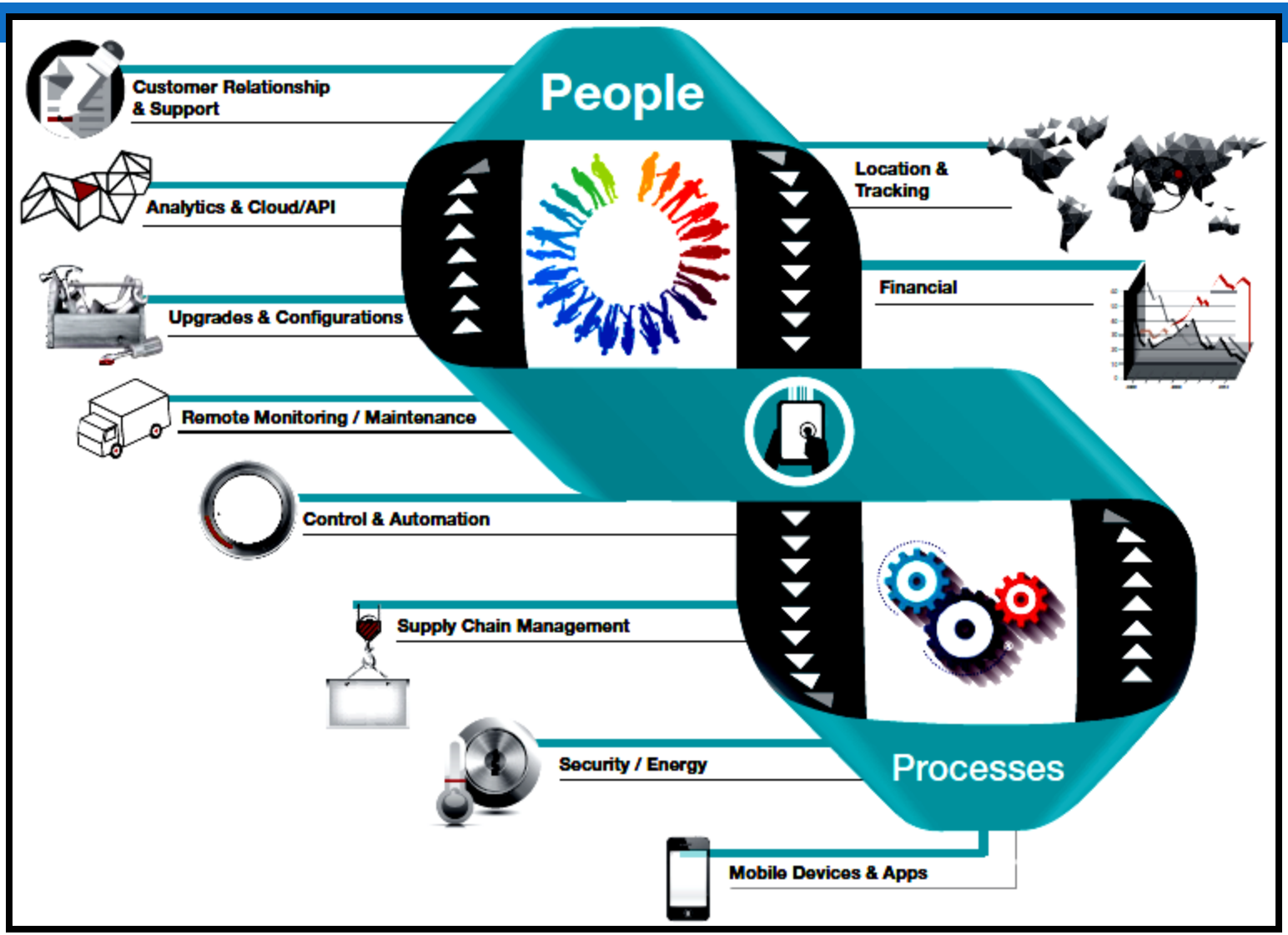
CONNECTIVITY

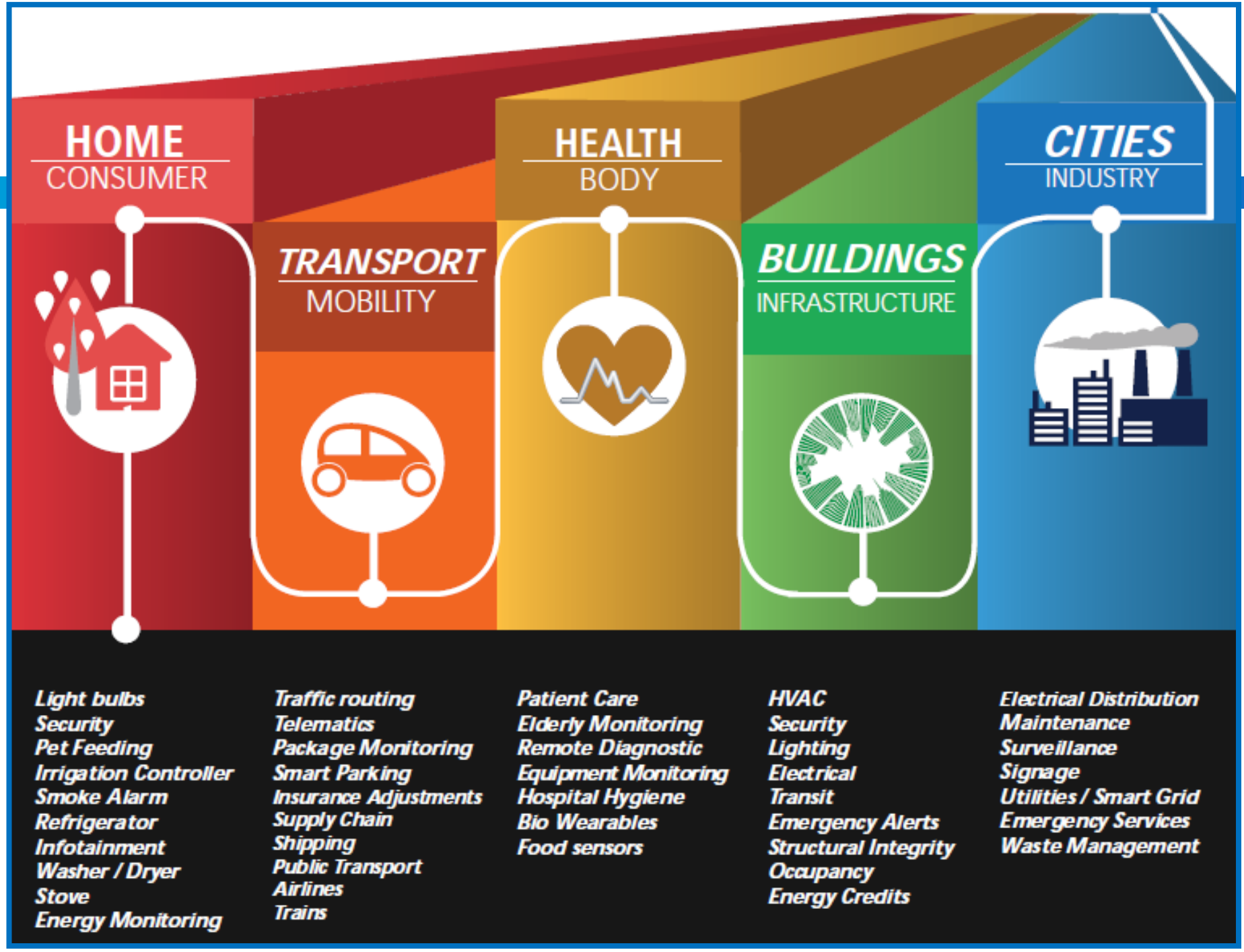
These inputs are digitized and placed onto networks.



PEOPLE & *PROCESSES*

These networked inputs can then be combined into bi-directional systems that integrate data, people, processes and systems for better decision making.




HOME
CONSUMER
Light bulbs
Security
Pet Feeding
Irrigation Controller
Smoke Alarm
Refrigerator
Infotainment
Washer / Dryer
Stove
Energy Monitoring
TRANSPORT
MOBILITY
Traffic routing
Telematics
Package Monitoring
Smart Parking
Insurance Adjustments
Supply Chain
Shipping
Public Transport
Airlines
Trains
HEALTH
BODY
Patient Care
Elderly Monitoring
Remote Diagnostic
Equipment Monitoring
Hospital Hygiene
Bio Wearables
Food sensors
BUILDINGS
INFRASTRUCTURE
HVAC
Security
Lighting
Electrical
Transit
Emergency Alerts
Structural Integrity
Occupancy
Energy Credits
CITIES
INDUSTRY
Electrical Distribution
Maintenance
Surveillance
Signage
Utilities / Smart Grid
Emergency Services
Waste Management

Starting with popular connected devices already on the market

SMART THERMOSTATS

nest

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

CAR 2GO

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

ACTIVITY TRACKERS

BASIS

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

SMART OUTLETS

belkin

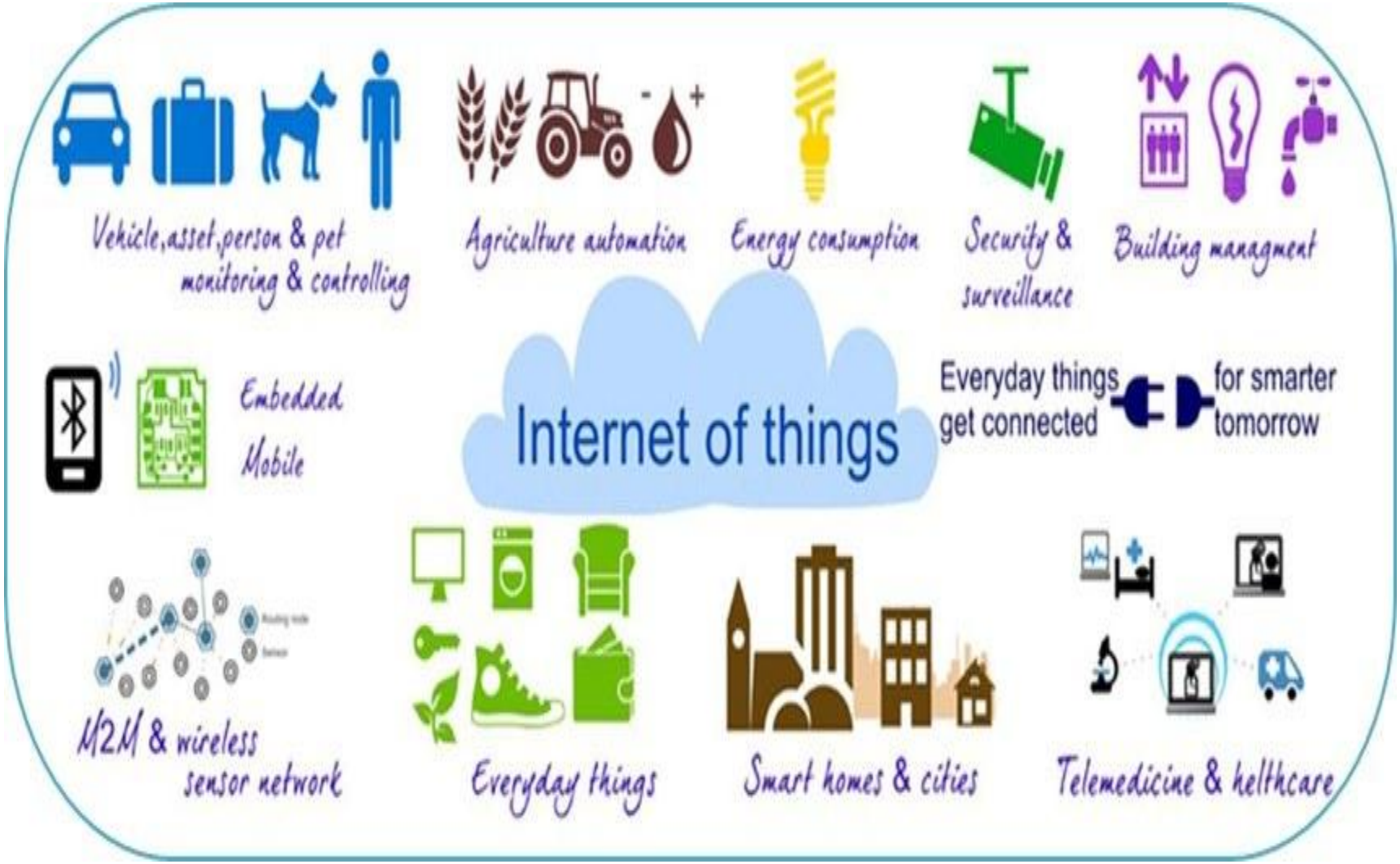
Remotely turn any device or appliance on or off. Track a device's energy usage and receive personalized notifications from your smartphone.

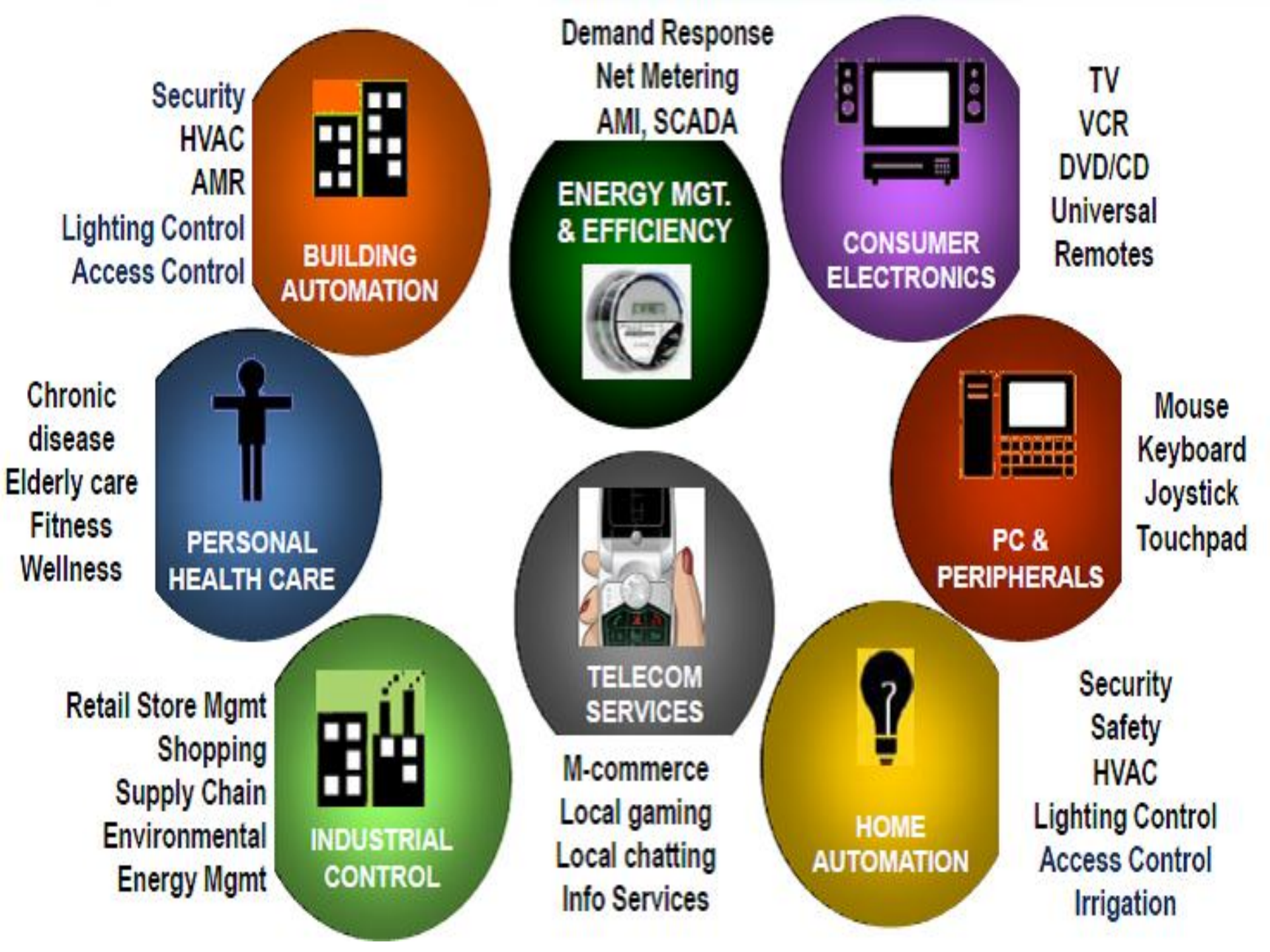
PARKING SENSORS

STREETLINE
CONNECTING THE REAL WORLD

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.

IOT Applications




Security
HVAC
AMR
Lighting Control
Access Control
BUILDING AUTOMATION
Demand Response
Net Metering
AMI, SCADA
ENERGY MGT. & EFFICIENCY
CONSUMER ELECTRONICS
TV
VCR
DVD/CD
Universal
Remotes
Chronic disease
Elderly care
Fitness
Wellness
PERSONAL HEALTH CARE
PC & PERIPHERALS
Mouse
Keyboard
Joystick
Touchpad
TELECOM SERVICES
M-commerce
Local gaming
Local chatting
Info Services
Retail Store Mgmt
Shopping
Supply Chain
Environmental
Energy Mgmt
INDUSTRIAL CONTROL
HOME AUTOMATION
Security
Safety
HVAC
Lighting Control
Access Control
Irrigation

Internet of Things - Challenges in Technology

- Many challenging issues still need to be addressed and both technological as well as social knots
  - The central issues are how to achieve full interoperability between interconnected devices.
  - How to provide them with a high degree of smartness by enabling their adaptation and autonomous behavior,
  - Guaranteeing trust, security and privacy of the users and their data
- Efficient utilization of resources in low-powered resource constrained objects.

Internet of Things - Challenges in Standardization

- Many challenging issues in Standardization need to be addressed.
  - Areas of protocol
  - Algorithm
  - System design and development
  - To support a wide range of applications.
  - To develop standardized semantic data models, ontologies and common interface.
- What are the future research and technology trends.

The security challenge

- Devices are not reachable
  - Most of the time a device is not connected
- Devices can be lost and stolen
  - Makes security difficult when the device is not connected
- Devices are not crypto-engines
  - Strong security difficult without processing power
- Devices have finite life
  - Credentials need to be tied to lifetime
- Devices are transportable
  - Will cross borders
- Devices need to be recognised by many readers
  - What data is released to what reader?

Challenges and Open Issues

(i) **Network Foundation** - limitations of the current Internet architecture in terms of mobility, availability, manageability and scalability are some of the major barriers to IoT.

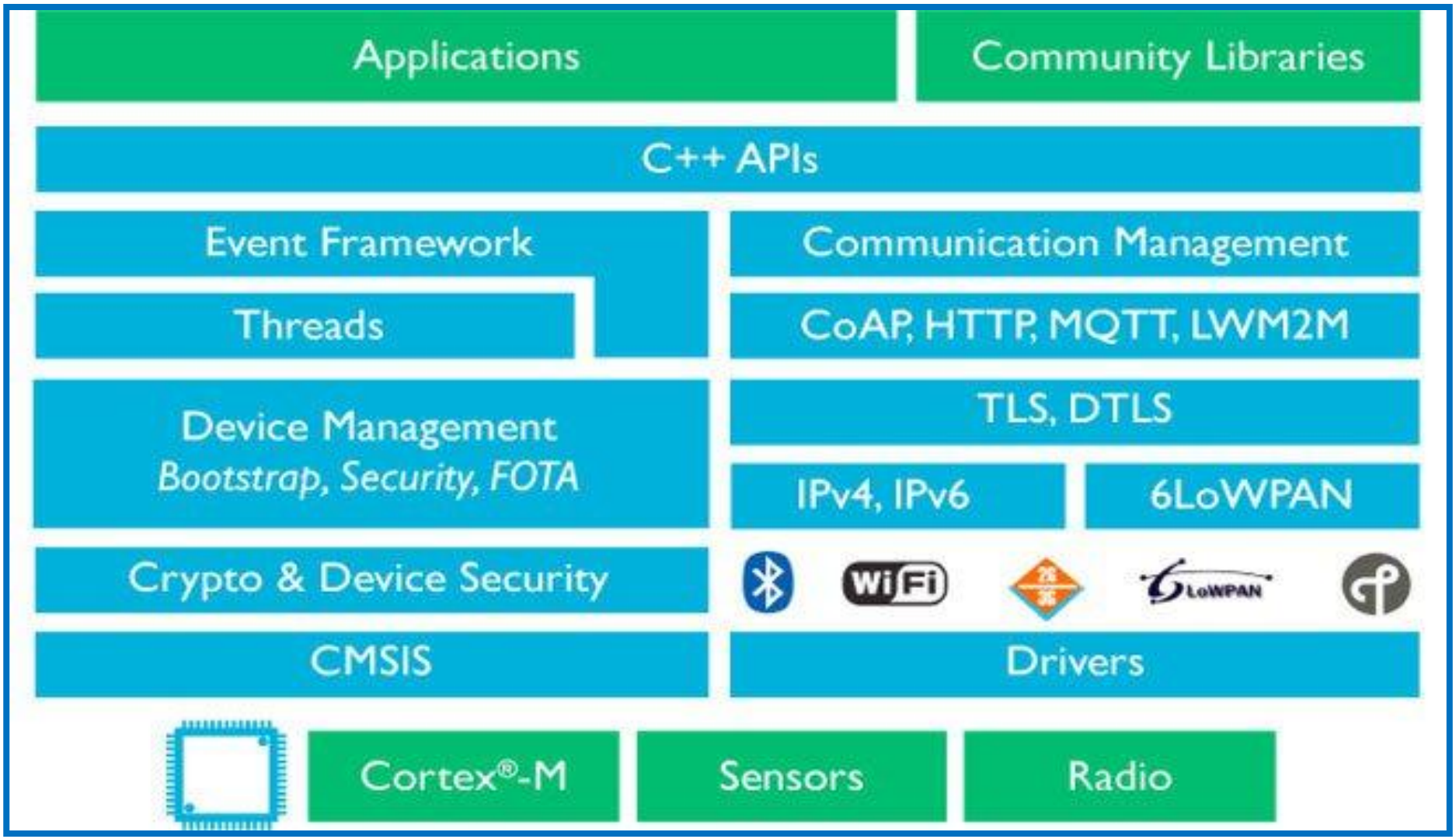
(ii) Security, Privacy and Trust - in the domain of security the challenges are: (a) securing the architecture of IOT - security to be ensured at design time and execution time, (b) proactive identification and protection of IOT from arbitrary attacks (e.g. DoS and DDoS attacks) and abuse, and (c) proactive identification and protection of IOT from malicious software.

(iii) Managing heterogeneity - managing heterogeneous applications, environments and devices constitute a major challenge.

Some of the other challenges

- Managing large amount of information and mining large volume.
- Designing an efficient architecture for sensor N/W and storage
- Designing mechanisms for sensor data discovery
- Designing sensor data communication protocols
- Developing sensor data stream processing mechanisms
- Sensor data mining: Correlation, aggregation filtering techniques.
- Finally, standardizing heterogeneous technologies, devices, application interfaces etc.

IoT Development Platform



Internet of Things Software

- Protocols
- Platforms
- Embedded Operating Systems
- Open Source
- Partner Systems
- Middleware
- JavaScript / Node.js
- Natural Language
- Additional Resources

Internet of Things Software

- **Protocols:**

  6LoWPAN, MQTT, CoAP

- **Platforms/ Data Brokers:**

  Thingworx, ioBridge, Sense and others

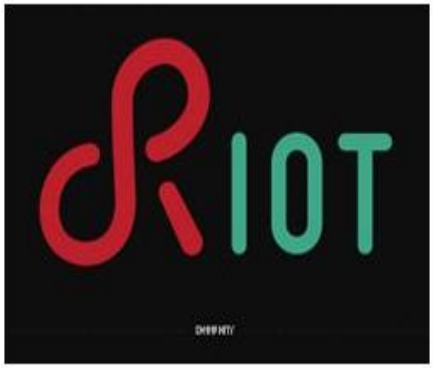
- **Embedded Operating Systems:**

  TinyOS is an open source, BSD-licensed operating system designed for low-power wireless devices, such as those used in sensor networks, ubiquitious computing, personal area networks, smart buildings, and smart meters.

Open Source

- Contiki is an open source, highly portable, multi-tasking operating system for memory-efficient networked embedded systems and wireless sensor networks.
- Contiki has been used is a variety of projects, such as road tunnel fire monitoring, intrusion detection, wildlife monitoring, and in surveillance networks.
- Contiki is designed for microcontrollers with small amounts of memory. A typical Contiki configuration is 2 kilobytes of RAM and 40 kilobytes of ROM.

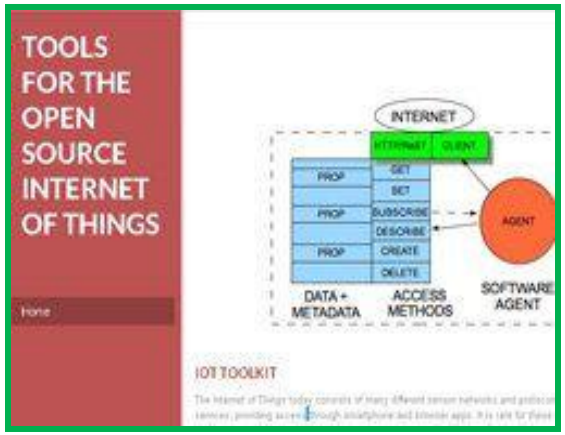
Operating System for Internet of Things



RIOT OS is an operating system for Internet of Things (IoT) devices. It is based on a microkernel and designed for: energy efficiency, hardware independent development, a high degree of modularity.

Thingsquare Mist brings resilient wireless mesh networking and true Internet-connectivity to the Internet of Things. The Thingsquare Mist open source firmware is exceptionally lightweight, battle-proven, and works with multiple microcontrollers with a range of radios.

Operating System for Internet of Things



Middleware

The **IoT Toolkit** is an Open Source project to develop a set of tools for building multi-protocol Internet of Things Gateways and Service gateways that enable horizontal co-operation between multiple different protocols and cloud services. The project consists of the Smart Object API, gateway service, and related tools

ProSyst

Internet of Things Connector. We do the middleware to make connected things and devices smart and enable value driven innovation.

Platform as a service

- **WoTKit**

  The Web of Things Toolkit is a platform as a service that allows you to connect things to the web. The system serves as a sensor data aggregator, dashboard, remote control and data processing tool. Developers can also create their own applications by using the RESTful API supplied with the platform.

- **JavaScript / Node.js**

  Node.js is a platform built on Chrome's JavaScript runtime for easily building fast, scalable network applications.

Natural Language

- **Wit.AI**

  Wit.AI enables developers to add a natural language interface to their app or device in minutes. It's faster and more accurate than Siri, and requires no upfront investment, expertise, or training dataset.

- **Additional Resources**
  - HyperCat is designed for exposing information about IoT assets over the web.
  - It allows a server to provide a set of resources to a client, each with a set of semantic annotations.

Future Works

Web of Things

- The **Web of Things** (WoT) is a term used to describe approaches, software architectural styles and programming patterns that allow real-world objects to be part of the World Wide Web. Similarly to what the Web (Application Layer) is to the Internet (Network Layer), the Web of Things provides an Application Layer that simplifies the creation of Internet of Things applications.

- The **Web of Things** reuses existing and well-known Web standards used in the programmable Web (e.g., REST, HTTP, JSON), semantic Web (e.g., JSON-LD, Microdata, etc.), the real-time Web (e.g., Websockets) and the social Web (e.g., oauth or social networks). Rather than re-inventing completely new standards

Nature of Things

- Research in the Web of Things usually considers things in the broad sense of physical objects. Things can include (but is not limited to) tagged objects (RFID, NFC, QR codes, Barcodes, Image Recognition) to Wireless Sensor Networks (WSN), machines, vehicles and consumer electronics.

Future?

- While looking into the next stages of this term and its technologies there are many opportunities and challenges to face including privacy concerns, security, costs, standards, regulations and the list goes on.
- IoT would add a new dimension to the world of information and communication.
- Where do you think the IoT is headed next?
- Share your opinion

I Acknowledge my sincere thanks to Jamal