

CPS in Social Spaces (Continued): Rise of the Internet of Things

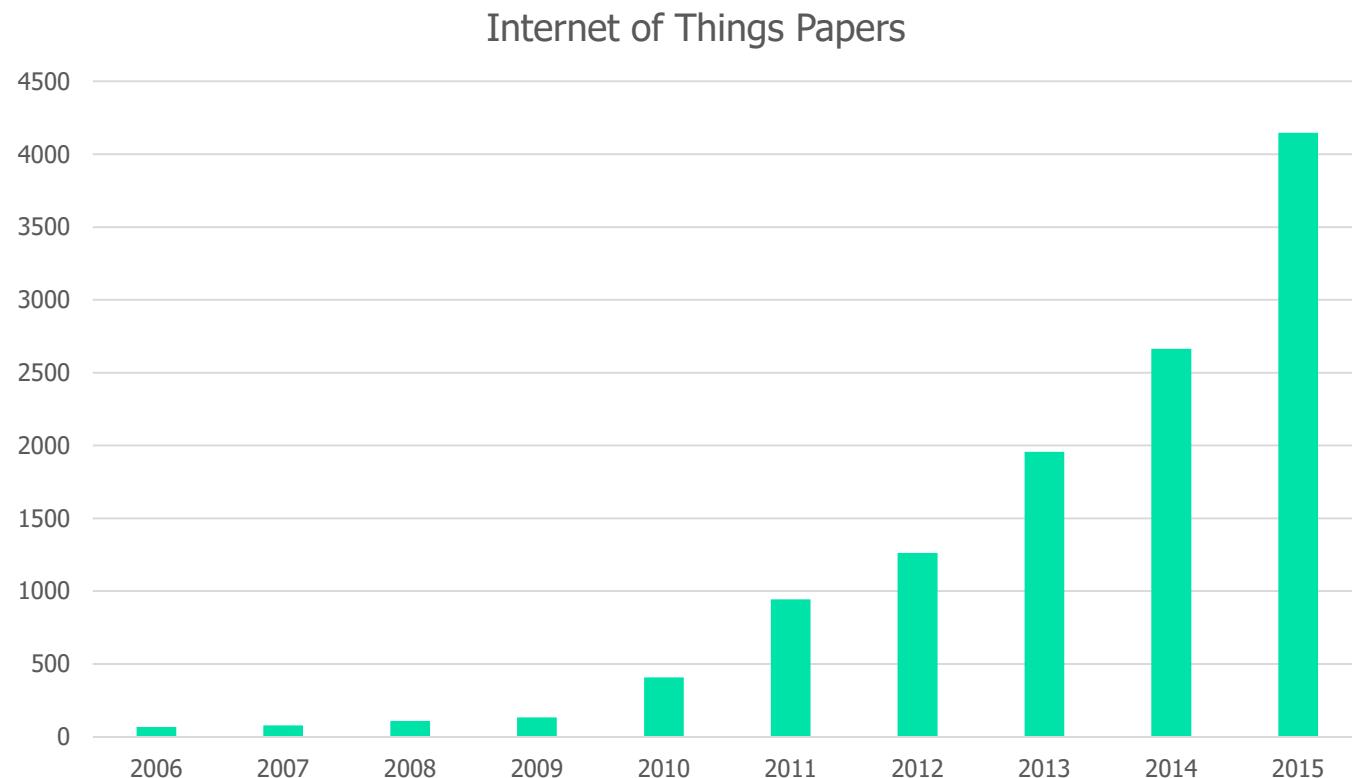
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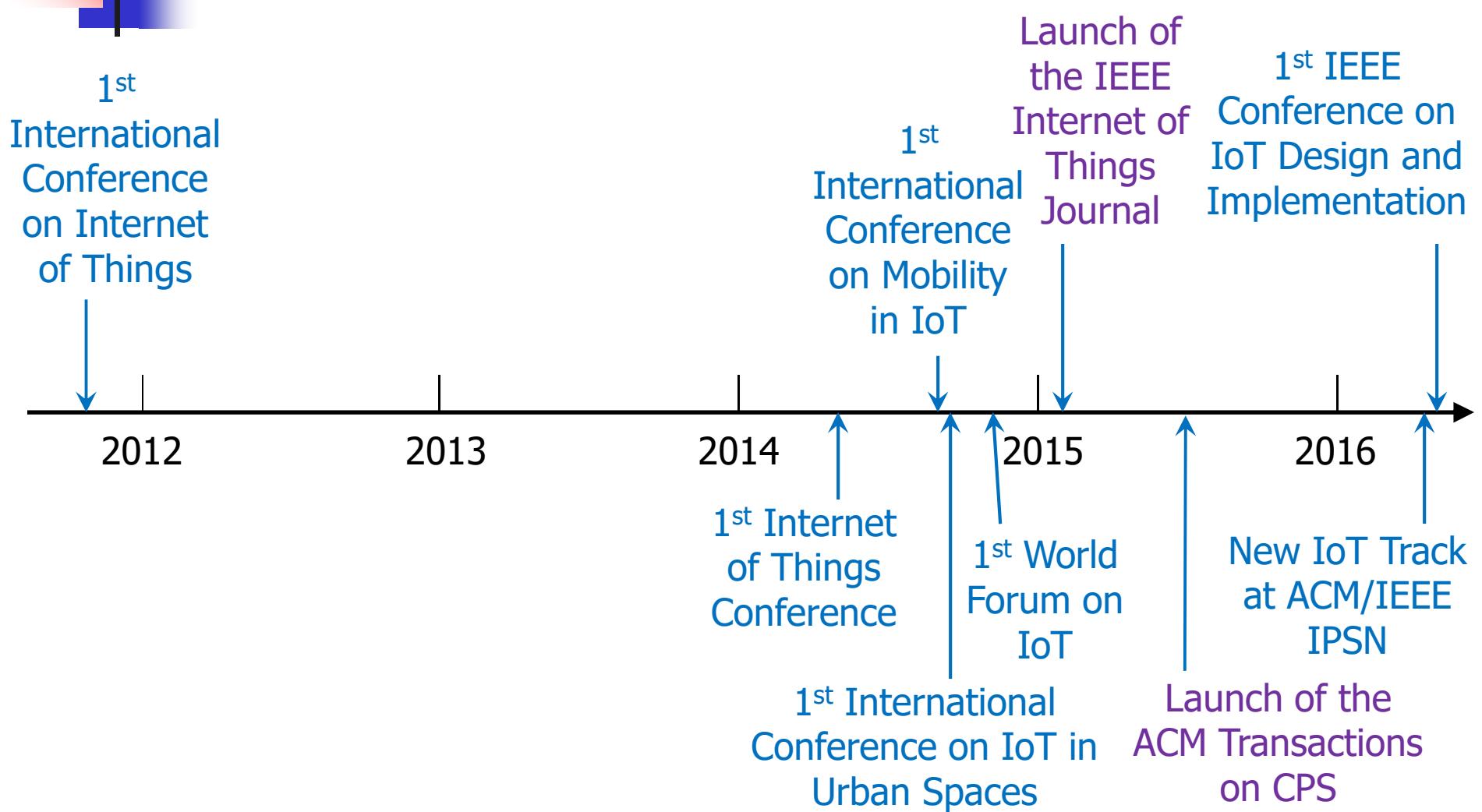
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Publications on the Internet of Things

- According to the Engineering Village database (computing and Engineering publications)



Publication Venues



Enabling Technologies

Source: Texas Instruments

Wearables

- Entertainment
- Fitness
- Smart watch
- Location and tracking



Building & Home Automation

- Access control
- Light & temp control
- Energy optimization
- Predictive maintenance
- Connected appliances



Smart Cities

- Residential E-meters
- Smart street lights
- Pipeline leak detection
- Traffic control
- Surveillance cameras
- Centralized and integrated system control



Smart Manufacturing

- Flow optimization
- Real time inventory
- Asset tracking
- Employee safety
- Predictive maintenance
- Firmware updates



Health Care

- Remote monitoring
- Ambulance telemetry
- Drugs tracking
- Hospital asset tracking
- Access control
- Predictive maintenance



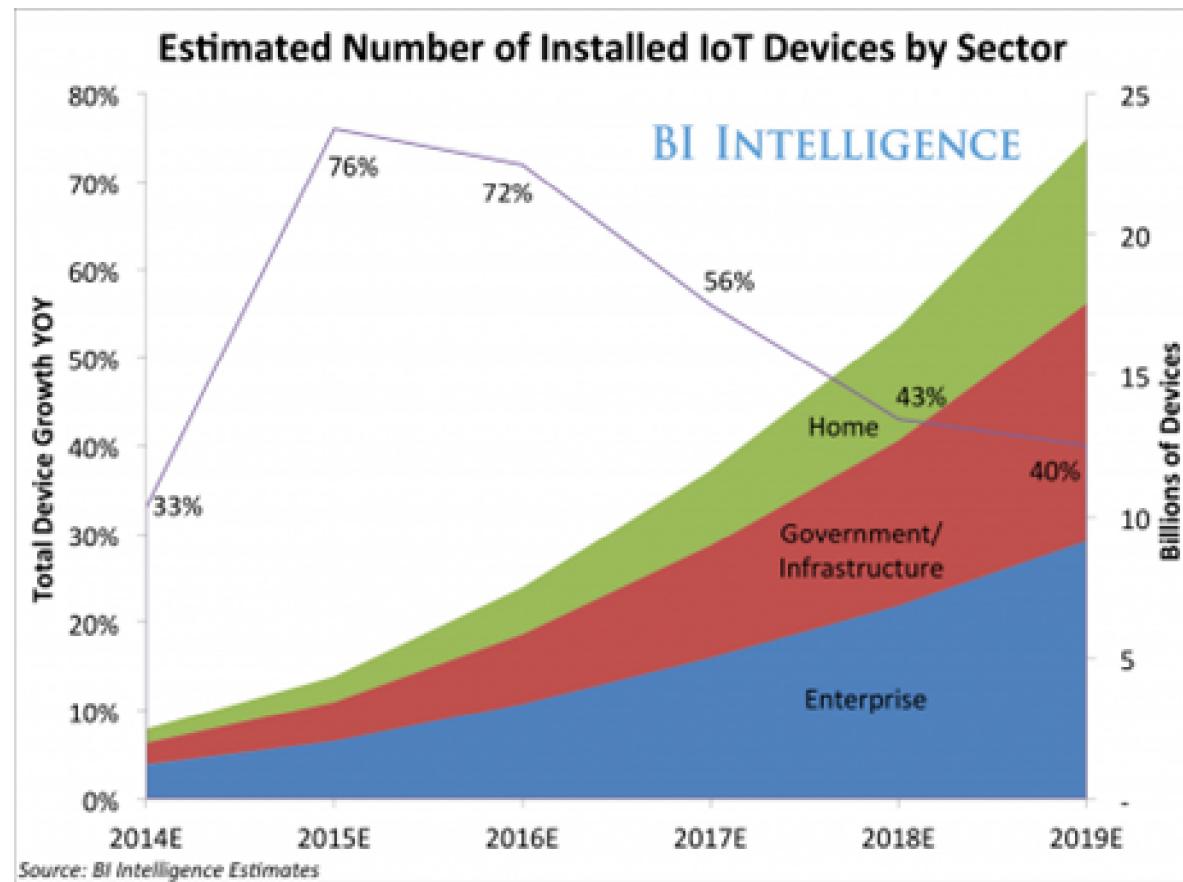
Automotive

- Infotainment
- Wire replacement
- Telemetry
- Predictive maintenance
- C2C and C2I



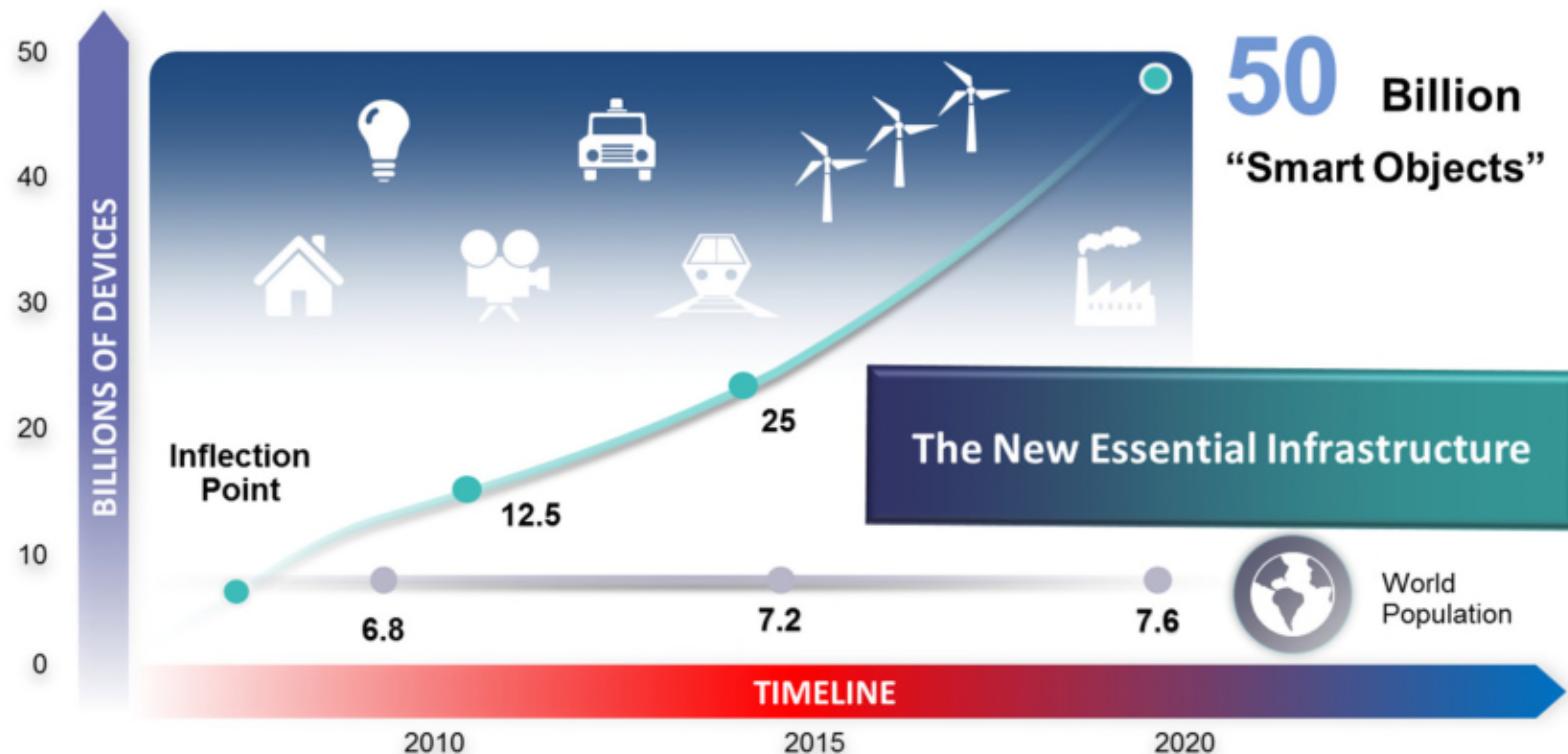
IoT Projections

- Estimated IoT Devices Growth (according to Business Insider)



IoT Projections

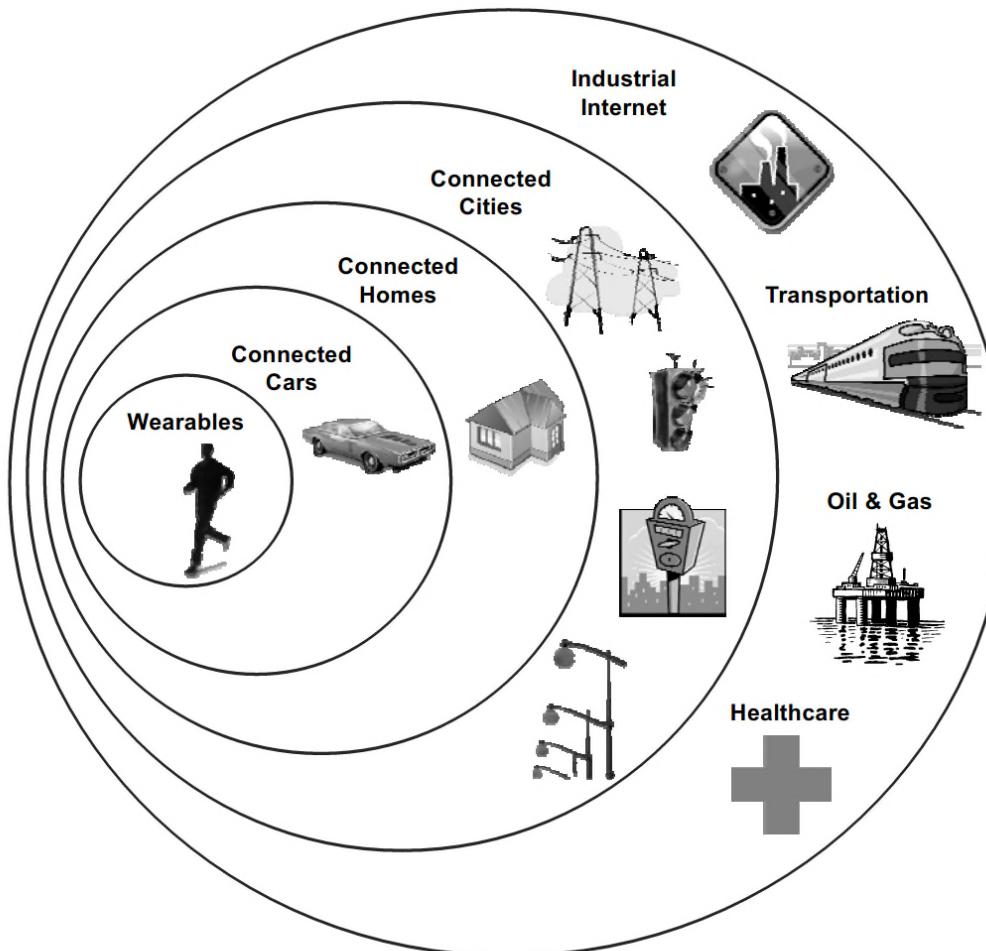
- Estimated IoT Devices Growth (according to Cisco)



Source: Cisco IBSG, 2011

Application Domains

(Source: Goldman Sachs)



Source: Goldman Sachs Global Investment Research.

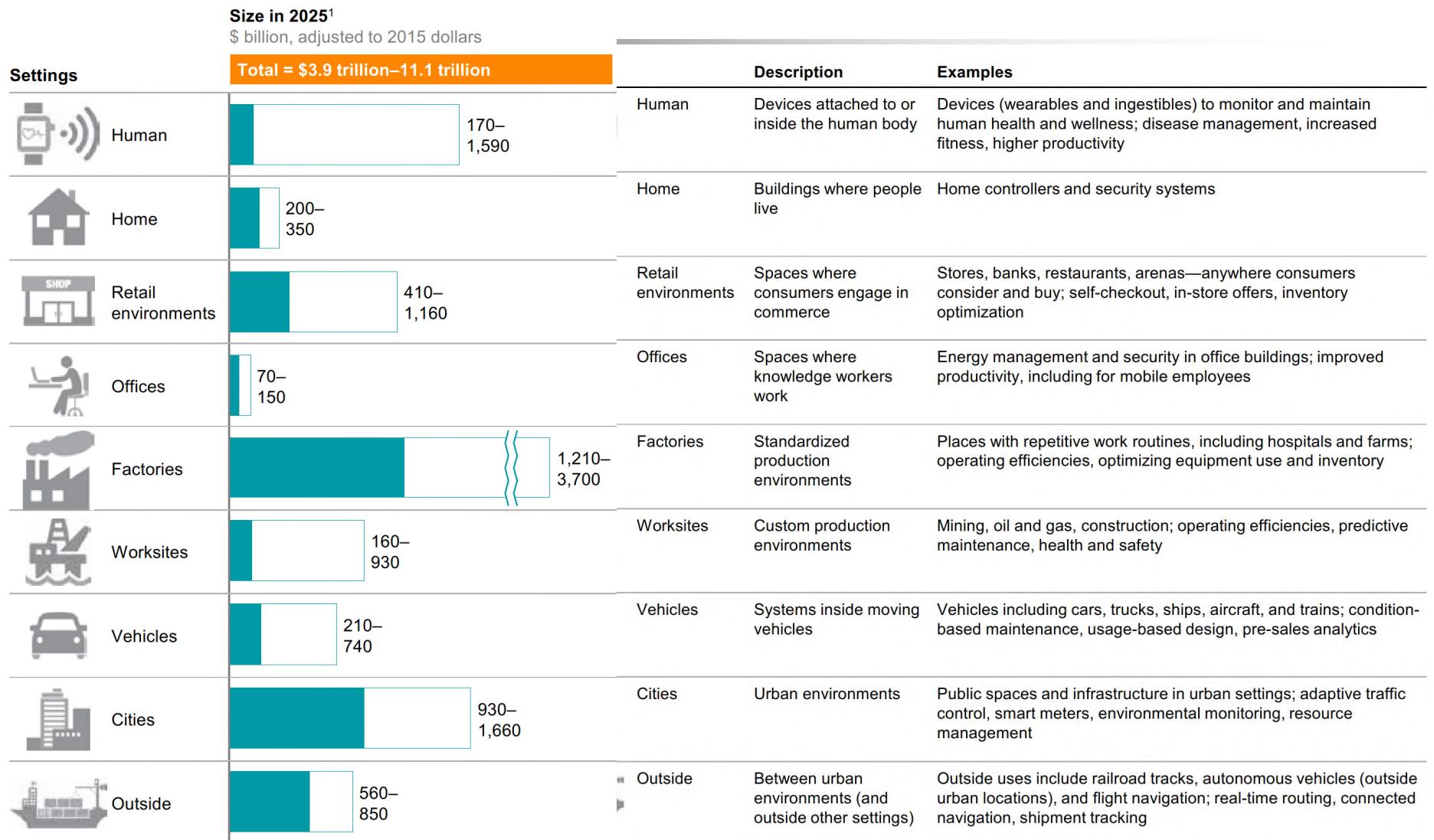
Application Categories

(Source: IBM)

	Banking	Healthcare	Automotive	Retail	Transport	E&U
Monetize	Cash replacement solutions Mobile Banking	Paid home care family services	Pay-per-drive car rental	Cash replacement Sensor enabled Loyalty cards	Paid Alerts to travellers Congestion charging	Pay-per-use energy
Optimize	Optimized Cash management	ER Bed Resource Mgmt	Component predictive replacement Fleet mgmt	Delivery and stock replenishment optimization Store layout optimization	Smart Cities Traffic mgmt Airport Management	Delay non-essential supply during peak loads
Extend	Banking the un-banked Biometrics Smarter Subsidies	Life style monitoring	In-car Movies, Music, Games Highly Automated Driving	Smart Vending Machines Delivery Lockers	Mobility Services	Smart home services
Control	Remote ATM Management Dynamic Authorization	Remote Hospital environment Mgmt	Remote Drive-train optimization	Store energy mgmt Store parking mgmt Dynamic price labels	Crowd mgmt Timetable mgmt Asset mgmt	Remotely control consumer devices

Application Settings

(Source: McKinsey)



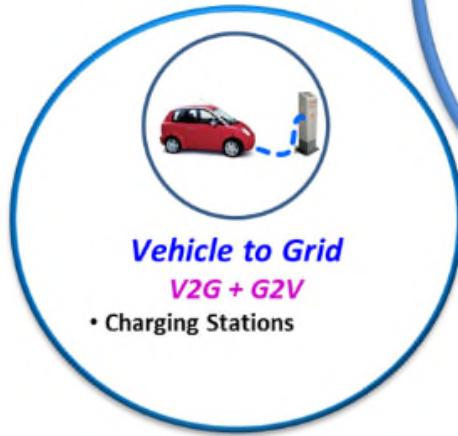
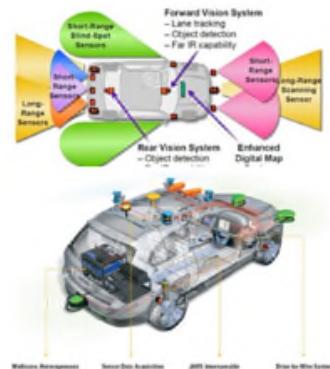
Smart Cars



Converging Technologies

Electric Vehicle
Electric Smart Grid
Connected Vehicle
Autonomous Vehicle

Internet of Vehicles Vehicle to Internet



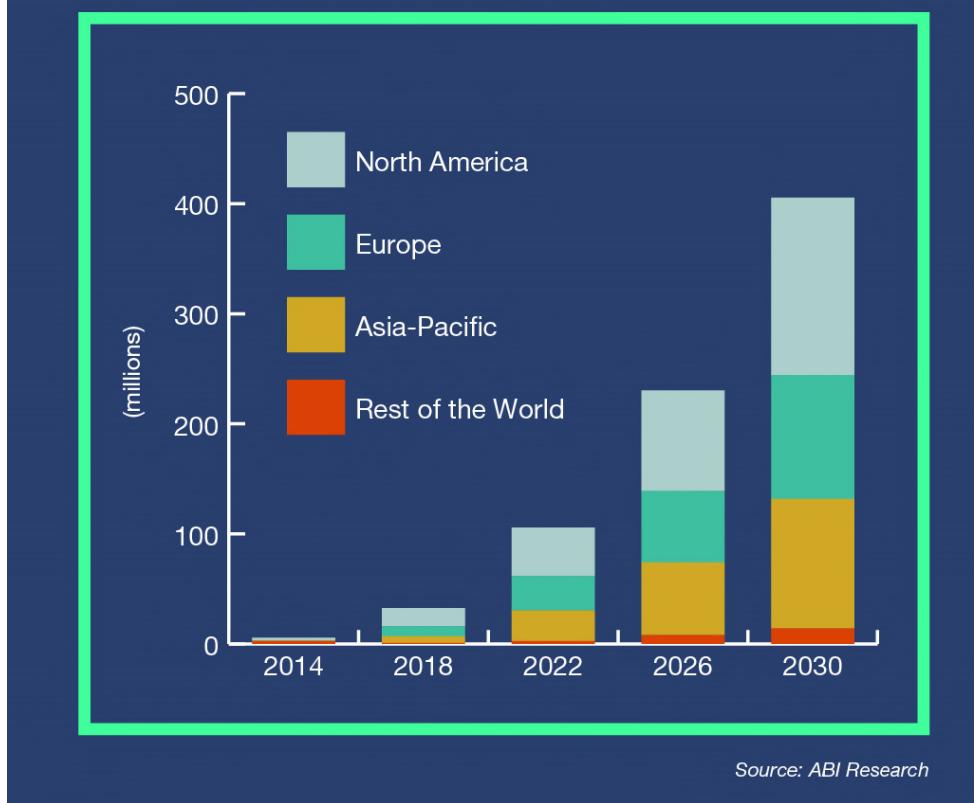
Smart Cars

- Cars will become connected to the “cloud” and share driving data.

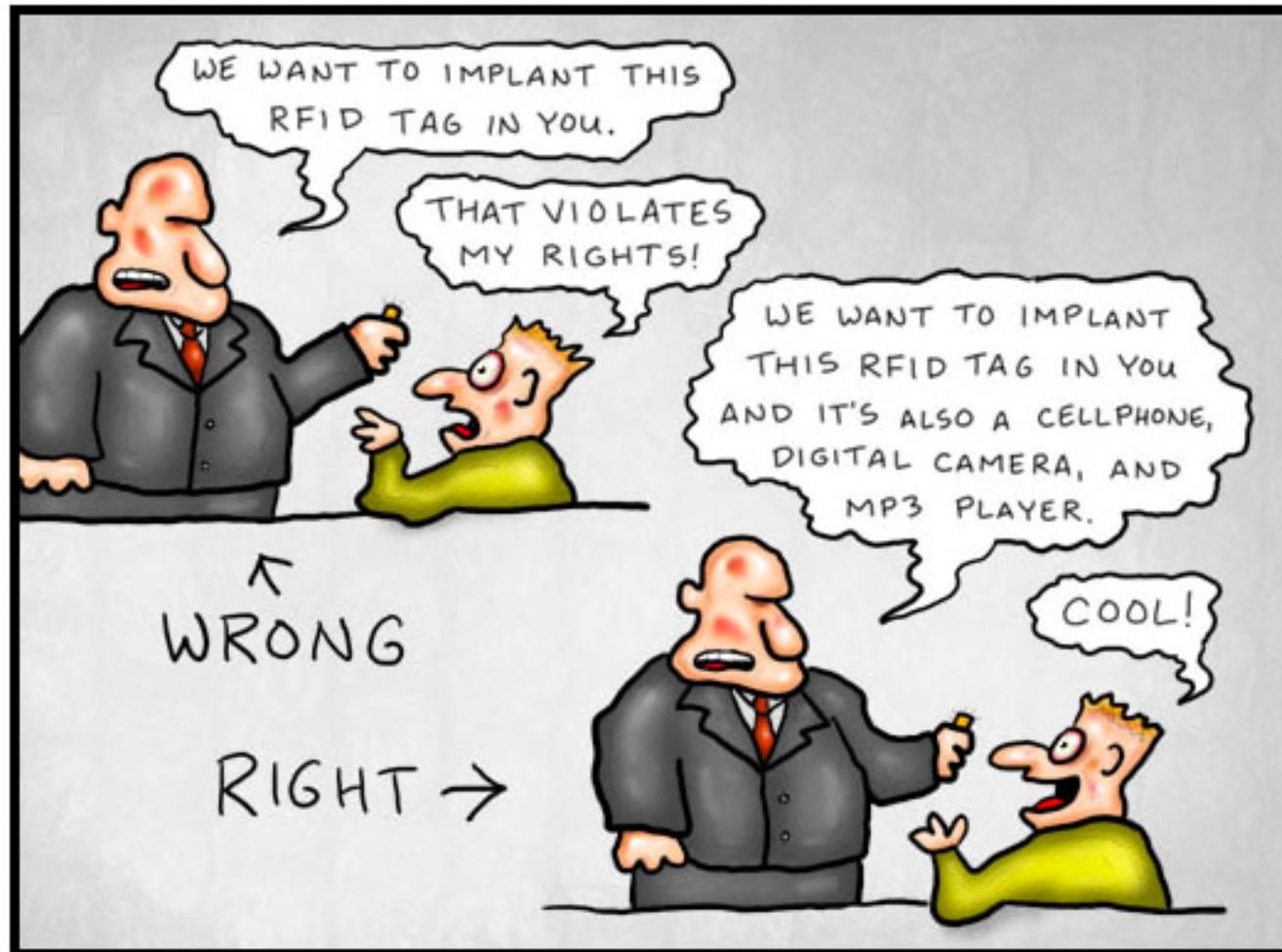
(ABI Research)

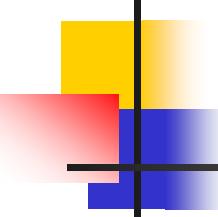
Registered Vehicles with IoT Application by Region

World Market, Forecast: 2013 - 2030



Smart Car Applications and Data Privacy





Smart Car Applications and Data Privacy

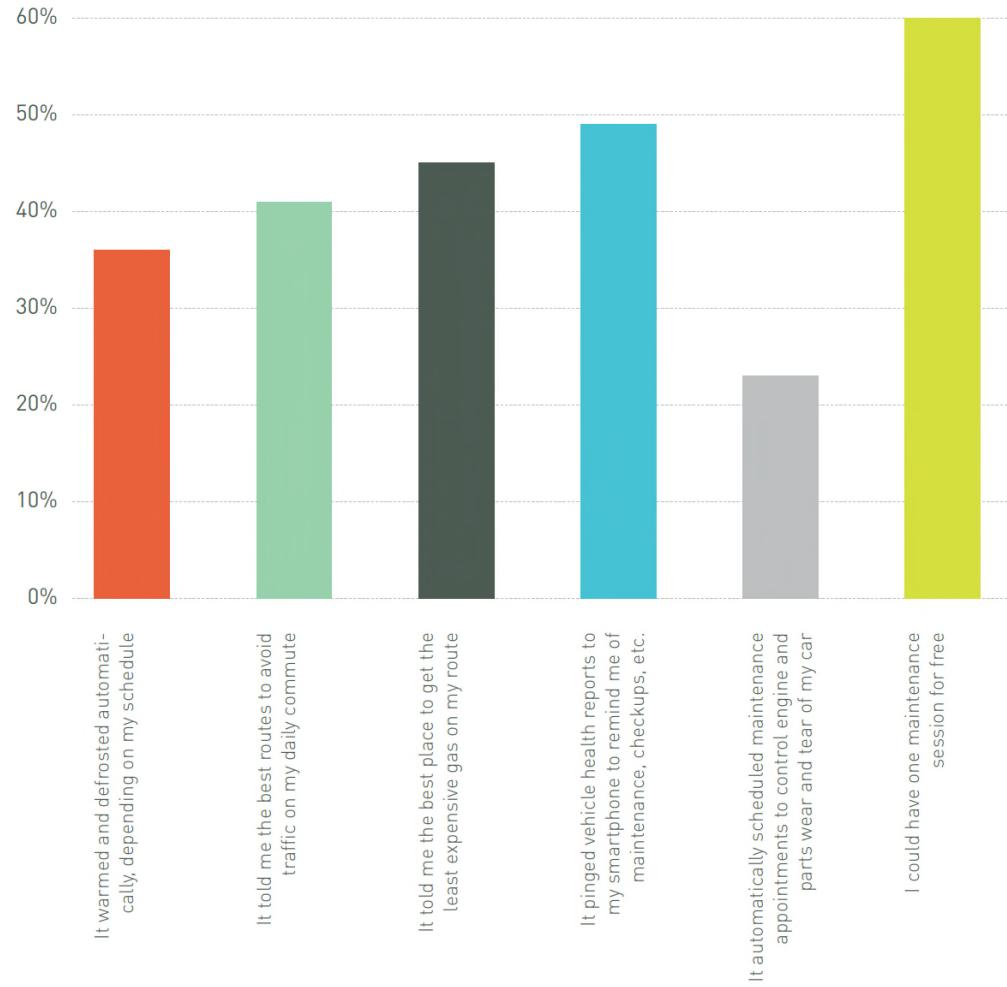
- Would you share data from your car with the manufacturer if
 - It warmed and defrosted automatically depending on your schedule?
 - It told you the best routes to avoid congestion?
 - It told you the best place to get the least expensive gas on your route?
 - It sent vehicle health reports to your smart phone and reminded you of maintenance?
 - It automatically schedule maintenance appointments?
 - It gave you a free maintenance session a year?

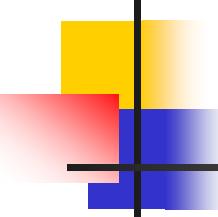
Smart Car Applications

- Why would you buy a car that shares data with the manufacturer?

(Acuity Group, 2014)

I WOULD BE WILLING TO SHARE DATA FROM MY CAR WITH THE CAR'S MANUFACTURER, IF _____.





Autonomous Cars

Morgan Stanley report, 2014:

“[Autonomous cars] are no longer just the realm of science fiction. They are real and will be on roads sooner than you think. Cars with basic autonomous capability are in showrooms today, semi-autonomous cars are coming in 12-18 months, and completely autonomous cars are set to be available before the end of the decade.”

Today (Semi-autonomous Cars)

2015 Infiniti Q50S



AMG2016 BMW 750i xDrive



2015 Tesla Model S P85D



2015 Mercedes-Benz S65 AMG



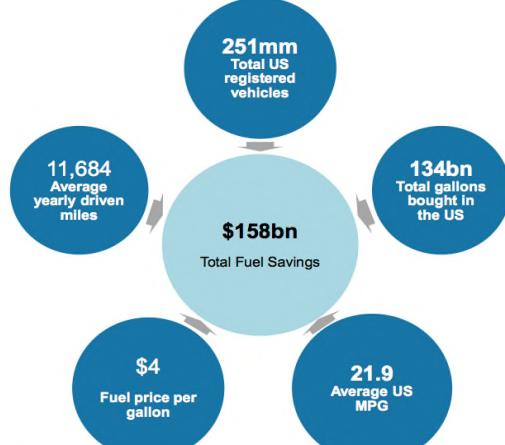
Autonomous Cars

Morgan Stanley report, 2014:

- Fuel savings
- Reduction in accident costs
- Productivity gains

Total Dollar Spent on Fuel (2012)

US data

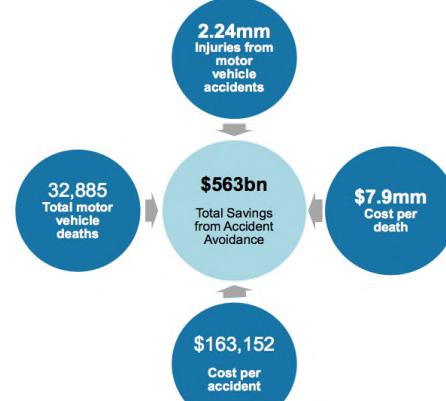


Source: US Department of Transportation, Federal Highway Administration, Morgan Stanley Research

Estimated Fuel Savings (Assuming 30% increase in efficiency)

Cost of Motor Vehicles-related Fatal and Non-fatal Injuries

US data

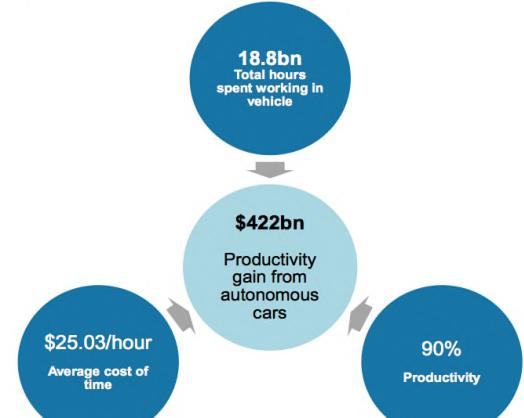


Source: US Department of Transportation, National Highway Traffic Safety Administration, Federal Highway Administration, EPA, FDA, AAA, Morgan Stanley Research

Estimated Accident Cost Savings (Assuming elimination of driver error)

Productivity Gain from Autonomous Cars

US data



Source: Census, Federal Highway Administration, Morgan Stanley Research

Estimated Productivity Gain

(Early) Smart Home Devices

Top 7 by Fortune Magazine (2014)



Security
Alarm



Smart Slow-
cooker



Smart Air
Conditioner



Weather-based Sprinkler Controller



Connected Smoke Detector



Water Leak
Detector

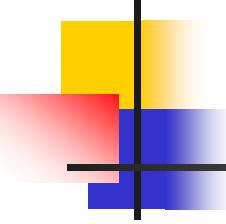


Remote
Temperature
Controller

Top Smart Home Device of 2016 (CNet)

- <https://www.cnet.com/topics/smart-home/best-smart-home-devices/>





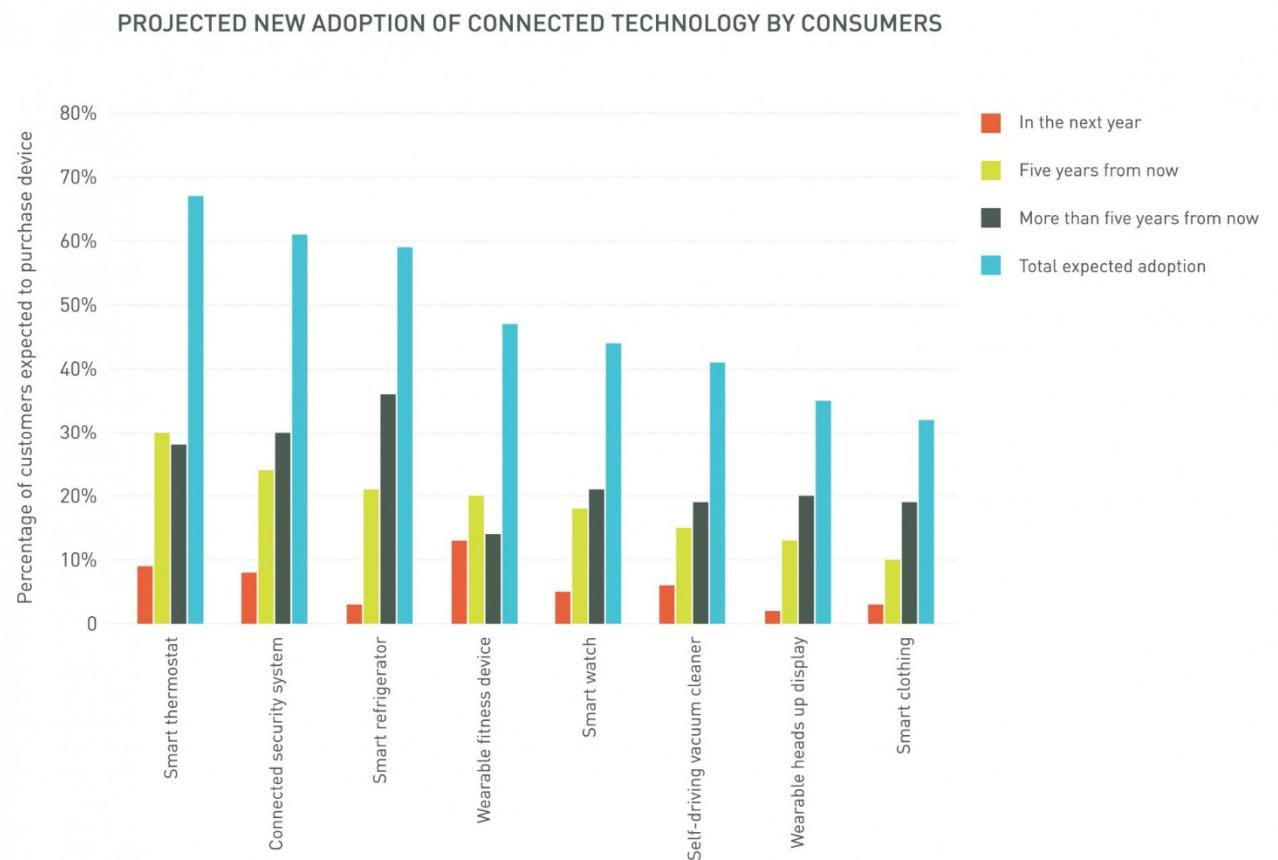
Smart Home Devices

- In the next 5 years, would you purchase:
 - A smart thermostat?
 - A smart refrigerator?
 - A wearable fitness device?
 - A smart watch?
 - A self-driving vacuum cleaner?
 - A wearable head-mounted display?
 - An item of smart clothing?

Smart Home Devices

- Percentage of consumers projected to buy some connected home device in the near future

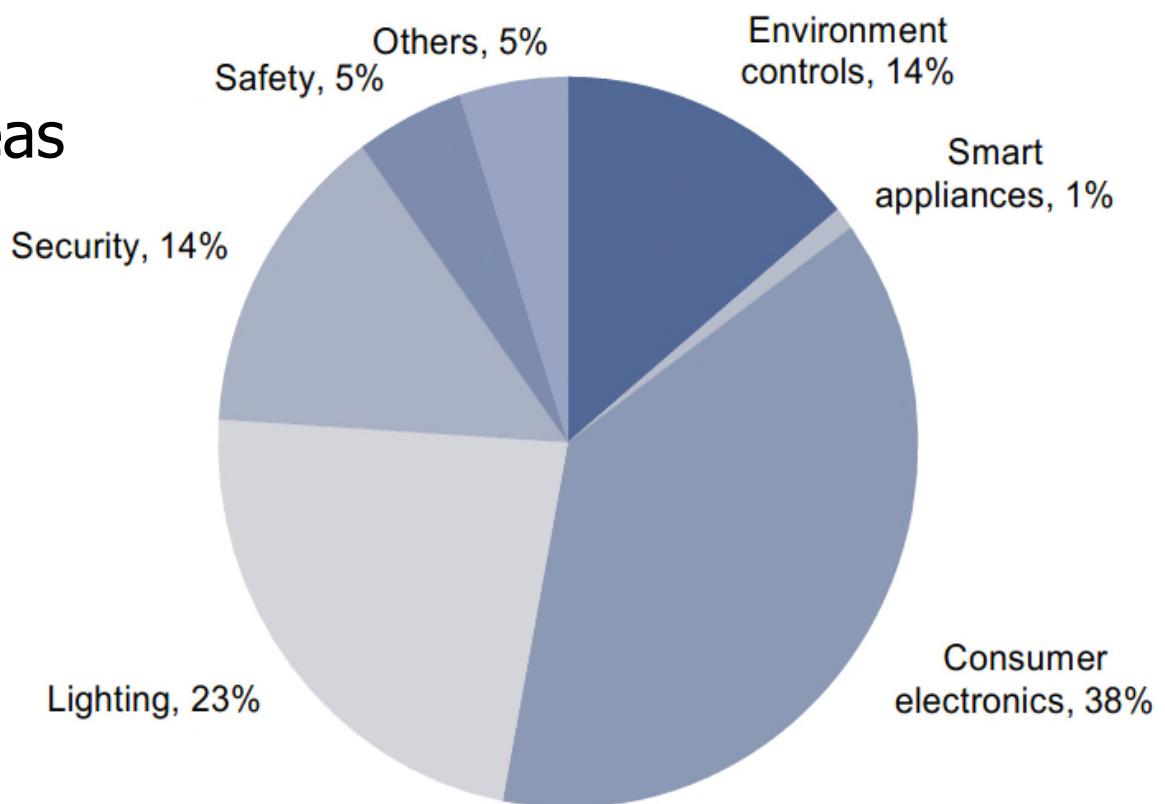
(Acquity Group, 2014)



Smart Home Markets

- Revenue projections from different smart home application areas

(Goldman Sachs, 2015)

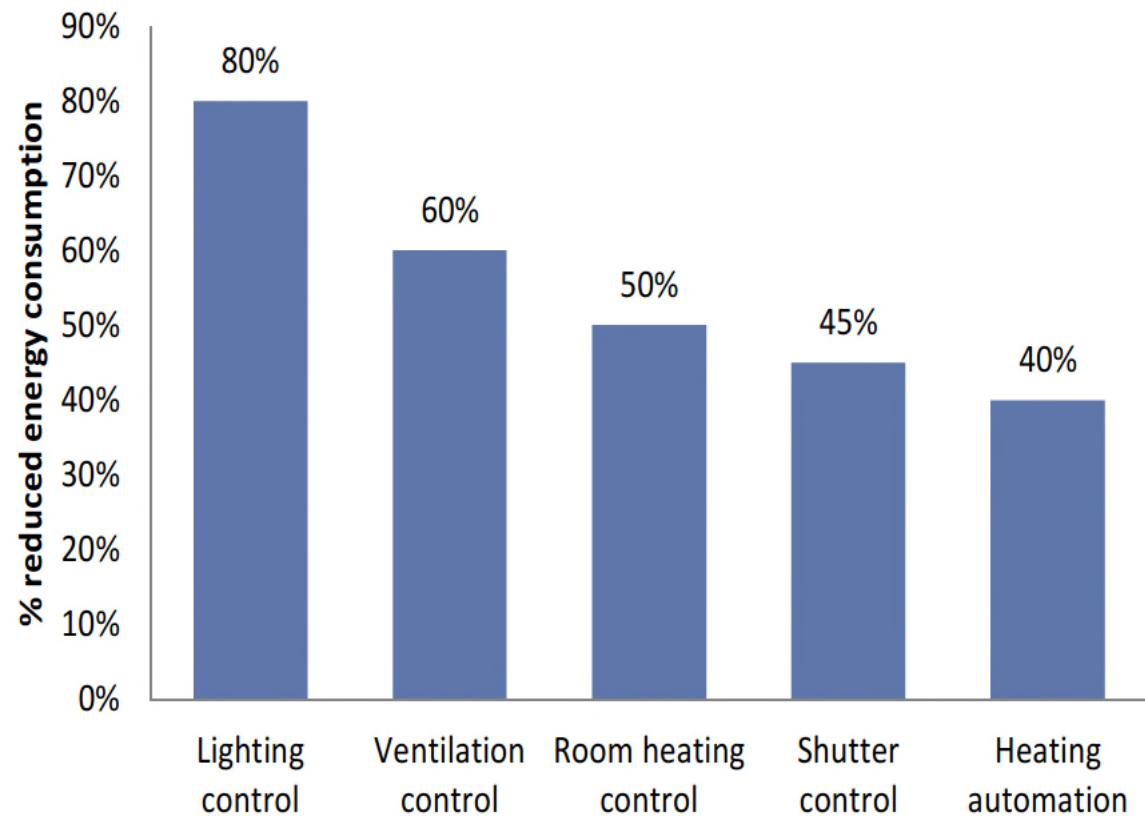


Home automation market - North America

Example: Building Energy Savings

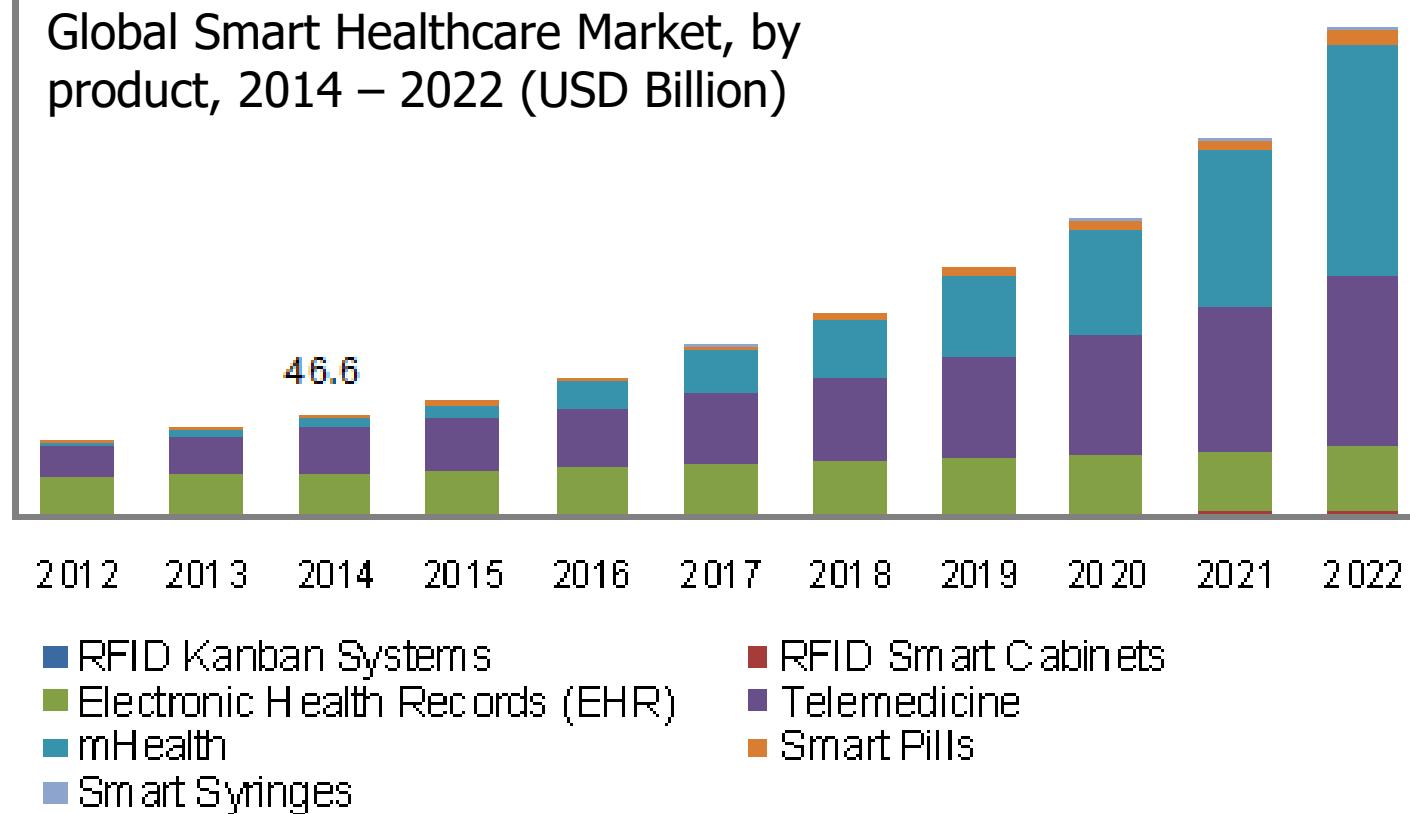
- Significant savings are expected thanks to sensing and automation

(Goldman Sachs)



Health and Wellness

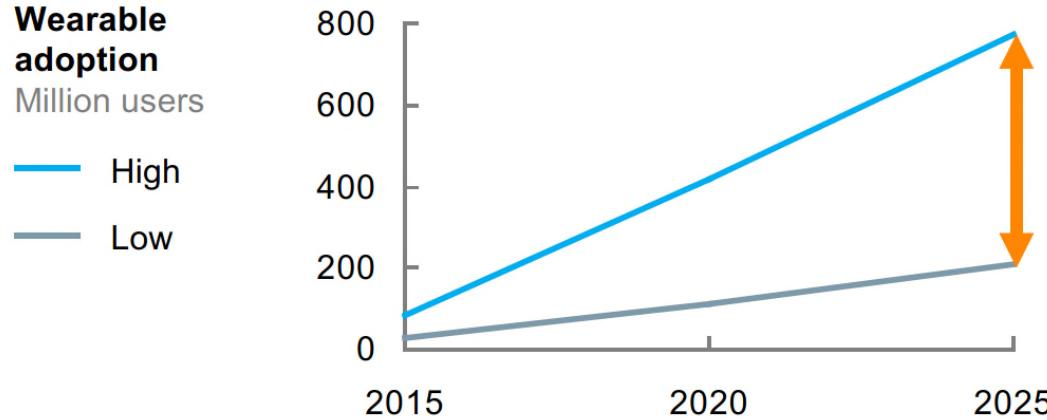
■ Healthcare products



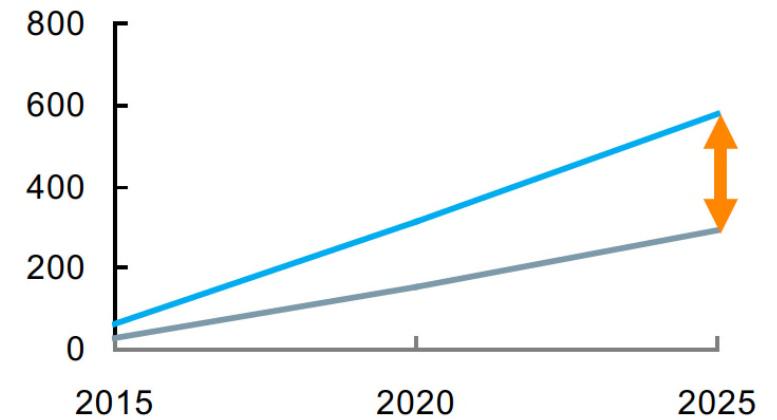
Health and Wellness

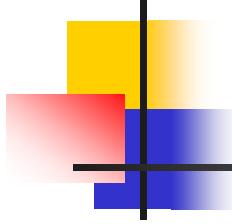
- Adoption of wearable health and wellness products (McKinsey)

Advanced economies
Wearable adoption
Million users



Developing economies



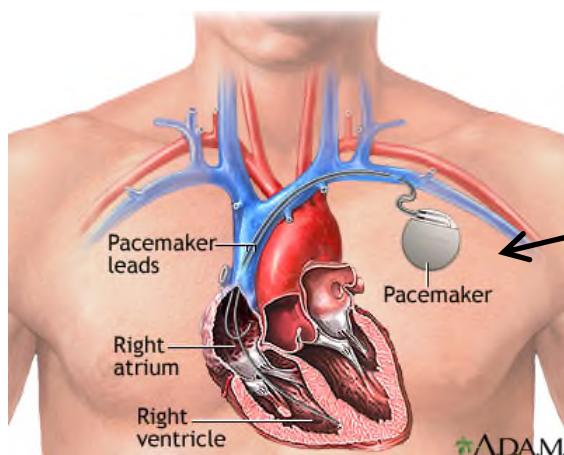


Examples: Pedometers

- Do you own one?
- 1 in 10 do.

Security in Personal and Implantable Devices

- Online murder?



Security in Personal and Implantable Devices

- Former US Vice President disables wireless on his pacemaker

Doctors disabled wireless in Dick Cheney's pacemaker to thwart hacking

by [Lisa Vaas](#) on October 22, 2013 | [1 Comment](#)

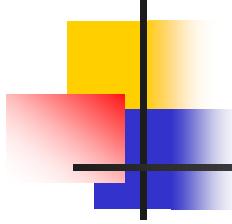
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Former US Vice President Dick Cheney's doctors disabled his pacemaker's wireless capabilities to thwart possible assassination attempts, he said in an interview with [CBS's "60 Minutes"](#) that aired on Sunday.

Cheney's heart problems were bad: between 1978 and 2010, he suffered five heart attacks, underwent quadruple bypass surgery, and had a pump implanted directly to his heart. A defibrillator was implanted to regulate his heartbeat in 2007.

Cheney told his 60 Minutes interviewer, CNN Chief Medical Correspondent Dr. Sanjay Gupta, that at the time of the pacemaker implant, he was concerned about reports that attackers could hack the devices and kill their owners:





More on Social CPS?

- There is a class on Social Sensing in Spring:

CS 598tar