Embedded Systems Design

Lecture 2: Introduction of Embedded Systems

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Embedded Systems

- Traditional definition
  - Systems with hardware and software for special-purposes with customized designs
  - Systems whose sub-components are CPUs, memory, I/O, and other specialized components with customized software stacks are running
- Convergence of general-purpose and embedded systems
  - The line btw. embedded systems and GP systems blurred
  - Issues shared between two platforms
    - Performance
    - Power consumption
    - Use of operating systems

Applications of Embedded Systems

Consumer electric devices	TVs, refrigerators, audio systems
Control systems	Factory automation, home automation, robot control
Portable devices	Phones, portable audio devices, cameras
Network systems	Routers, access points, switches
Game machines	Console game terminals, mobile game devices
Defense systems	Avionics, defense attack systems
Logistics	RFID, GPS-based tracking systems
Automotive systems	Car embedded systems, IVIs, telematics
Medical systems	Medical imaging devices (CTs, MRIs)
Wearable devices	Smartwatches, smartglasses

Portable Devices

- Portable information terminals
  - Simple voice communication devices => smart devices
  - Architecture of modern smart devices resembles those of general purpose computing systems
  - Diverse smart devices are being converged into one powerful smart phones

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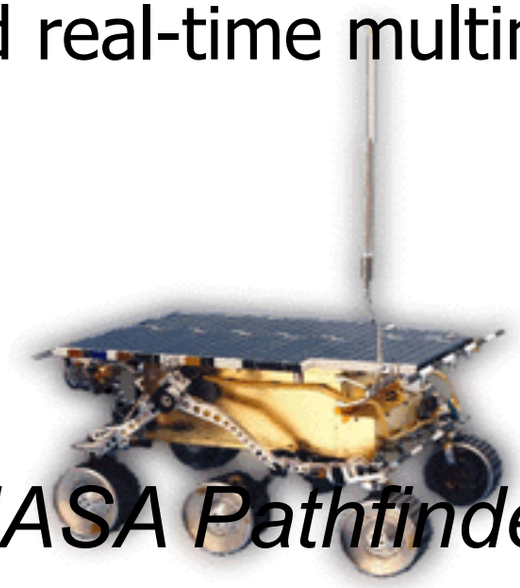
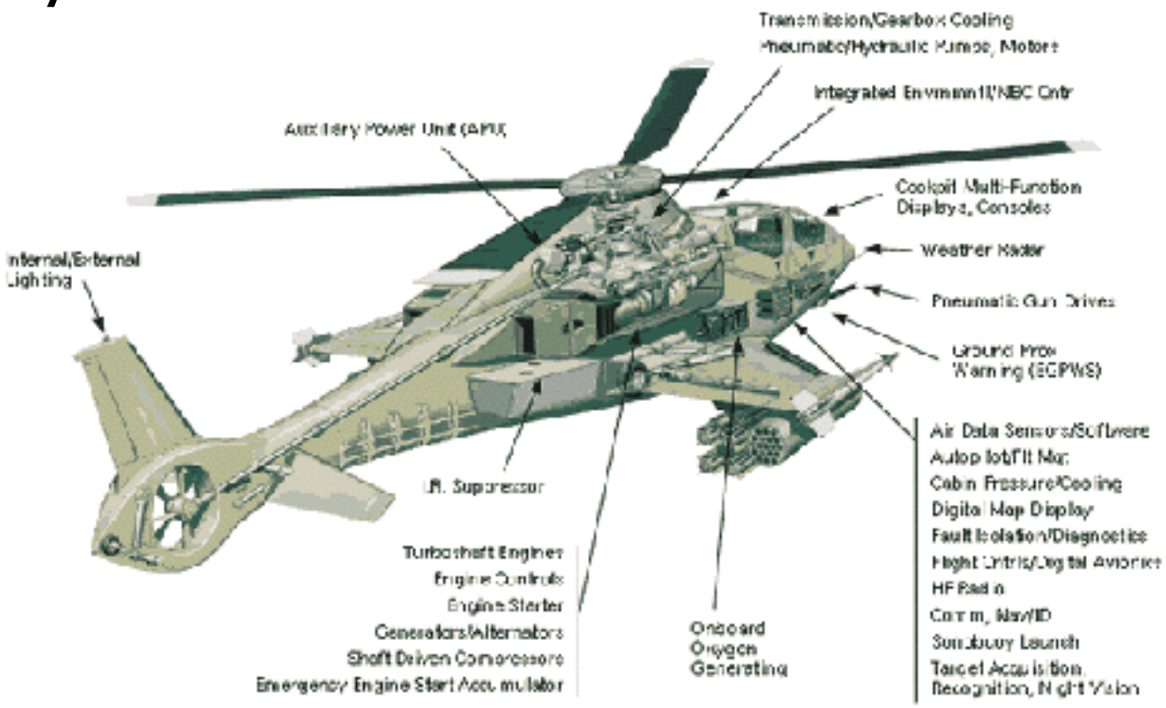
Avionics

- Aircraft
  - A safety critical, hard real-time system with hundreds of control CPUs
- Space aircrafts
  - RTOS-based mission critical systems (VxWorks from WindRiver)
  - Hard real-time multimedia systems



NASA Pathfinder (mission to MAR 19



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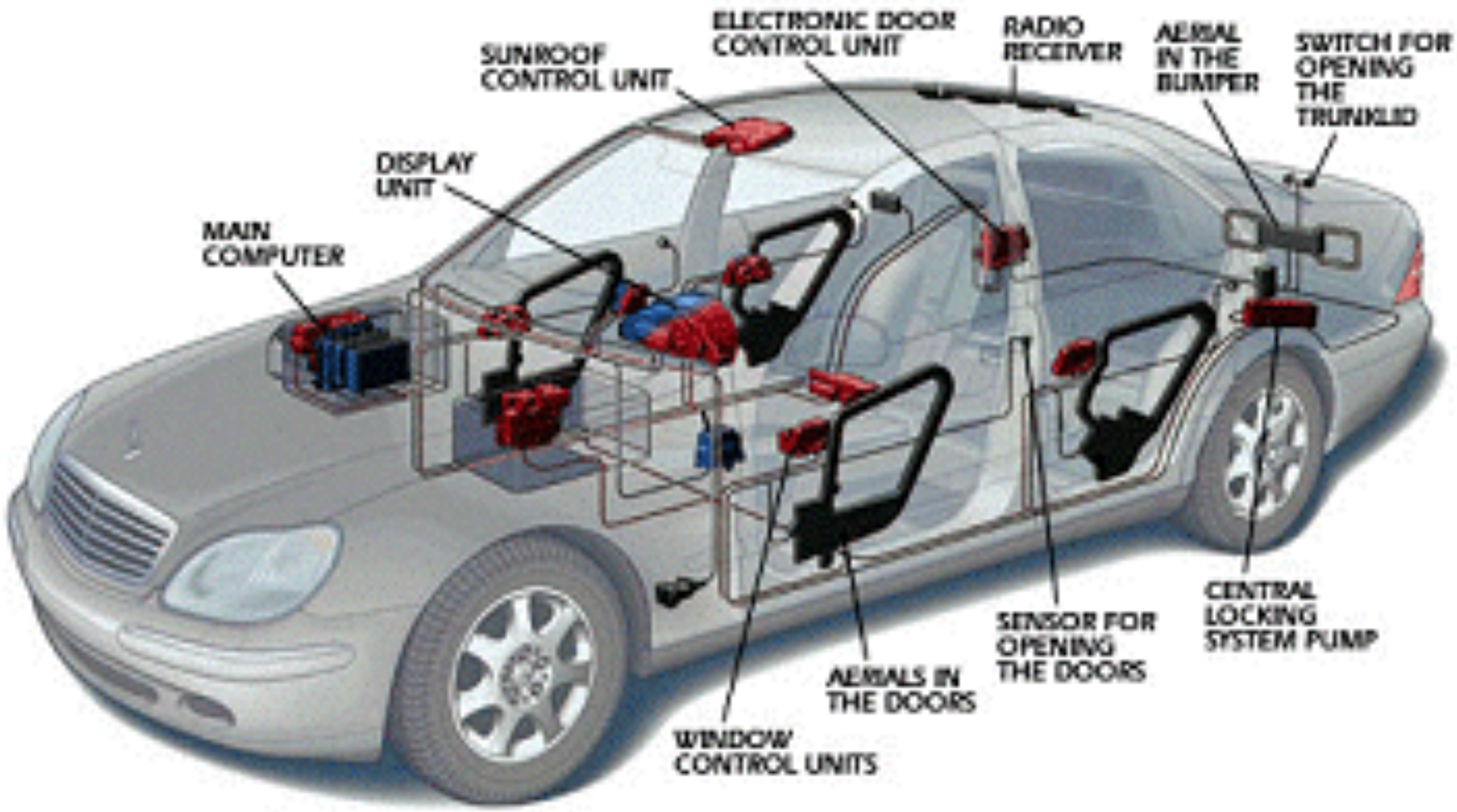
Automotives

- Automotive systems
  - Car embedded systems, self-driving cars, electric cars
  - Intelligent transportation systems



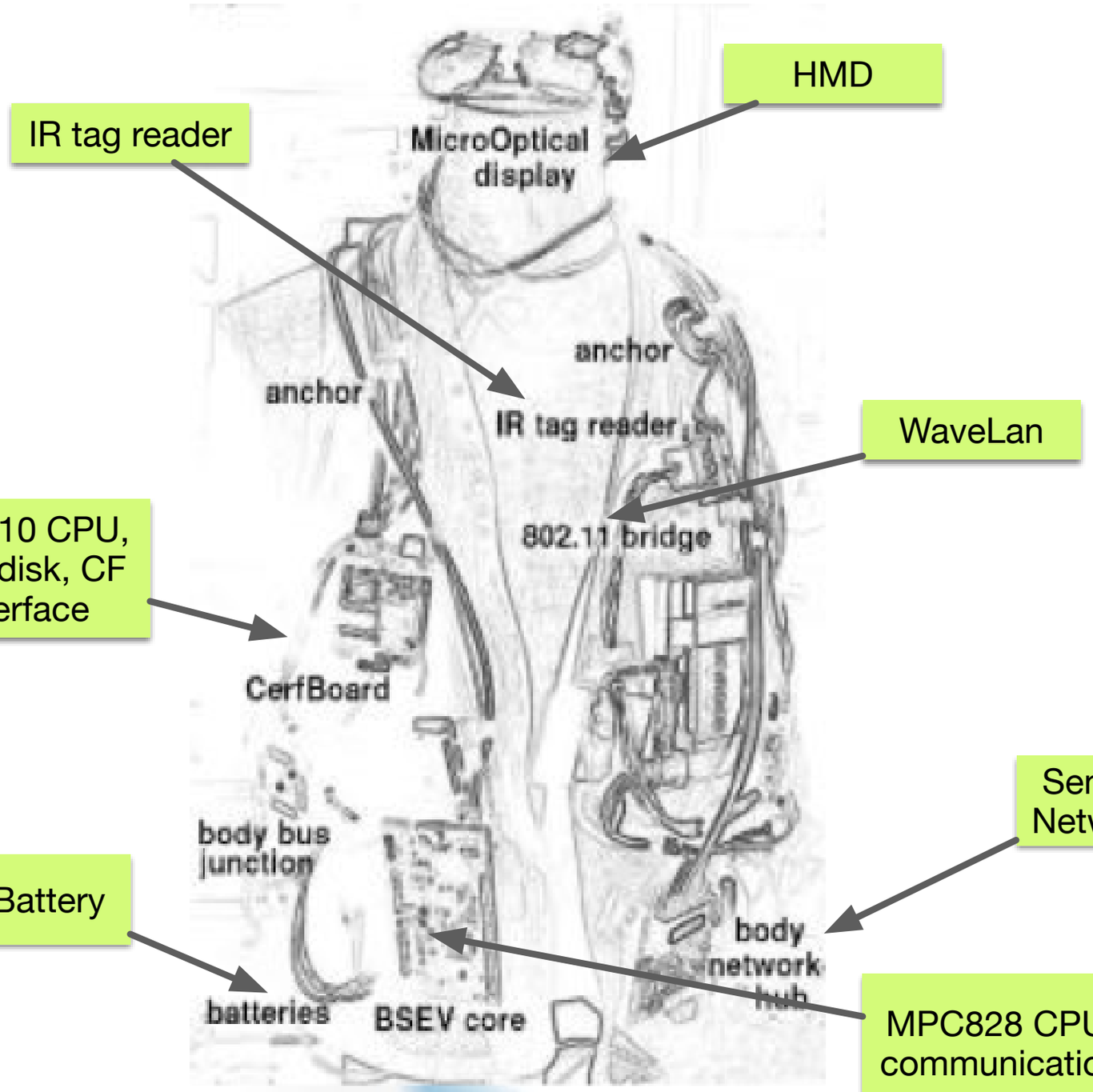
Driving In-Vehicle Innovation with the Internet of Things

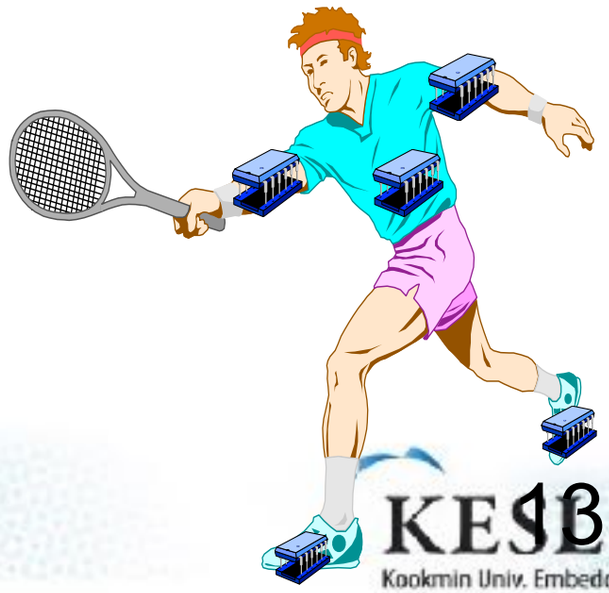
https://www.youtube.com/watch?v=UTye-7t7ln4

Introduction of Electric Cars

https://www.youtube.com/watch?v=3SAxXUIre28

Wearable Computer





Make It Wearable | Episode 1: Human Communication

https://www.youtube.com/watch?v=O0iPNr-142Q

IoT Systems

- Connected home
- Automotive
- Retail
- Transportation
- Logistics
- Energy / utilities
- Building automation
- Industrial automation
- Law enforcement
- Fitness

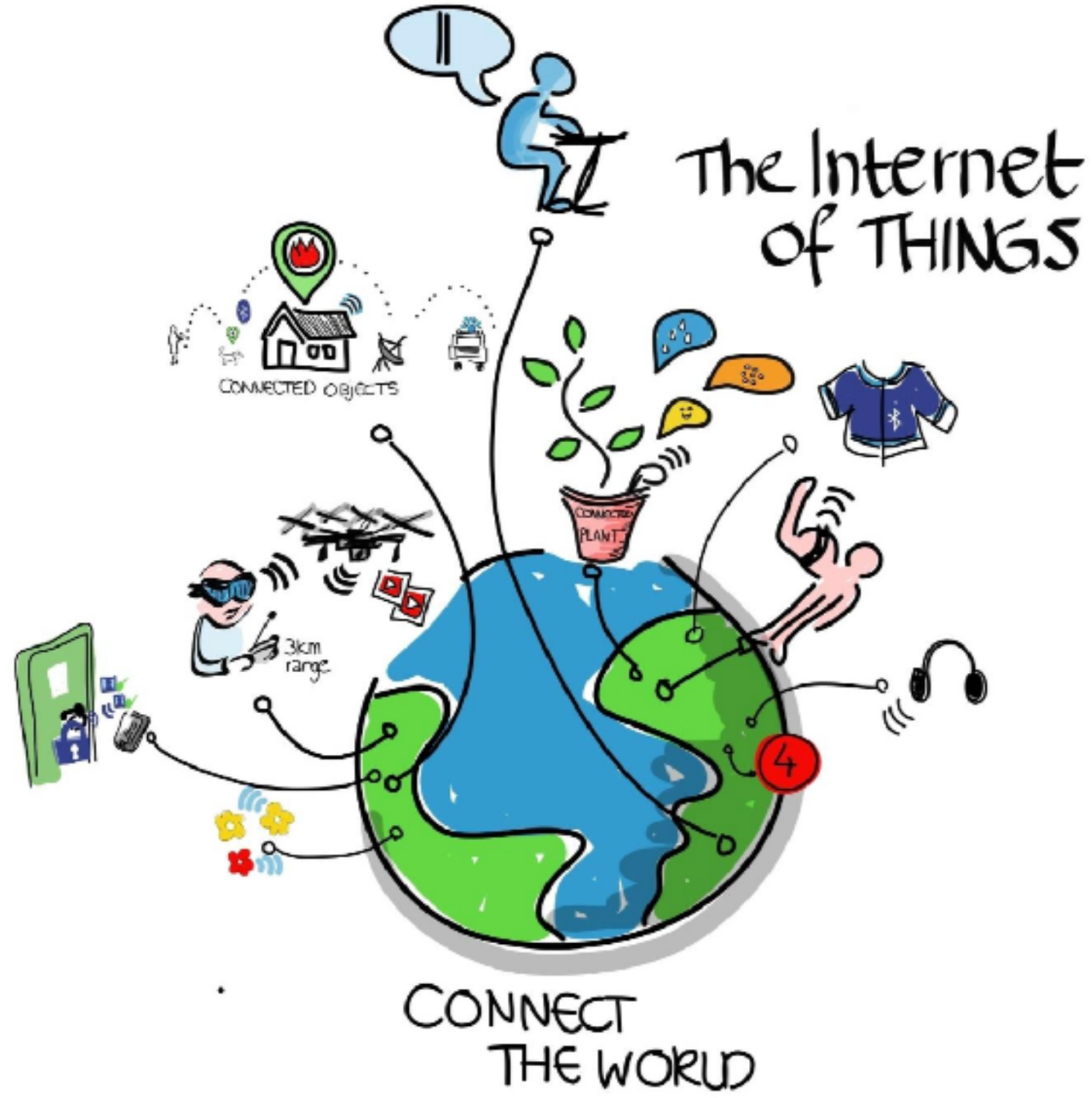


Image courtesy Wikipedia

https://www.youtube.com/watch?time_continue=106&v=TyzUqpqfCDA

Healthcare Example

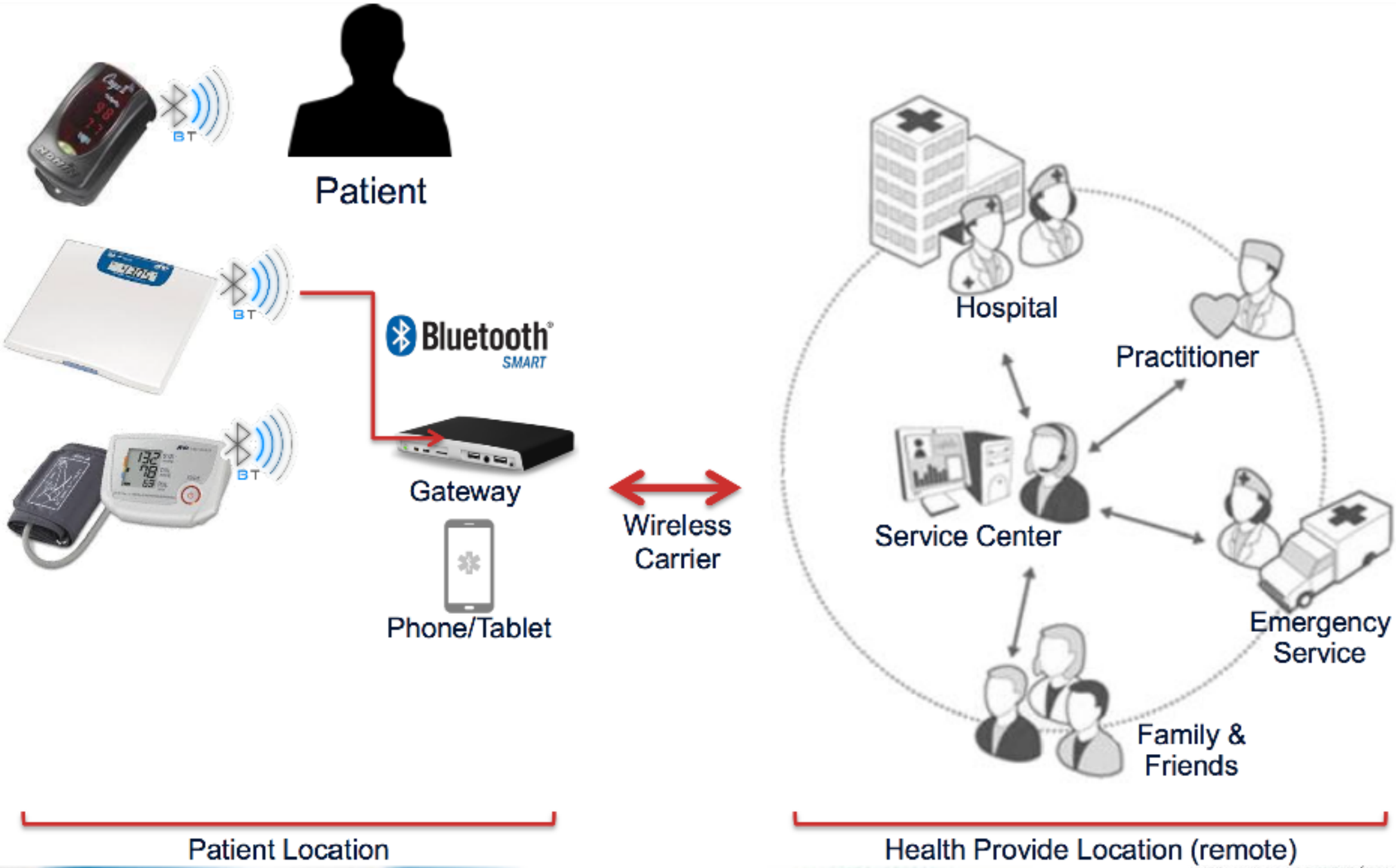
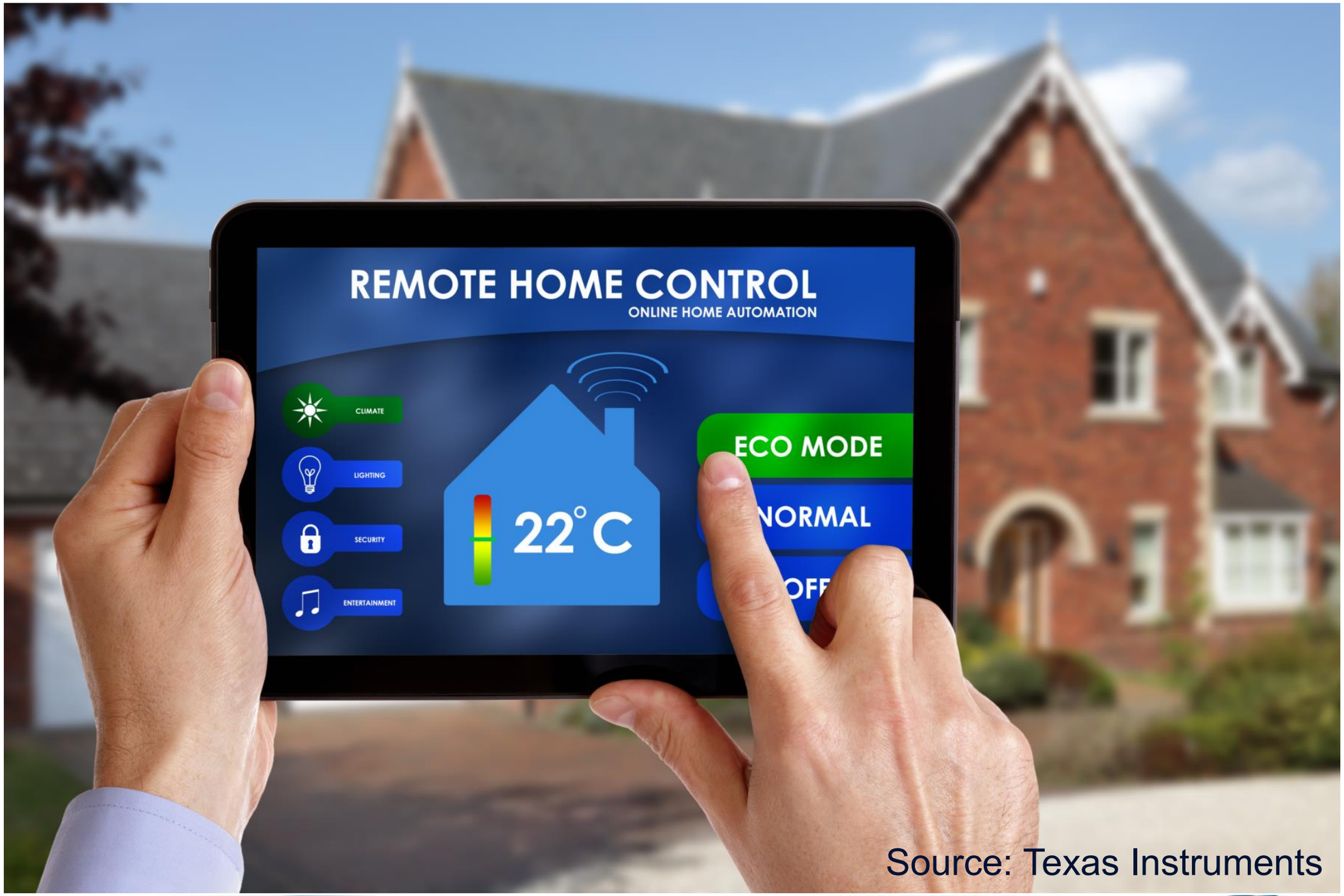


Image source: ARM Techcon 2014

Make It Wearable | Episode 2: Human Health

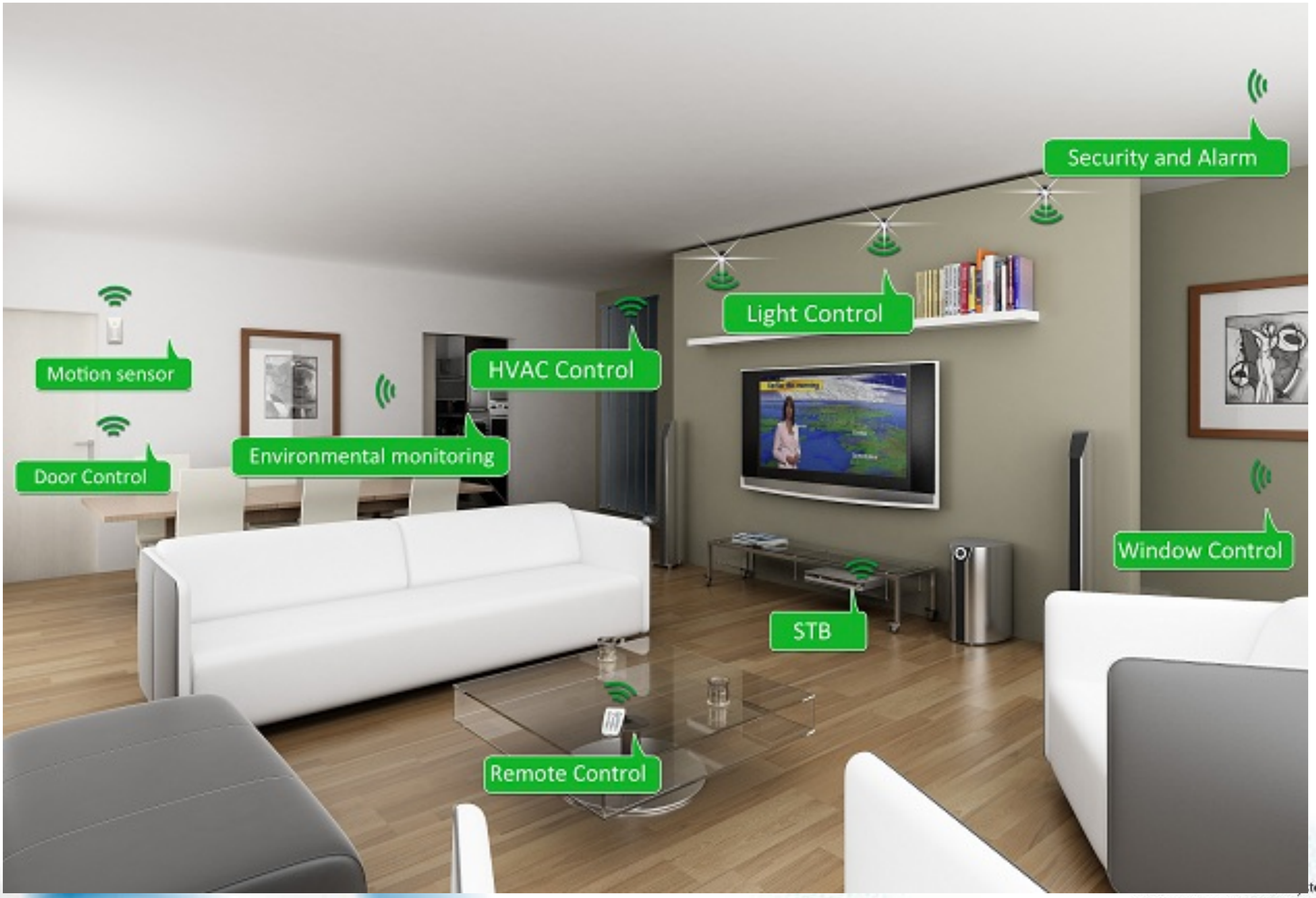
https://www.youtube.com/watch?v=I2l3e1oNwUU

Home Networking with IoT



Source: Texas Instruments

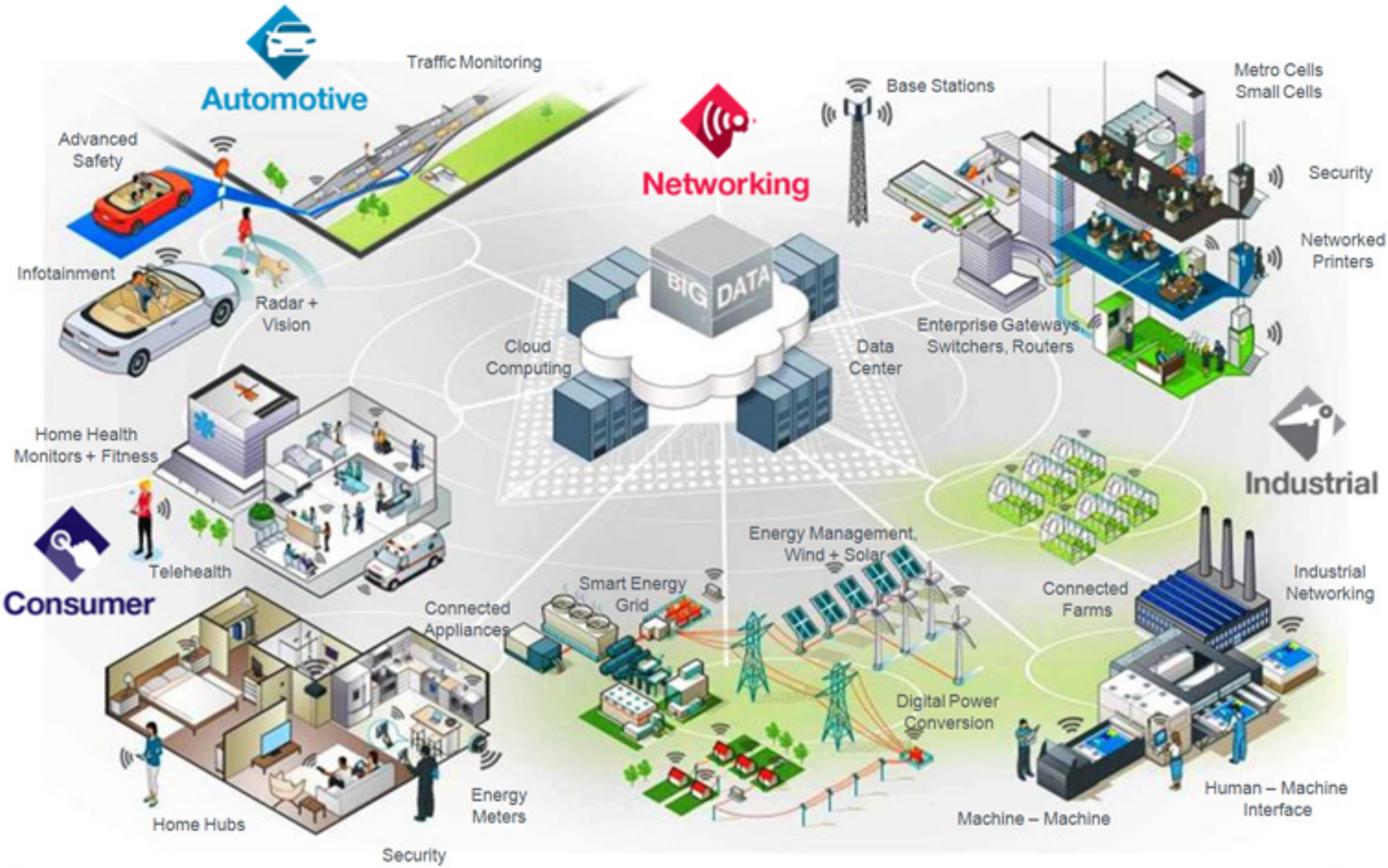
Home Networking with IoT



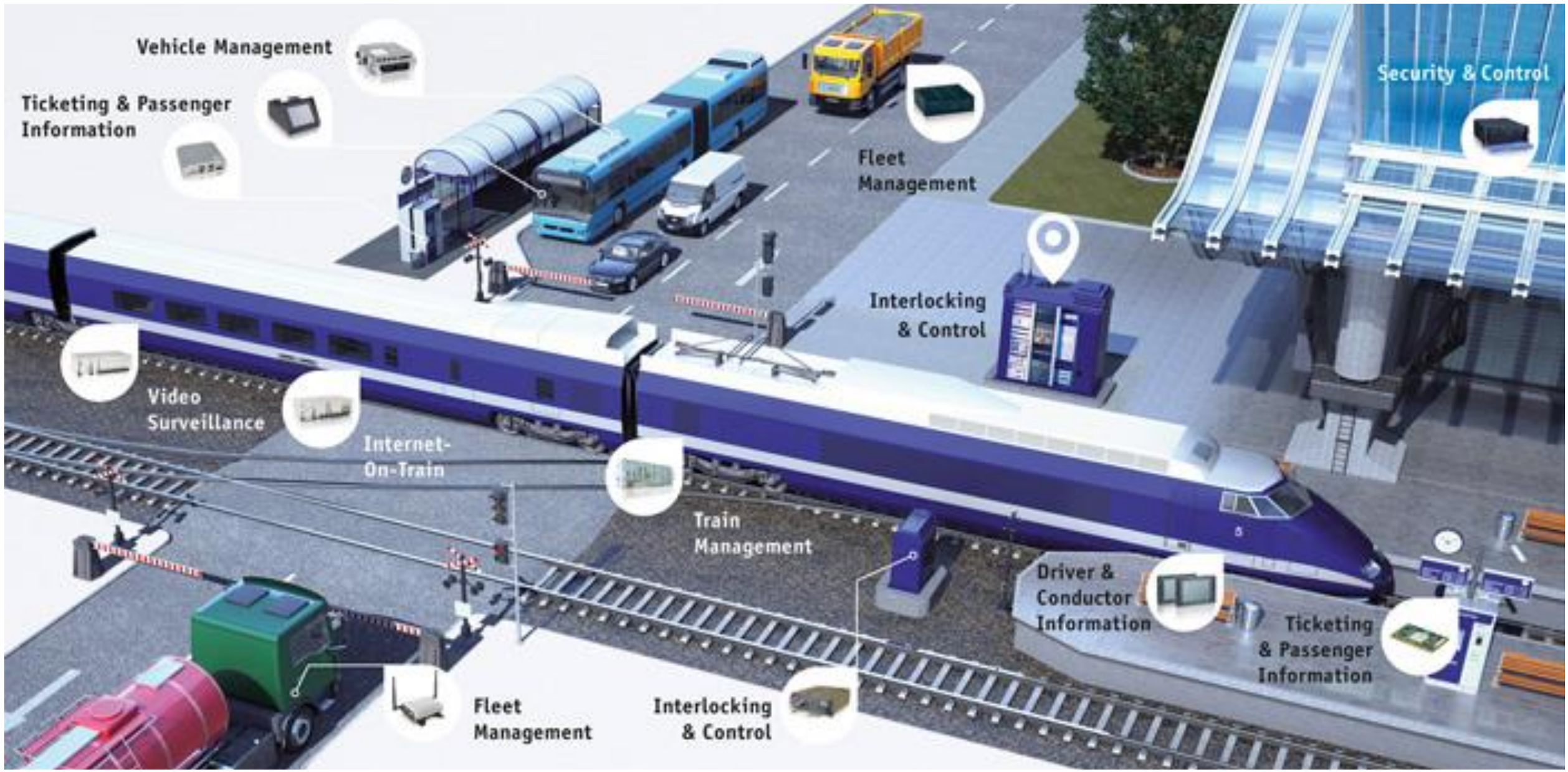
The Future of Home & Factory Automation Systems | Grant Imahara | Mouser Electronics (0:00 - 2:10)

https://www.youtube.com/watch?v=O0iPNr-142Q

IoT Practical Uses



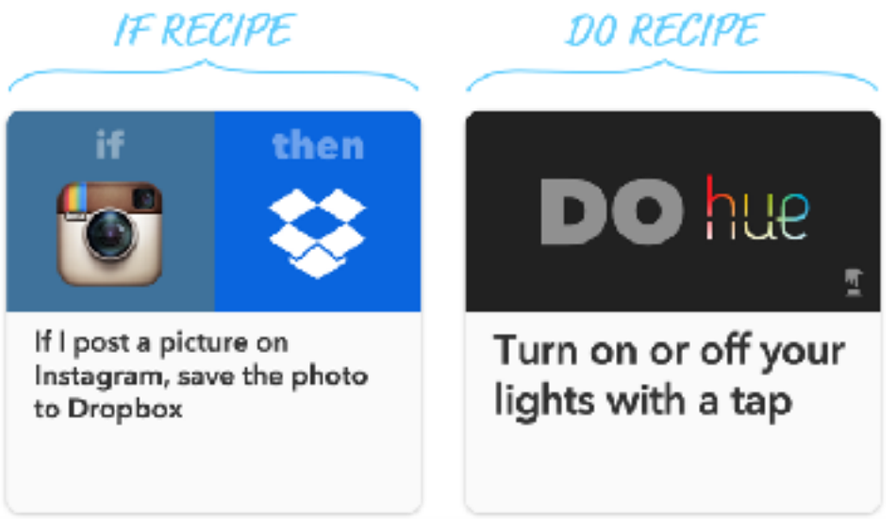
Other Practical Uses

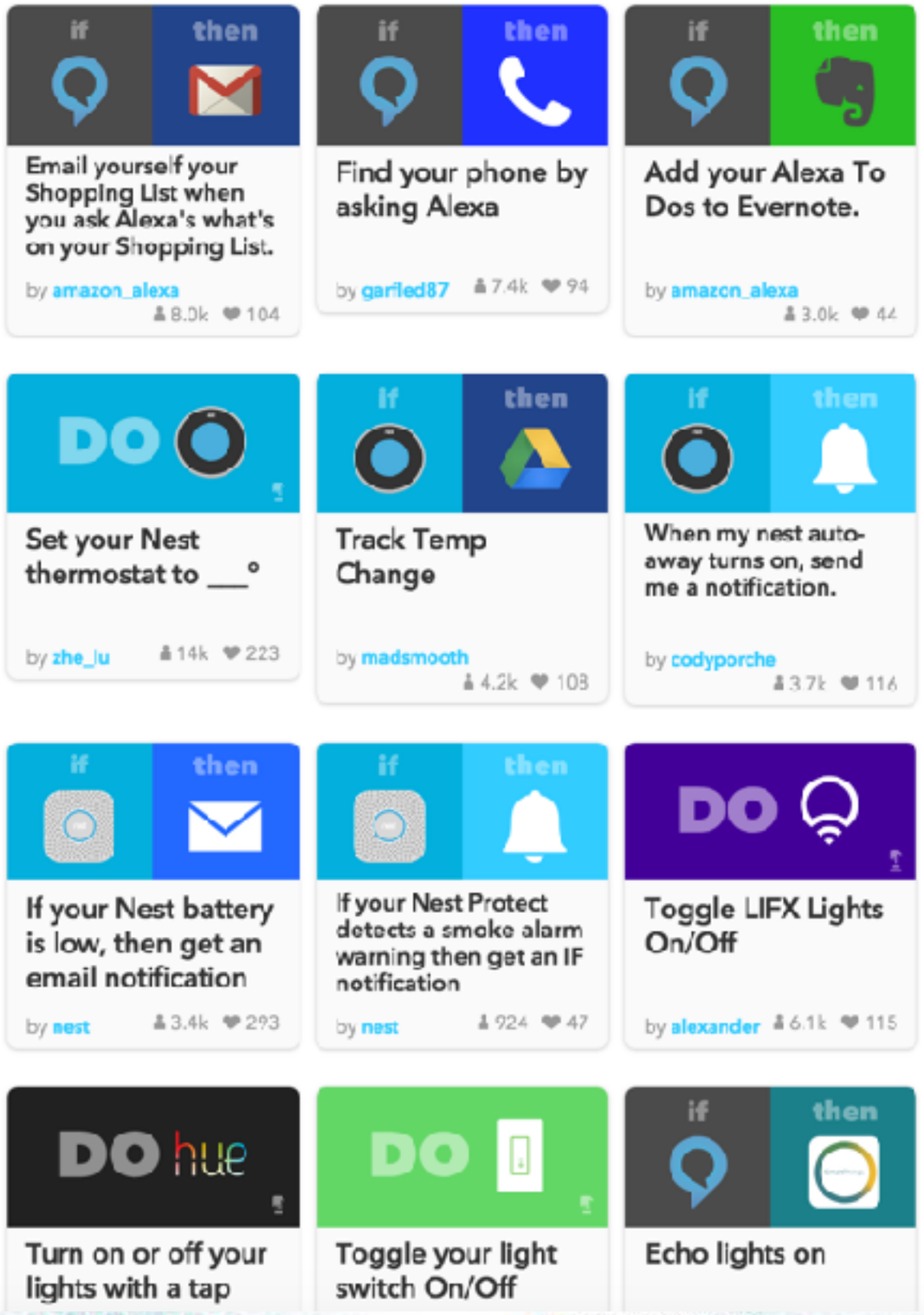


IoT Software Platforms

- IFTTT

What is IFTTT? IFTTT gives you creative control over the products and apps you love.





https://www.youtube.com/watch?v=zKv5hkOAgT0

IoT Hardware Platforms

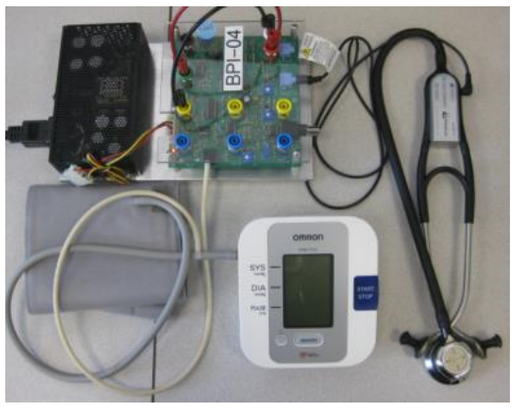
Arduino Smart Home Automation
https://www.youtube.com/watch?v=1TF1s9ziu-I

ARM-based Devices

Tablets

Wearables

Phones & Phablets



Sensors
Other Embedded

Characteristics of Embedded Systems

- Usually lower performance CPUs are used
- Pre-determined functionalities
- Light-weight and low power
- Low cost
- Mission critical
- Mostly hard real-time