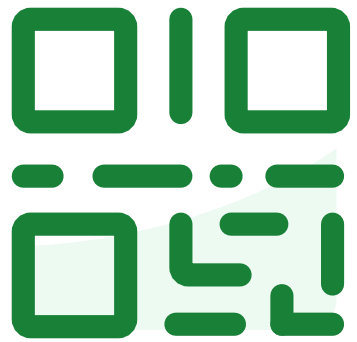


Recap: Take-home Points, Applications and Projections for Intelligent IoT

TAREK ABDELZAHER





**Join at slido.com
#2142827**



AI algorithms are often used to match people with suitable content. As a result, a vicious cycle is created where individuals are matched with similar content to what they clicked on in the past. Such content usually agrees with their confirmation bias, thereby reinforcing their beliefs and biases, ultimately creating echo-chambers that contribute to polarization. Are the content matching algorithms ethically to blame for the polarization, or is polarization an artifact that would have played out anyway, as people will seek content that confirms their biases in any case?

Today's Debate:

Part I: Group #3 Argues for “To Blame”

Alfridy, Ebrahim

Murshed, Rafid

Plote, Avery

Part II: Group #7 Argues for “Not to Blame”

He, Jingjie

Lin, Kevin

Wang, Ricky

Part III: Moderated Open Discussion: All are welcome to join in contributing any further pro/counter arguments



AI algorithms are often used to match people with suitable content. As a result, a vicious cycle is created where individuals are matched with similar content to what they clicked on in the past. Such content usually agrees with their confirmation bias, thereby reinforcing their beliefs and biases, ultimately creating echo-chambers that contribute to polarization. Are the content matching algorithms ethically to blame for the polarization, or is polarization an artifact that would have played out anyway, as people will seek content that confirms their biases in any case?

Reminders

Project report is due by May 14th (on Canvas)

Project presentation slides are due by May 14th (on Canvas)

Please give me feedback in the course evaluation on what went well, what needs improved, and which changes would you like to see implemented in a next version of this class.

Please give me feedback on course content, such as

- Sections to add/expand
- Sections to keep
- Sections to abbreviate/remove
- Activities/assignments/etc to alter/add/remove

Course Key Take-home Point

IoT applications are an expanding domain for the use of AI, but they impose new research challenges (beyond conversational interfaces and generative AI artifacts) due to their physical interactions and edge constraints:

The data challenges:

- Specialized multimodal/multi-vantage time-series sensor data
- Frequency domain inputs (spectrograms)
- Spatial-temporal reasoning (e.g., for localization, tracking, etc)
- Physical laws of nature
- Noise and curation challenges (use of unlabeled, unvetted data for training can degrade models)

The computational resource challenges:

- Model pruning/quantization/distillation
- Neural architecture search
- Real-time guarantees and model disaggregation (mixture of expert cascades)
- Distribution/federation
- Control and sensing/language/action models

Addressing those challenges is the responsibility of IoT researchers and practitioners interested in future intelligent IoT

IoT Applications and Growth Projections

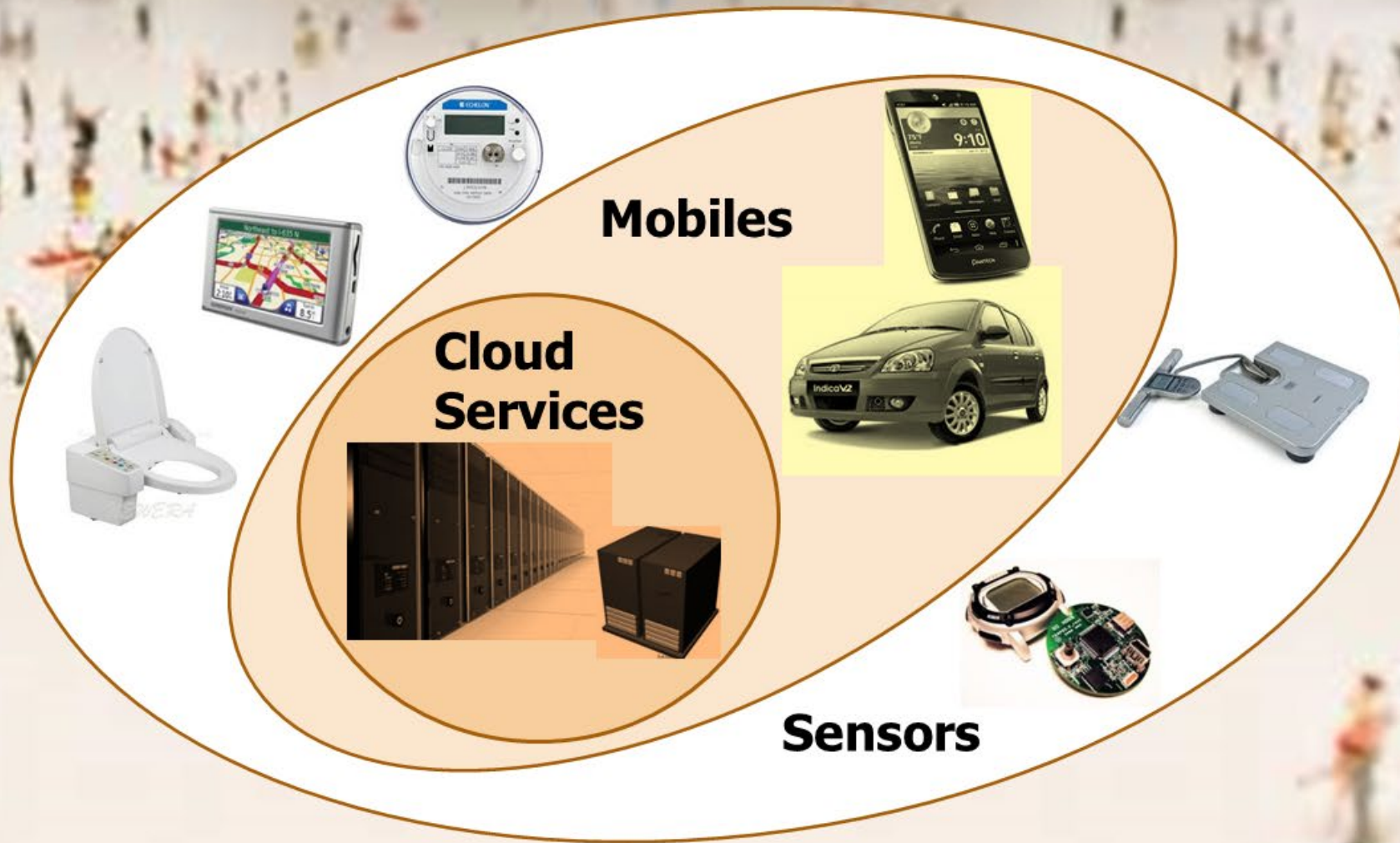
An Expanding Impact Story

Where to apply the methods and
solutions learned in this class?

Pick an Application

The Intelligent IoT Space

People



Mobiles

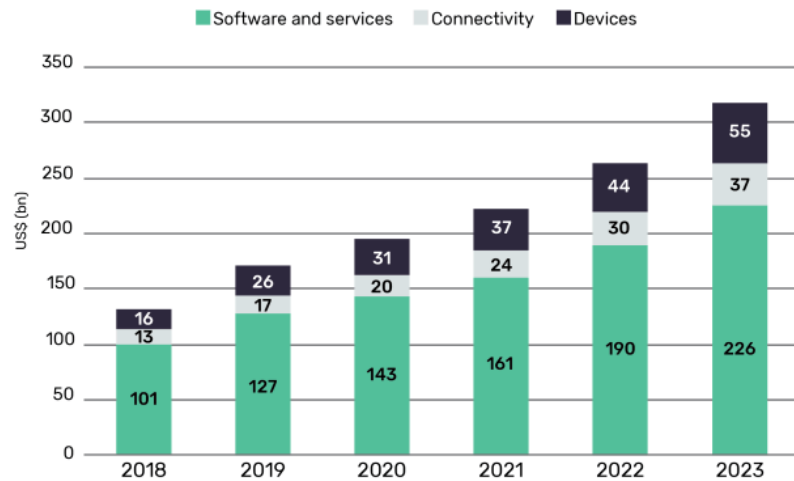
Cloud Services

Sensors

IoT Growth Projections

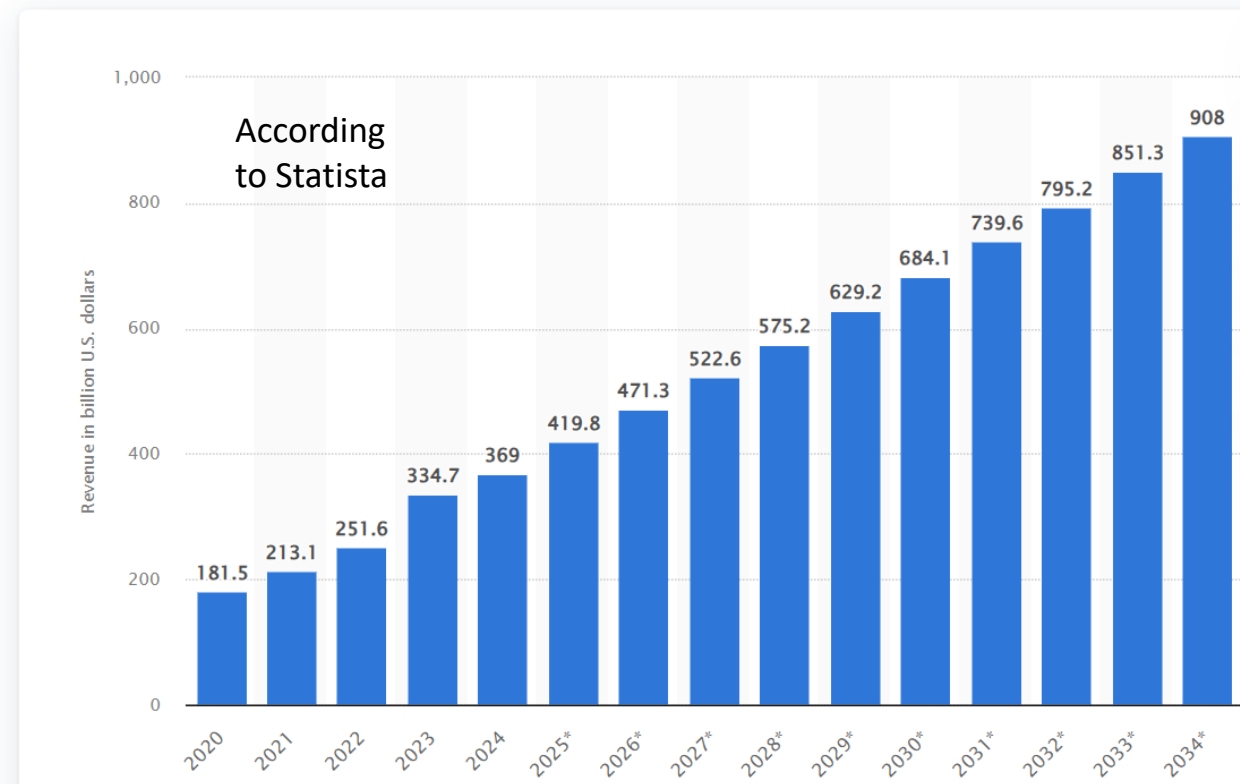
Consistent projections of growth over the year, reaching nearly \$1 trillion USD in 2034

Global IoT revenue by technology segment (\$bn), 2018–2023 



Source: GlobalData, Technology Intelligence Centre

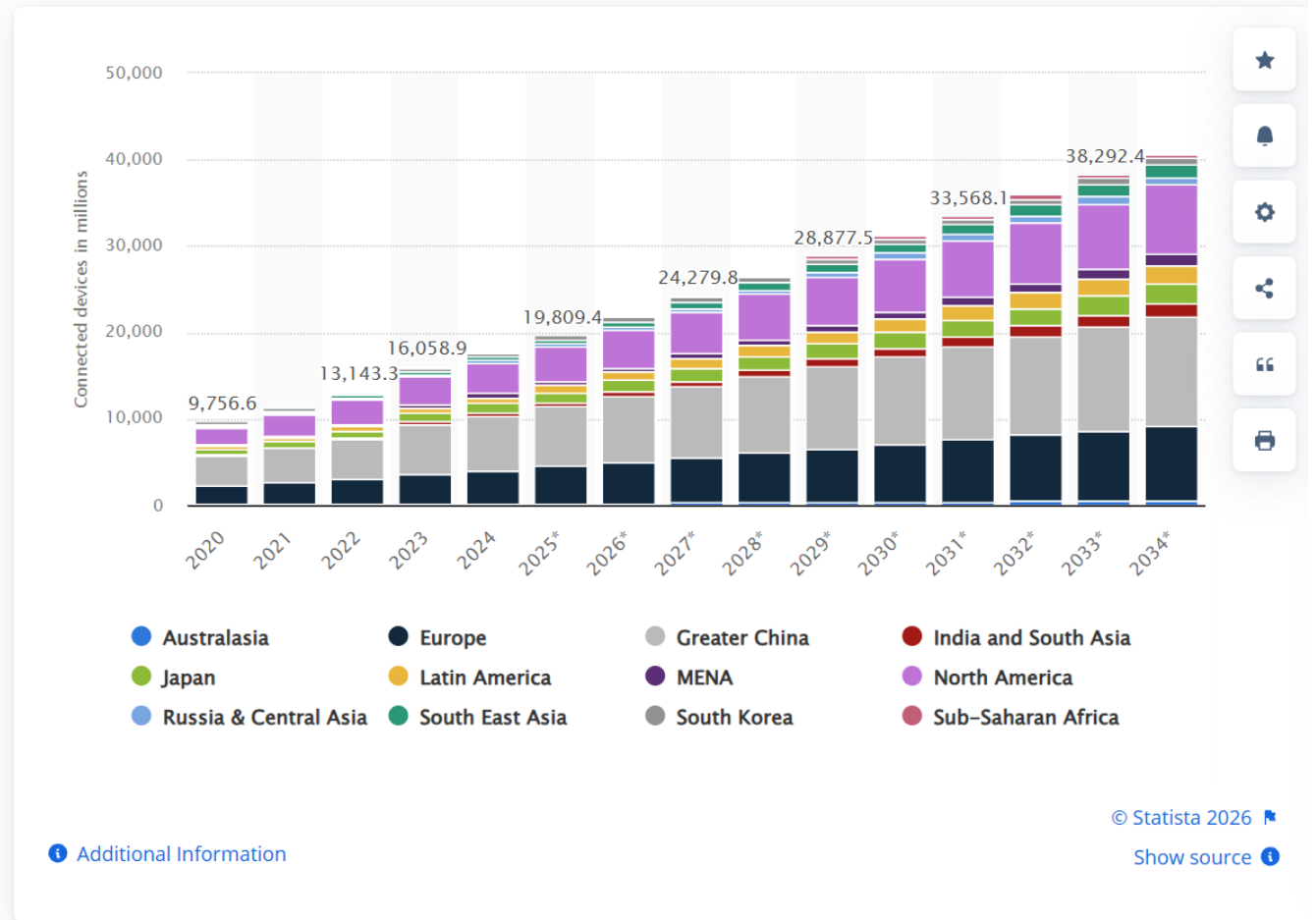
Internet of Things (IoT) total annual revenue worldwide (in billion U.S. dollars)



IoT Connected Devices Base

Nearly 20 billion connected devices today, expected to double within a decade

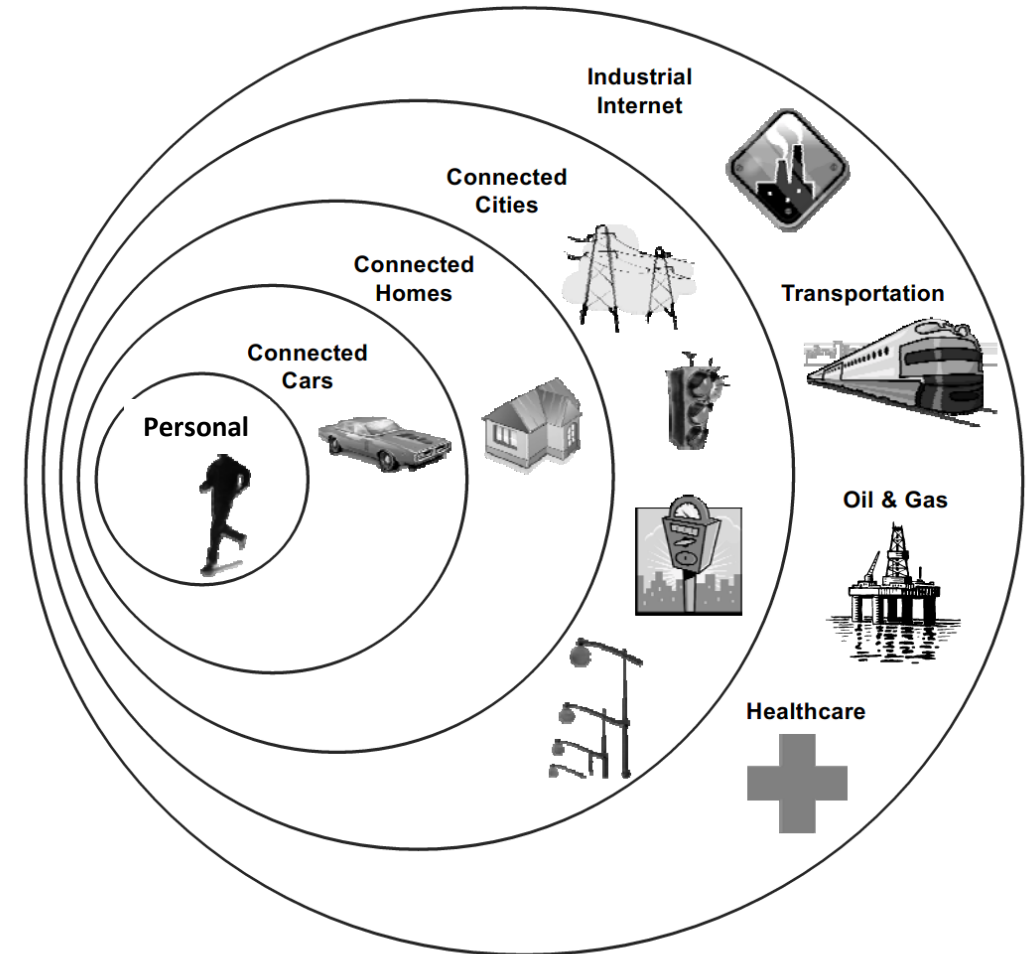
Most of the deployment is in China, North America, then Europe, respectively.



Application Domains

(Source: Goldman Sachs)

- Personal
- Mobility/Cars
- Homes
- Cities
- National/Global
- Industrial



Applications: Personal (e.g., Fitness/Medical/Tele-health)

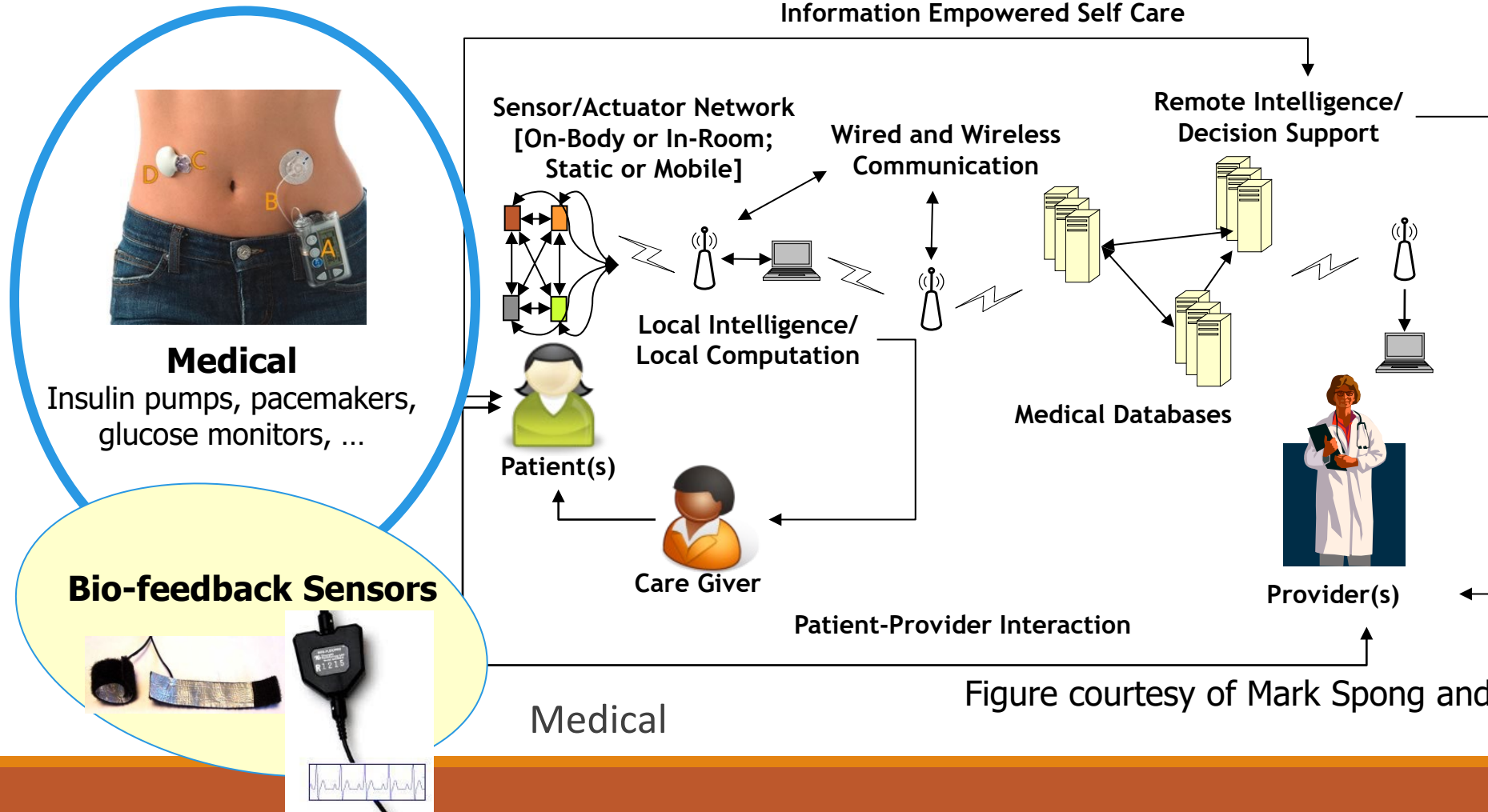
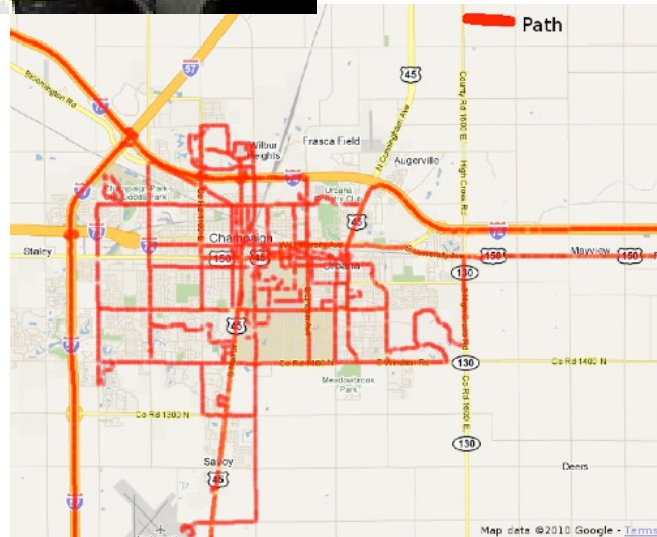
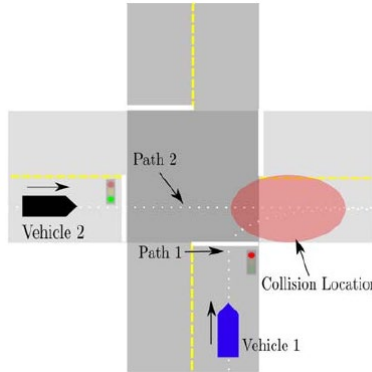


Figure courtesy of Mark Spong and Bill Sanders

Applications: Vehicular (e.g., Green Navigation)



$$F_{engine} = \frac{\Gamma(\omega)Ggk}{r}$$

$$F_{air} = \frac{1}{2}c_dA\rho v^2$$

$$F_{friction} = c_{rr}mg\cos(\theta)$$

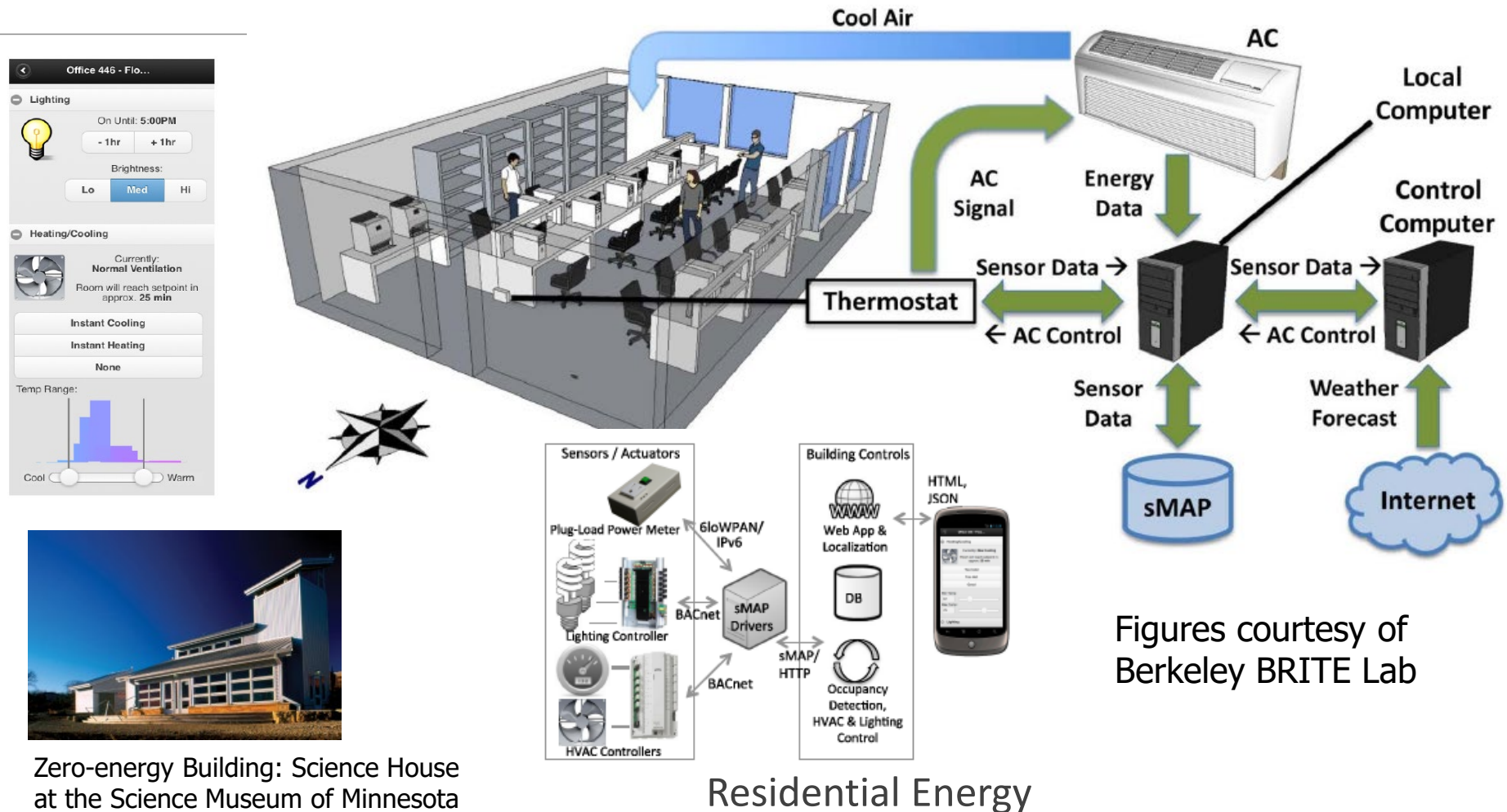
$$F_g^s = mgsin(\theta)$$

$$F_{car} = F_{engine} - F_{friction} - F_{air} - F_g$$



Transportation

Applications: Home/Group-oriented (e.g., Smart Homes/Buildings)



Zero-energy Building: Science House at the Science Museum of Minnesota

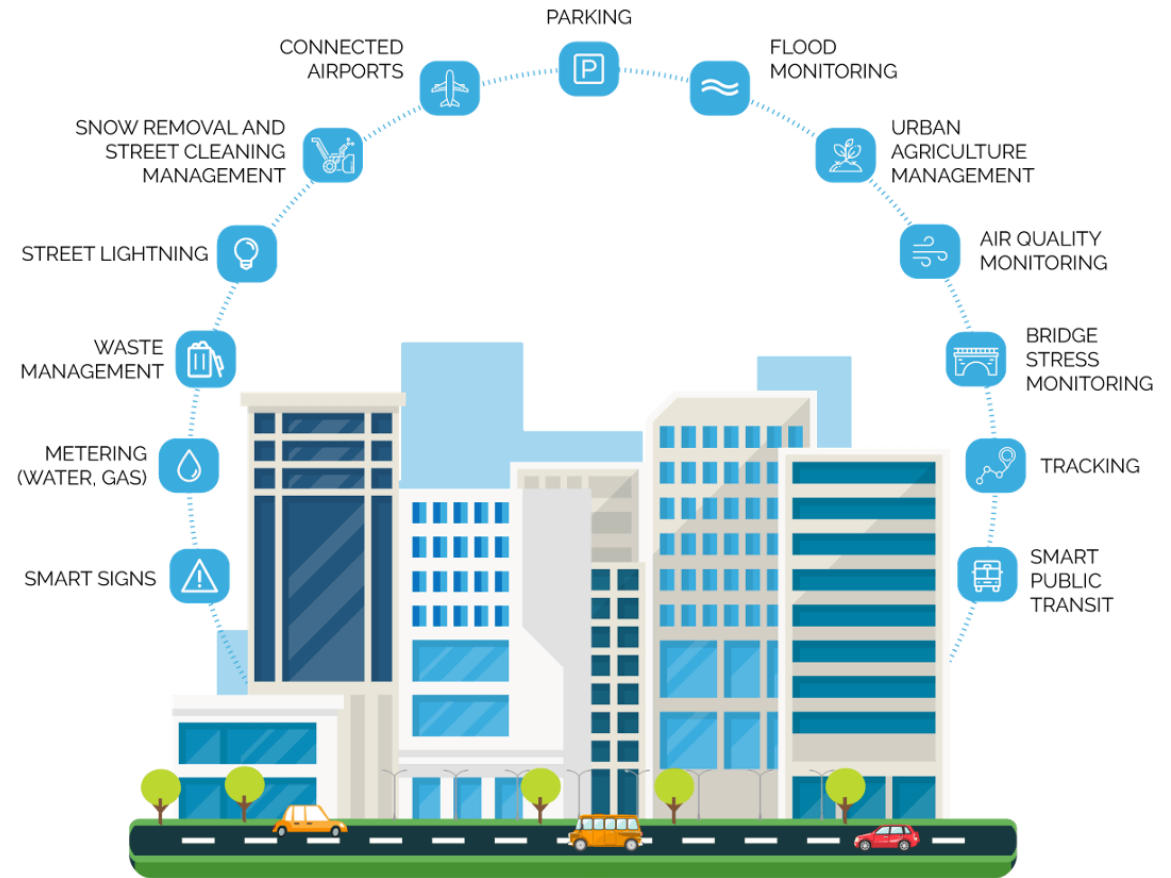
Residential Energy

Figures courtesy of Berkeley BRITE Lab

Applications: City-Scale

- Smart public transit
- Structural monitoring
- Air quality monitoring
- Flood monitoring
- Parking
- Airports
- Snow removal
- Street lighting
- Waste management
- Smart signs

...



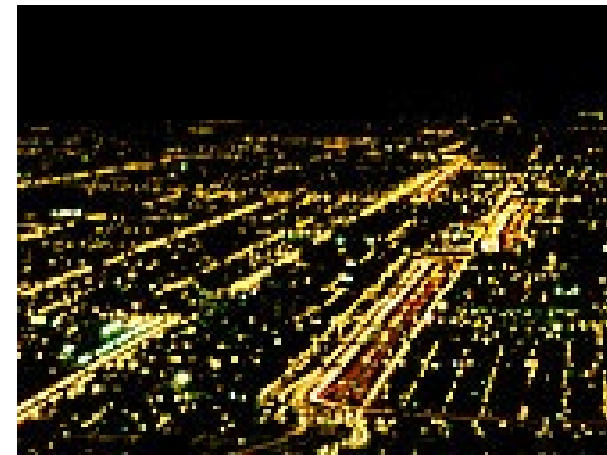
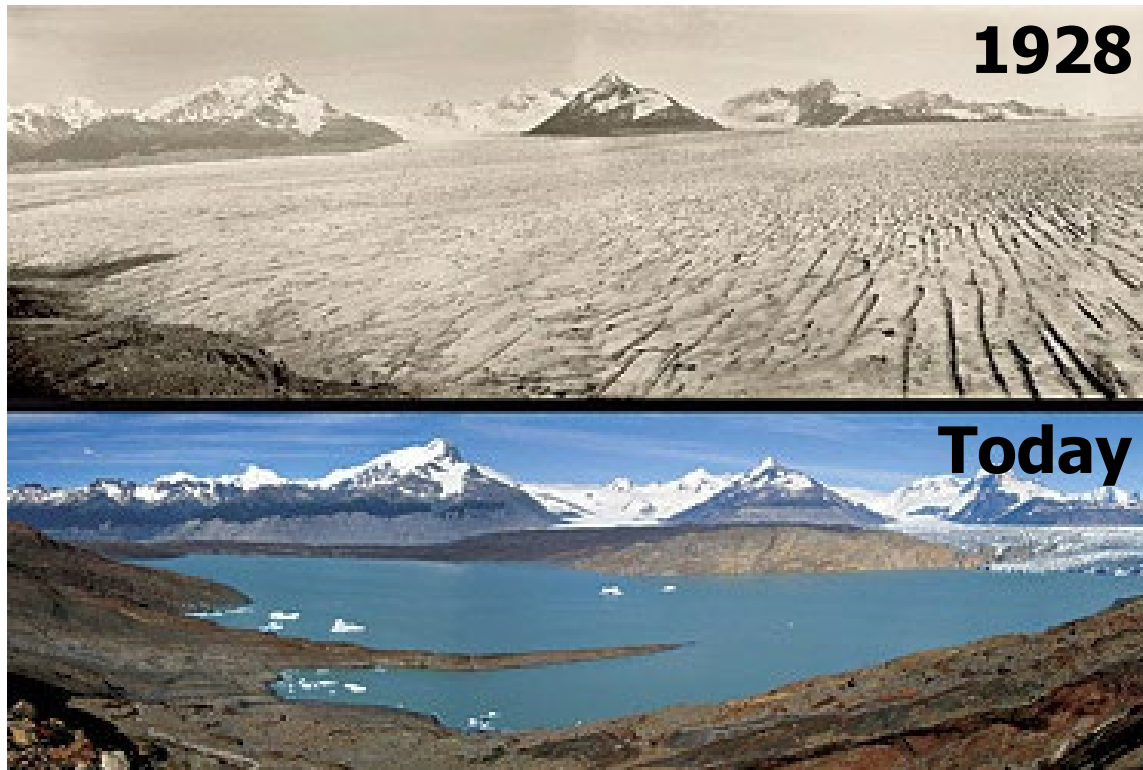
Applications: National (e.g., Disaster Response)



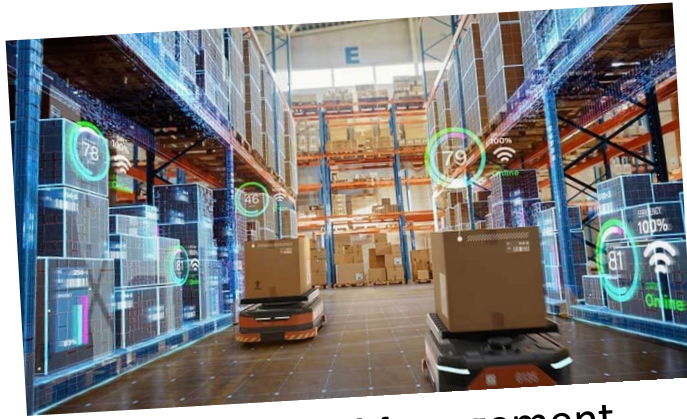
Japan's Tsunami and Nuclear Event, 2011

Applications: Global (e.g., Sustainability)

Uppsala Glacier (Time Magazine, Special
Issue on Global Warming, March 26, 2006)



Applications: Industrial



Supply Chain Management



Energy Management (Smart Grid)



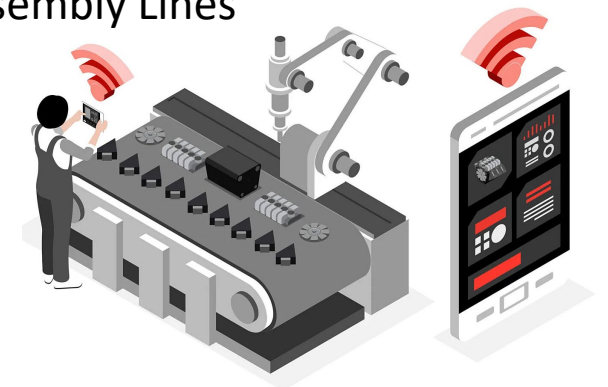
Manufacturing and
Assembly Lines



Healthcare



Smart Agriculture



Another Application Taxonomy

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 Devices and Deployment

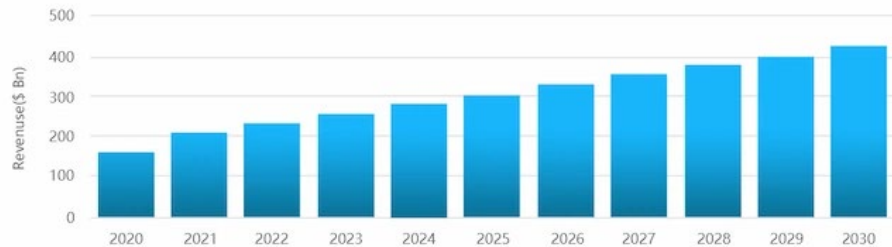
A Growing Market

Where to apply the methods and
solutions learned in this class?

Pick a Device Class or Embodiment

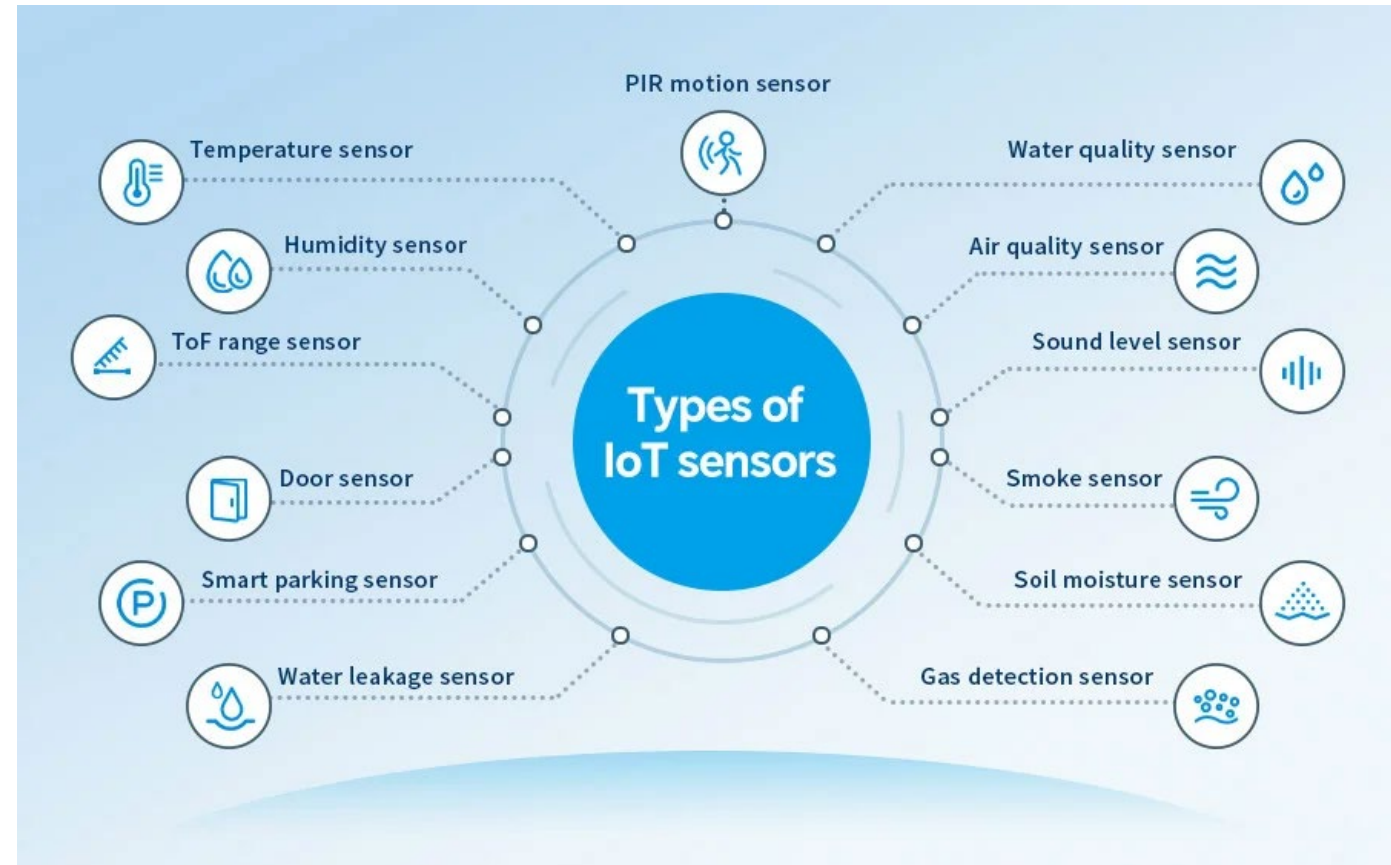
IoT Device Markets: Infrastructure Sensors

Sensor Market Revenue, 2020-2030 (USD Bn)



IoT Sensor Market Revenue

According to Next Move Strategy Consulting, the global sensor market is projected to more than double in size from 151.40 billion in 2020 to [431.21 billion dollars in 2030](#)

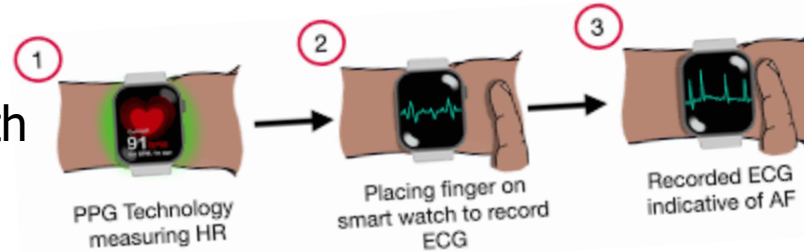


IoT Device Markets: Consumer Wearables



Wristware (Watches and Bands)

Medical/Health Monitoring



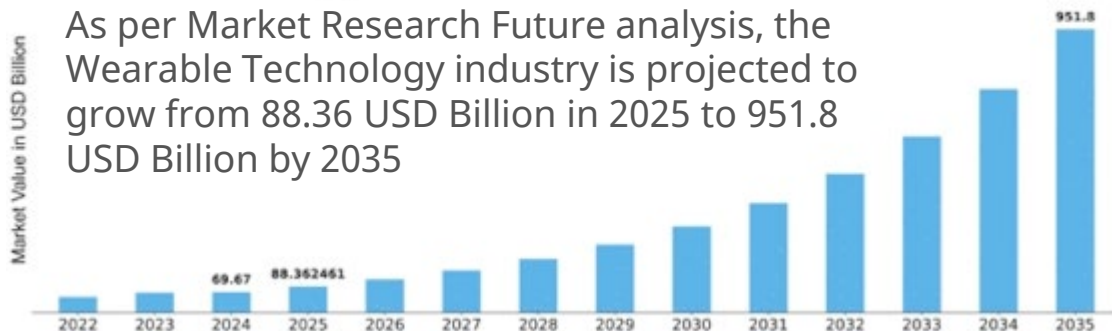
- Health monitoring
- Integration with smart home devices
- Focus on fashion and customization
- Rising health consciousness and fitness tracking



Clothing

Wearable Technology Market

As per Market Research Future analysis, the Wearable Technology industry is projected to grow from 88.36 USD Billion in 2025 to 951.8 USD Billion by 2035



Jewelry

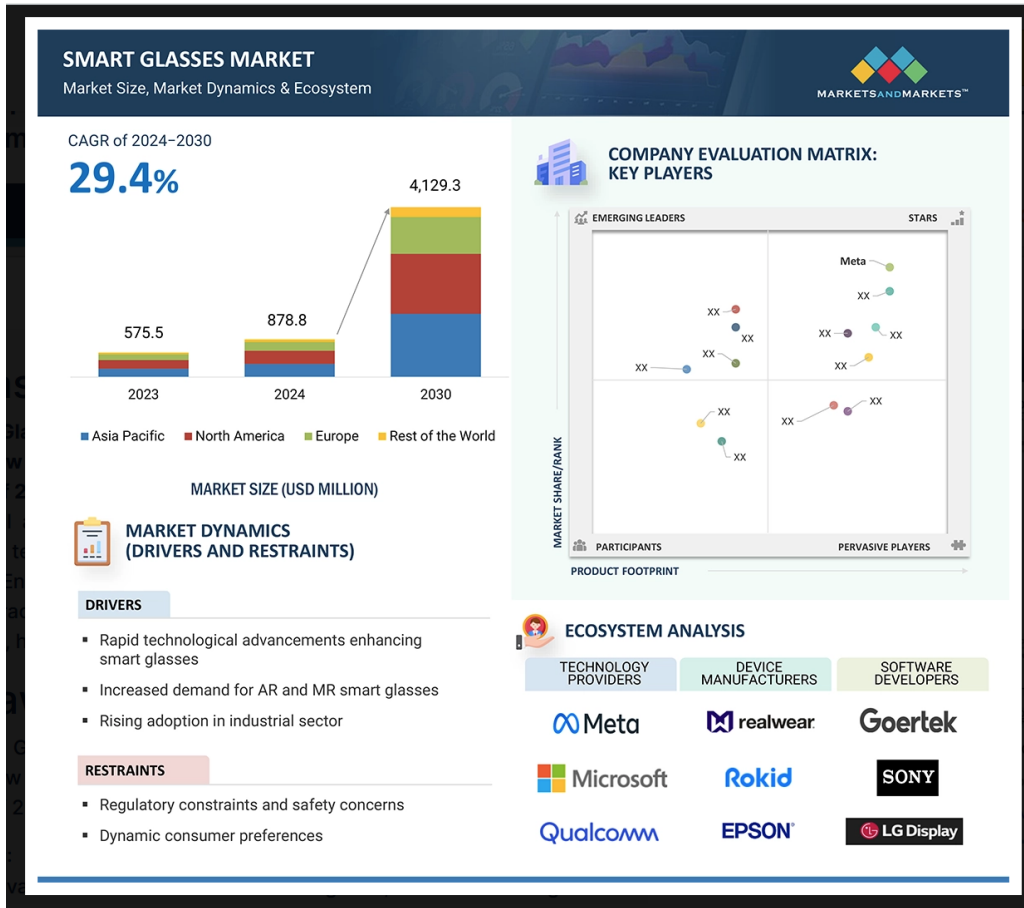


Rings



Earables

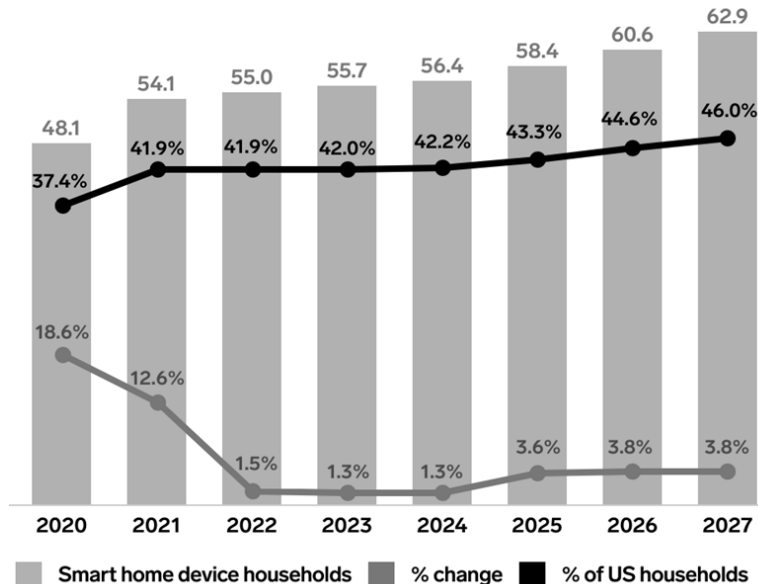
IoT Device Markets: Consumer Wearables – AR/VR



IoT Device Markets: Smart Home

Share of US Households With Smart Home Devices

millions, % change, and % of US households, 2020-2027



Note: households that actively use smart home devices at least once per month
Source: Insider Intelligence | eMarketer Forecast, Sep 2023

350658

Insider Intelligence | eMarketer



Smart Air Conditioners



Security Alarms



IoT Smoke Detectors



Home Assistants



Smart Cookware



Weather-based Sprinkler Controllers



Remote Temperature Controllers



Water Leak Detectors

IoT Device Markets: Assistive Robotics



IoT Device Markets: Humanoid Robots

<https://humanoidroboticstechnology.com/articles/top-12-humanoid-robots-of-2026/>



Devices: Mobility/Autonomy

Early Pioneers (2015-2016)

2015 Infiniti Q50S

AMG 2016 BMW 750i xDrive



2015 Tesla Model S P85D

2015 Mercedes-Benz S65 AMG

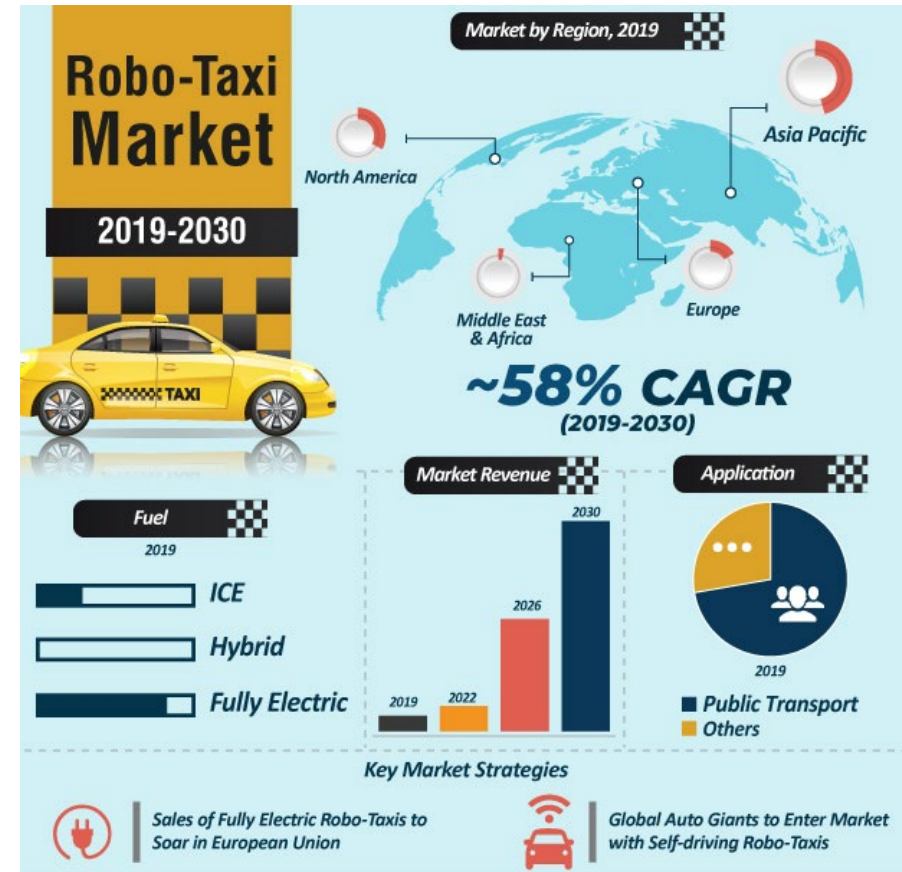
Today



Robo-Taxi Market

The Global Robo Taxi Market was valued at USD 399.30 Million in 2019 and is projected to reach USD 29.08 Billion by 2027, growing at a rate of 61.88% from 2020 to 2027

Expected: **90% or more reduction in vehicle crashes** (autonomous cars don't drink and drive, don't text, don't get tired and fall asleep at the wheel, and don't have emotional issues that distract them from driving)



Autonomous Drone Delivery

Amazon drone delivery
(Prime Air)



Walmart drone
delivery



Little Caesars unveils drone
delivery (for pizza) in Texas

Privacy Concerns



Example: Smart Car Applications and Data Privacy

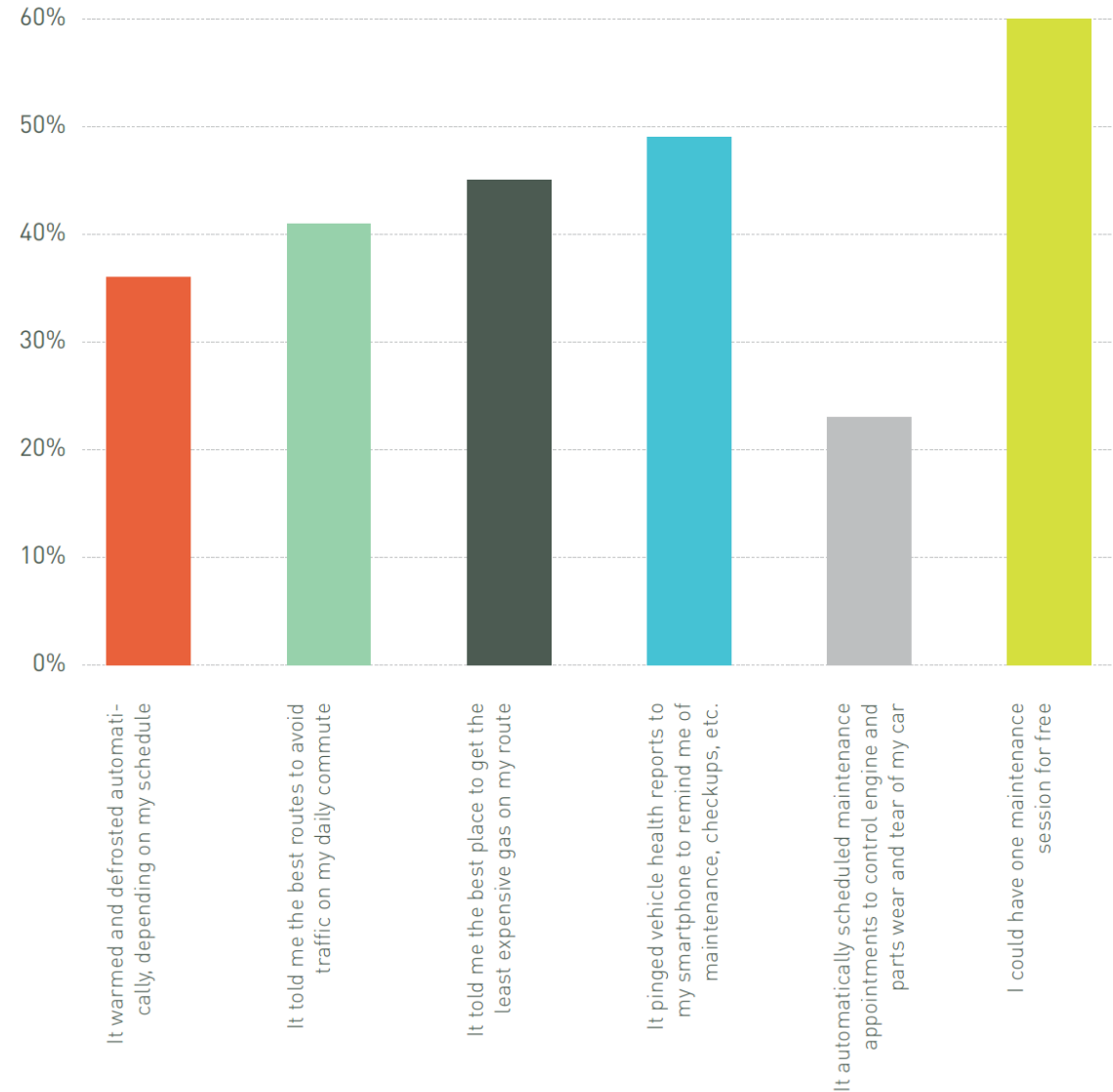
- Would you share data from your car with the manufacturer if
- It warmed and defrosted automatically depending on your schedule?
 - It told you the best routes to avoid congestion?
 - It told you the best place to get the least expensive gas on your route?
 - It sent vehicle health reports to your smart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

Smart Car Applications

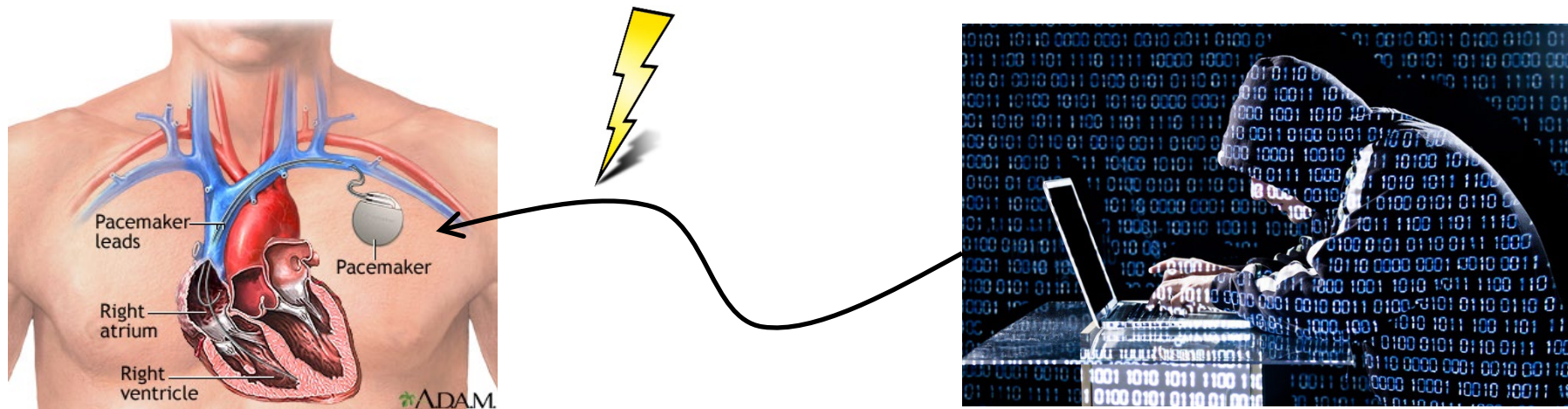
Why would you buy a car that shares data with the manufacturer?

(Acquity Group, 2014)

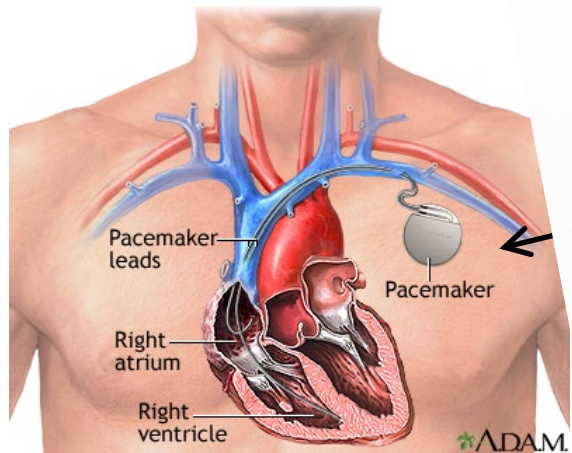
I WOULD BE WILLING TO SHARE DATA FROM MY CAR WITH THE CAR'S MANUFACTURER, IF _____ .



Security Concerns: Online Murder via Implantable Devices?



Security Concerns: Online Murder via Implantable Devices?



The Guardian

This article is more than 2 years old
Hacking risk leads to recall of 500,000 pacemakers due to patient death fears
FDA overseeing crucial firmware update in US to patch security holes and prevent hijacking of pacemakers implanted in half a million people

Alex Hern
Thu 31 Aug 2017 08:23 EDT

Almost half a million pacemakers have been recalled by the US Food and Drug Administration (FDA) due to fears that their lax cybersecurity could be hacked to run the batteries down or even alter the patient's heartbeat.



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:

Conclusions

The IoT field imposes different research challenges in AI that are worthy of their own “lane” in the research superhighway

The IoT applications and device markets are expanding, placing the above research on a trajectory of increasing impact

Ethical, privacy, and security concerns add further research questions to answer