

# CS596 IoT

# IoT Introduction

Silicon Valley University  
Vicky HSU

# **CS596 IoT Introduction**

## **Ch-2 IoT Application Overviews**

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# Class-2 Outline

- ▶ IoT Application Overview
  - 1. Connected Car
  - 2. Home Automation /Smart Home
  - 3. Smart City
  - 4. Smart Grid
  - 5. Healthcare
  - 6. Wearables
  - 7. Smart Building
  - 8. Industrial Automation

# IoT Applications



Smart Cities



Smart Water



Industrial Control



Smart Grid



Smart Farming



Smart Homes



Smart Environment



Smart Retail



eHealthcare



Safety and Security

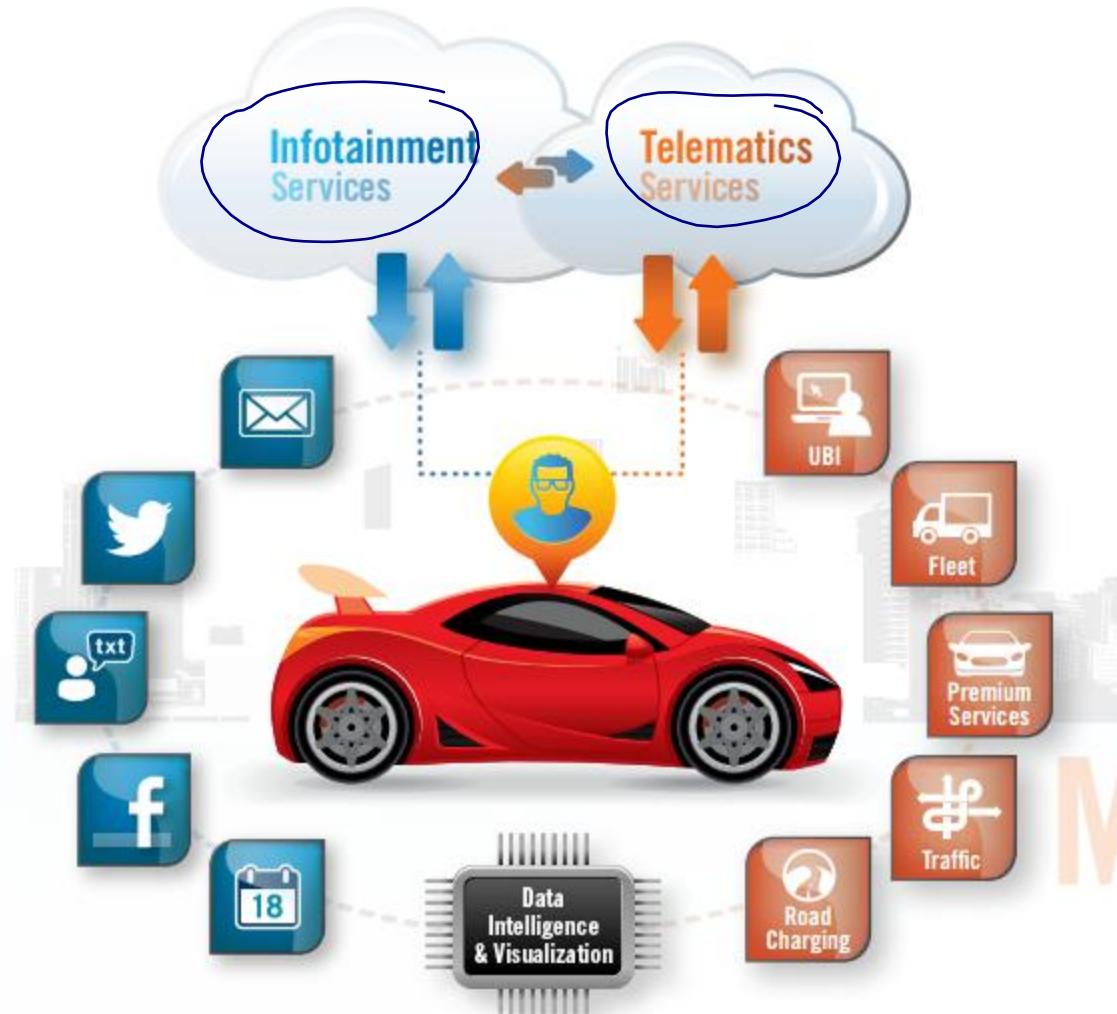


Smart Logistics



Customer Service

# Connected Car - 1



Source: Imatec

# Connected Car – 2

- ▶ 2004 General Motors' OnStar
  - UBI: Usage Based Insurance (eg. IMS)
- ▶ Telematics service provider DriveFactor and Deutsche Telekom
- ▶ Apple CarPlay vs Google Auto
  - Nvidia, Nokia, Microsoft (Windows in the car)
- ▶ Vision:
  - Life Simplified with connected devices –  
<https://www.youtube.com/watch?v=NjYTzvAVozo>
  - AT&T – <https://www.youtube.com/watch?v=uoZHPZ1CXkk>
  - McKinsey –  
<https://www.youtube.com/watch?v=lZ0swPoekmY>
  - US Transportation –  
<https://www.youtube.com/watch?v=YxmLkqVrg4c>
  - Telit – <https://www.youtube.com/watch?v=fFqEx--b7hU>

# AT&T Connected Car Lab



# Connected Car Application / Research

- ▶ Connected Car is :
  - Mobile, Social, Big Data, Cloud
  - Diagnosis, Safety, Navigation, Infotainment
- ▶ ITS: Intelligent Transportation System
- ▶ Auto Pilot
- ▶ E-Calls (EU laws) *emergency call*
- ▶ Eco-Drive
- ▶ Intelligent Drive
- ▶ Smart Vehicles
- ▶ Vehicle to Vehicle Communications
- ▶ Smart Roads Communication Infrastructures

# 24 COOL CONNECTED CAR FEATURES WORTHY OF OUR FAVORITE SPY

## DRIVER'S SAFETY

- Smart camera and radar (**MERCEDES S- CLASS**)
- Warning radar system
- Smart rear view camera
- Laser headlight (**Audi R8**)
- Lane control system (**INFINITY Q50S**)
- Junction camera views (**RANGER ROVER SPORT**)
- Smart Belts (**CADILLAC CTS**)
- Cyclist detection (**VOLVO XC60**)

## IN VEHICLE INFOTAINMENT

- In- car gaming
- Hand gestures
- Run multiple application
- Handwriting recognition
- Speech to text
- Text to speech
- Wi-Fi hotspot
- Smart keys

## NAVIGATION

- 3D navigation
- Concierge service
- Parking assistant
- Traffic notification

## SERVICE NOTIFICATION AND DIAGNOSTICS

- Vehicle health app
- Intelligent emergency call (**BMW X5**)
- Vehicle diagnostics
- Smart windscreen

Source: 24 CONNECTED CARS FOR BOND 24

# The Electro Revolution

It started 15 years ago, now this is where we are.

## Safety

According to a 2010 study<sup>1</sup> by the National Highway Traffic Safety Administration, vehicular communication systems could help avoid **79% of all** traffic incidences. Driverless cars are here to save us! Check out Google's<sup>2</sup>.

## Industry Growth

The 19 trillion dollar<sup>3</sup> IoT opportunity is the contemporary **gold rush**. The automotive segment is **growing 50% per year, 10 times more** than the unconnected car branch.

## Timing

Now is **100% the right time** to get involved in this industry. Soon we will see how Apple and Android got involved.

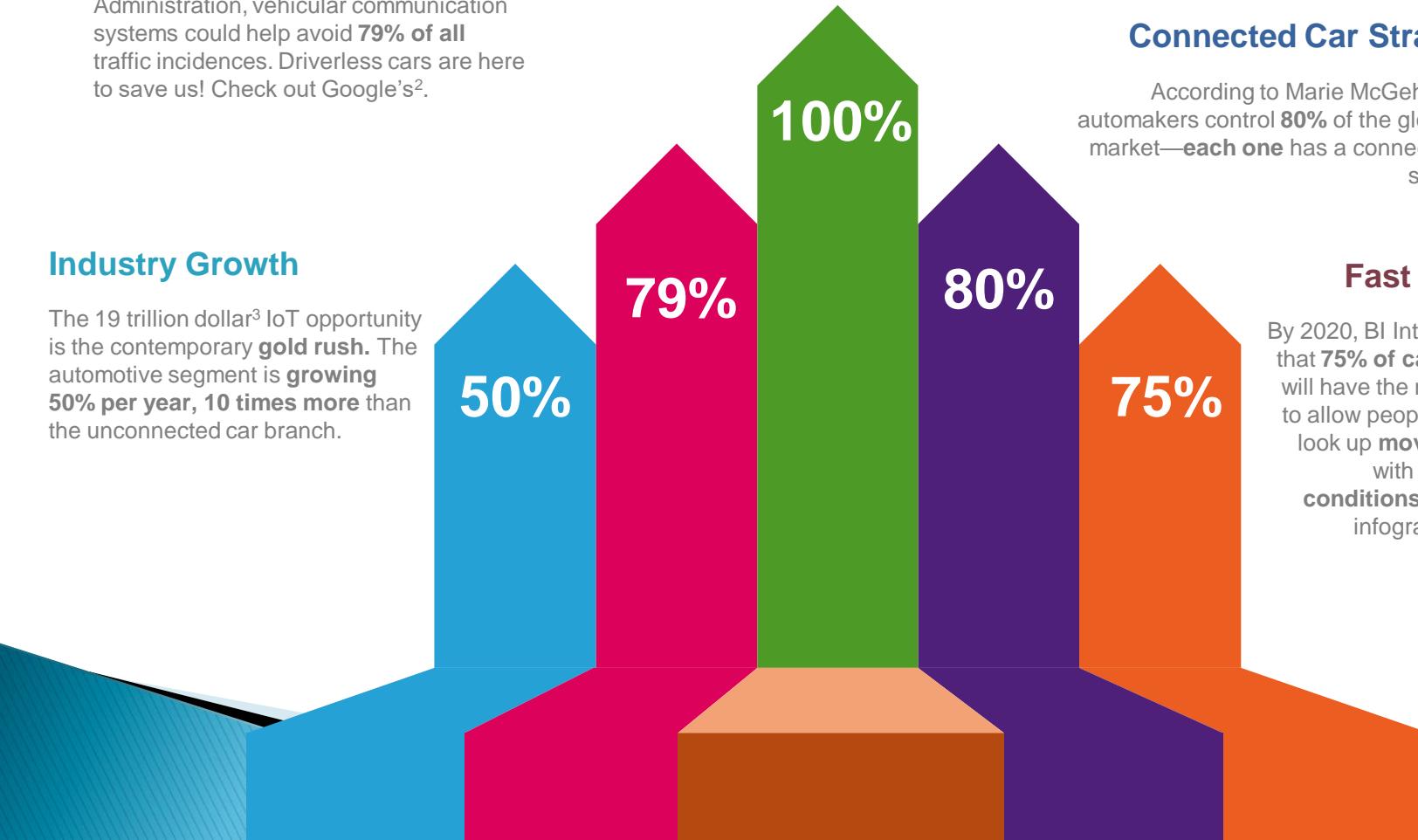
## Connected Car Strategy

According to Marie McGehee<sup>4</sup>, 14 automakers control **80%** of the global car market—**each one** has a connected car strategy.

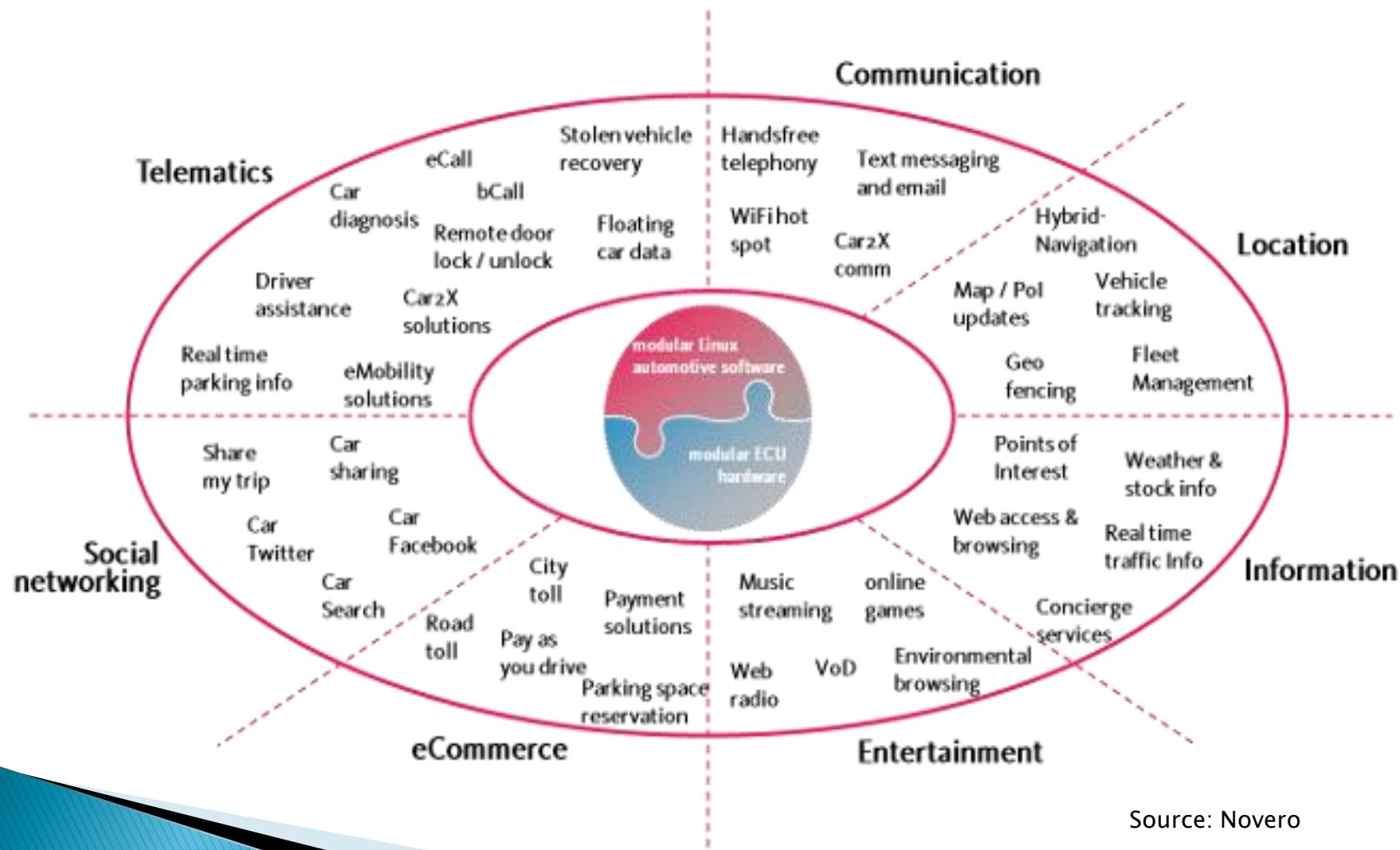
## Fast Development

By 2020, BI Intelligence estimates<sup>5</sup> that **75% of cars** shipped globally will have the necessary hardware to allow people to **stream music, look up movie times, be alerted with weather and traffic conditions**, etc. Check out this infographic<sup>6</sup> to learn more.

Source: Atooma

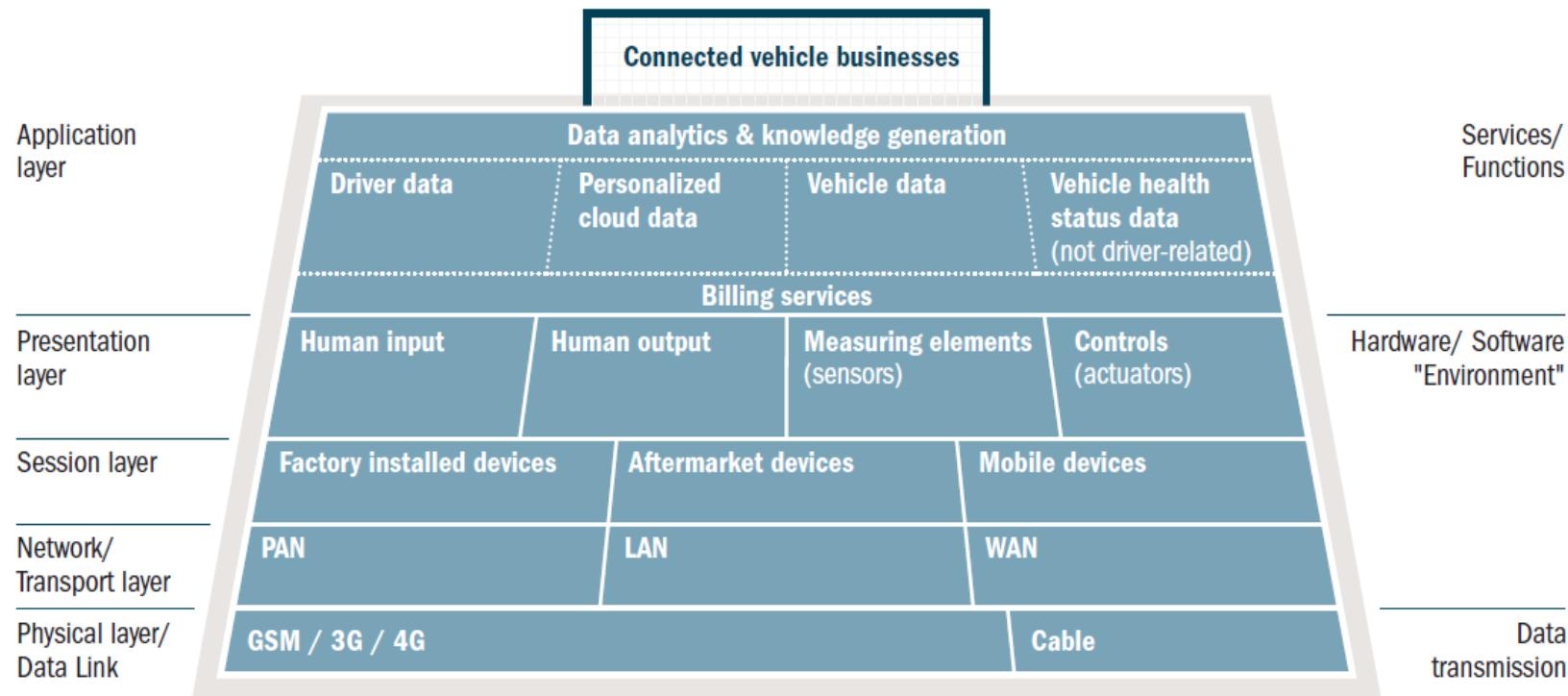


# Connected Car Applications



Source: Novero

# Connected Vehicle Playing Field



OEM



Automotive supplier



Cloud service provider



Other service provider



Web company

Source: Roland Berger

# Car Networking Options (Car2X)

## ▶ **Car-to-car**

- Increased safety as vehicles can communicate with each other and inform on dangerous situations such as wet roads, ice, accidents, etc.

## ▶ **Car-to-OEM and/or services**

- Technical problems could be diagnosed and even repaired remotely (e.g. for software/firmware updates)
- Valuable data for OEMs, app developers, Mobile Service Providers

## ▶ **Car-to-enterprise**

- New business opportunities to existing and future automotive players, from gas stations, car park operators, to music streaming, navigation, insurance providers and new web services

## ▶ **Car-to-x-connectivity**

- Communication with any Internet capable device

## ▶ **Car-to-infrastructure**

- Traffic, red lights, paying tolls, etc.

▶ **Note: Car2Roadside, Car2Service, Car2Home**

# Connected Car Domains

- ▶ **The vehicle**, consisting of the in-vehicle network and ECUs:
  - Both software and firmware
- ▶ **The cloud and/or back office at the OEM, enterprise or customer:**
  - Delivering services to the vehicle, and to the customer
  - Big data, storage, analytics
- ▶ **The connectivity between the vehicle and the services, that could be owned by:**
  - OEM, Enterprise, Customer, or others

Connectivity Type	Embedded	Tethered (IP sharing)	Smartphone integration
Modem	Built-in	Brought-in	Brought-in
UICC ("SIM")	Built-in	Brought-in	Brought-in
Intelligence/ Applications	Built-in	Embedded	Brought-in
User Interface	Vehicle HMI	Vehicle HMI	In vehicle HMI OR Phone HMI

# Connected Car Issues & Risks

- ▶ OEM supply chain
  - Vehicles are assembled, not an integrated design (ex Tesla)
  - Numerous layers, software platforms, operating systems
- ▶ OEM & Dealer network business model incongruent with technology, internet, data–driven business model
- ▶ Software / technology cycles (weeks or months) versus OEM development cycles (years)
- ▶ Regulatory
  - Distracted driver
  - Safety and security
  - Differing international standards
- ▶ Who owns the data?
- ▶ What is the value?
- ▶ How is the data protected?

# Advanced ITS Research

- ▶ Applying Vehicular Networks for Reduced Vehicle Fuel Consumption and *CO<sub>2</sub> Emissions*
- ▶ An Investigation of Measurement for Travel Time Variability
- ▶ Microwave Beamforming Networks for Intelligent Transportation Systems
- ▶ Deploying Wireless Sensor Devices in Intelligent Transportation System Applications
- ▶ Active Traffic Management as a Tool for Addressing Traffic Congestion
- ▶ How to Provide Accurate and Robust Traffic Forecasts Practically?
- ▶ A Review of Embedded Automotive Protocols
  - AUTOSAR Standard, CAN Networks, FlexRay Protocol, Automotive Architecture Description Languages, Scheduling Messages with Offsets on Controller Area Network

# Smart Home / Home Automation

## TURN OFF THE LIGHTS & TV IN THE LIVING ROOM

**Given** nobody is in the living room

**When** I activate the sleep mode on my <fitbit>

**Then** turn off the lights in the living room

**And** turn off the tv

**And** fade out my bedside light

**And** set my alarm clock on my <fitbit>

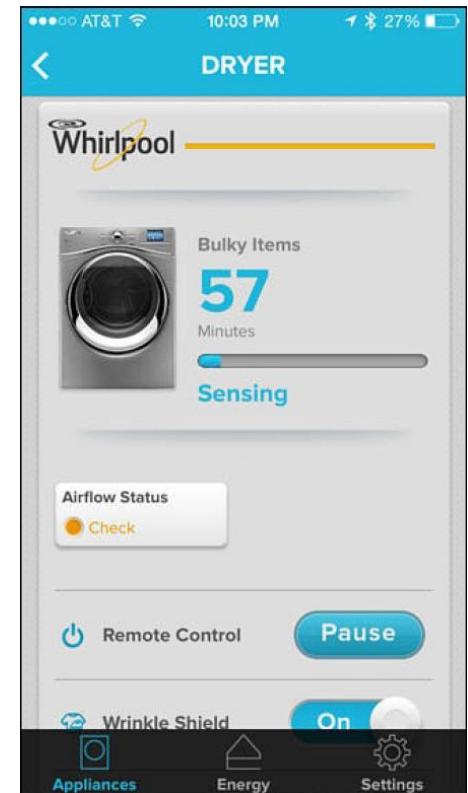
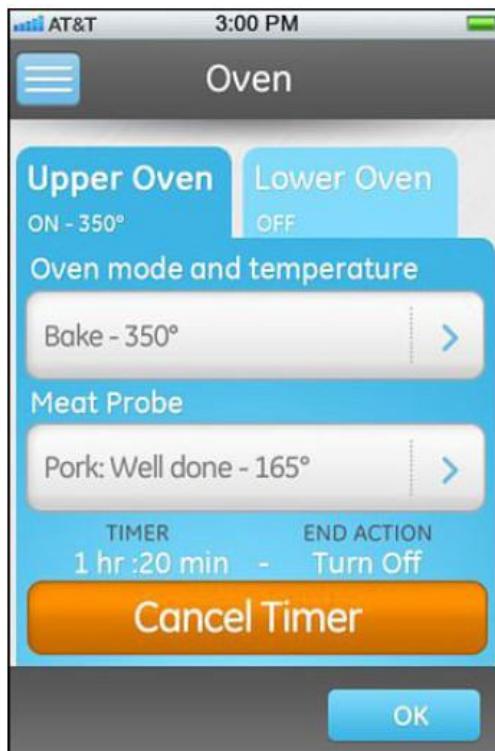
# Smart Home Technologies

- 1. X10**
- 2. INSTEON**
- 3. Z-Wave**
- 4. ZigBee**
- 5. 6LoWPAN**
- 6. HomePlug**



Source: The Internet of Things,  
by Michael Miller

# Smart Home Apps



Source: The Internet of Things,  
by Michael Miller

# Home Automation Protocols



ZigBee®

THREAD  
GROUP



INSTEON®



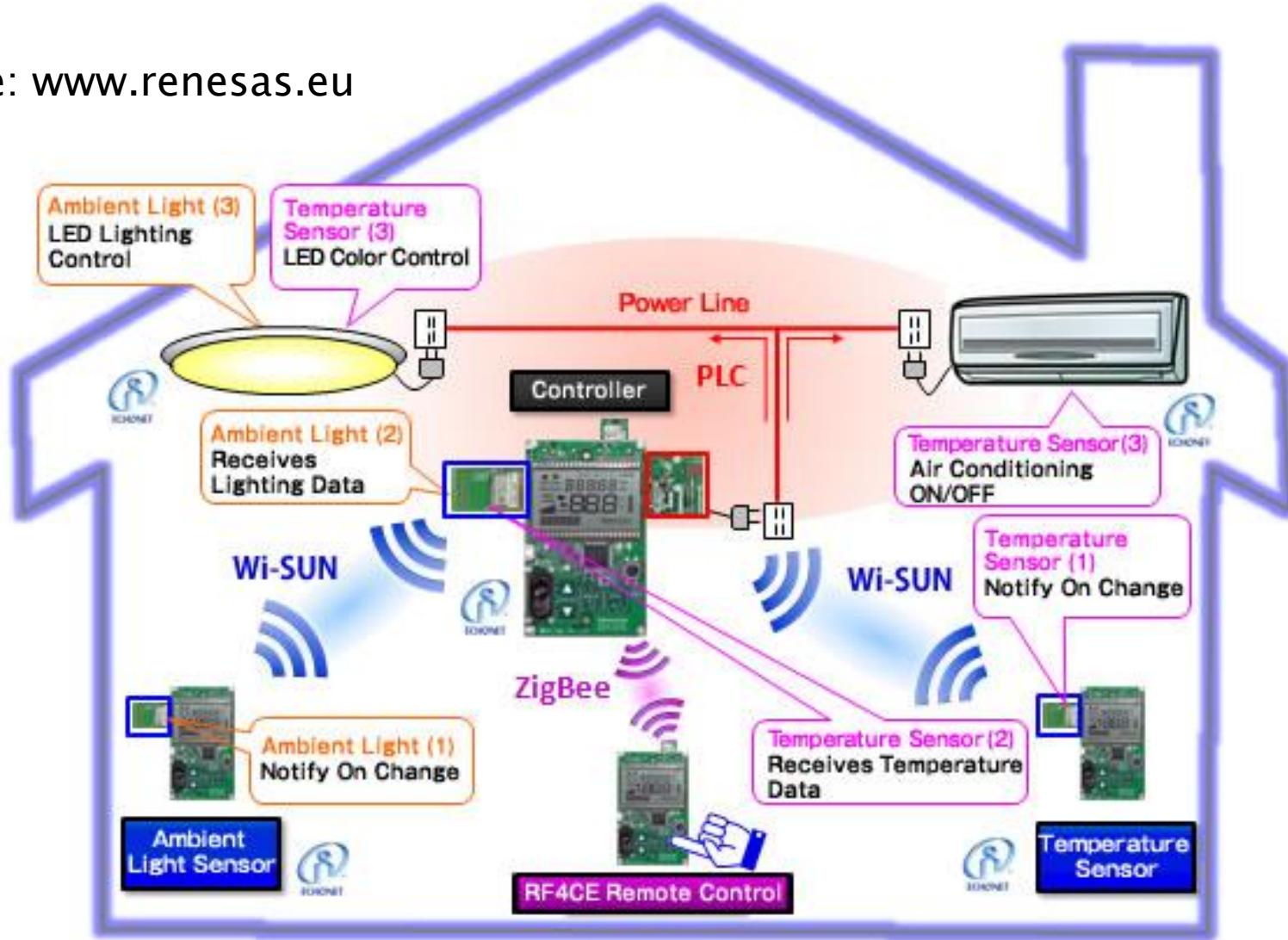
Source: [www.mysmahome.com](http://www.mysmahome.com)

SMAhome Expo Buyers Guide 2015:  
Protocols Adopted by Asian Smart Home Makers

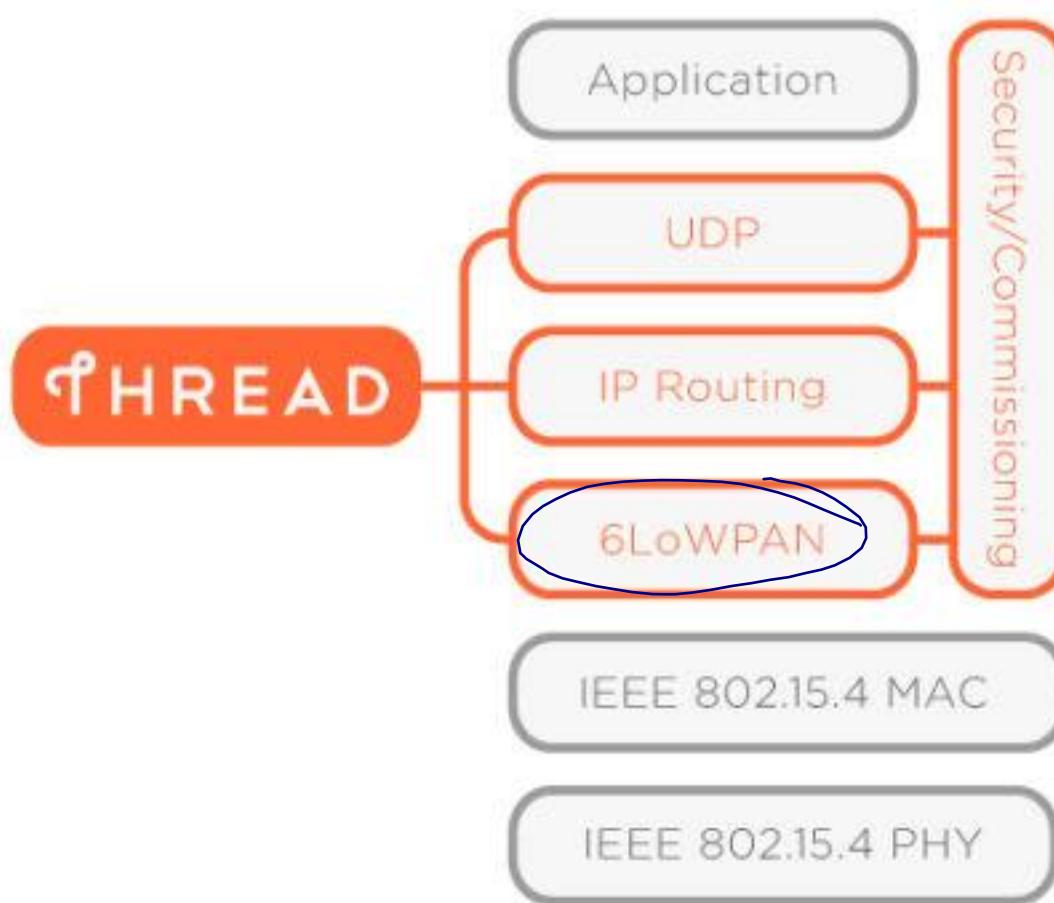
# Home Area Network Connectivities

Figure 3: Home Area Network: Managing the Entire Home

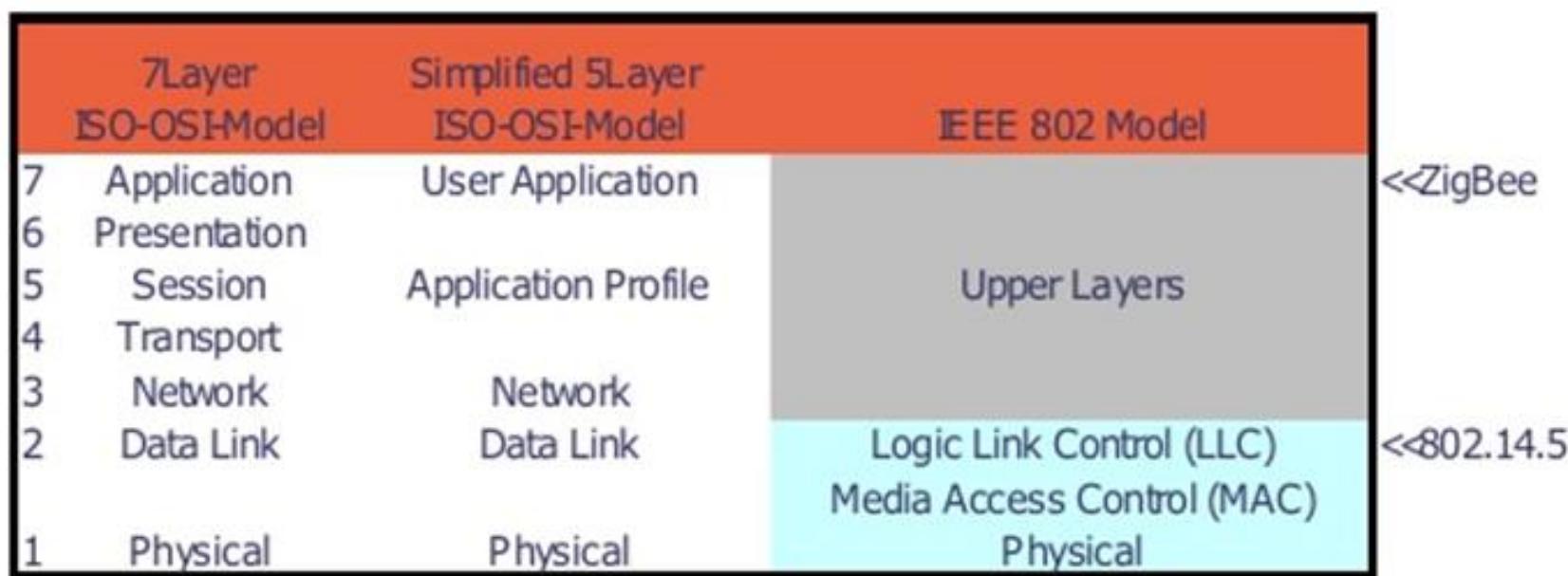
Source: [www.renesas.eu](http://www.renesas.eu)



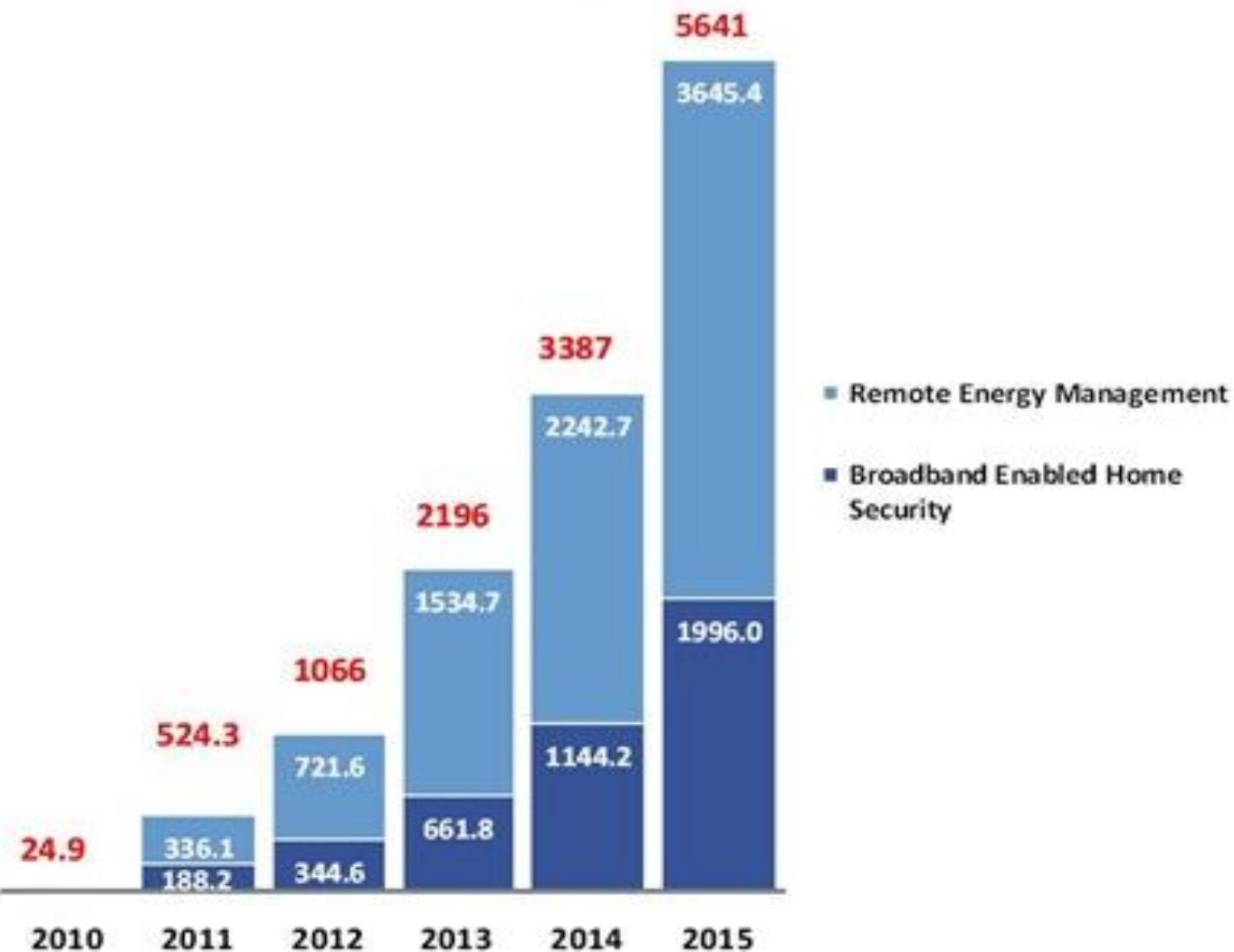
# Sample Detailed Protocol Stack Architecture – Thread



# ZigBee Protocol Stack

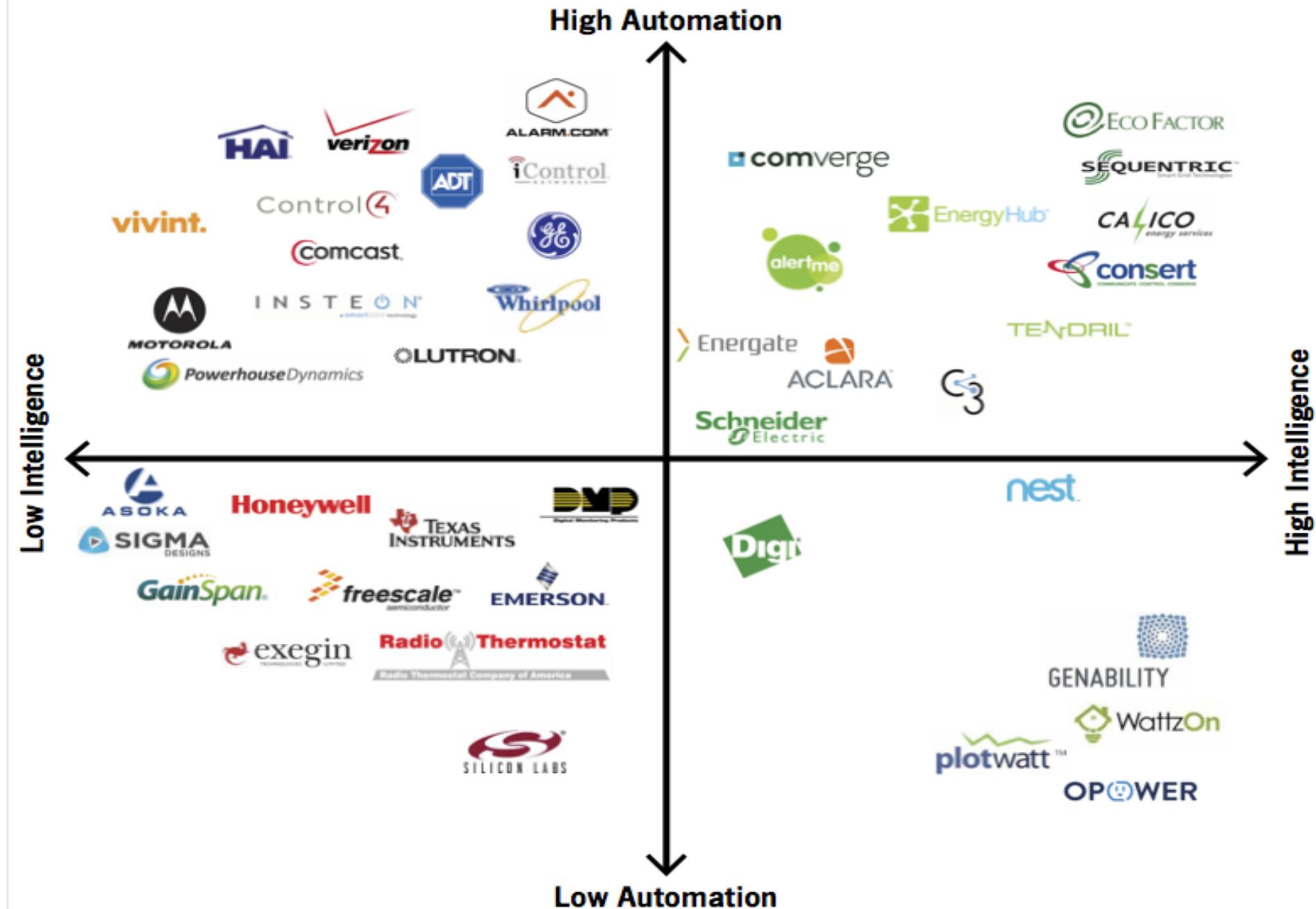


## US Smart Home Applications Service and Equipment Revenues 2010-2015 (\$M)



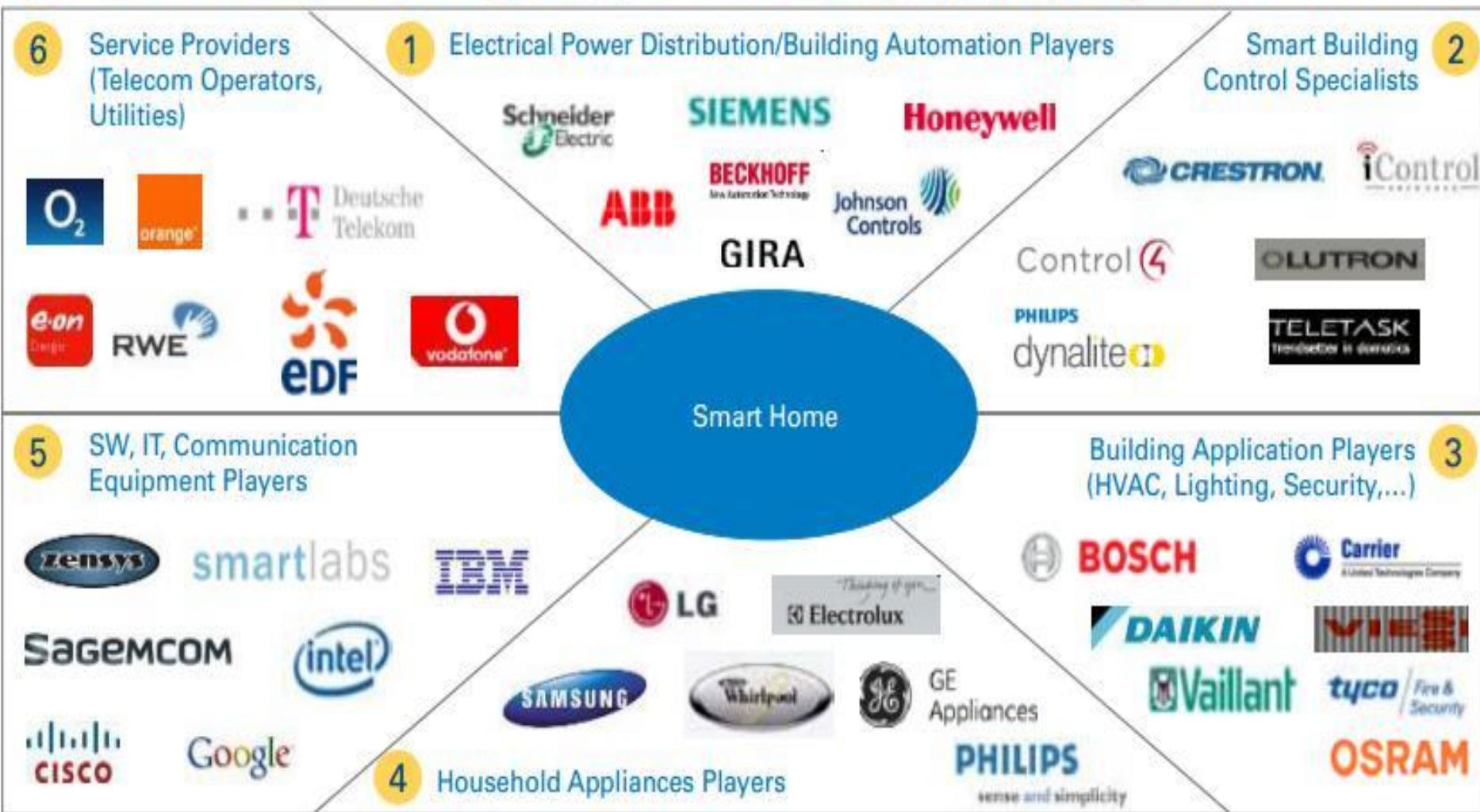
Source: Strategy Analytics, Multiplay Market Dynamics

FIGURE 1-10: AUTOMATION AND "SMARTNESS" (INTELLIGENCE) VENDOR MAPPING



# Smart Home Players

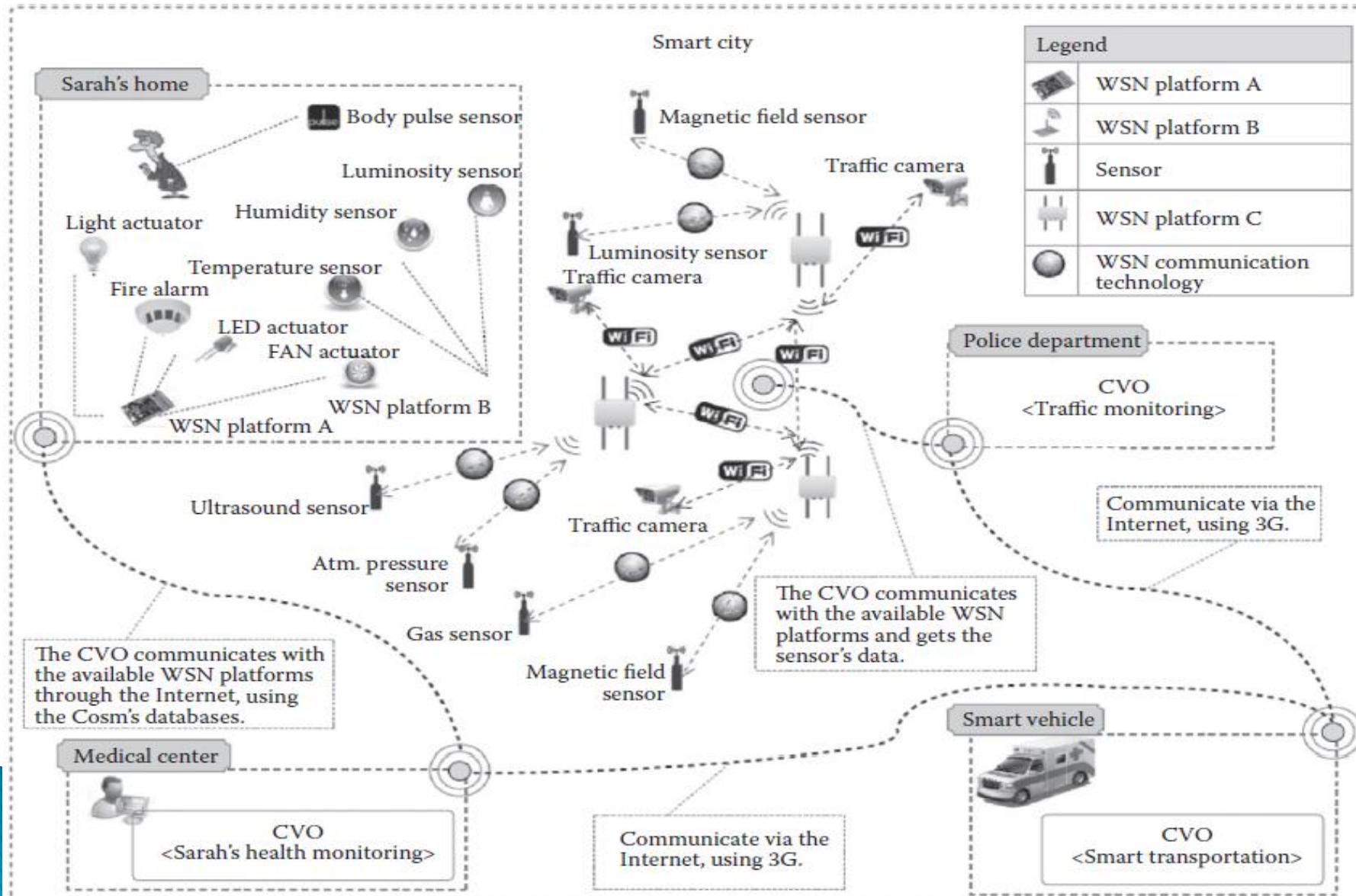
Figure 1: Smart Home has become a hot topic and players from various industries are now placing their bets



# Smart City

- ▶ smart lighting
  - ▶ smart water
  - ▶ smart meters
  - ▶ smart infrastructure
  - ▶ smart transportation
- 
- ❖ Smart Homes
  - ❖ Security and Surveillance
  - ❖ Remote Asset Management
  - ❖ Connected Goods
  - ❖ Connected Consumer Electronics

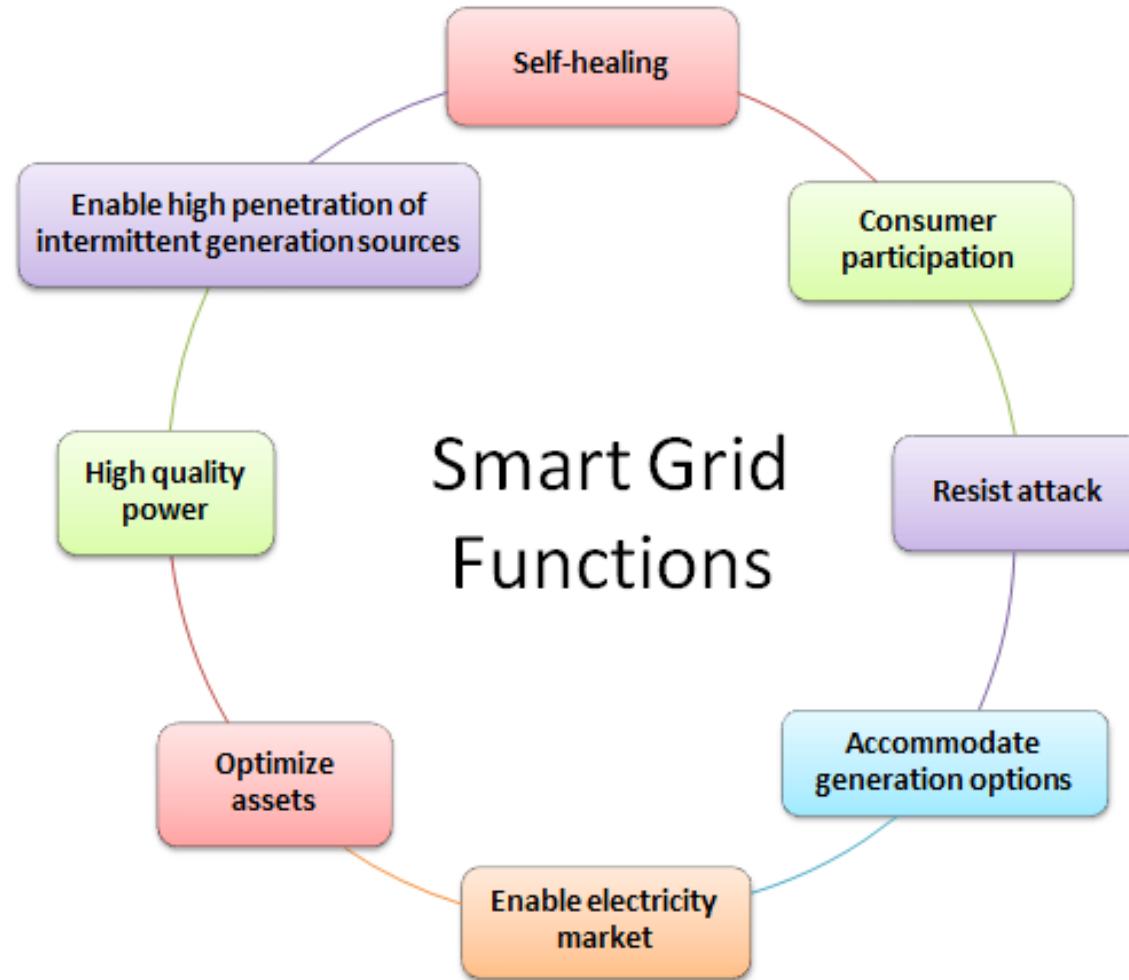
# A citywide use case covering smart traffic, home, hospital, and police department



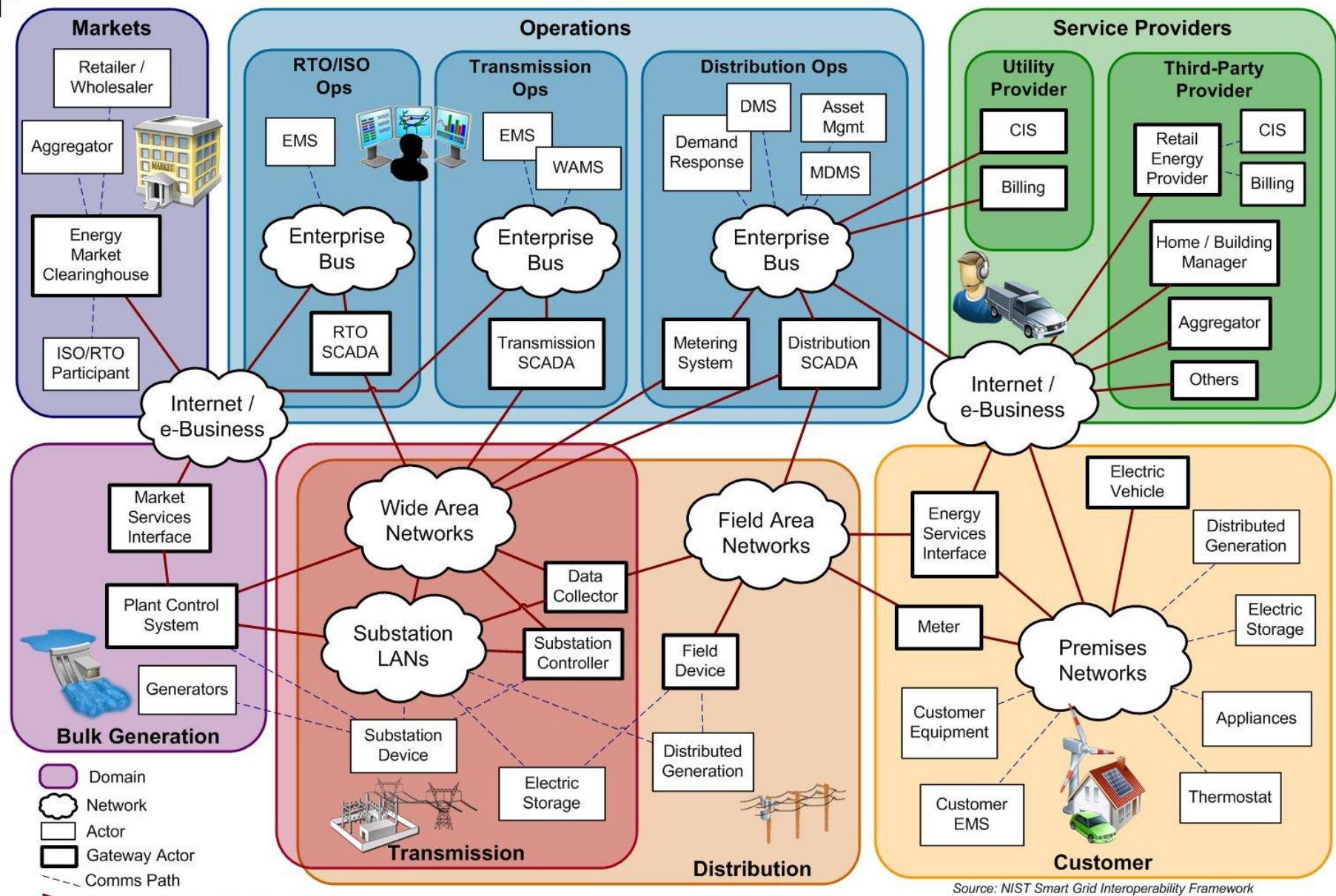
# Leading Smart City Platforms

- ▶ IBM Intelligent Operations Center
  - manage complex city environments, incidents and emergencies
  - offers integrated data visualization, near real-time collaboration and deep analytics
  - plan for growth and coordinate and manage response efforts
  - integrated maps, online dashboards, customizable reports, multiple analytic algorithms, interactive standard operating procedures
- ▶ Oracle Smart City Platform
- ▶ The Thales Hypervisor Supervision System

# Smart Grid Functions



# Smart Grid Networks



# Smart Grid



SEP 1.x	REST Web Services CIM IEC 61968		C12.18/ C12.19	DLMS/ COSEM IEC 62056	PANA RFC 5193	SNMP RFC 1157	NTP RFC 5905	SSH RFC 4251	DNS RFC 1085	DNP3 IEEE 1815	SunSpec						
ZigBee Cluster Libraries	EXI	CoAP/ HTTP RFC2616	TLS/ RFC5246 DTLS RFC6347														
ZigBee Pro	TCP RFC 793/UDP RFC 768								RPL RFC 6553	ICMP RFC 4443	MODBUS						
	IPsec RFC 2401		IPv6 RFC 2460, IPv6 Addressing 4291 IPv4 RFC 791						DSCP RFC 2474								
	6LoWPAN RFC 4944		PPP RFC 1661		Satellite	4G LTE 3GPP TF25.913 WiMAX - IEEE 802.16		IEEE 802.3	IEEE 802.11								
802.15.4 MACs		IEEE L2R	GPRS			4G LTE 3GPP TF25.913 WiMAX - IEEE 802.16											
802.15.4 DSSS	802.15.4g FHSS	2G GPRS	3G		4G LTE 3GPP TF25.913 WiMAX - IEEE 802.16												



30.3%

Percentage of IoT devices  
found in healthcare

69.7%

Percentage of IoT devices  
found elsewhere\*

\* Business/Manufacturing, Retail, Security, Transportation

\$2.5  
**trillion**

The predicted global  
worth of IoT in healthcare  
in 2025

Deployment of the Industrial Internet can help to **drive down costs** from clinical and operations inefficiencies by roughly **25%** or about **\$100 billion per year**

# Health Care Applications

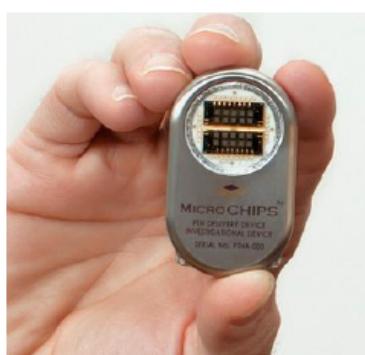


## ELECTRONIC PILL DISPENSERS

Designed to remind individuals to take their medication at the right time and to ease the burden of complex medication regimens, electronic pill dispensers such as [my uBox](#) and [MedMinder](#) alert both the patient and their caregivers.

## ELECTRONIC BOTTLES, CAPS AND POUCHES

Wireless smart pill bottles, such as [Adheretech](#), measure the volume of tablets or liquid left in a bottle, while [GlowCaps](#) use light and sound to signal when it's time to take your medication. Inhaler attachments, such as [GeckoCap](#) and [Asthmapolis](#), monitor where and when an inhaler is used.



## 'PHARMACY ON A CHIP'

Currently undergoing clinical trials, [microchips drug delivery](#) technologies administer controlled doses of a drug at precisely the right time via a microchip inserted on the waist. Still in its infancy, the technology holds promise for improved patient adherence managed remotely.



## BIOMONITORING DRUGS

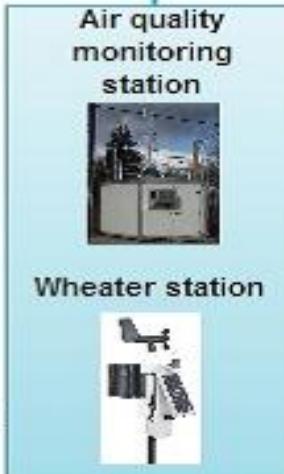
Ingestible sensors as small as a grain of sand exist today. [Helius by Proteus Digital Health](#) is a digital health feedback system. Embedded in a tablet, sensors communicate with a patch worn on the stomach. This then relays information to your phone, and further to your support network and care providers.



## SMART WATCHES

Already designed to act as a health and fitness companion with all the capabilities of a fitness tracker, smart watches (such as [Apple Watch](#)) have the potential to integrate with multiple technologies, including those described here.

## Non-living things linked to living things



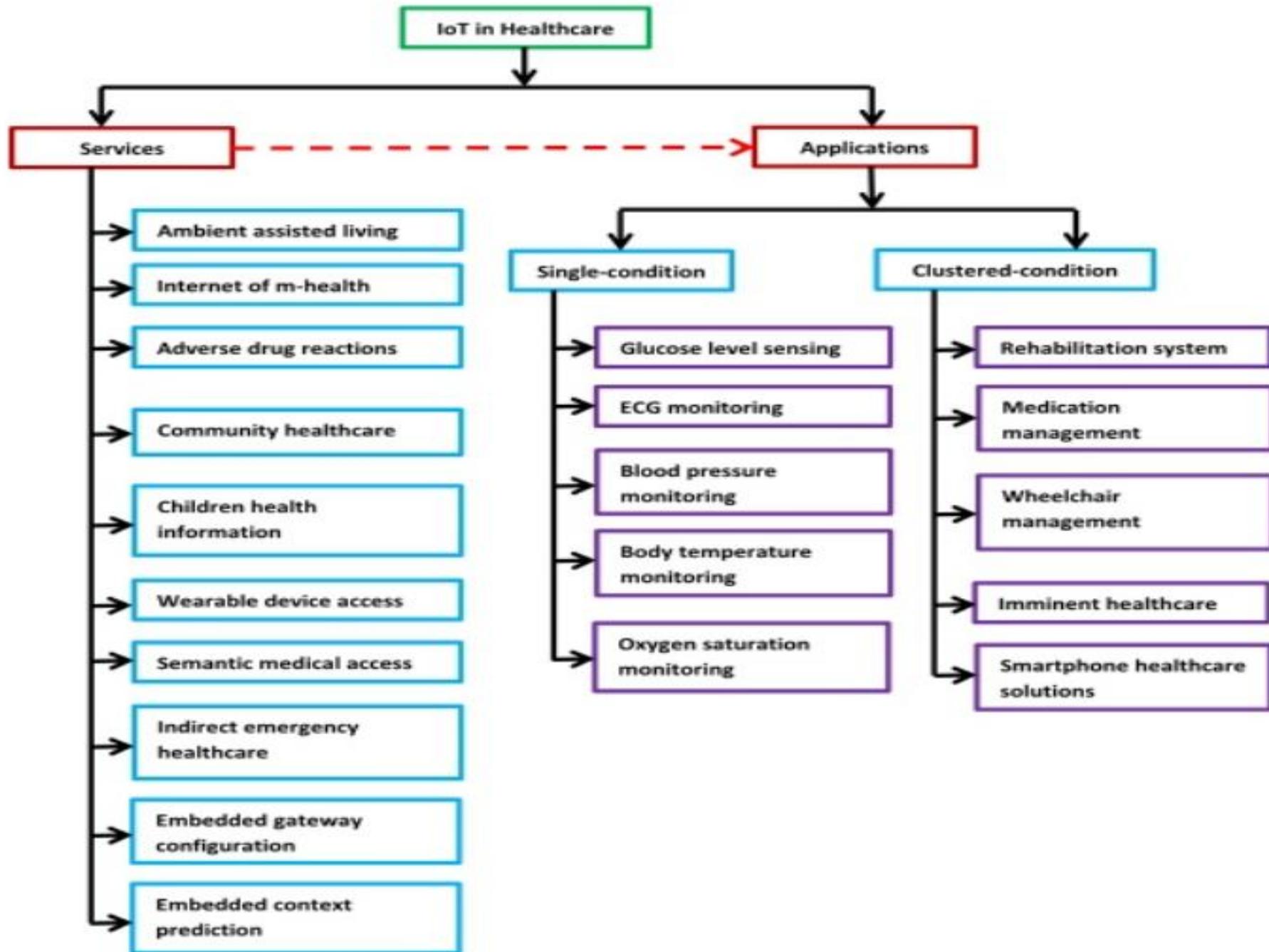


FIGURE 13. IoT healthcare services and applications.

Source: IEEE Access