Smart Cities – Myths and Realities

Invited Talk, IIT Bhubaneswar

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Talk - Outline

- Smarty City Drivers
- Smarty City Components
- Smarty City Technologies
- Design and Operation of Smarty Cities
- Challenges and Research on Smarty Cities
- Tools and Solutions for Smarty Cities
- Standards for Smarty Cities
- Initiatives on Smarty Cities
- Conclusions and Future Directions

Drivers

Population Trend – Urban Migration

"India is to be found not in its few cities, but in its 700,000 villages."
- Mahatma Gandhi

- 2025: 60% of world population will be urban
- 2050: 70% of world population will be urban

Source: http://www.urbangateway.org

Issues Challenging Sustainability

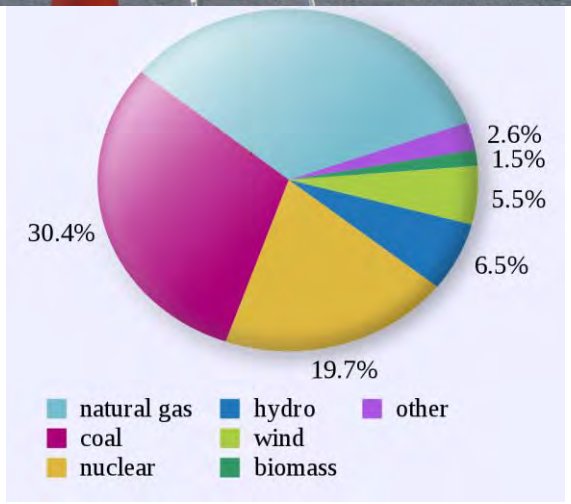
- Pollutions

Issues Challenging Sustainability

- Water crisis

Issues Challenging Sustainability

- Energy crisis



Issues Challenging Sustainability

- Traffic

The Problem

- Uncontrolled growth of urban population
- Limited natural and man-made resources

Source: https://humanitycollege.org

The Solution – Smart Cities

- Smart Cities: For effective management of limited resource to serve largest possible population to improve:
  - Livability
  - Workability
  - Sustainability

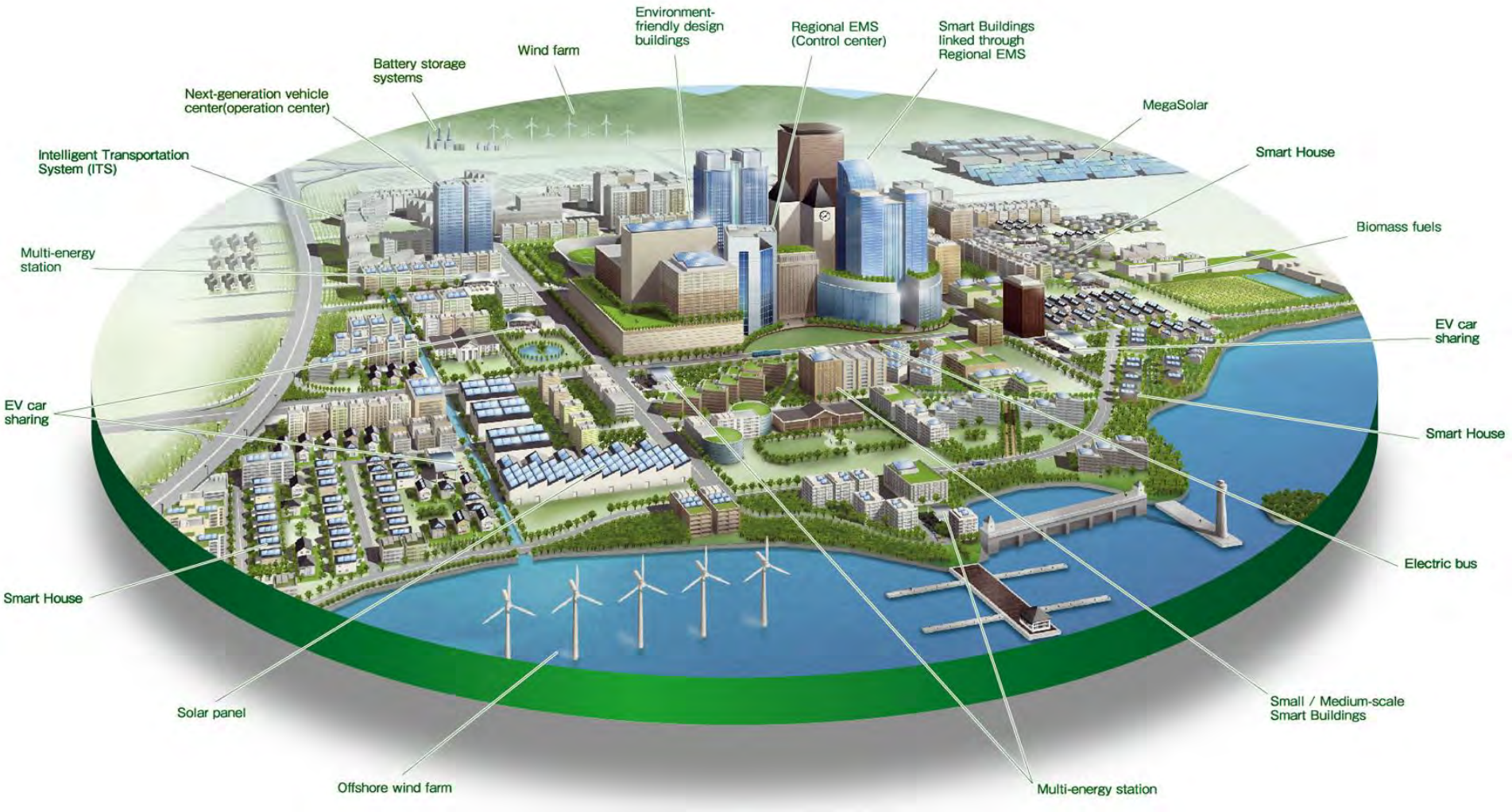
Other Drivers …

- Managing vital services
  - Waste management
  - Traffic management
  - Healthcare
  - Crime prevention
- Making the city competitive
  - Investment
  - Tourism
- Technology push
  - IoT, CPS, Sensor, Wireless

Source: Sangiovanni-Vincentelli 2016, ISC2 2016

Components

Smart Cities – A Broad View



Source: http://edwingarcia.info/2014/04/26/principal/

Cities - History

City - An inhabited place of greater size, population, or importance than a town or village

-- Merriam-Webster

"First true cities arose in Mesopotamia, and in the Indus and Nile valleys sometime around 3500 BCE."

-- LeGates and Stout 2016, The City Reader

Hippodamus of Miletus, 498-408 BC, the first Greek city planner, considered as "the Father of European Urban Planning".

-- Edward Glaeser - 2011, Triumph of the City

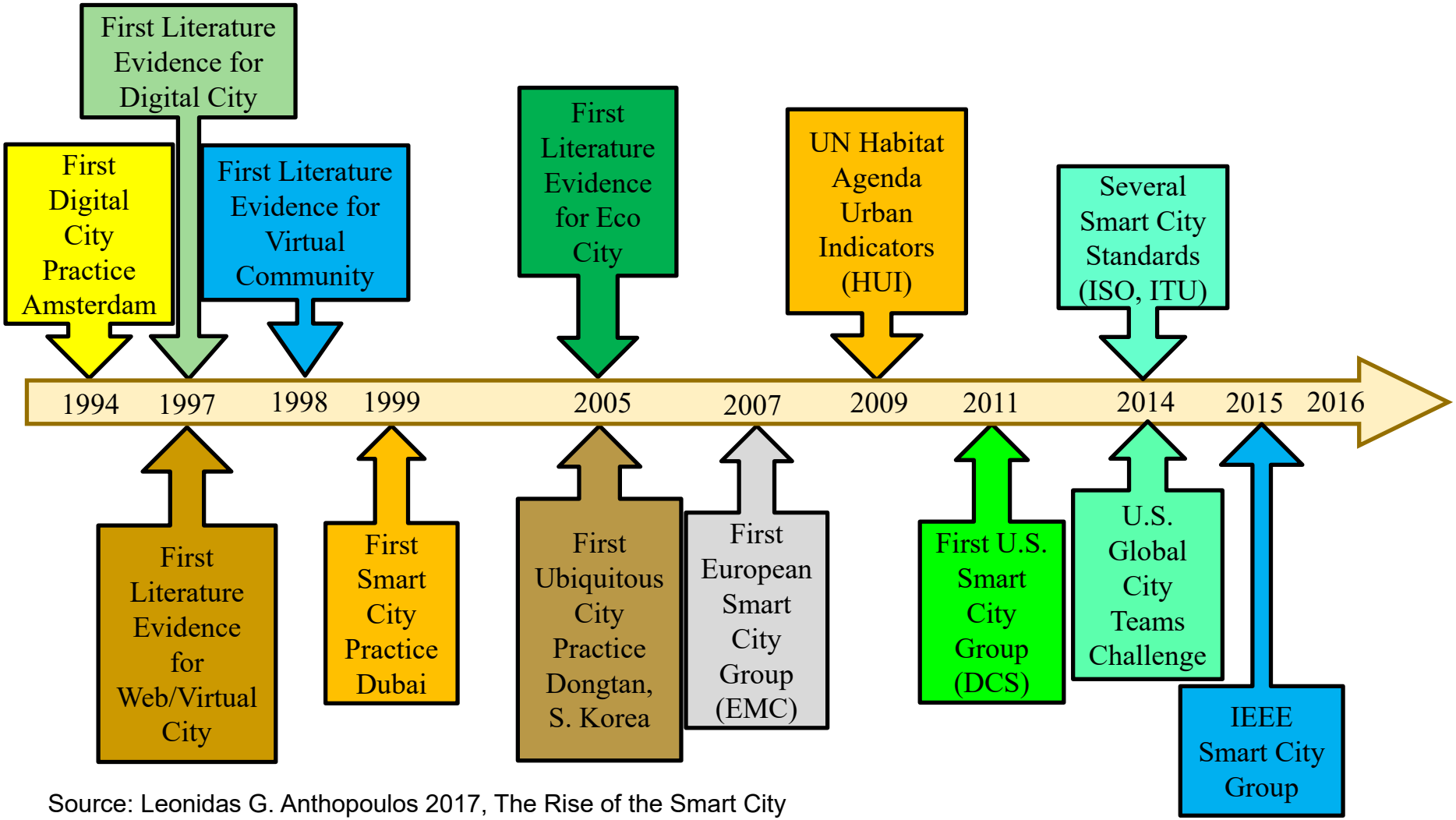
Smart Cities - Formal Definition

- Definition - 1: A city "connecting the physical infrastructure, the information-technology infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city".

- Definition - 2: "A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects".

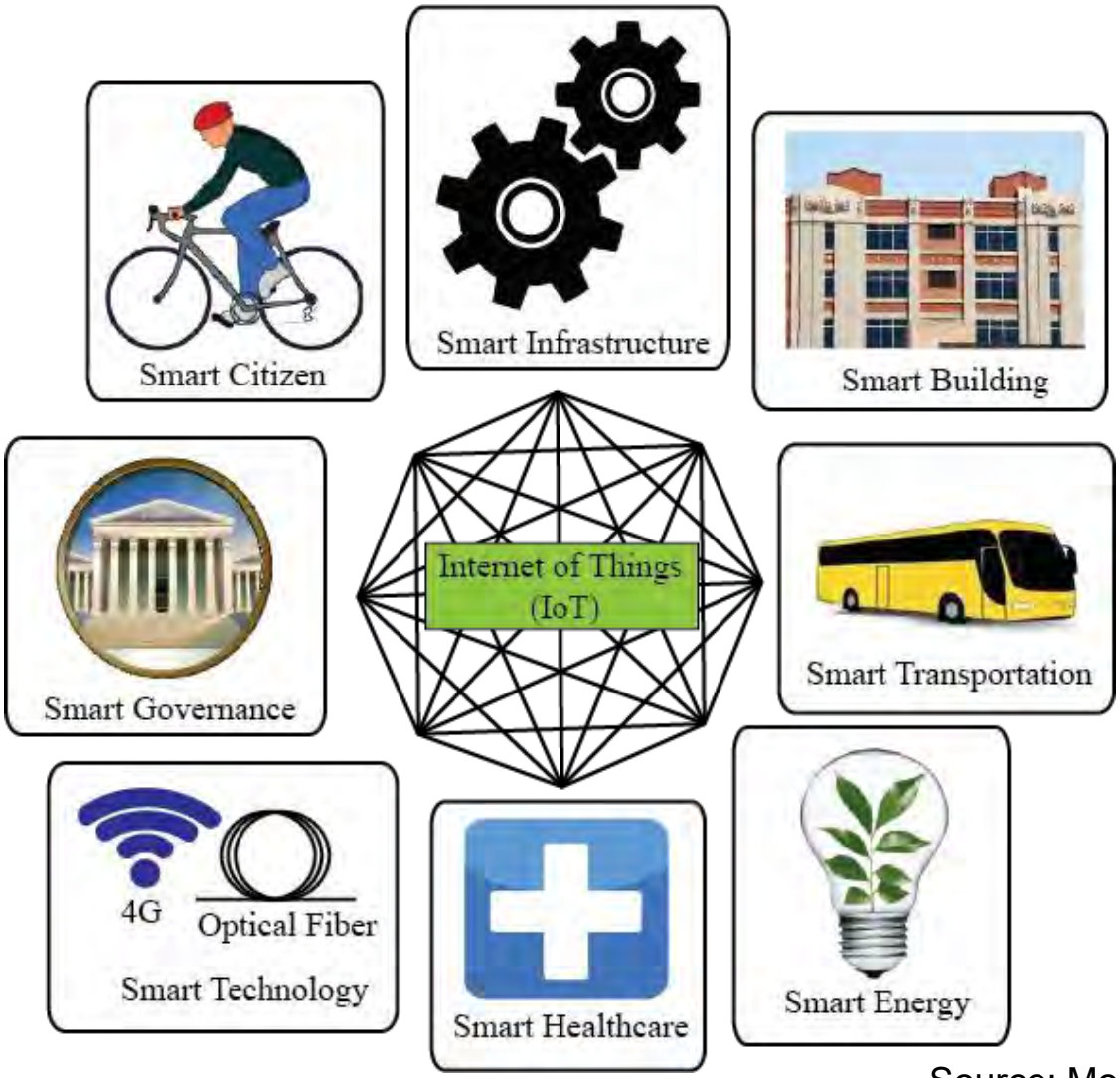
Source: Mohanty 2016, CE Magazine July 2016

Smart Cities - History



Source: Leonidas G. Anthopoulos 2017, The Rise of the Smart City

Smart Cities - Components



A smart city can have one or more of the smart components.

Source: Mohanty 2016, CE Magazine July 2016

Smart Transportation

Smart Transportation Features:

- Autonomous driving
- Effective traffic management
- Real-time vehicle tracking
- Vehicle safety – Automatic brake
- Vehicle-to-Vehicle communication
- Better scheduling of train, aircraft
- Easy payment system

"The smart transportation system allows passengers to easily select different transportation options for lowest cost, shortest distance, or fastest route."

Source: Mohanty 2016, CE Magazine July 2016

Smart Healthcare

Healthy Living

- Fitness Tracking
- Disease Prevention
- Food monitoring

Home Care

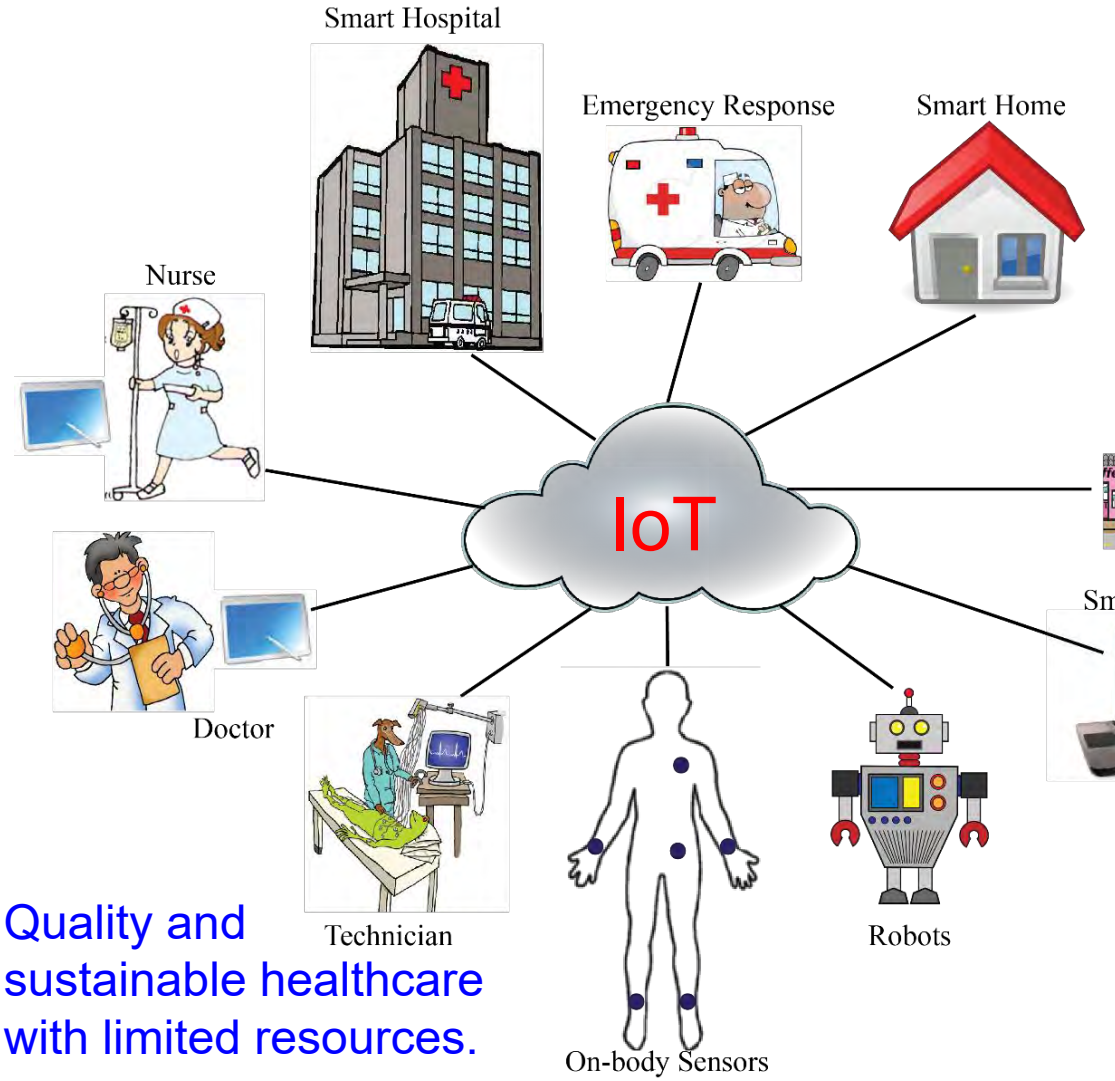
- Mobile health
- Telemedicine
- Self-management
- Assisted Living

Acute care

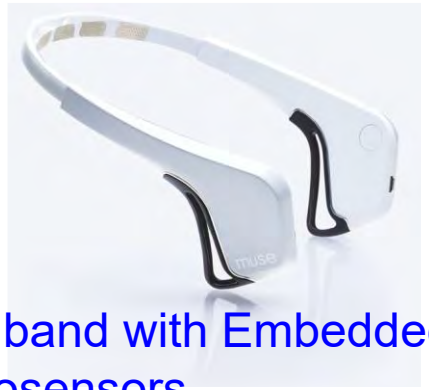
- Hospital
- Specialty clinic
- Nursing Home
- Community Hospital

Source: Mohanty 2018, CE Magazine January 2018

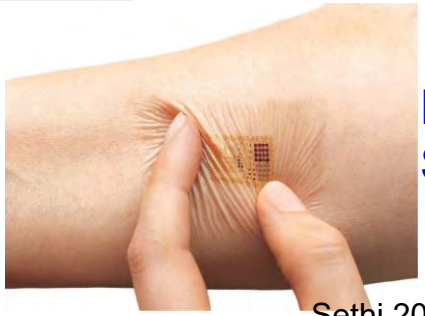
Smart Healthcare



Fitness Trackers



Headband with Embedded Neurosensors



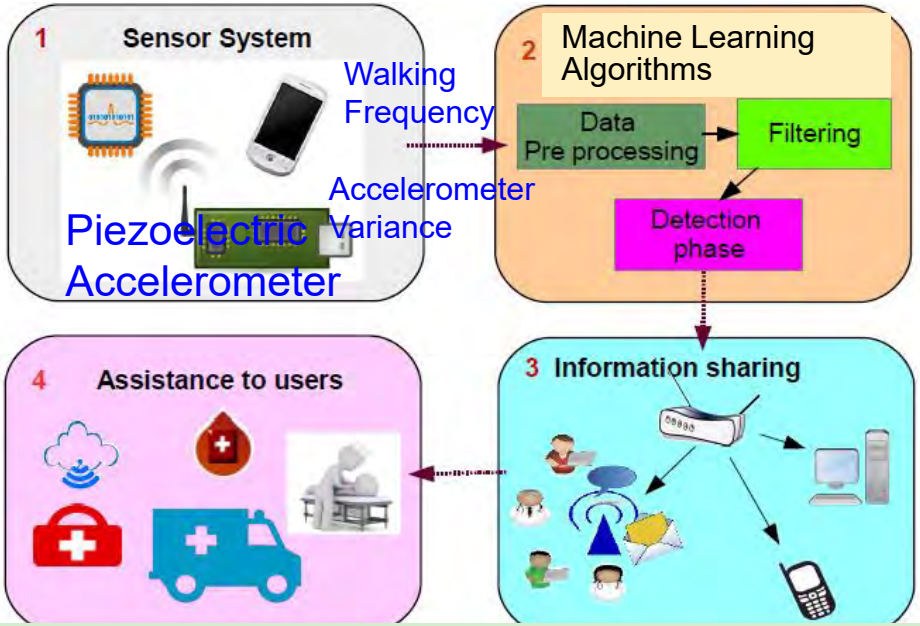
Embedded Skin Patches

Sethi 2017: JECE 2017

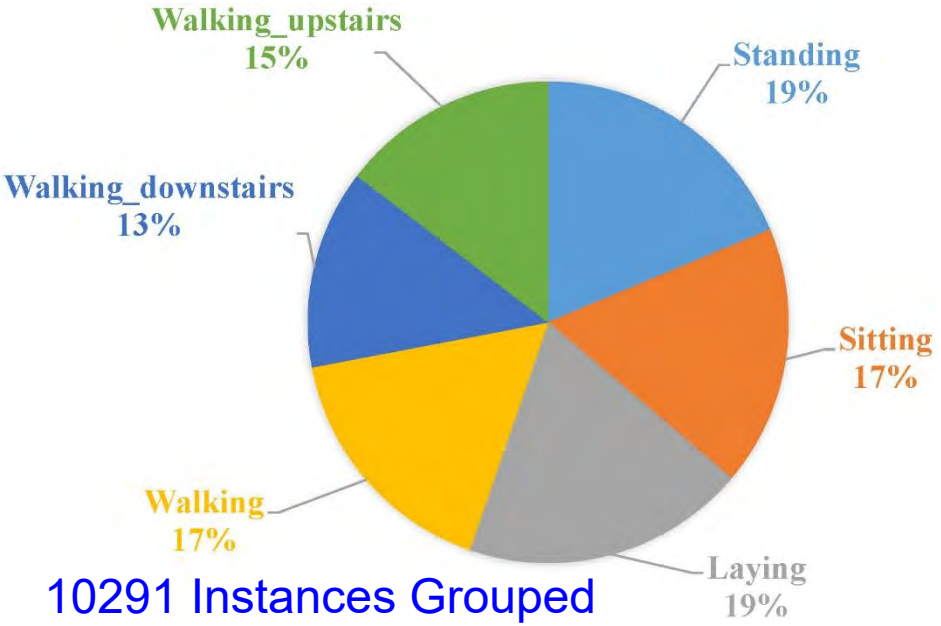
Quality and sustainable healthcare with limited resources.

Source: Mohanty 2016, CE Magazine July 2016

Smart Healthcare - Smart-Walk



Automated Physiological Monitoring System



10291 Instances Grouped Under 6 Activities - Kaggle

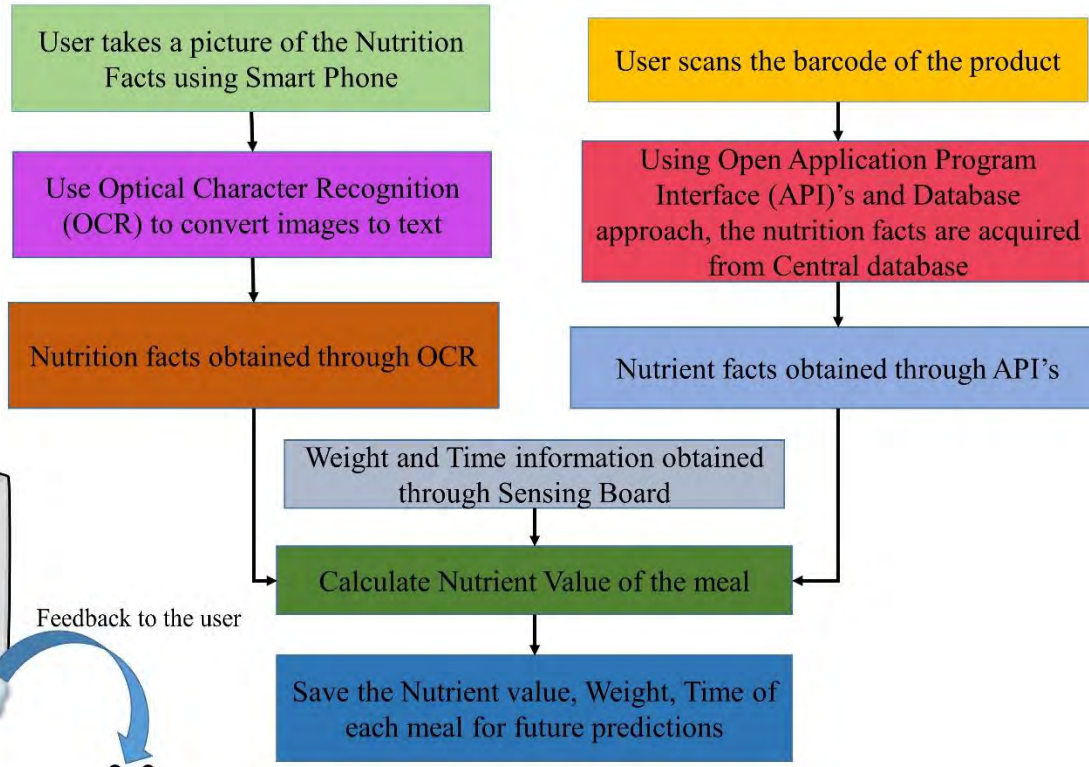
Research Works	Method	Features considered	Activities	Accuracy (%)
This Work	Adaptive algorithm based on feature extraction (WEKA)	Step detection and Step length estimation	Walking, sitting, standing, etc.	97.9

Source: Mohanty ICCE 2018

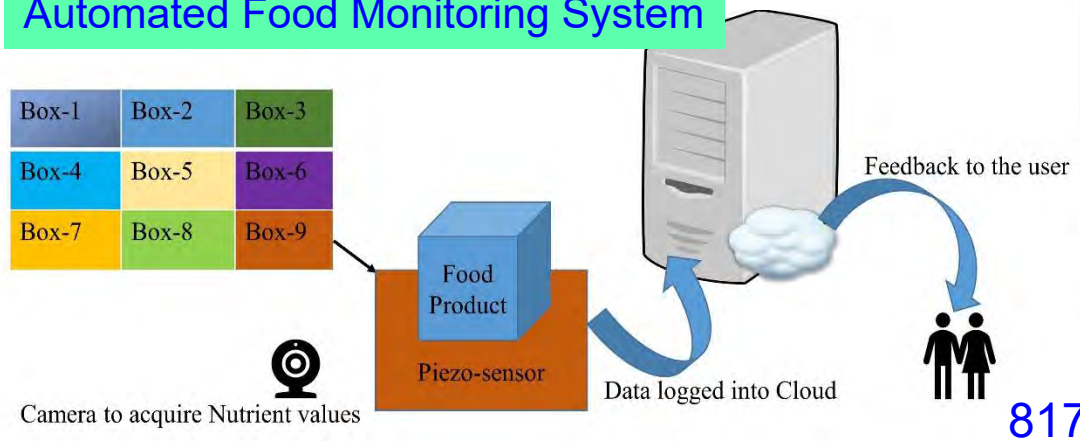
Smart Healthcare - Smart-Log

- Smart Sensor Board
- Data Acquisition
- Future Meal Predictions

USDA National Nutrient Database for Standard Reference is used for nutrient values of 8791 items.



Automated Food Monitoring System

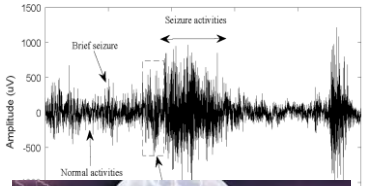


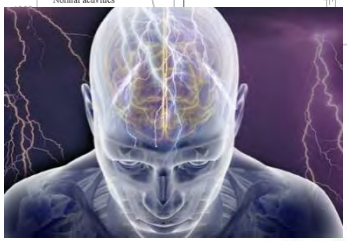
8172 user instances were considered

Research Works	Food Recognition Method	Efficiency (%)
This Work	Mapping nutrition facts to a database	98.4

Source: Mohanty ICCE 2018

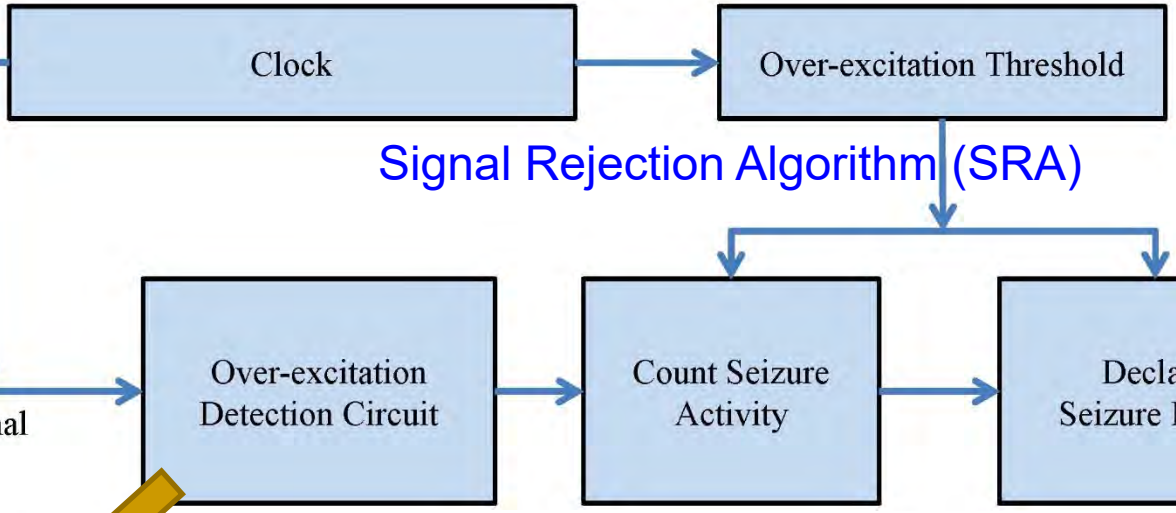
Smart Healthcare – Efficient Epileptic Seizure Detector

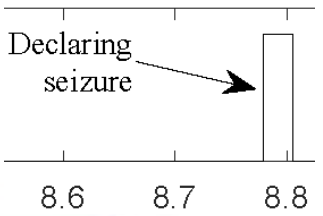


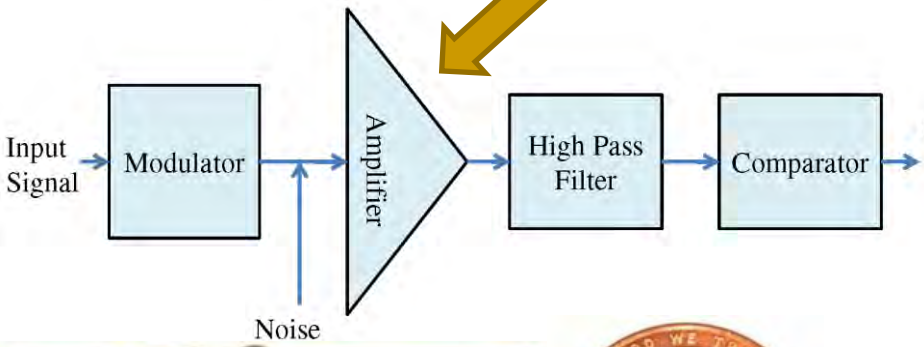


EEG Signal

Input Signal





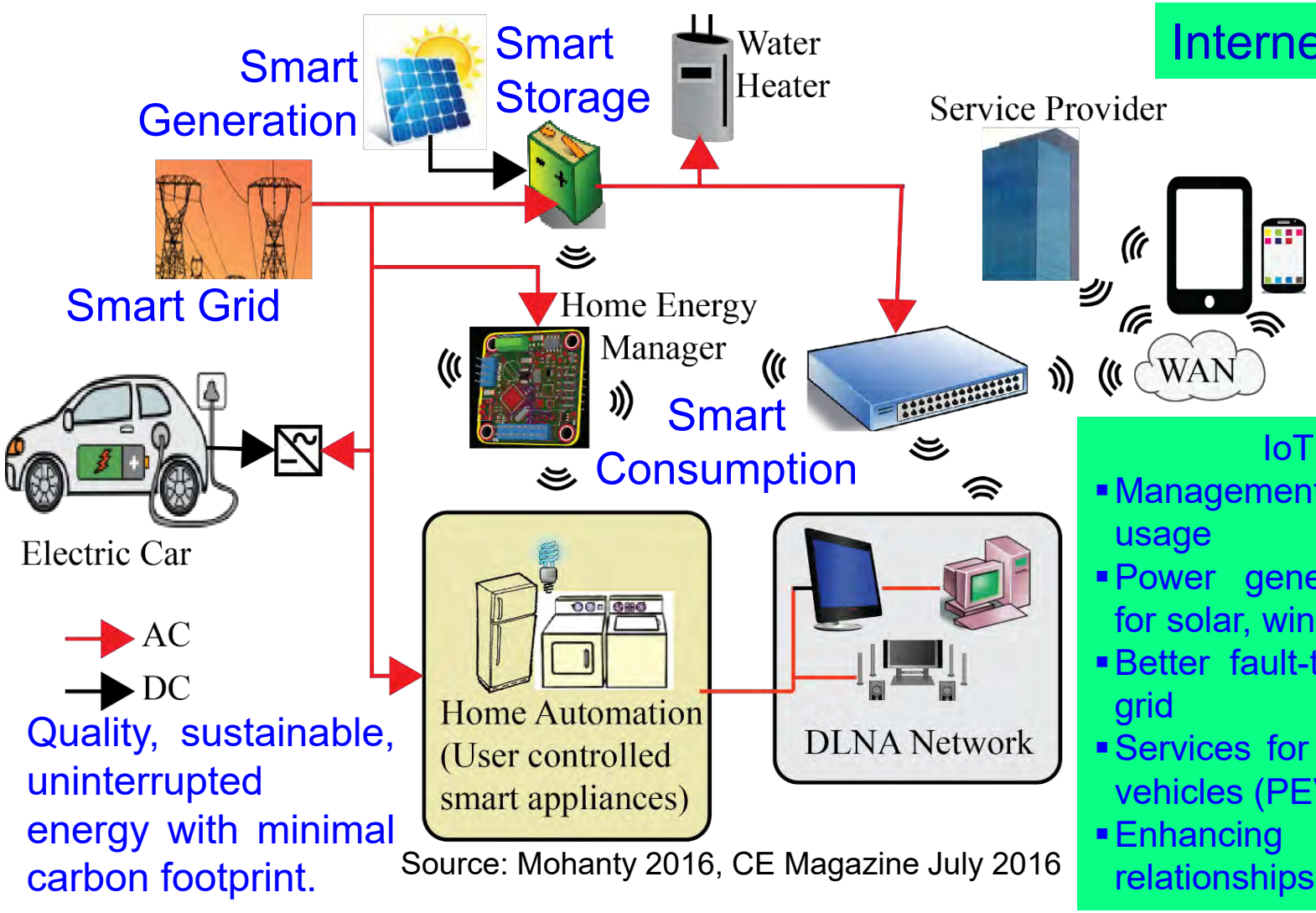


Source: Zaveri, Yale University

Parameter	Value
Seizure Frequency (Minimum)	5 Hz
Seizure Frequency (Minimum)	25 HZ
Voltage Level Detector (Avg. Lower Threshold)	210 mV
Voltage Level Detector (Avg. Upper Threshold)	380 mV
Total power consumption	6.18 µW

Source: Mohanty ICCE 2018

Smart Energy



Source: Mohanty 2016, CE Magazine July 2016

Quality, sustainable, uninterrupted energy with minimal carbon footprint.

Internet of Energy

IoT Role:

- Management of energy usage
- Power generation dispatch for solar, wind, etc.
- Better fault-tolerance of the grid
- Services for plug-in electric vehicles (PEV)
- Enhancing consumer relationships

EV Charging System …

Mix-Energy-Source Electric Vehicle Charging System Design and its Impact on Indian Smart-distribution-grid

As Electric Vehicles become mainstream, chargers will play an important role in the success of this idea. This project will try to answer a part of this question by looking into the optimal EV charger suitable for Indian condition.

India

IIT Kanpur
Dr. Shantanu K. Mishra

IIT Kharagpur
Dr. Souvik Chattopadhyay

IIT BHU
Dr. Rajeev K. Singh

International

University of Texas
Dr. Saraju P. Mohanty

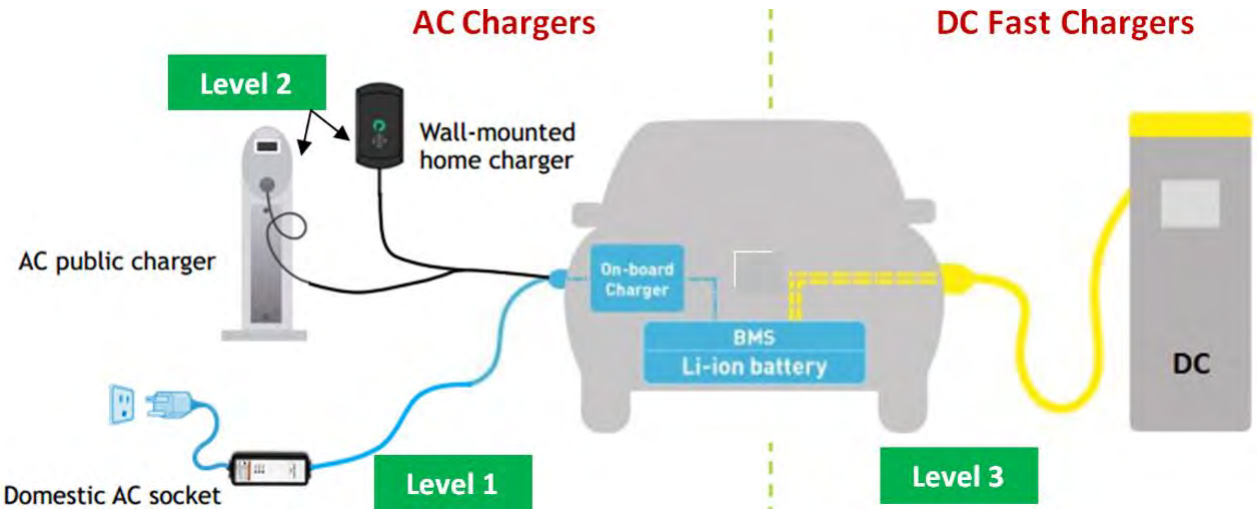
Virginia Tech
Dr. Khai D. T. Ngo

Concordia University
Dr. Akshay K. Rathore

Imperial College London
Dr. Balarko Chaudhuri

Source: Mission Innovation Project 2018-2021: Senior Personnel - Mohanty, PI - Mishra

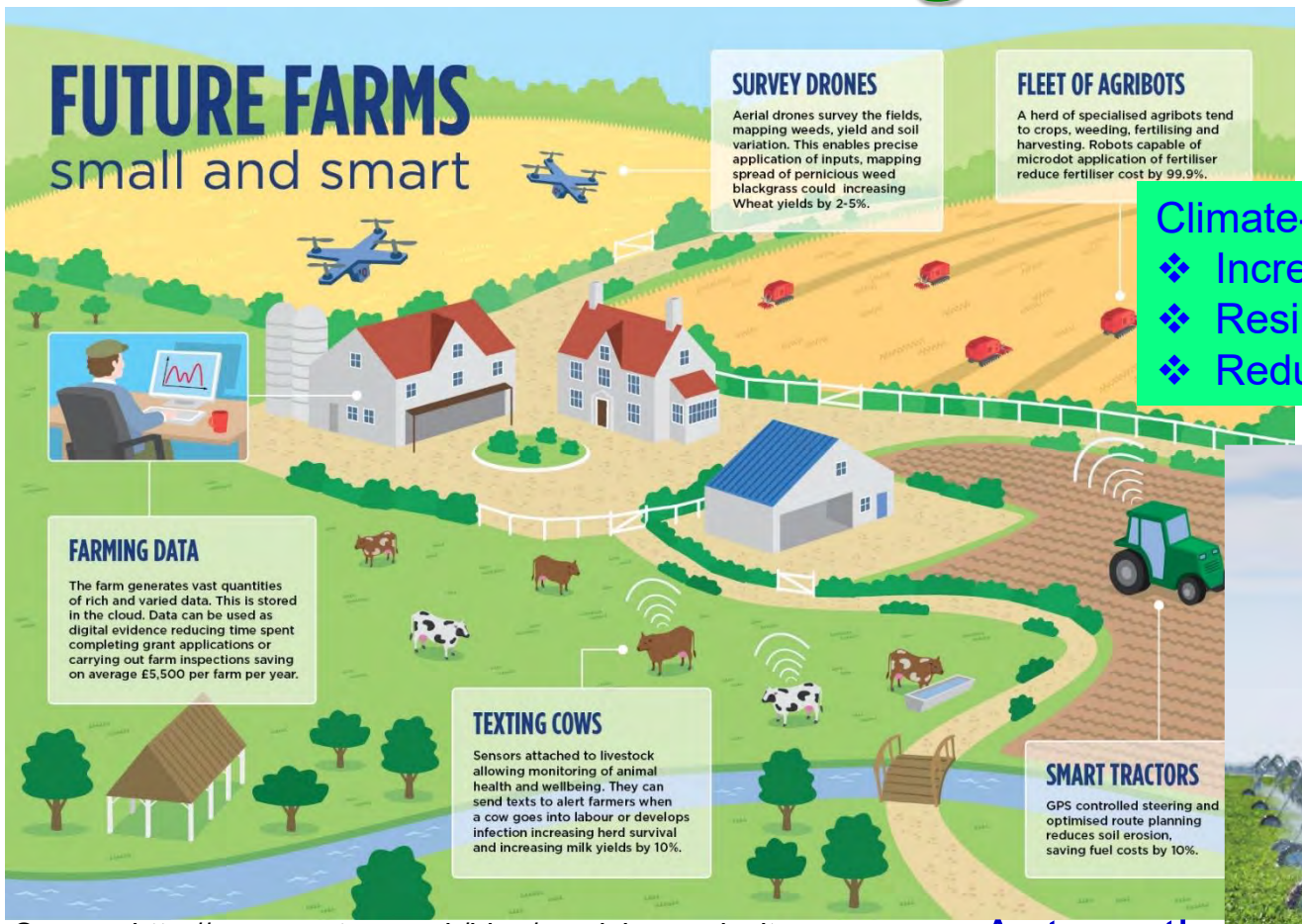
EV Charging System



- Design and deployment of Level 2 (AC) and combined charging system
- Design and deployment of hybrid input DC Fast charger
  - (a) with multi-input source and single-output
  - (b) with 5-10 kW output EV charger for E-Rickshaws
  - (c) universal charger design and implementation
- Impact study of storage on EV chargers
- Study the impact of EV chargers on Indian distribution system
- Techno-economic study of EV chargers

Source: Mission Innovation Project 2018-2021: Senior Personnel - Mohanty, PI - Mishra

Smart Agriculture



Source: http://www.nesta.org.uk/blog/precision-agriculture-almost-20-increase-income-possible-smart-farming

Climate-Smart Agriculture Objectives:

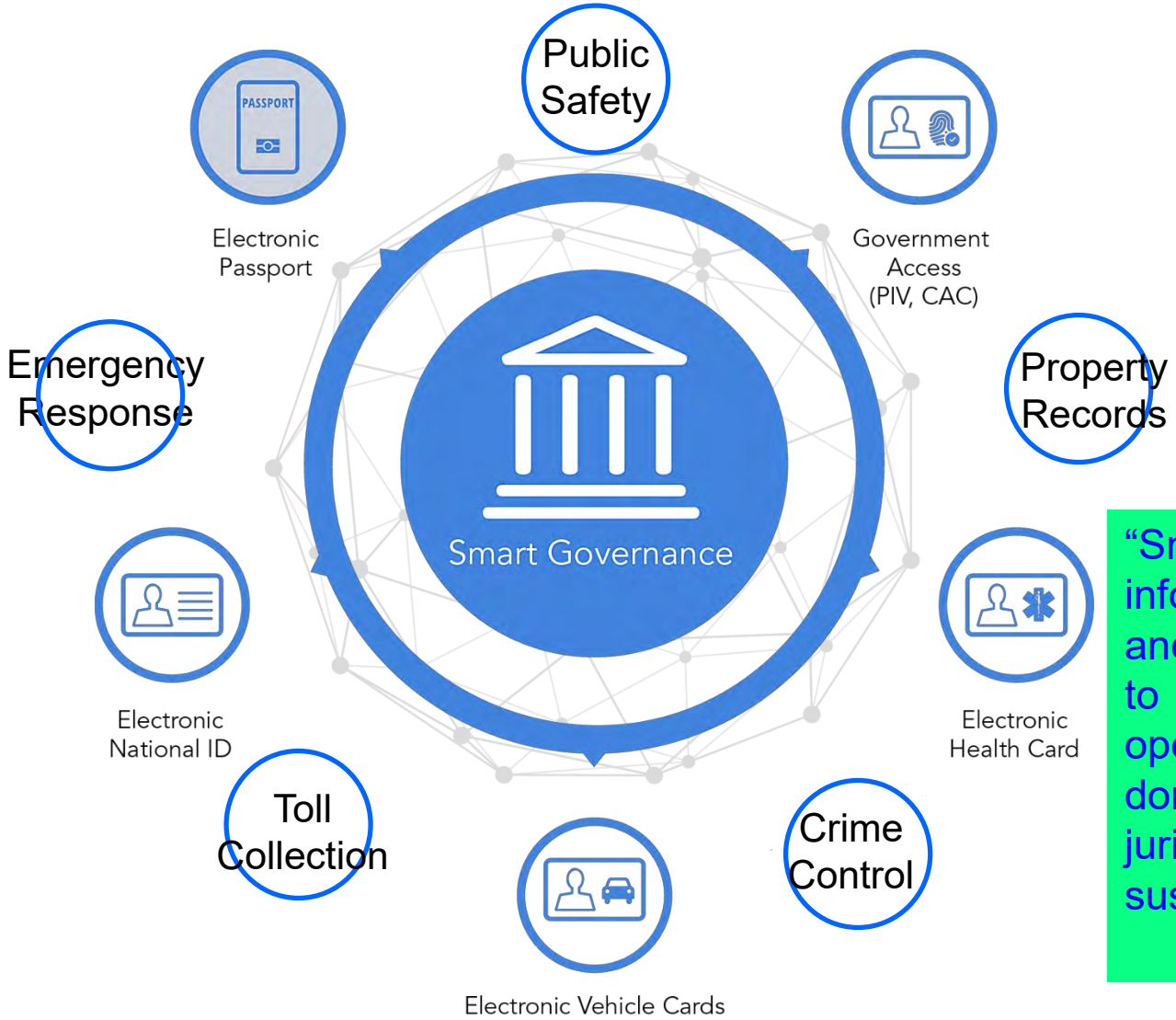
- Increasing agricultural productivity
- Resilience to climate change
- Reducing greenhouse gas

http://www.fao.org

Automatic Irrigation System

Source: Maurya 2017: CE Magazine July 2017

Smart Government



"Smart government integrates information, communication and operational technologies to planning, management and operations across multiple domains, process areas and jurisdictions to generate sustainable public value."

-- http://www.gartner.com

Source: http://www.nxp.com/applications/internet-of-things/secure-things/smart-government-identification:SMART-GOVERNANCE

Technologies

Smart Cities

Smart Cities ←

Regular Cities

+ Information and Communication Technology (ICT)

+ Smart Components

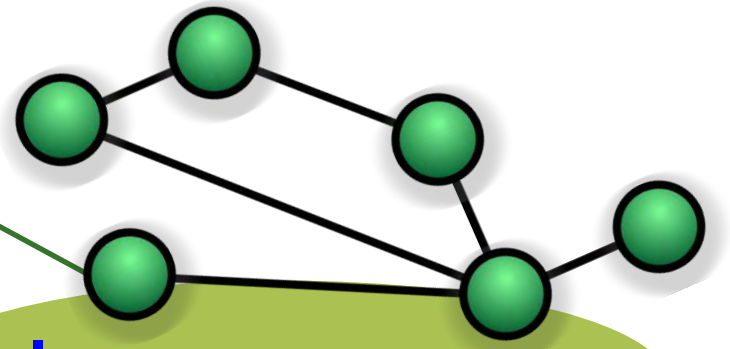
+ Smart Technologies

Smart Cities - 3 Is

Instrumentation

The 3Is are provided by the Internet of Things (IoT).

Smart Cities



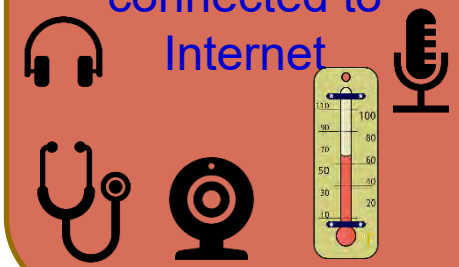
Intelligence

Interconnection

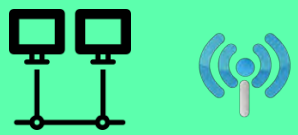
Source: Mohanty 2016, EuroSimE 2016 Keynote Presentation

Internet of Things (IoT) – Concept

Things
Sensors/actuators with IP address that can be connected to Internet



Local Network
Can be wired or wireless: LAN, Body Area Network (BAN), Personal Area Network (PAN), Controller Area Network (CAN)



Cloud Services
Data either sent to or received from cloud (e.g. machine activation, workflow, and analytics)

Global Network
Connecting bridge between the local network, cloud services and connected consumer devices

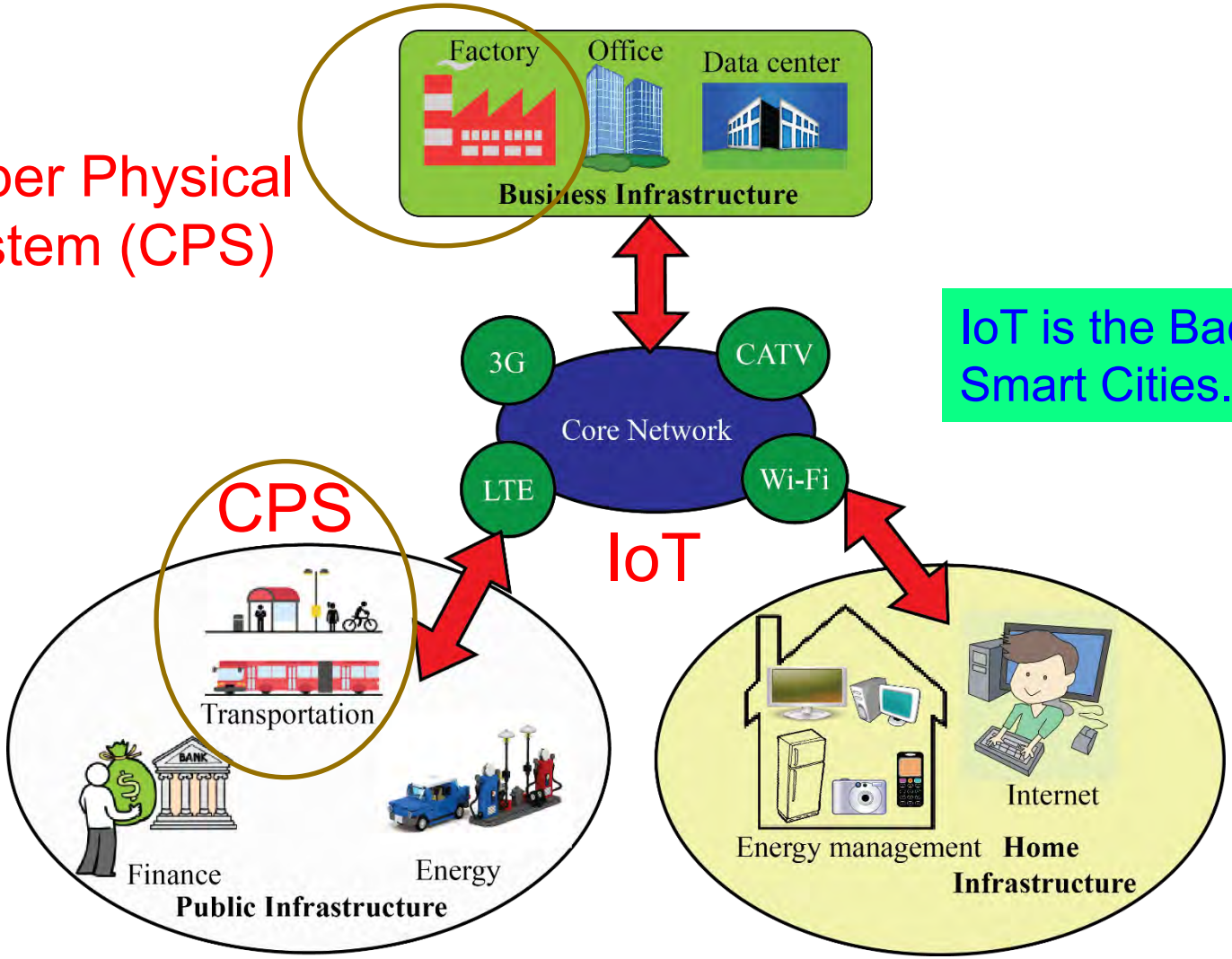
Connected Consumer Electronics
Smart phones, devices, cars, wearables which are connected to the Things

Overall architecture:
- A configurable dynamic global network of networks
- Systems-of-Systems

Source: Mohanty ICIT 2017 Keynote

Smart Infrastructure

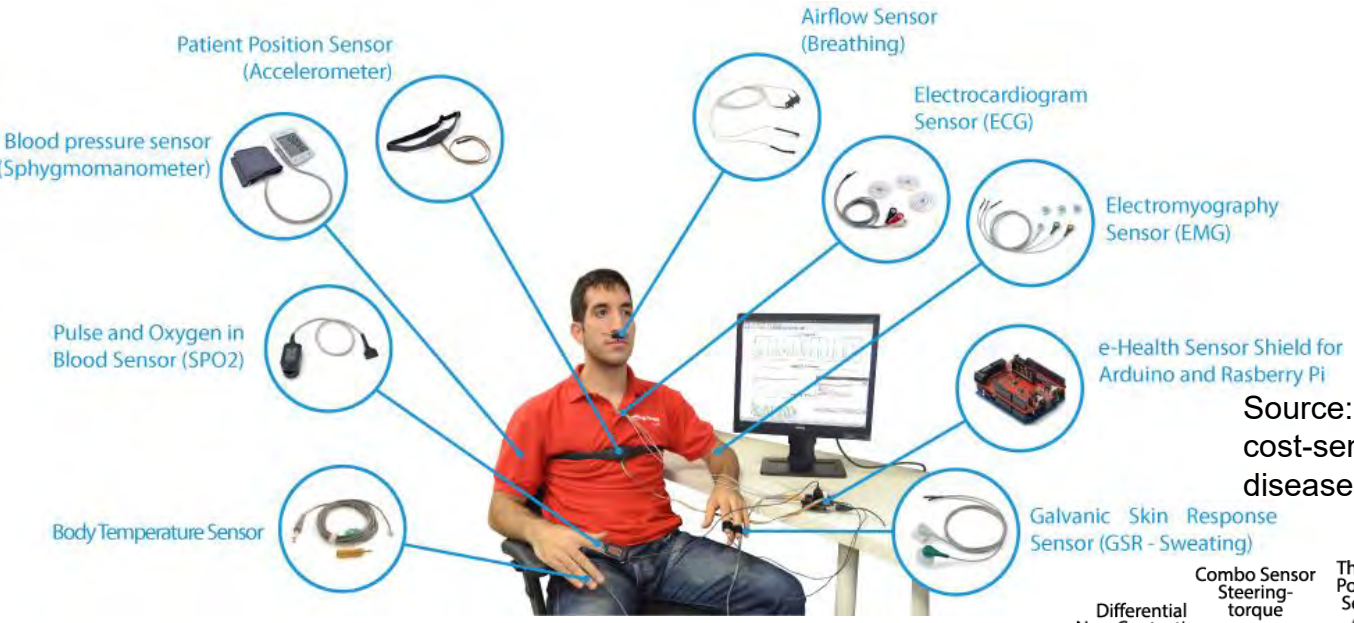
Cyber Physical System (CPS)



IoT is the Backbone Smart Cities.

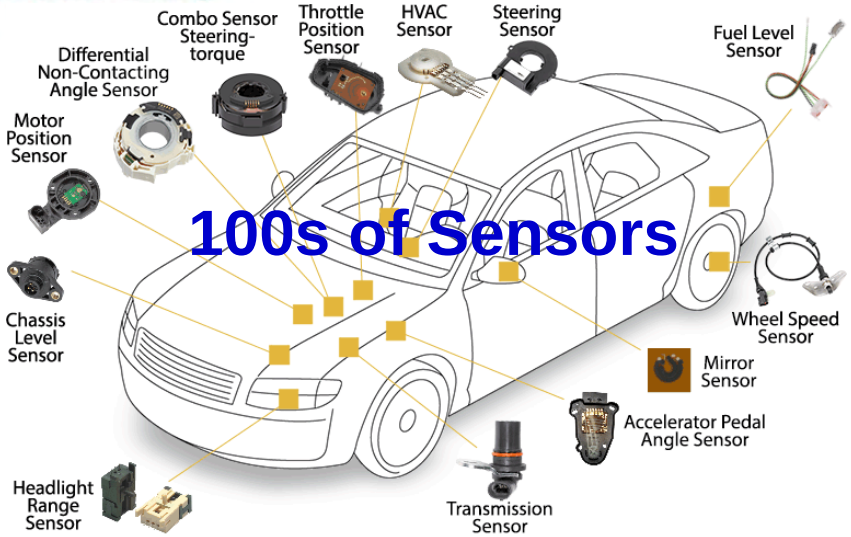
Source: Mohanty 2016, CE Magazine July 2016

Sensor Technology – Variety of Them



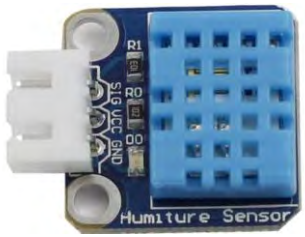
Source: http://www.libelium.com/e-health-low-cost-sensors-for-early-detection-of-childhood-disease-inspire-project-hope/

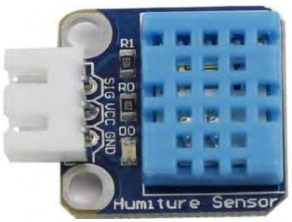
Thing ← Sensor
+ Device with its own IP address



IoT – Things

Sensor





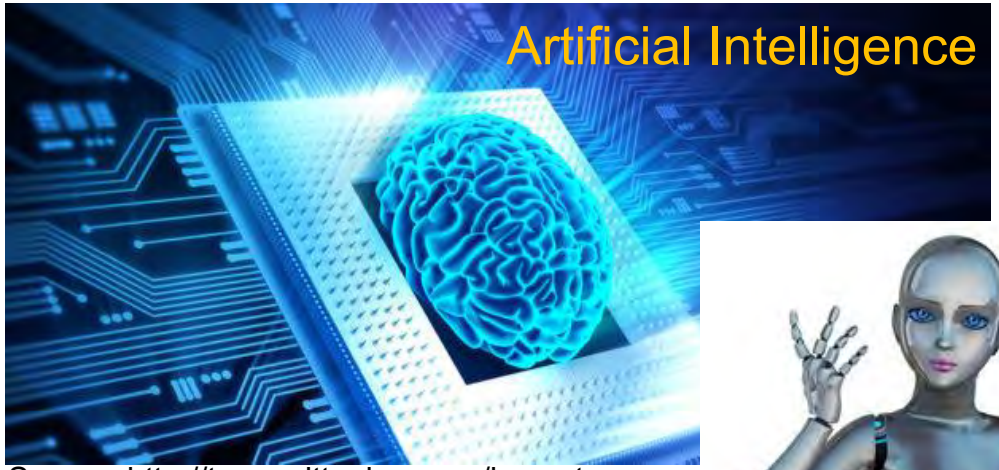
Thing

Sensors + Device with its own IP address → Things

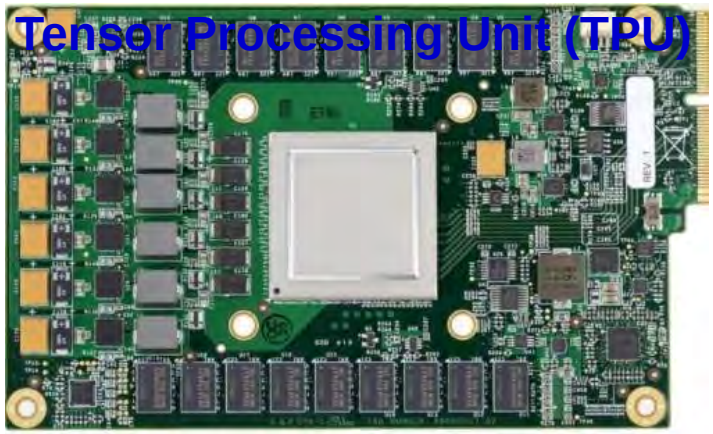
IP Address for Internet Connection

The “Things” refer to any physical object with a device that has its own IP address and can connect and send/receive data via network.

Machine Learning Technology

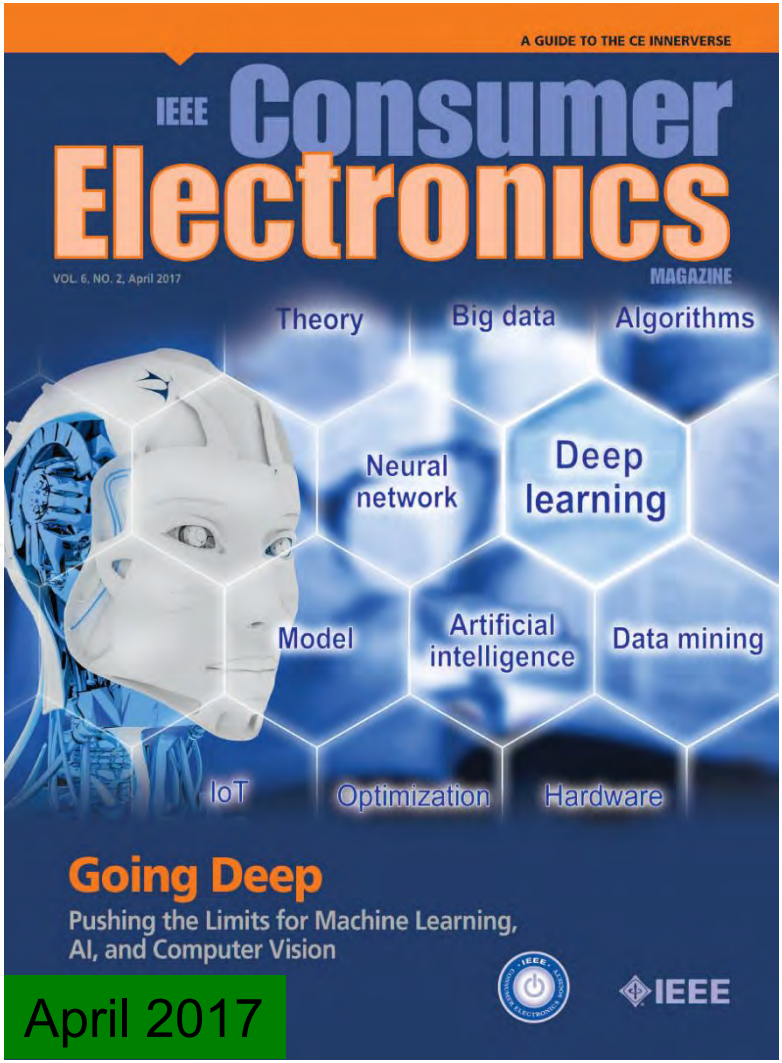


Source: http://transmitter.ieee.org/impact-aimachine-learning-iot-various-industries/



Source: https://fossbytes.com/googles-home-made-ai-processor-is-30x-faster-than-cpus-and-gpus/

Smart City Use:
- Better decision
- Faster response



Virtual and Augmented Reality Technology

Virtual Reality

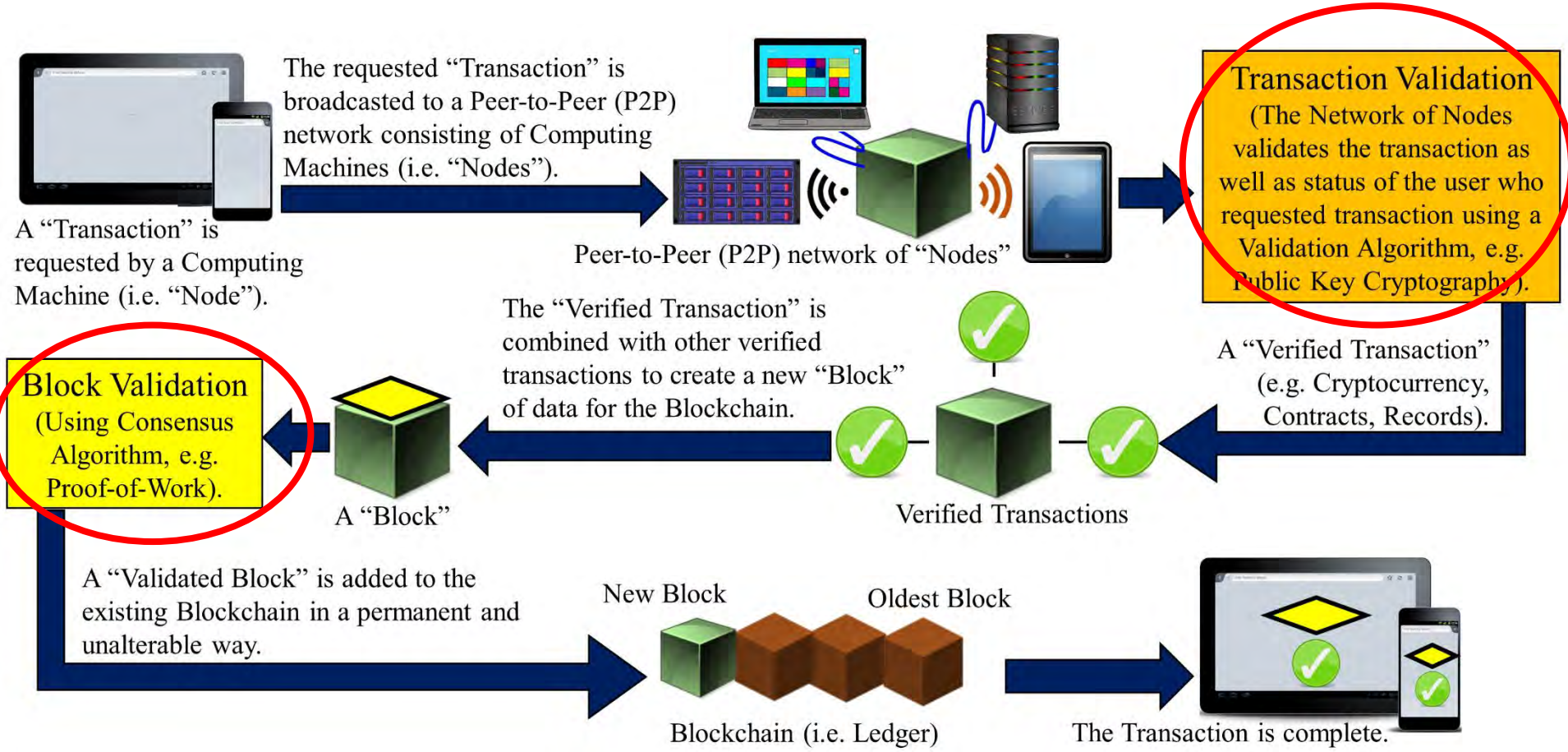
Smart City Use:

- Healthcare - Therapy, Surgery
- Tourism - Recreate History
- Entertainment - Movies

Augmented Reality

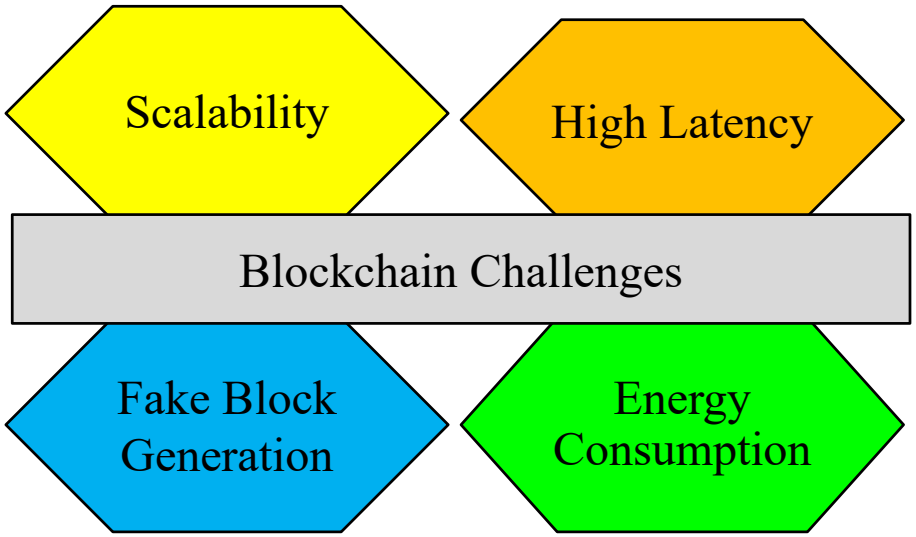
Source: http://www.prweb.com/releases/2011/5/prweb8462670.htm

Blockchain Technology



Source: Puthal, Mohanty 2018, CE Magazine July 2018

Blockchain – Energy Issue

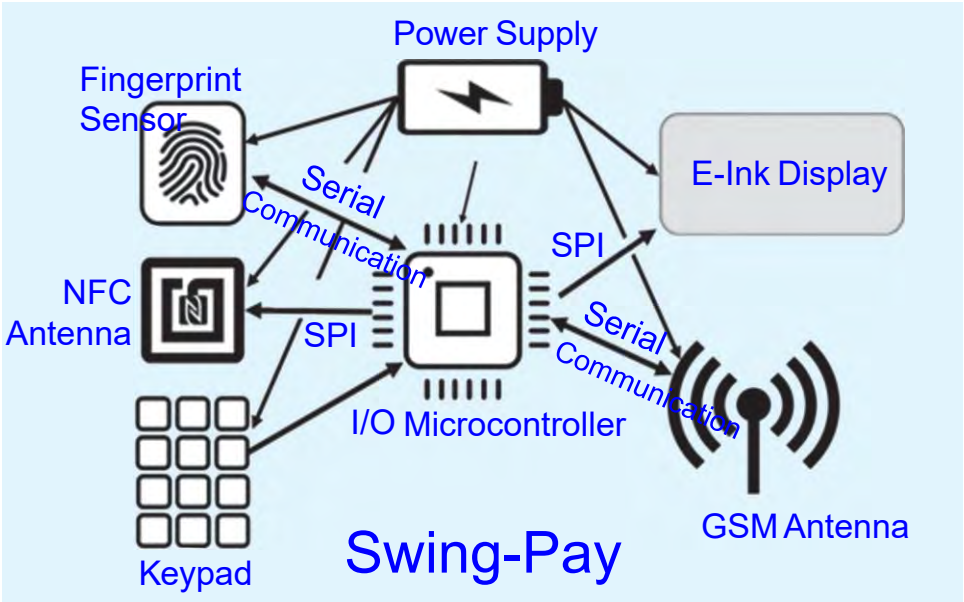


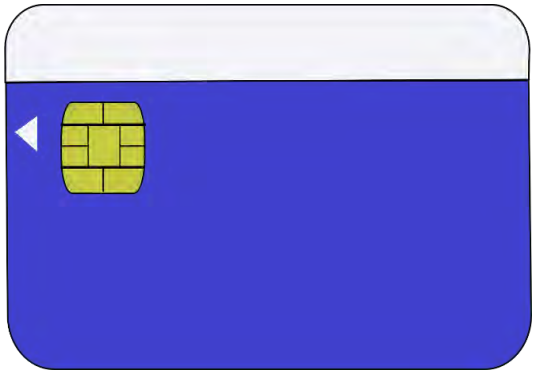
Source: Puthal, Mohanty 2018, CE Magazine July 2018

- Energy for mining of 1 bitcoin → 2 years consumption of a US household.
- Energy consumption for each bitcoin transaction → 80,000X of energy consumption of a credit card processing.

Source: N. Popper, "There is Nothing Virtual About Bitcoin's Energy Appetite", The New York Times, 21st Jan 2018, https://www.nytimes.com/2018/01/21/technology/bitcoin-mining-energy-consumption.html.

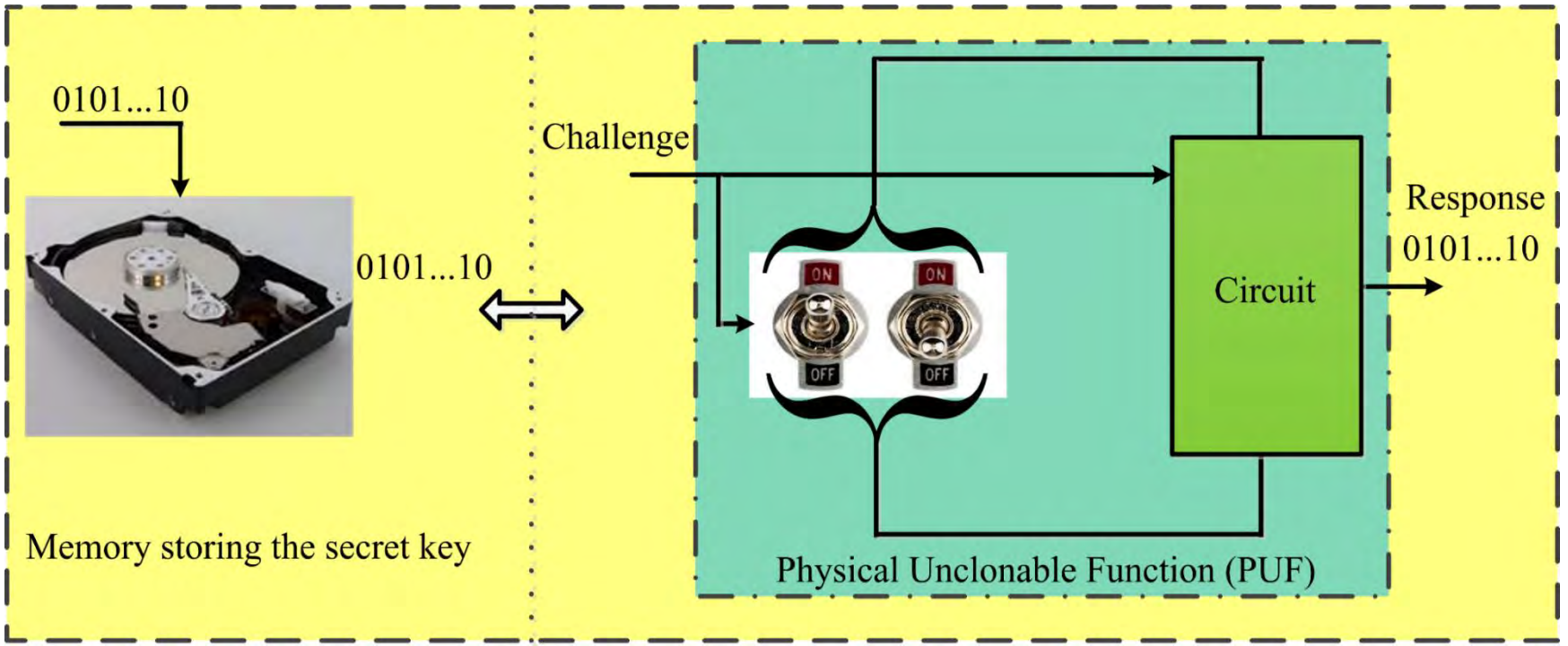
Cashless Payment Technology – An Example





Source: Majumder, Mohanty 2017, CE Magazine Jan 2017

PUF – Principle …

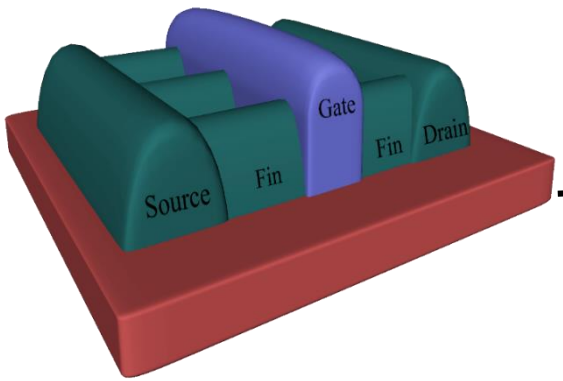


PUFs don't store keys in digital memory, rather derive a key based on the physical characteristics of the hardware; thus secure.

Source: Mohanty 2017, IEEE Potentials Nov-Dec 2017

PUF - Principle

Manufacturing Variations (e.g. Oxide Growth, Ion Implantation, Lithography)



Parameters Affected Due to Variations (e.g. Length, Gate-Oxide Thickness, Fin Height, Fin Width)

Challenge Inputs (Inputs given to PUF Module, e.g. Select line of Multiplexer)

PUF Design (e.g. Arbiter PUF, SRAM PUF, Ring Oscillator PUF)

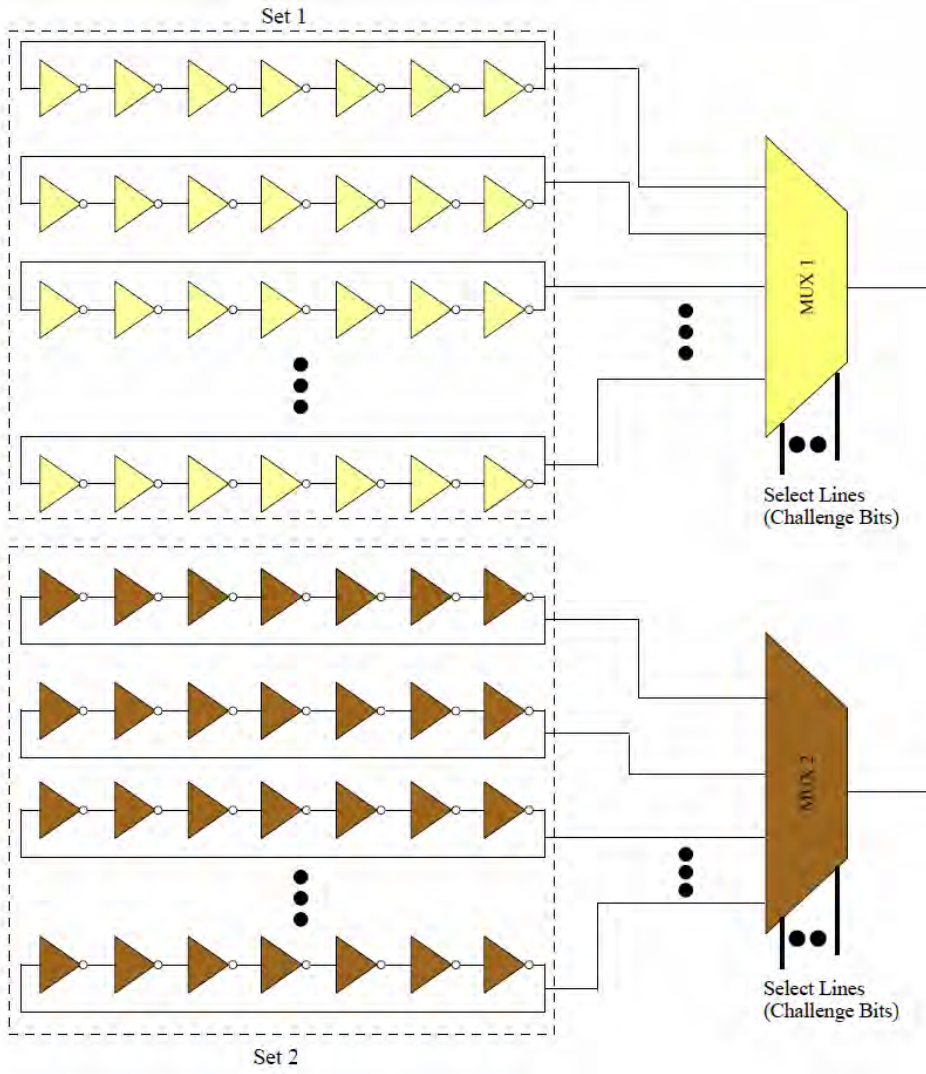
Challenge Response (Outputs from a PUF Module)

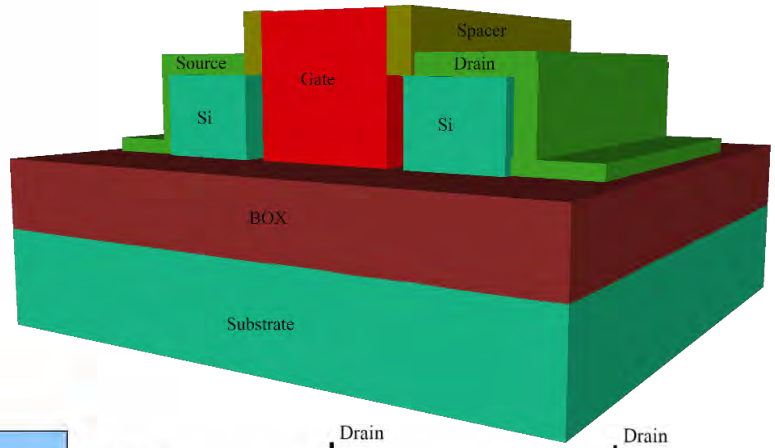
Random Binary Output 010101 …

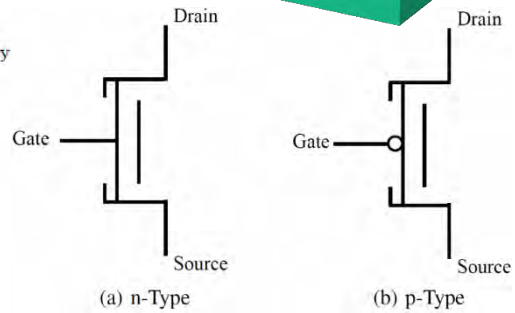
Silicon manufacturing process variations are turned into a feature rather than a problem.

Source: Mohanty 2017, Springer ALOG 2017

Power Optimized Hybrid Oscillator Arbiter PUF







Characteristics	FinFET Technology	DLFET Technology
Average Power	219.34 μW	121.3 μW
Hamming Distance	49.3 %	48 %
Time to generate key	150 ns	150 ns

Source: Mohanty 2018, TSM May 2018

Technology in Smart Cities

Smart Cities Technology	% of Cities Adopting
Geospatial/mapping	69
Virtualization	67
Performance benchmarking	60
Transaction processing	58
Project management	57
Consolidation	57

Source: http://www.cnbc.com/2016/10/25/spending-on-smart-cities-around-the-world-could-reach-41-trillion.html

Design and Operation

Smart City - Infrastructure

- The infrastructure of the smart city includes physical, information and communication technology (ICT), and services.
- The physical infrastructure is the real physical or structural entity of the smart city including buildings, roads, railway tracks, power supply lines, and water supply system. The physical infrastructure is typically the non-smart component of the smart cities.
- The ICT infrastructure is the core smart component of the smart city which glues together all the other components in essentially acting as the nerve center of the smart city.
- Service infrastructure is based on physical infrastructure and may have some ICT components. Examples of service components include mass rapid transit system and smart grids.

Source: Mohanty 2016, CE Magazine July 2016

Smart City - Infrastructure

- The number of city facilities required as a function of city population can be calculated as follows:

$$N_f = N_p\ People\left(\frac{R_p}{Year}\right)\left(\frac{1\ Year}{D\ Days}\right)\left(\frac{1\ Hour}{N_c\ People}\right)\left(\frac{1\ Day}{H\ Hours}\right)$$

where N_f is the number of facilities, N_p is the city population in millions, R_p is the rate per person use in year/week, D is days per year, N_c is the customers per hours, and H is the hours per day.

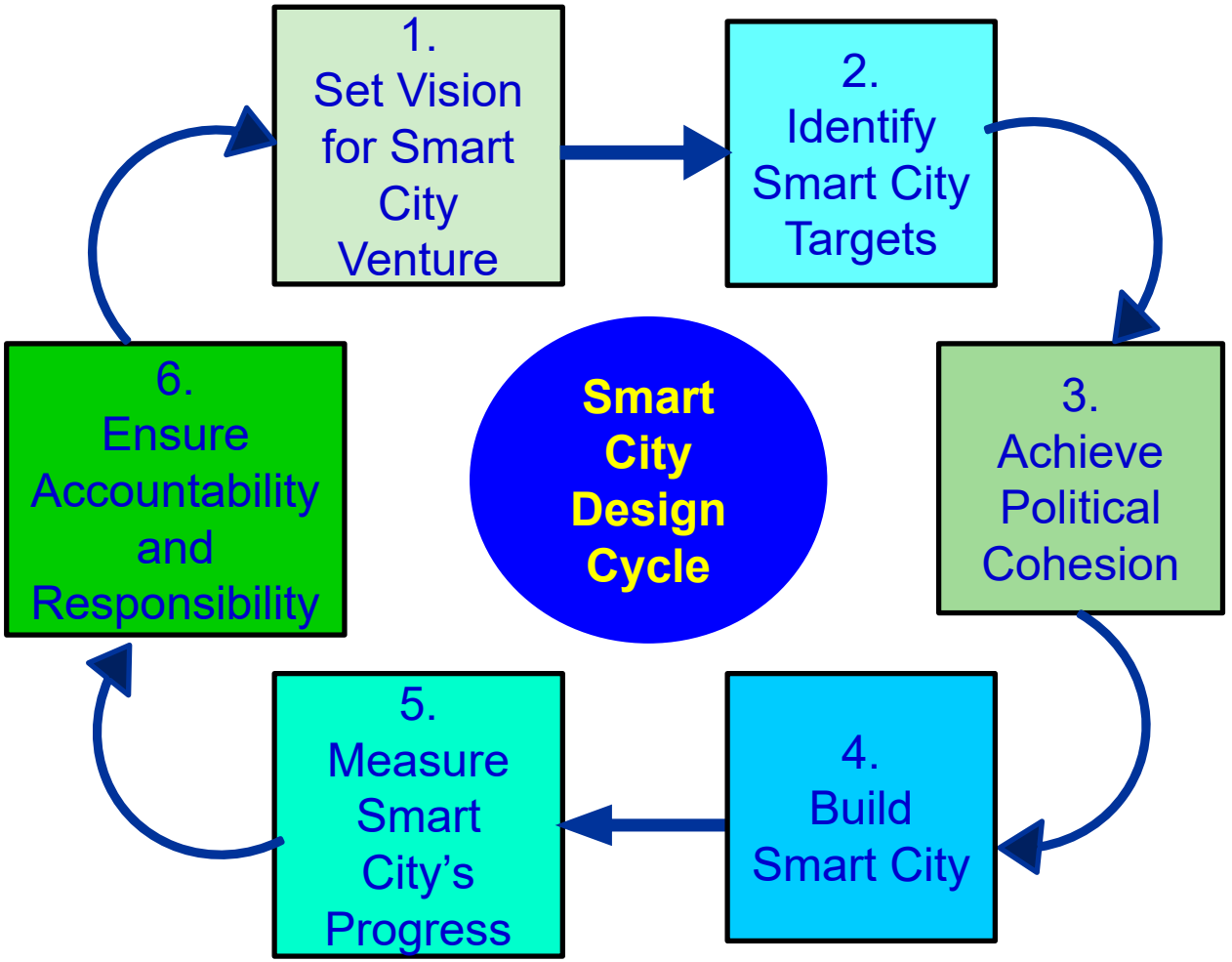
- For example: How many dental offices might there be for a city population of one million? One Solution:

$$N_f = 10^6\ People\left(\frac{1}{Year}\right)\left(\frac{1\ Year}{300\ Days}\right)\left(\frac{1\ Hour}{5\ People}\right)\left(\frac{1\ Day}{8\ Hours}\right)$$

$$= \left(\frac{10^6}{1.2\ \mathrm{x}\ 10^4}\right) \simeq 100$$

Source: Adam 2012, X and the city : modeling aspects of urban life

Smart Cities - Design Cycle



Source: Paolo Gemma 2016, ISC2 2016

Smart City Design – Vision and Target

1.
Set Vision for Smart City Venture

2.
Identify Smart City Targets

Source: Paolo Gemma 2016, ISC2 2016

Smart City Design - Stakeholders

3. Achieve Political Cohesion

4. Build Smart City

Academia, Research Organizations and Specialized Bodies

International, Regional and Multilateral Organizations

ICT Companies

City Service Companies

Utility Providers

Urban Planners

Municipalities, City Council and City Administration

Standardization Bodies

National and Regional Governments

Citizens and Citizen Organizations

Non-Governmental Organization (NGO)

Industry Associations

Source: Paolo Gemma 2016, ISC2 2016

Smart City Design - Sustainable Developmental Goals

5. Measure City's Progress

Dimensions of Key Performance Indicators (KPIs)

Environment	Society and Culture	Economy
• Air quality • Water • Noise • Biodiversity • Energy • Environmental quality	• Education • Health • Safety • Housing • Culture • Social inclusion	• Innovation • Employment • Trade • Productivity • Physical infrastructure • ICT infrastructure and Access/Usage • Public Sector

Source: Paolo Gemma 2016, ISC2 2016

Smart City Design – Building Trust

6. Ensure Accountability and Responsibility

Citizen-Centric

Smart Tools

Data-Driven Decision

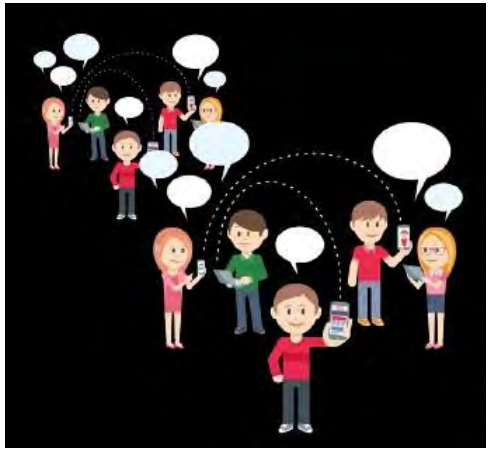
Cost Effective

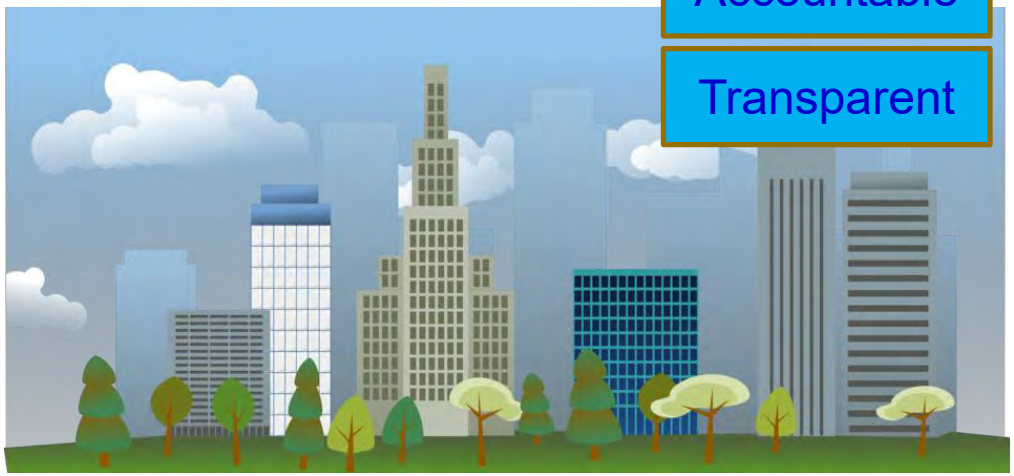
Collaborative

Responsive

Accountable

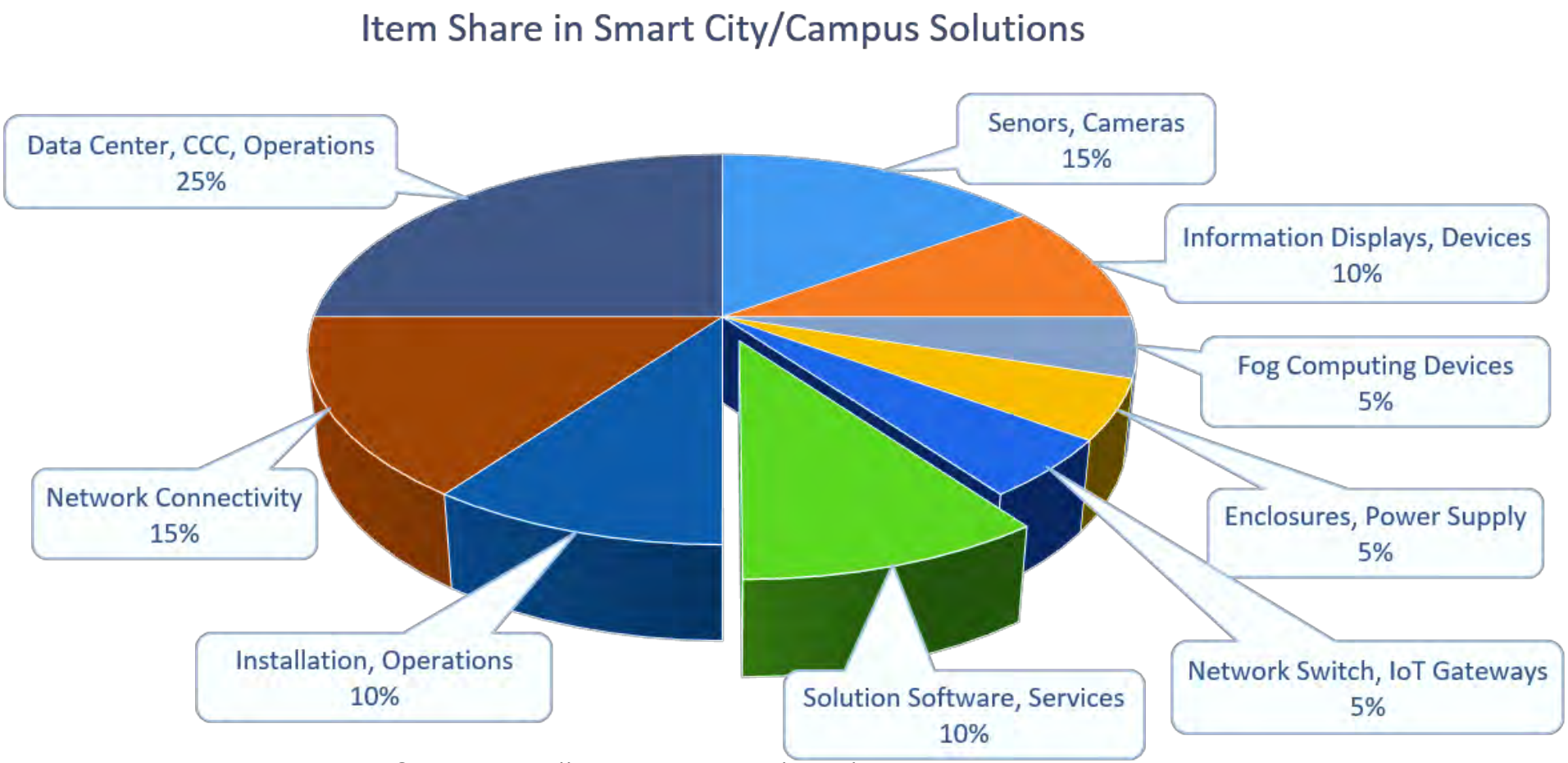
Transparent





Source: Paolo Gemma 2016, ISC2 2016

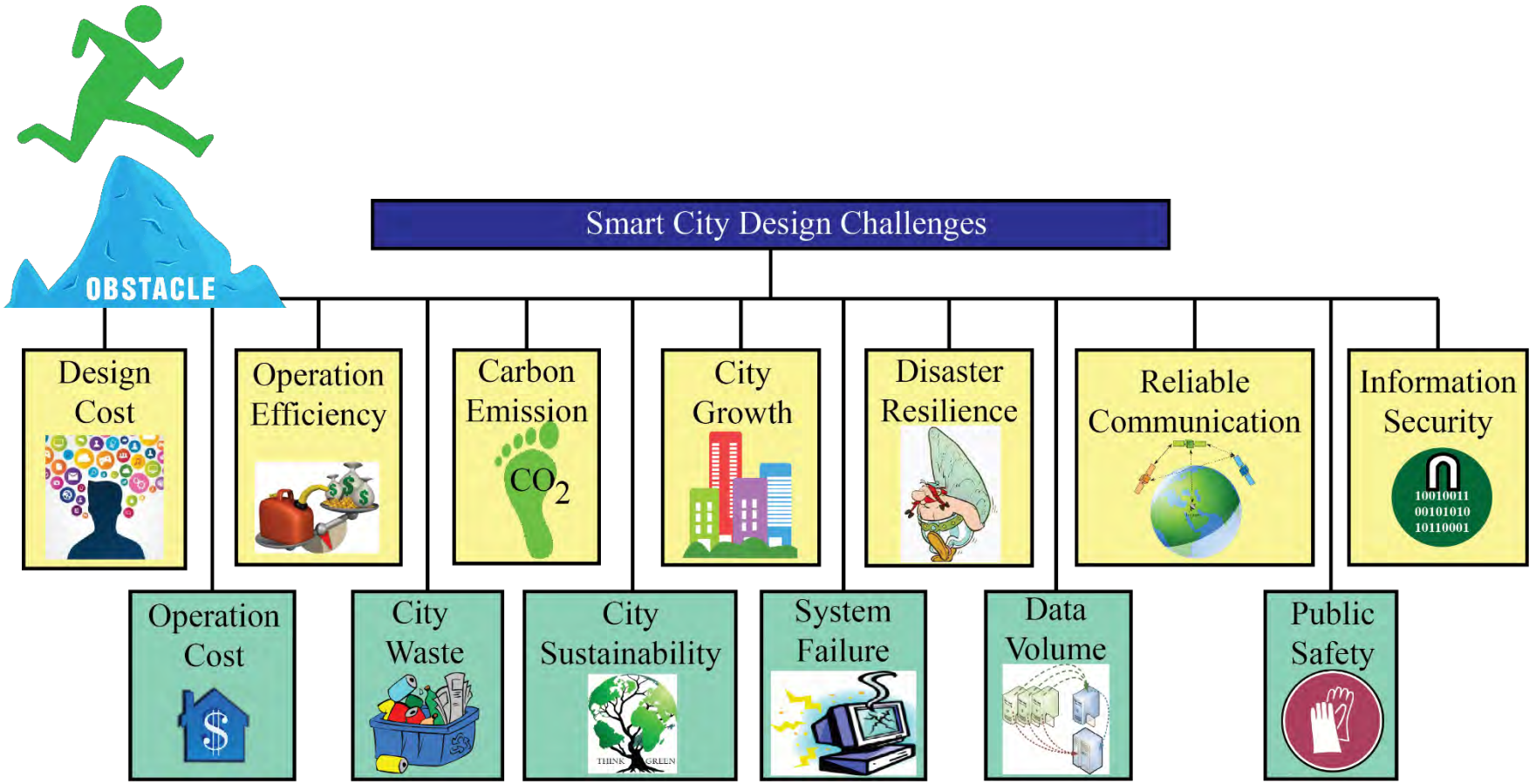
Smart City Design - Verticals



Source: https://www.linkedin.com/pulse/smart-citiescampus-what-could-your-share-suresh-kumar-kk

Challenges and Research

Smart City - Selected Design Challenges



Source: Mohanty 2016, CE Magazine July 2016

Design and Operation Cost

- The design cost is a one-time cost.
- Design cost needs to be small to make a IoT realization possible.
- The operations cost is that required to maintain the IoT.
- A small operations cost will make it easier to operate in the long run with minimal burden on the budget of application in which IoT is deployed.

Source: http://www.industrialisation-produits-electroniques.fr

"Cities around the world could spend as much as $41 trillion on smart tech over the next 20 years."

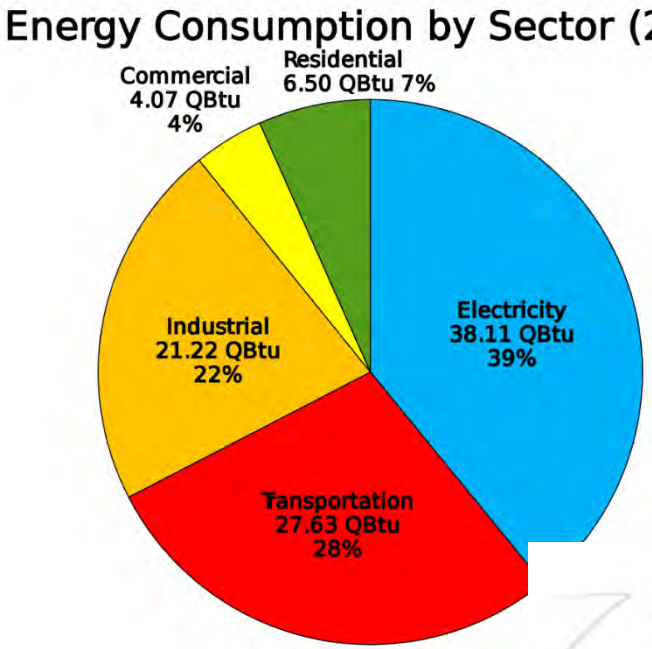
Source: http://www.cnbc.com/2016/10/25/spending-on-smart-cities-around-the-world-could-reach-41-trillion.html

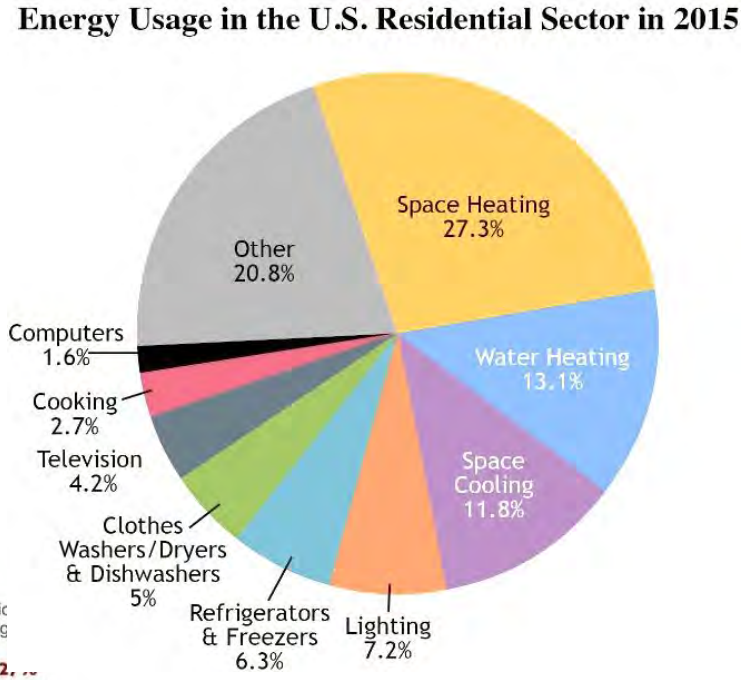
Cost - Technology

Smart Cities Technology	% Net Increase in All Cities
Cloud apps	86
Mobile devices	66.6
Business applications	61.9
Outsourcing	53.8
Security & privacy	53.8

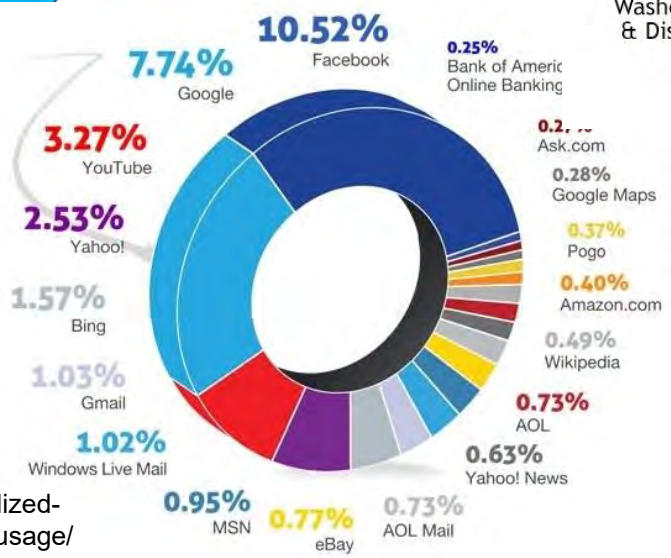
Source: http://www.cnbc.com/2016/10/25/spending-on-smart-cities-around-the-world-could-reach-41-trillion.html

Energy Consumption





Data Center
Power Usage

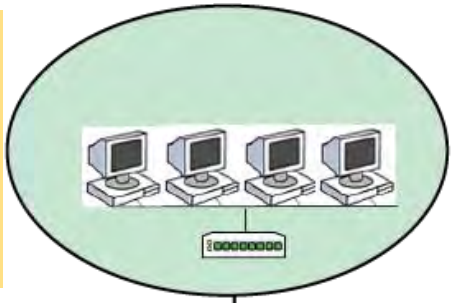


Individual Level:
Imagine how often we charge our portable CE!

Source:
https://www.engadget.com/2011/04/26/visualized-ring-around-the-world-of-data-center-power-usage/

Energy Consumption Challenge in IoT

Energy from Supply/Battery - Energy consumed by Workstations, PC, Software, Communications



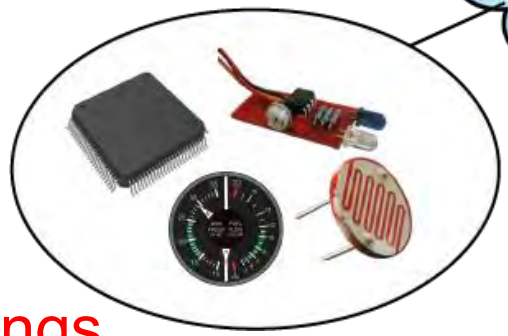
Local Area Network (LAN)

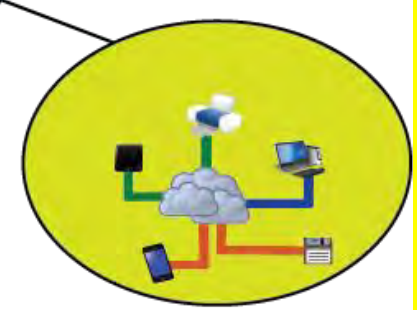
Energy from Supply/Battery - Energy consumed by Communications

Battery Operated - Energy consumed by Sensors, Actuators, Microcontrollers

Internet

The Cloud





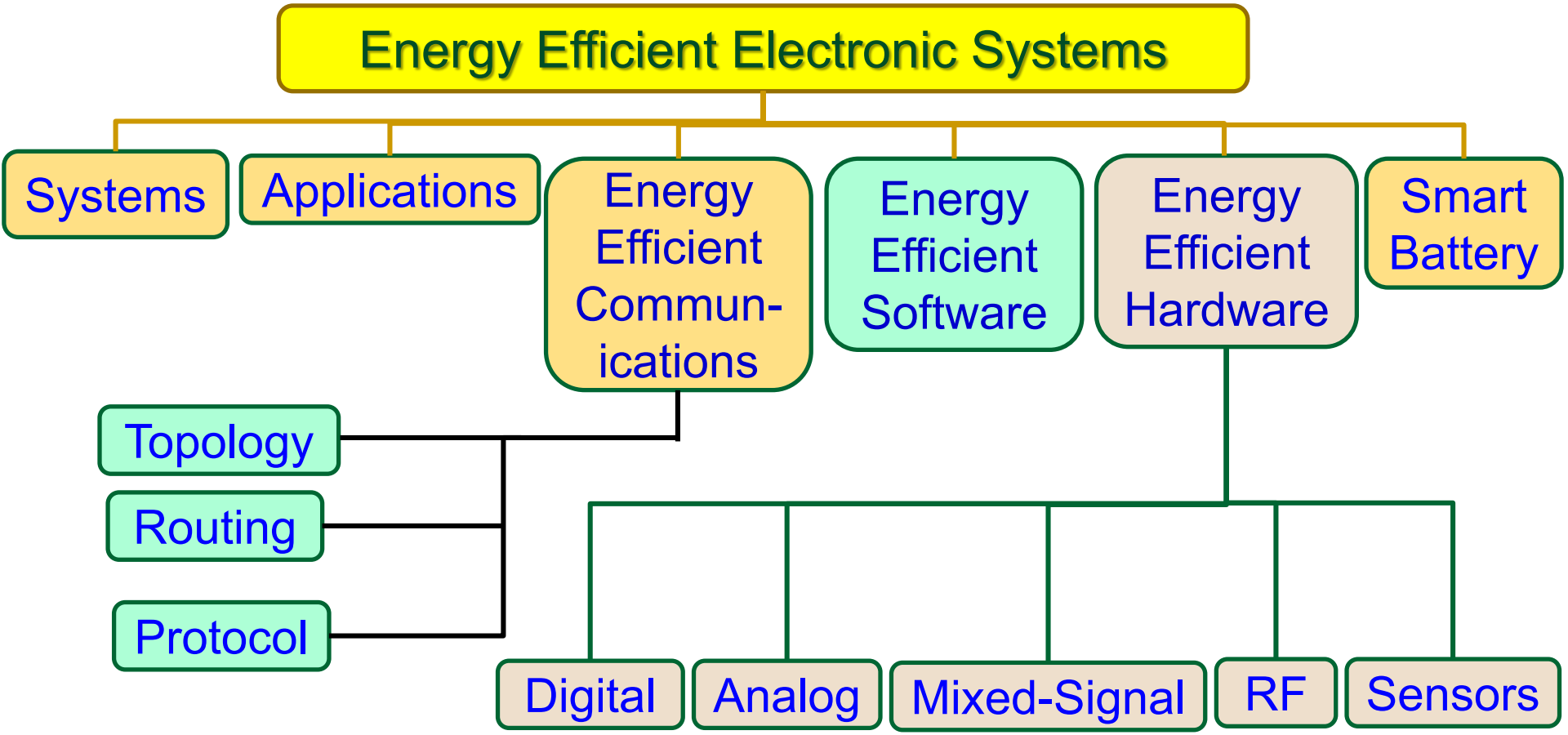
Energy from Supply - Energy consumed in Server, Storage, Software, Communications

The Things

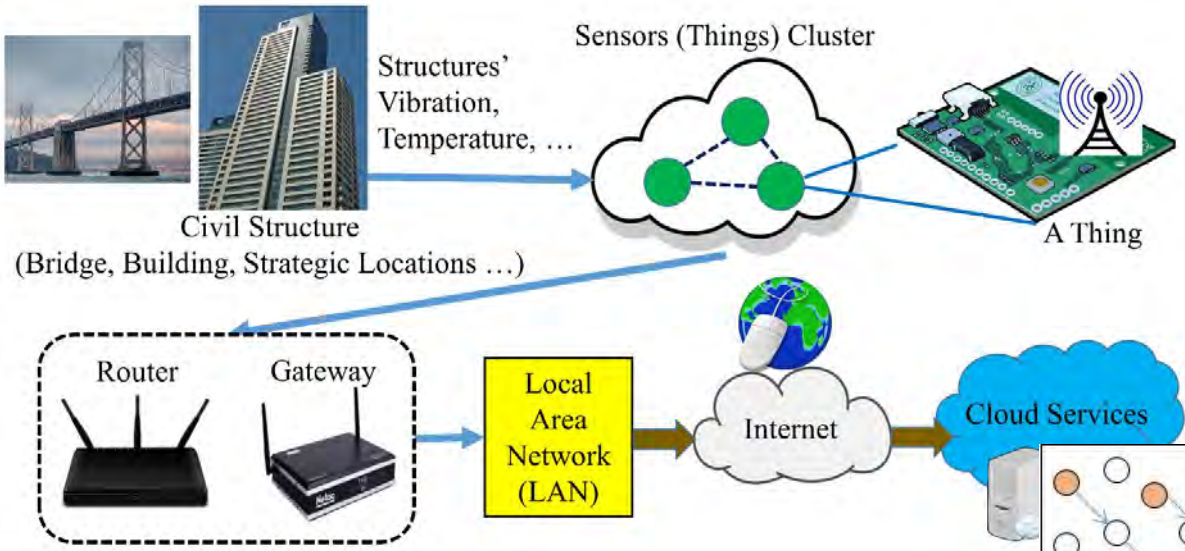
Four Main Components of IoT.

Source: Mohanty 2016, EuroSimE 2016 Keynote Presentation

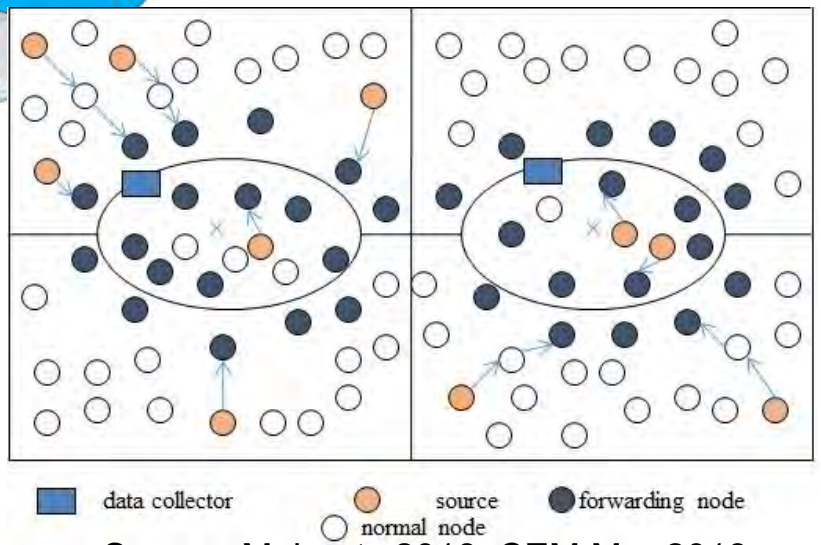
Energy Efficient Electronic Systems: Possible Solution Fronts



Sustainable IoT – Low-Power Sensors and Efficient Routing

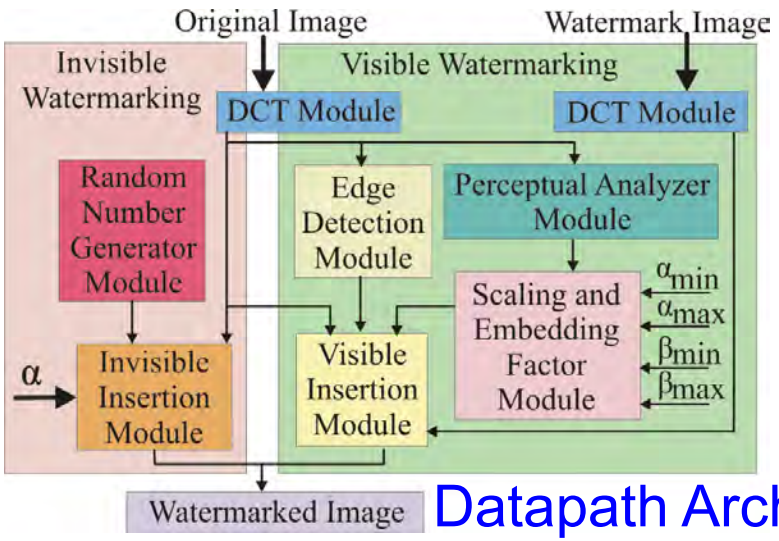


- IoT - sensors near the data collector drain energy faster than other nodes.
- Solution Idea - Mobile sink in which the network is balanced with node energy consumption.
- Solution Need: New data routing to forward data towards base station using mobile data collector, in which two data collectors follow a predefined path.

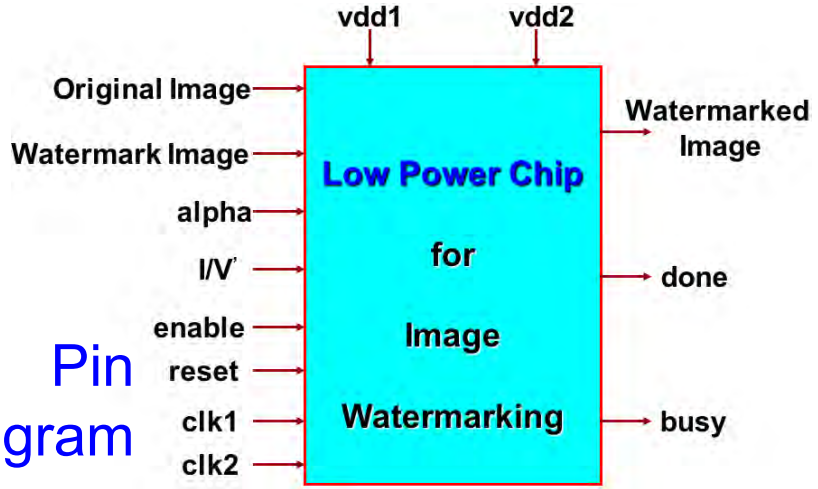


Source: Mohanty 2018, CEM Mar 2018

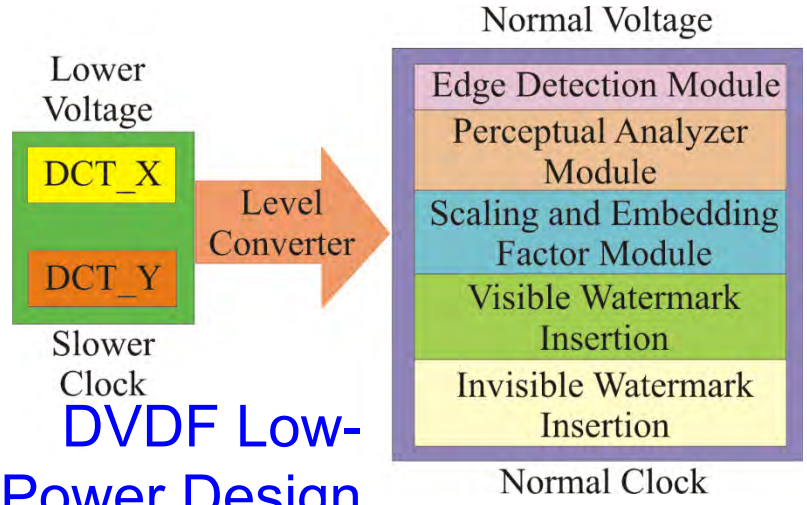
Dual-Voltage/Frequency Based Hardware



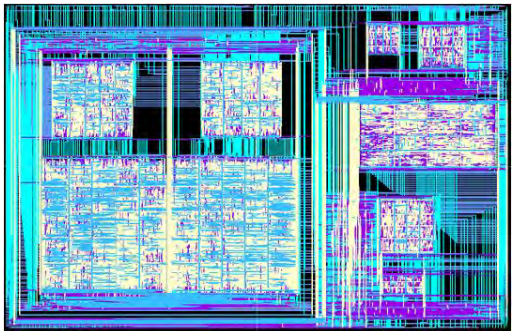
Datapath Architecture



Pin Diagram



DVDF Low-Power Design



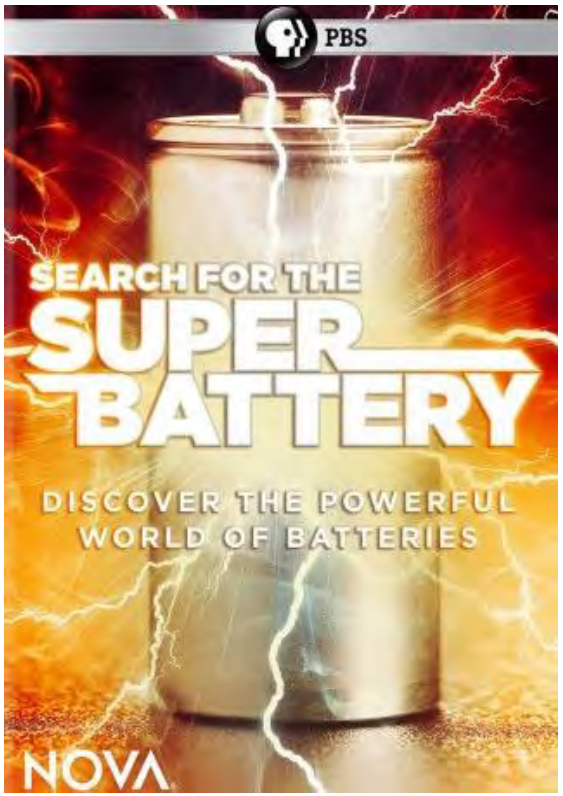
Hardware Layout

Physical Design Data
Total Area : 16.2 sq mm
No. of Transistors: 1.4 million
Power Consumption: 0.3 mW

Source: Mohanty 2006, TCASII May 2006

Energy Storage - High Capacity and Efficiency Needed

Battery	Conversion Efficiency
Li-ion	80% - 90%
Lead-Acid	50% - 92%
NiMH	66%



Intelligent Battery

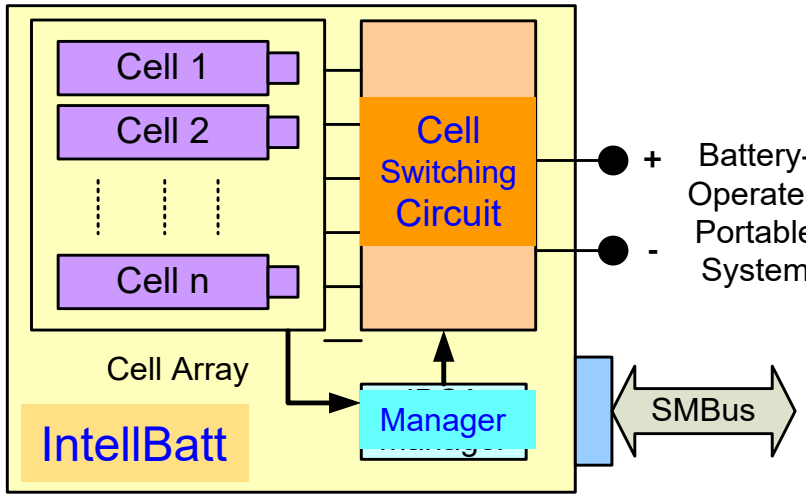


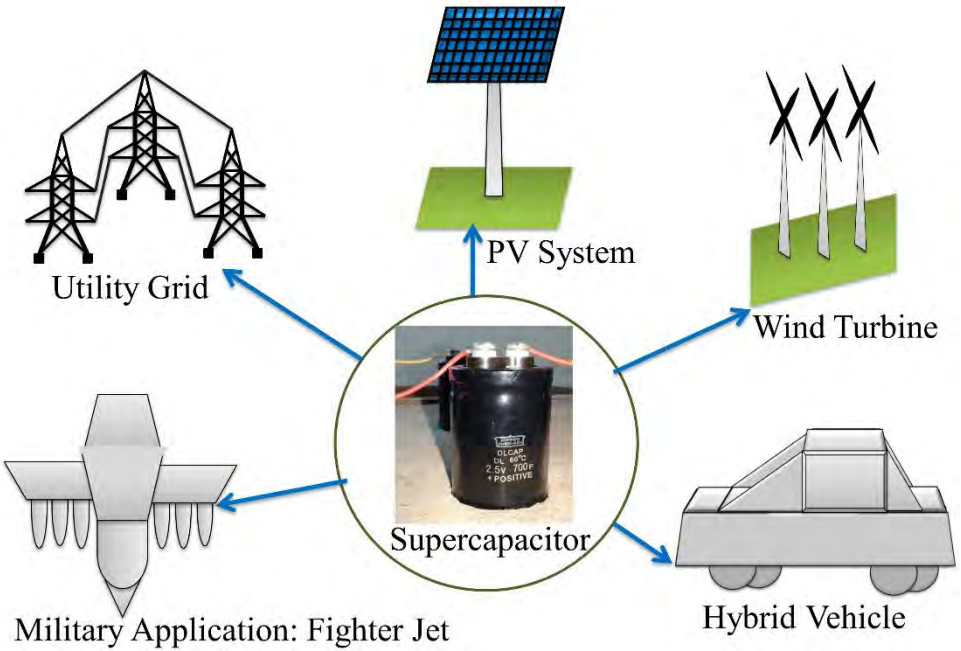
Figure 1: IntellBatt Architecture

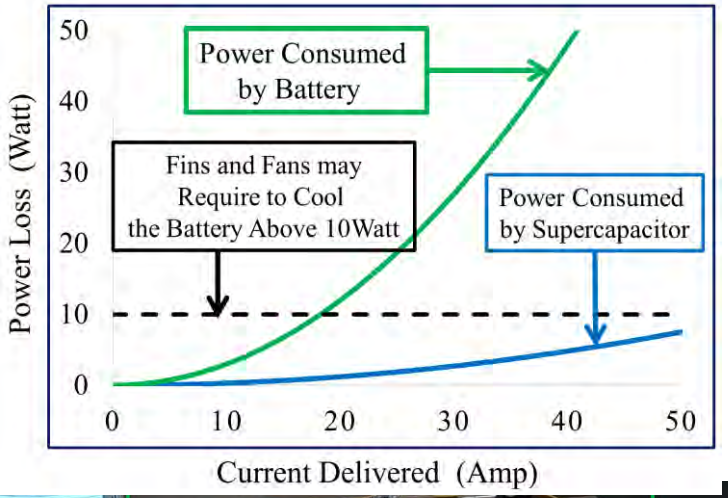
Mohanty 2010: IEEE Computer, March 2010.
Mohanty 2018: ICCE 2018

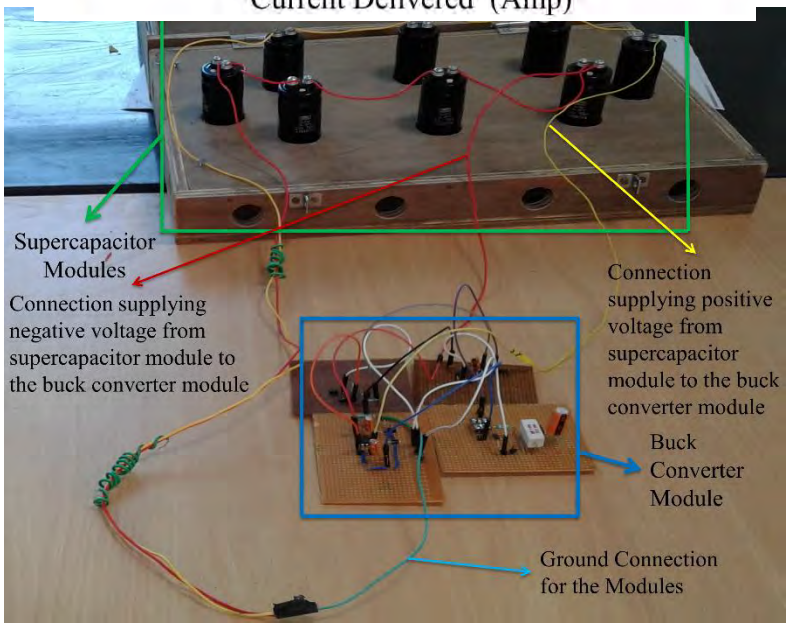
Lithium Polymer Battery

Supercapacitor

Supercapacitor based Power for CE







Source: Mohanty 2018, CEM Sep 2018

Cyber Attacks

September 2017: Cybersecurity incident at Equifax affected 143 million U.S. consumers.

Hacked: US Department Of Justice

Who did it: Unknown

What was done: Information on 10,000 DHS and 20,000 FBI employees.

Details: The method of the attack is still a mystery and it's been said that it took a week for the DOJ to realize that the info had been stolen.

February 2016

Hacked: Yahoo #2

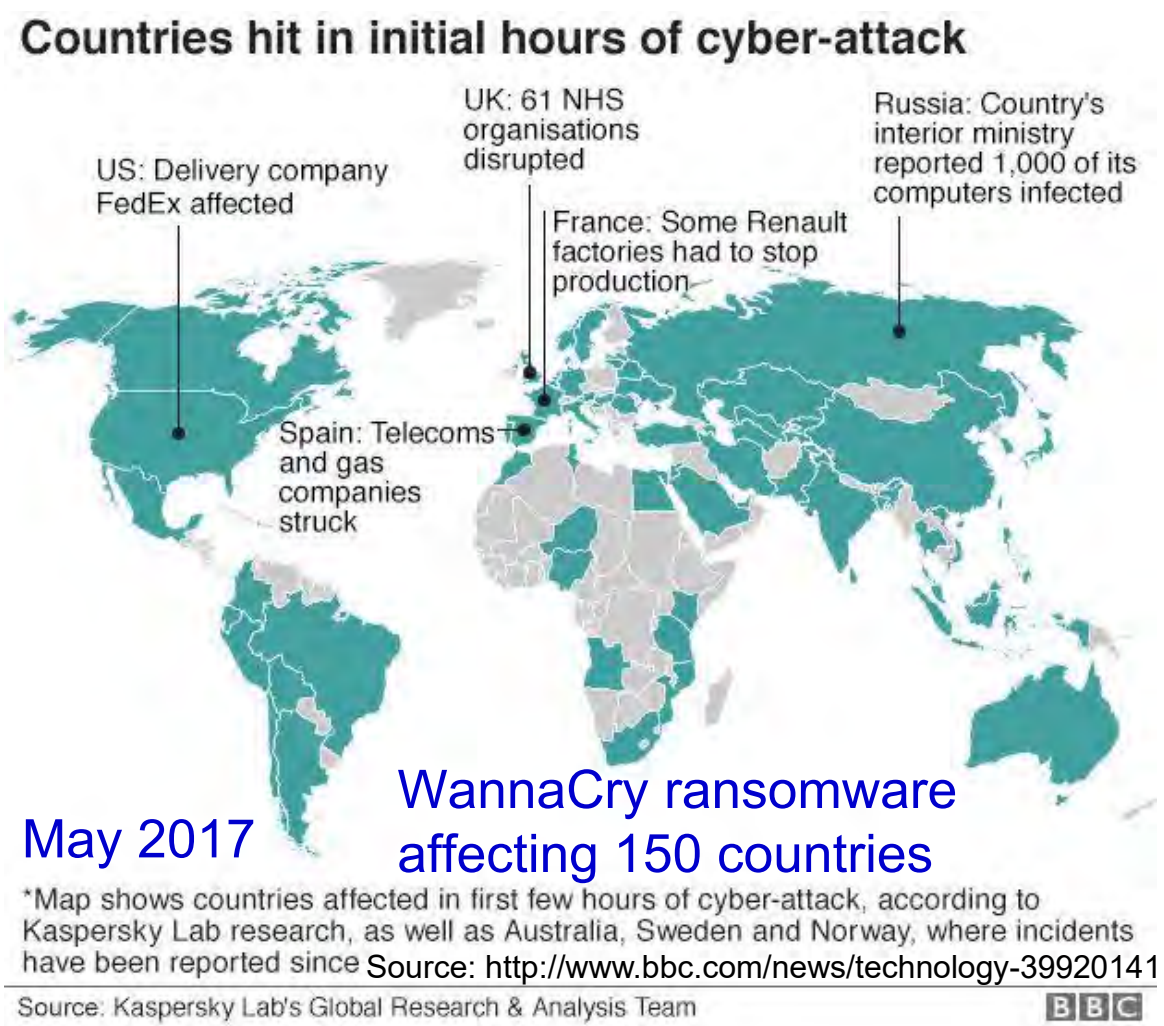
YAHOO!

Who did it: Unknown

What was done: 1 billion accounts were compromised.

Details: Users names, email addresses, date of birth, passwords, phone numbers, and security questions were all taken.

December 2016



May 2017

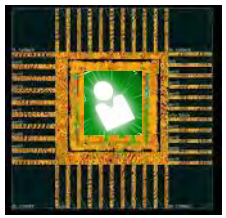
WannaCry ransomware affecting 150 countries

Source: http://www.bbc.com/news/technology-39920141

Source: https://www.forbes.com/sites/kevinanderton/2017/03/29/8-major-cyber-attacks-of-2016-infographic/#73bb0bee48e3

Security, Privacy, and IP Rights

Hardware Trojan



Counterfeit Hardware

Source: Mohanty ICIT 2017 Keynote

Security Challenge – Information

Online Banking

...

Credit Card Theft

Hacked: Linkedin, Tumbler, & Myspace

LinkedIn tumblr. myspace

Who did it: A hacker going by the name Peace.

What was done: 500 million passwords were stolen.

Details: Peace had the following for sale on a Dark Web Store:

- 167 million Linkedin passwords
- 360 million Myspace passwords
- 68 million Tumbler passwords
- 100 million VK.com passwords
- 71 million Twitter passwords

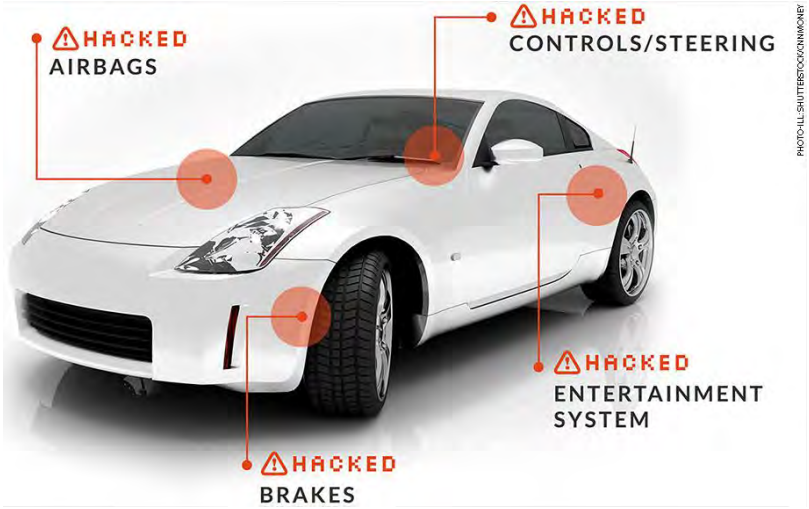
Personal Information

Credit Card/Unauthorized Shopping

Security Challenge - System …

Power Grid Attack

Source: http://www.csoonline.com/article/3177209/security/why-the-ukraine-power-grid-attacks-should-raise-alarm.html



Source: http://money.cnn.com/2014/06/01/technology/security/car-hack/

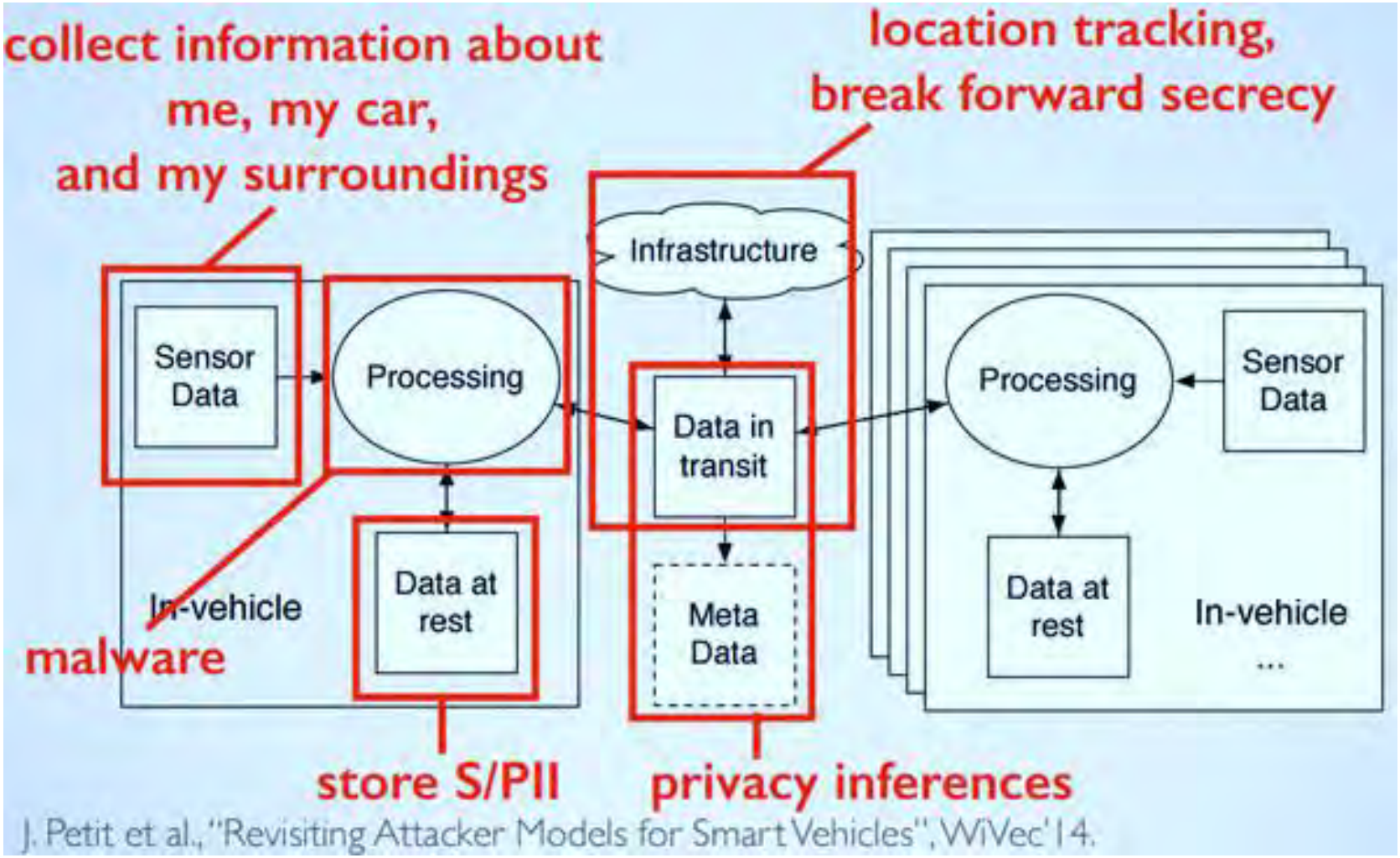
Source: http://politicalblindspot.com/u-s-drone-hacked-and-hijacked-with-ease/

Privacy Challenge - Information

Source: http://ciphercloud.com/three-ways-pursue-cloud-data-privacy-medical-records/

Source: http://blog.veriphyr.com/2012/06/electronic-medical-records-security-and.html

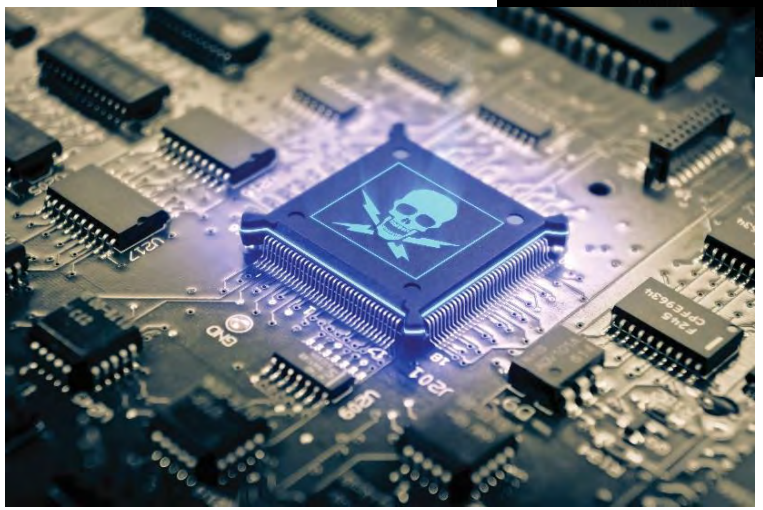
Privacy Challenge – System, Smart Car



Source: http://www.computerworld.com/article/3005436/cybercrime-hacking/black-hat-europe-it-s-easy-and-costs-only-60-to-hack-self-driving-car-sensors.html

Ownership - Media, Hardware, Software

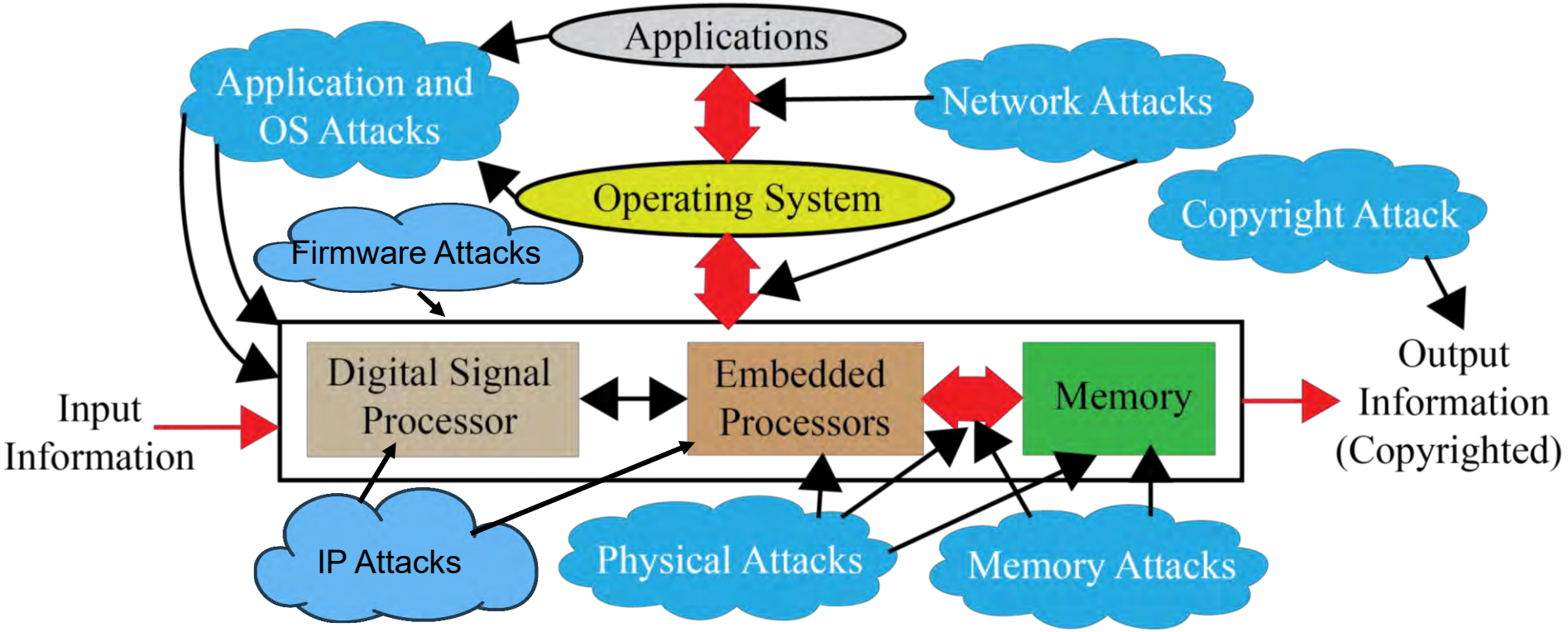
Media Piracy



Hardware Piracy → Counterfeit Hardware

Software Piracy

Selected Attacks on a CE System – Security, Privacy, IP Rights

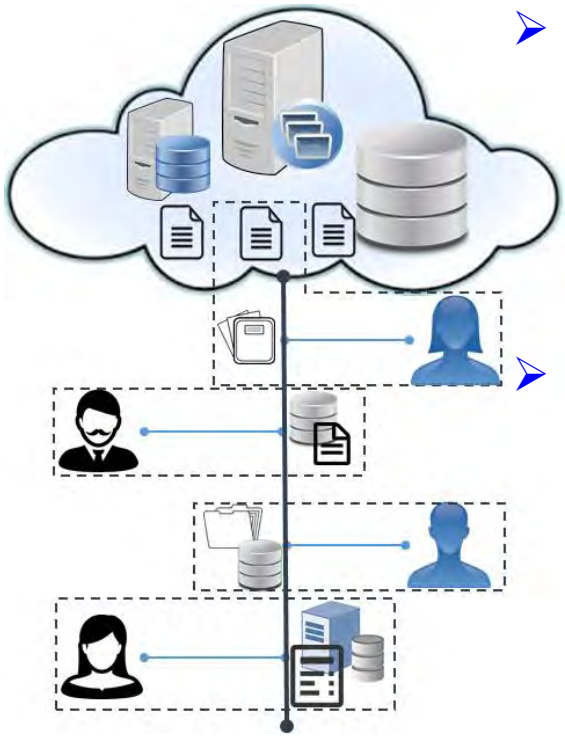


Diverse forms of Attacks, following are not the same: System Security, Information Security, Information Privacy, System Trustworthiness, Hardware IP protection, Information Copyright Protection.

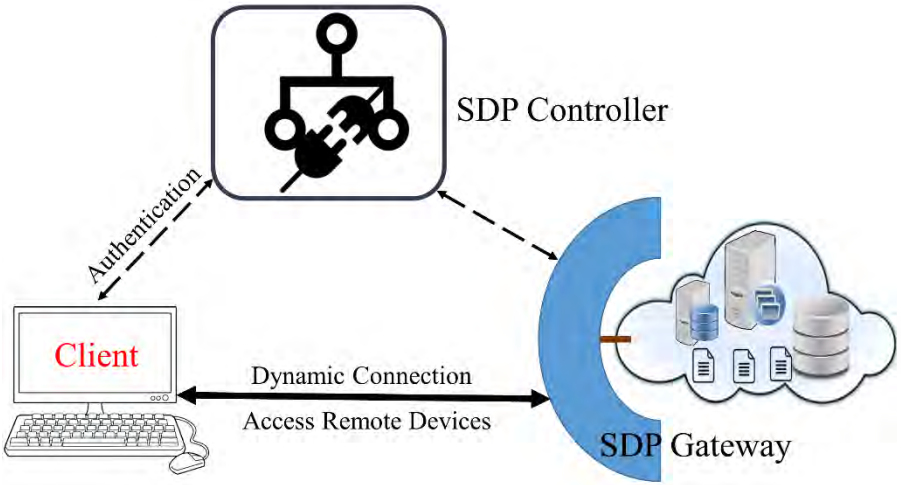
IoT Security - Software Defined Perimeter (SDP)

TCP/IP based security | Traditional | Connect First and then Authenticate

Software-Defined Perimeter | Advanced | Authenticate First and then Connect

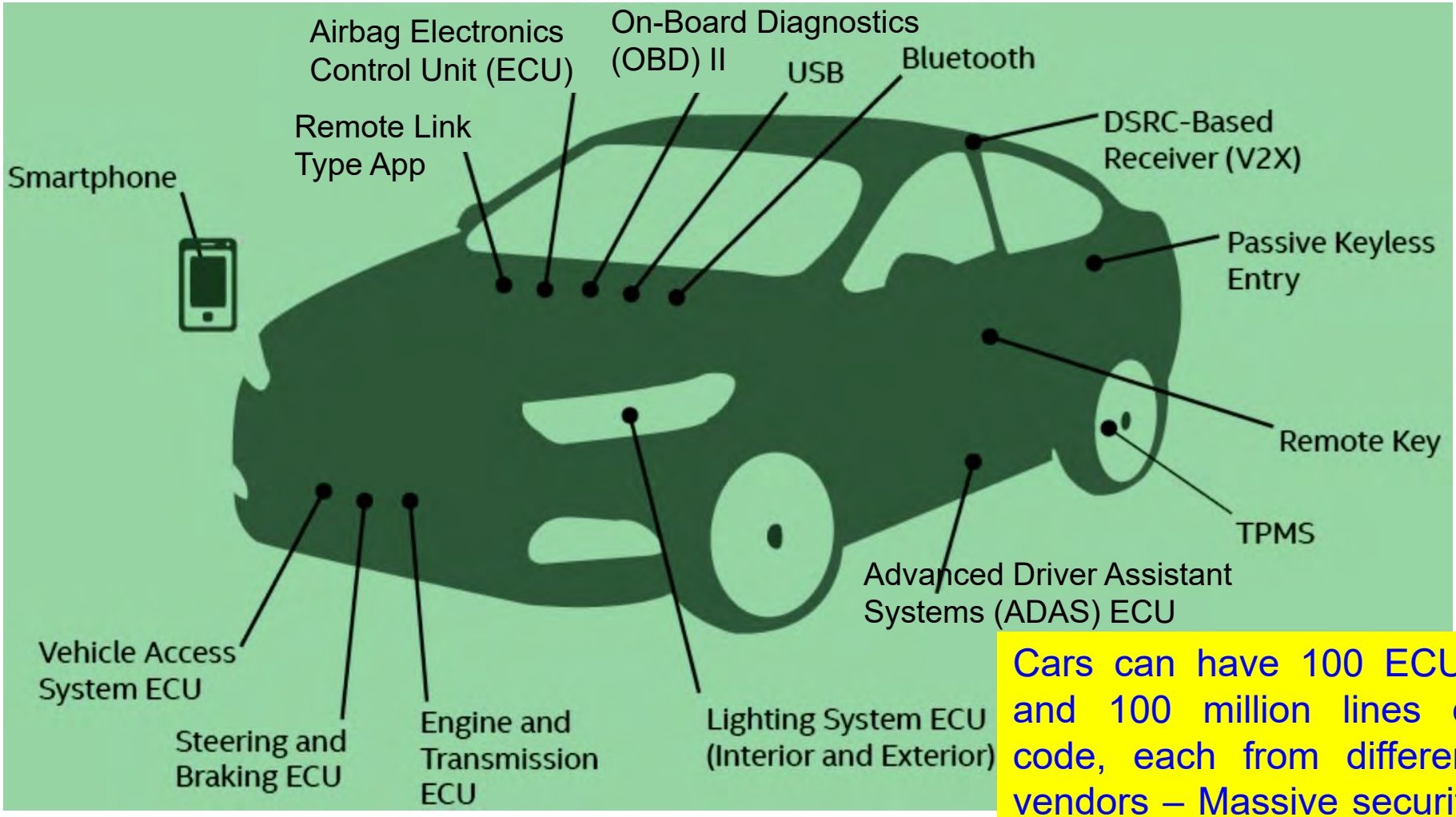


- SDP creates a cryptographic perimeter from a source device to the edges and cloud data center.
- SDP provides user-centric security solution by creating a perimeter to enclose source and destination within the perimeter.



Source: Puthal, Mohanty 2017, CEM Oct 2017

Smart Car – Security Venerability

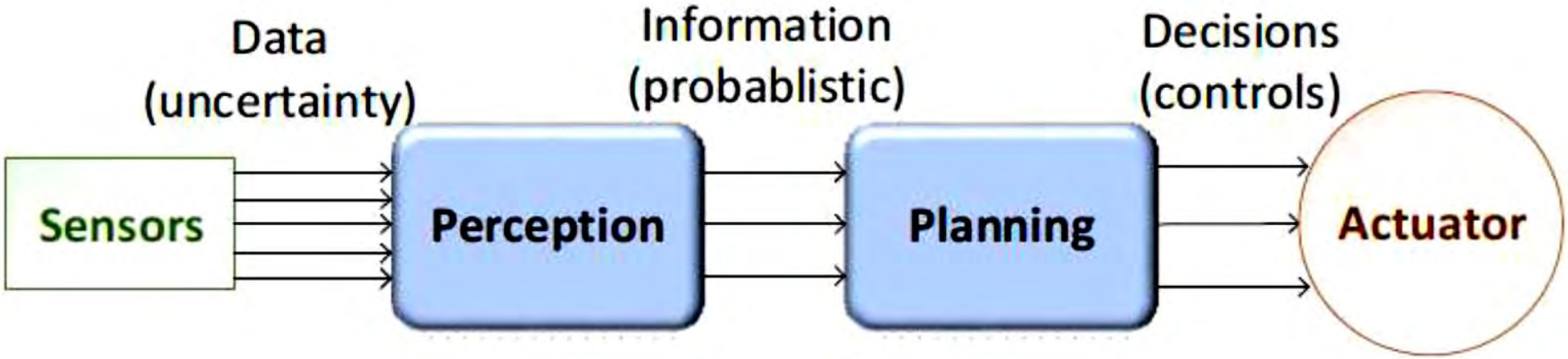


Cars can have 100 ECUs and 100 million lines of code, each from different vendors – Massive security issues.

Source: https://www.mcafee.com/us/resources/white-papers/wp-automotive-security.pdf

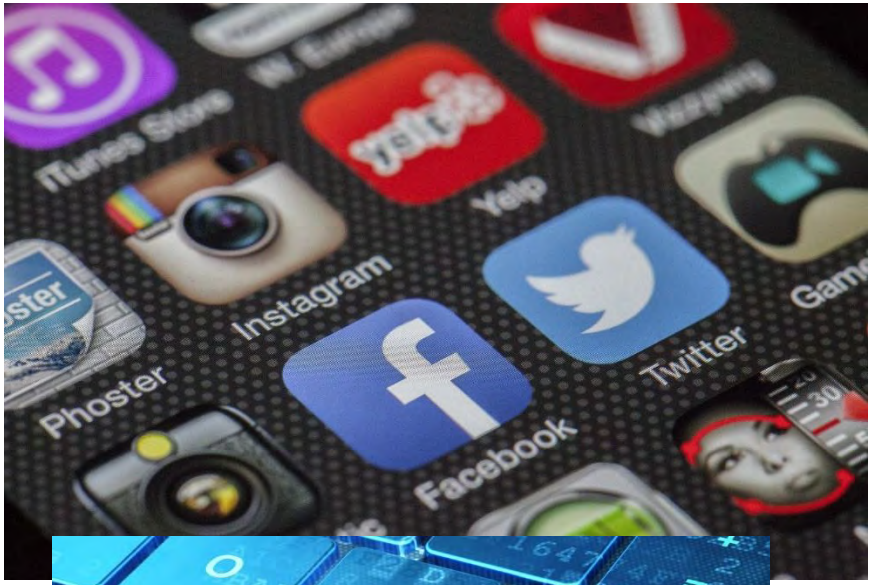
Smart Car – Decision Chain

- Designing an AV requires decision chains.
- Human driven vehicles are controlled directly by a human.
- AV actuators controlled by algorithms.
- Decision chain involves sensor data, perception, planning and actuation.
- Perception transforms sensory data to useful information.
- Planning involves decision making.



Source: Plathottam 2018, COMSNETS 2018

Privacy



Source: http://ciphercloud.com/three-ways-pursue-cloud-data-privacy-medical-records/

Source: http://blog.veriphyr.com/2012/06/electronic-medical-records-security-and.html

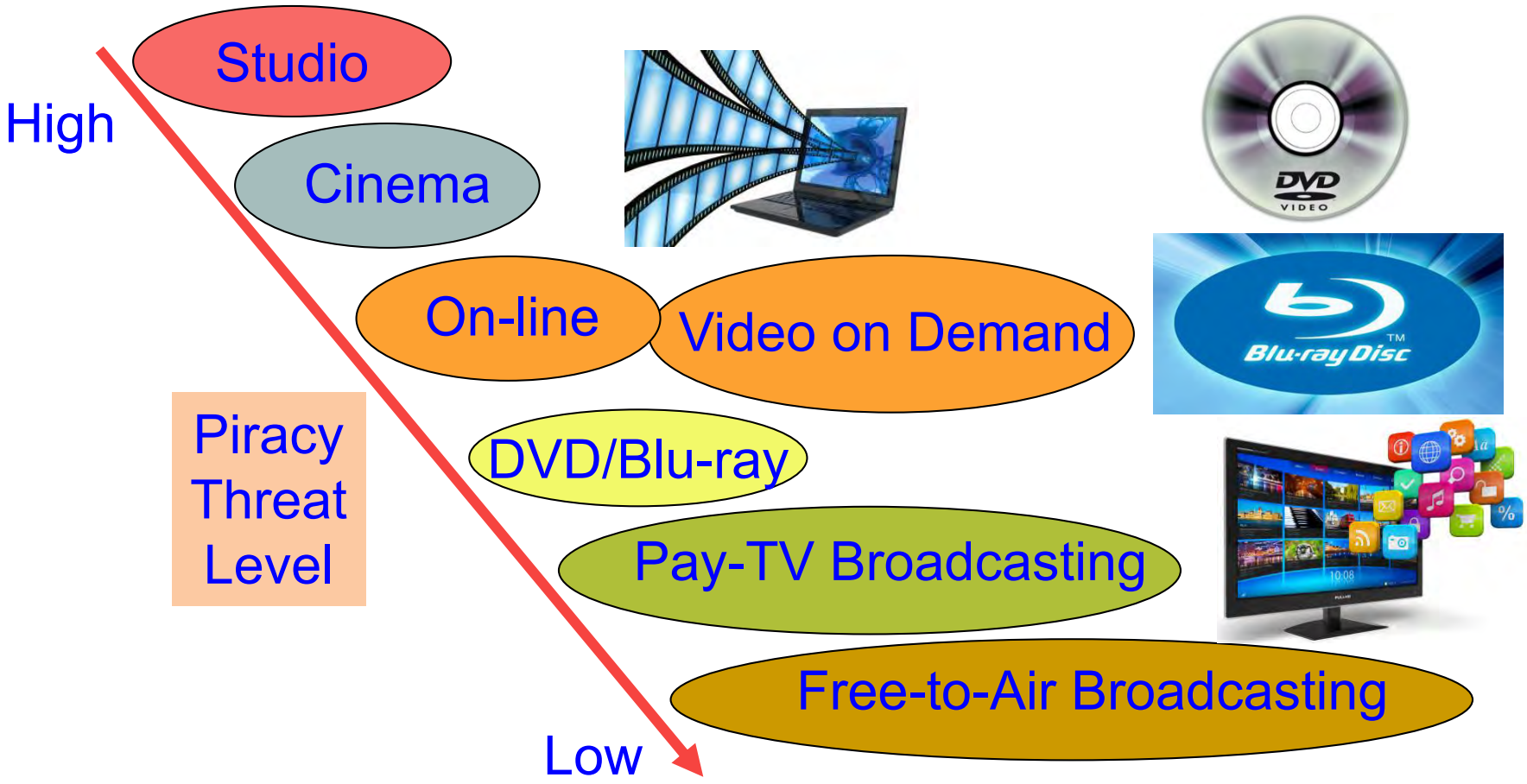
Copyright - Media, Hardware, Software

Media Piracy


Hardware Piracy → Counterfeit Hardware

Software Piracy

Media Piracy – Movie/Video



"Film piracy cost the US economy $20.5 billion annually."

Source: http://www.ipi.org/ipi_issues/detail/illegal-streaming-is-dominating-online-piracy

Counterfeit Hardware Challenge

2014 Analog Hardware Market (Total Shipment Revenue US $)

Wireless Market
$18.9 billion (34.8%)

Consumer Electronics
$9.0 billion (16.6%)

Industrial Electronics
$8.9 billion (16.5%)

Automotive
$8.5 billion (15.7%)

Data Processing
$6.0 billion (11%)

Wired Communications
$2.9 billion (5.4%)

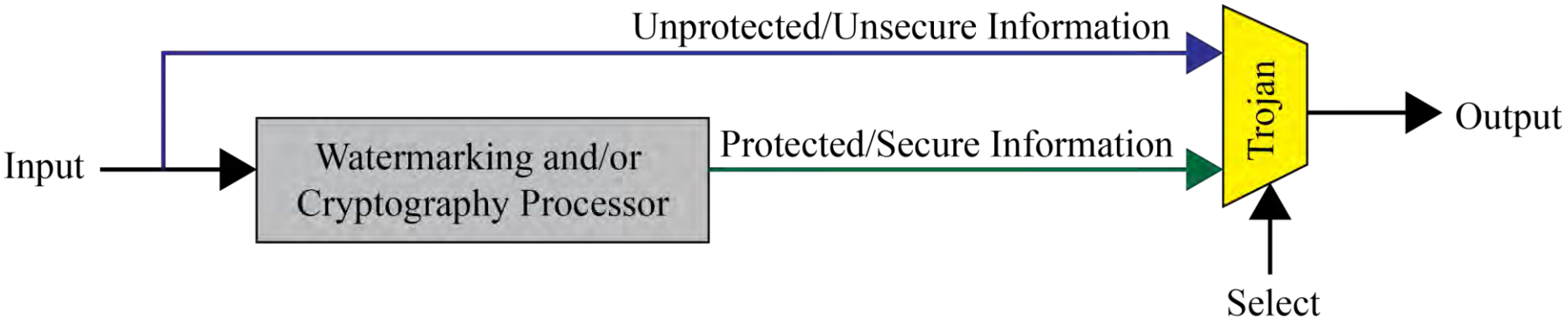
Source: https://www.slideshare.net/rorykingihs/ihs-electronics-conference-rory-king-october

Top counterfeits could have impact of $300B on the semiconductor market.

Malicious Design Modifications Issue

Information may bypass giving a non-watermarked or non-encrypted output.

Hardware Trojans



Source: Mohanty 2015, McGraw-Hill 2015

Provide backdoor to adversary.
Chip fails during critical needs.

Trojan Secure Digital Hardware Synthesis

Architecture Module Library Comprising of Modules Info from Different Vendors

Datapath Resource configuration (R_n)

Vendor Allocation Type (A_v)

Unrolling Factor (U)

Trojan Detection Block

Dual Modular Redundant (DMR) Scheduling

Modified Allocation in DMR based on Distinct Vendor Rule

PSO-Driven Exploration for Optimizing Independent Factors Simultaneously

Optimizing Datapath Configuration

Optimizing Vendor Allocation Type

Optimizing Unrolling Factor

Binding

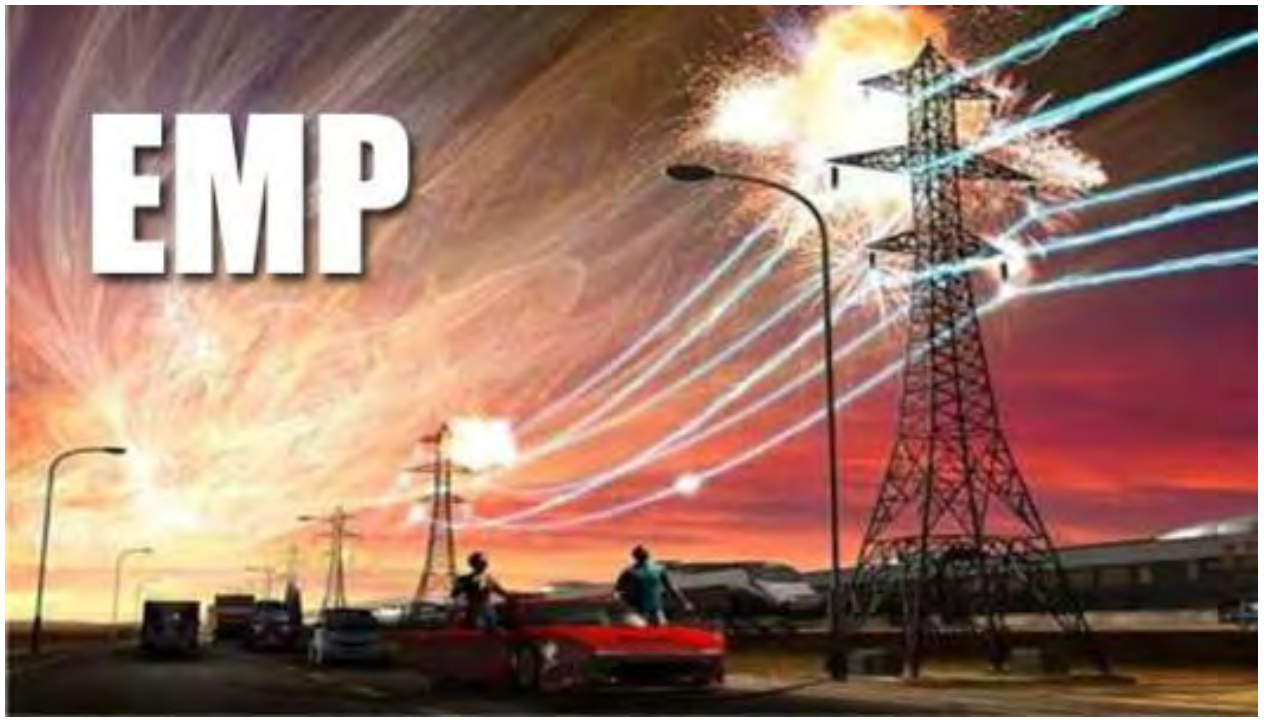
Cost Evaluation

Provide backdoor to adversary. Chip fails during critical needs.

Low Cost Trojan Secured Datapath

Source: Sengupta, Mohanty 2017: TCAD April 2017

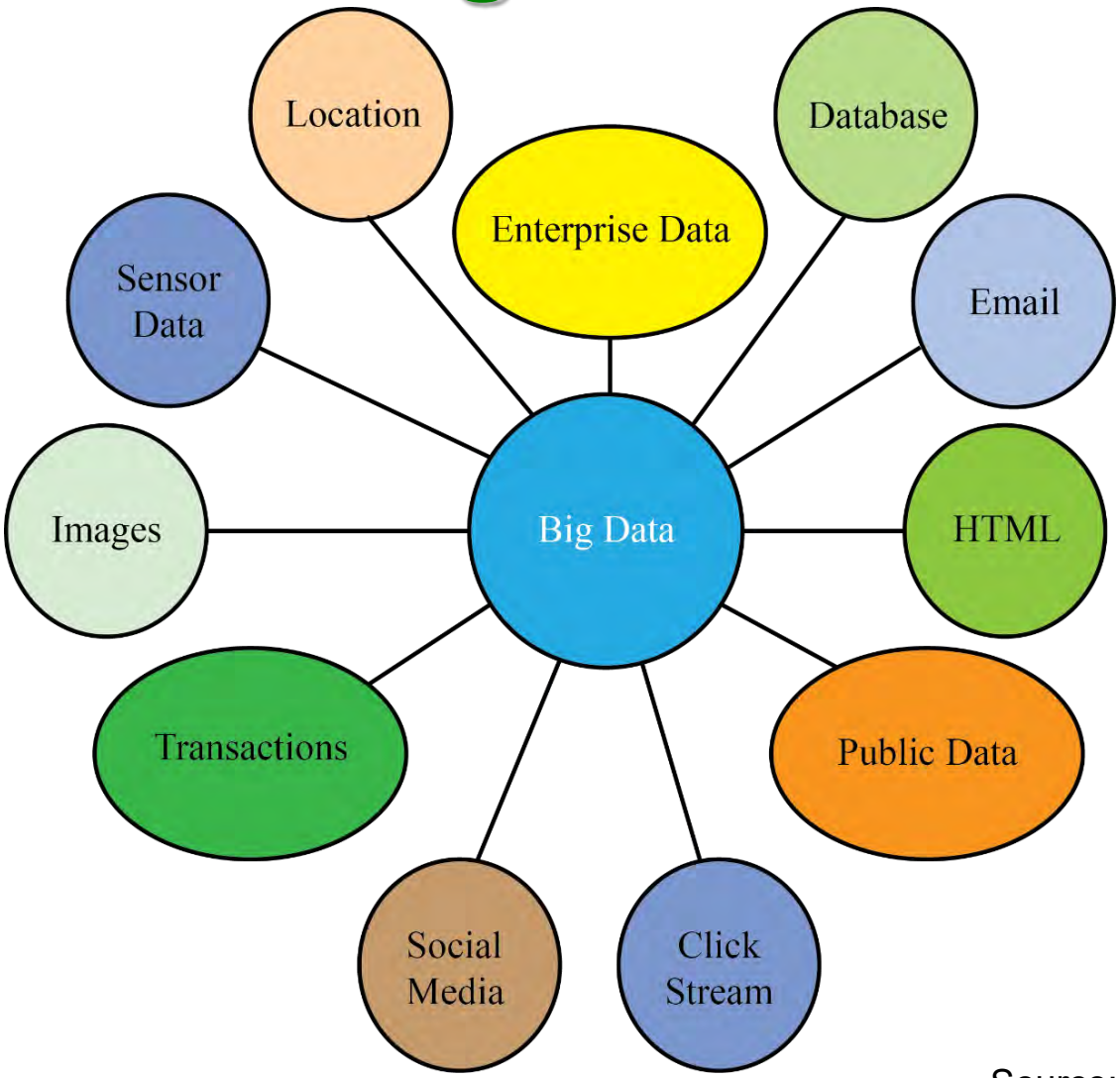
Electromagnetic Pulse (EMP) Attack



- An electromagnetic pulse (EMP) is the electric wave produced by nuclear blasts which can knocking out electronics and the electrical grid as far as 1,000 miles away.
- The disruption could cause catastrophic damage and loss of life if power is not restored or backed up quickly.

Source: http://bwcentral.org/2016/06/an-electromagnetic-pulse-emp-nuclear-attack-may-end-modern-life-in-america-overnight/

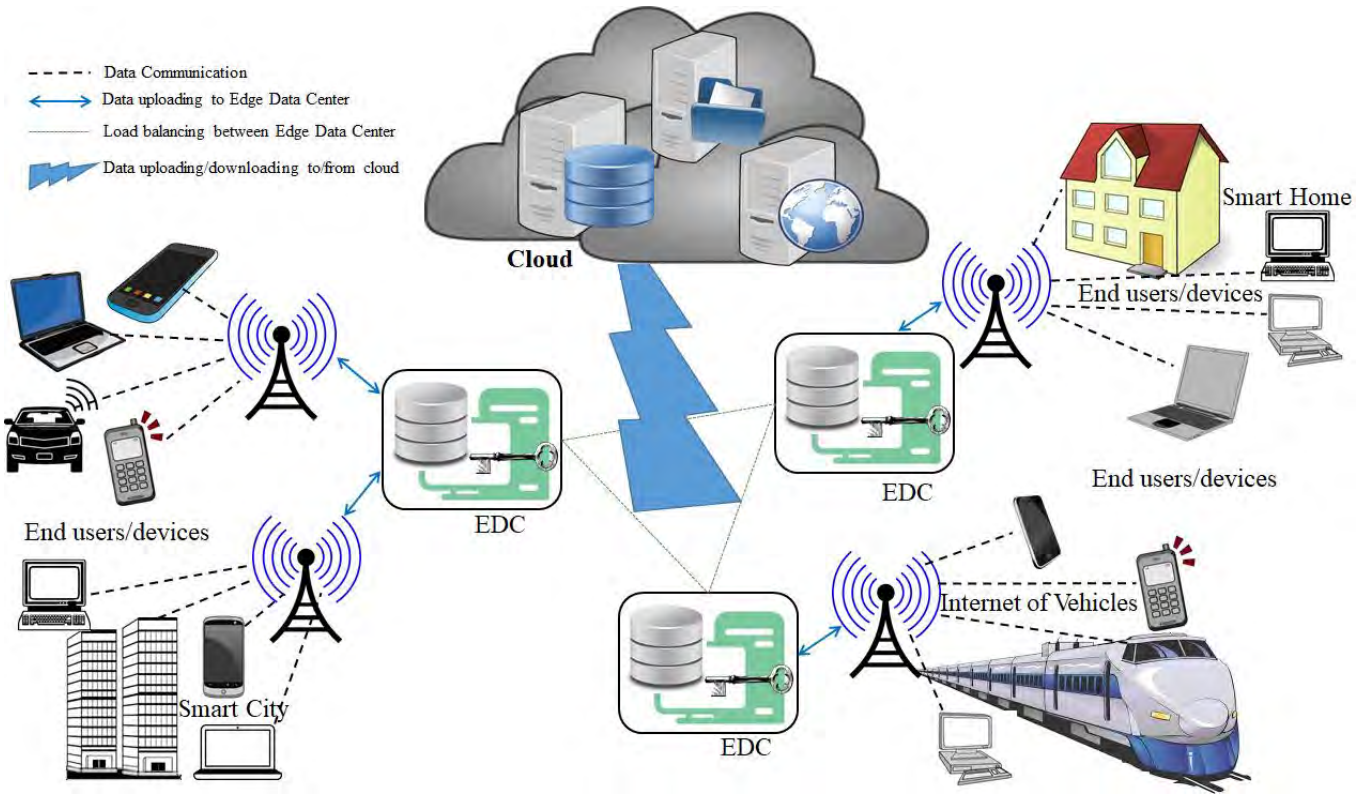
Bigdata in Smart Cities

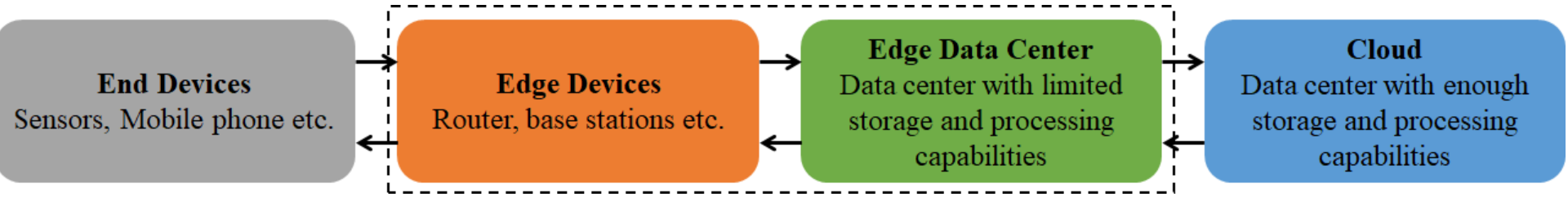


Sensors, social networks, web pages, image and video applications, and mobile devices generate more than 2.5 quintillion bytes data per day.

Source: Mohanty 2016, CE Magazine July 2016

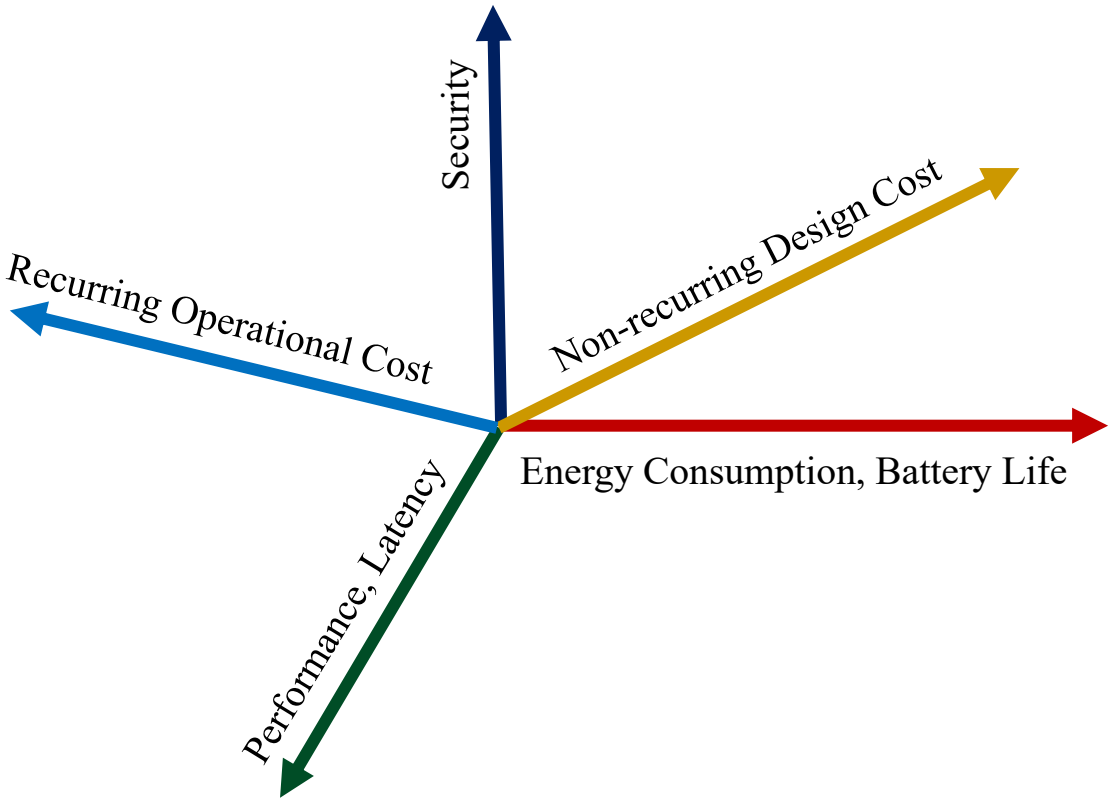
Big Data - Edge Datacenter



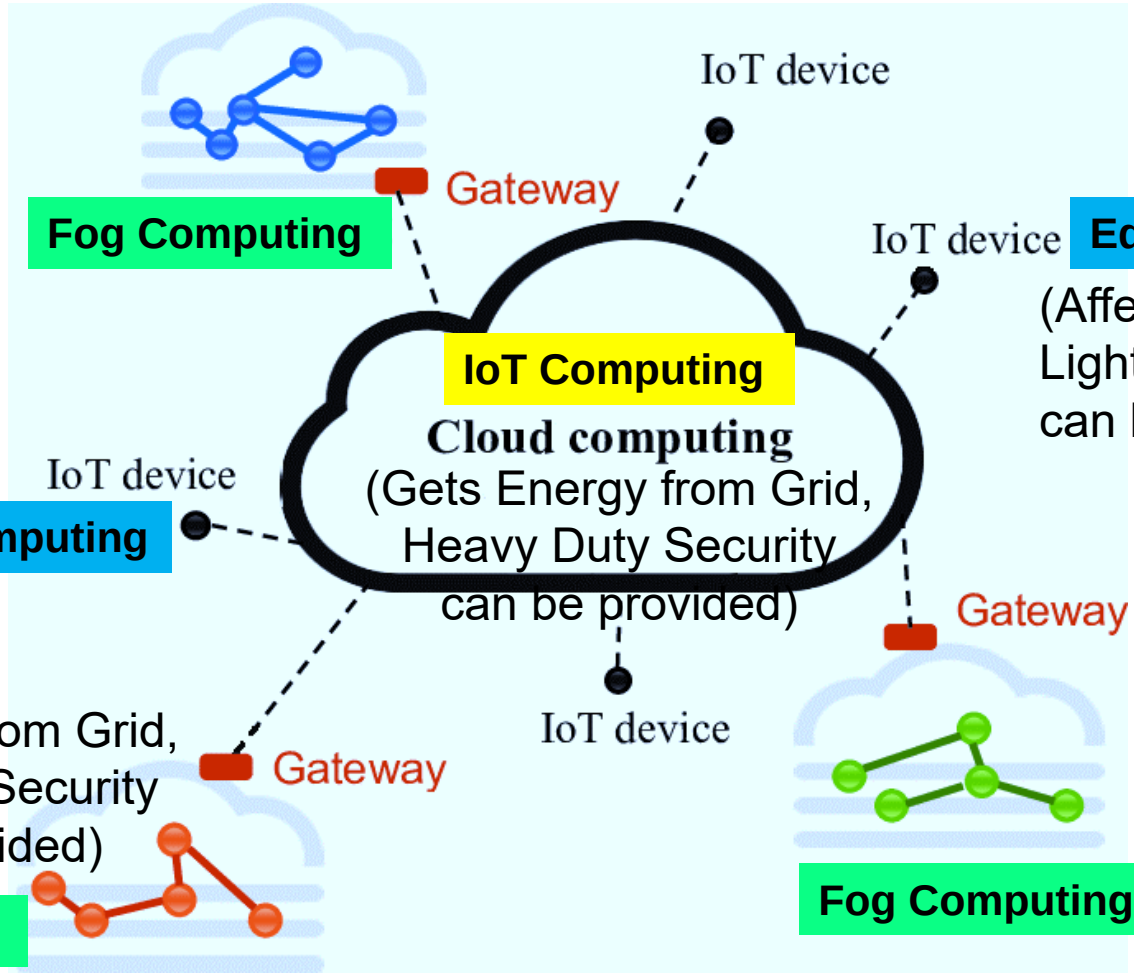


Source: Puthal, Mohanty 2018, IEEE Comm. Magazine May 2018

CE System Design and Operation Tradeoffs

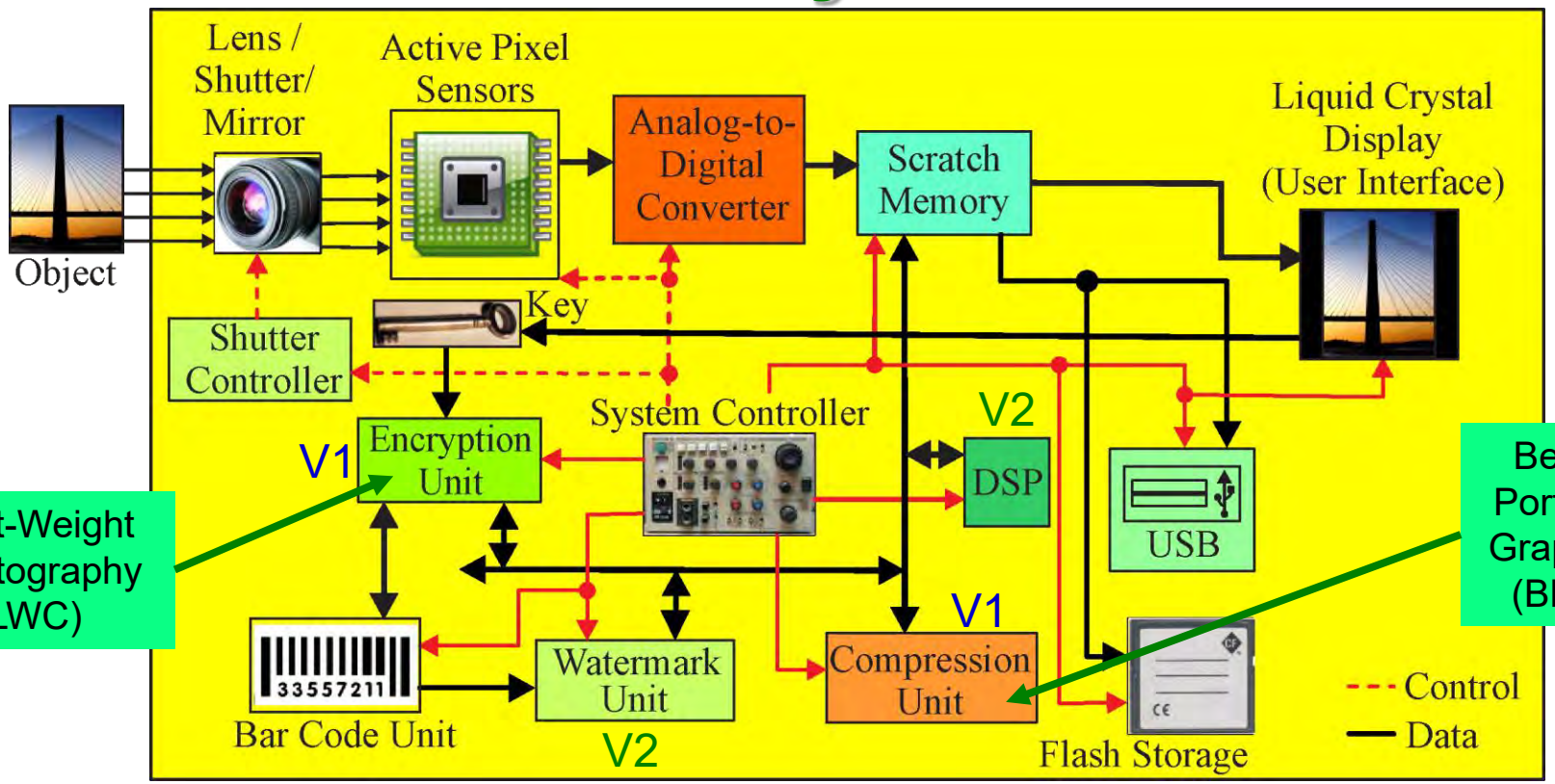


IoT Vs Fog Vs Edge Computing
– Security, Energy Tradeoffs



Source: https://www.researchgate.net/figure/311918306_fig1_Fig-1-High-level-architecture-of-Fog-and-Cloud-computing

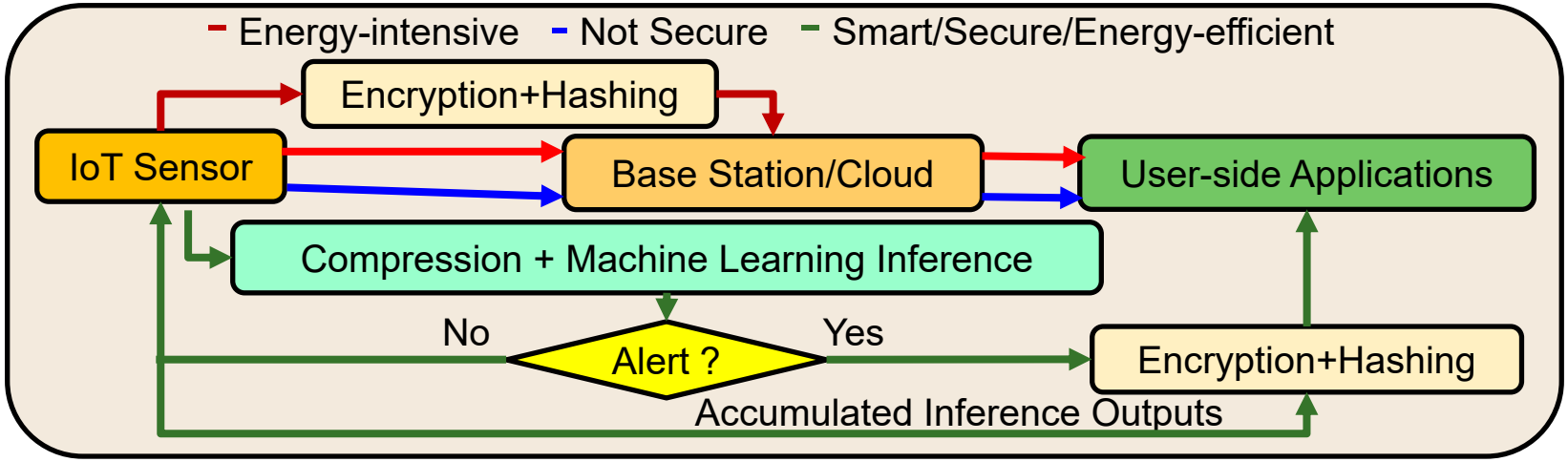
CE System Security & Energy Tradeoffs – System Level



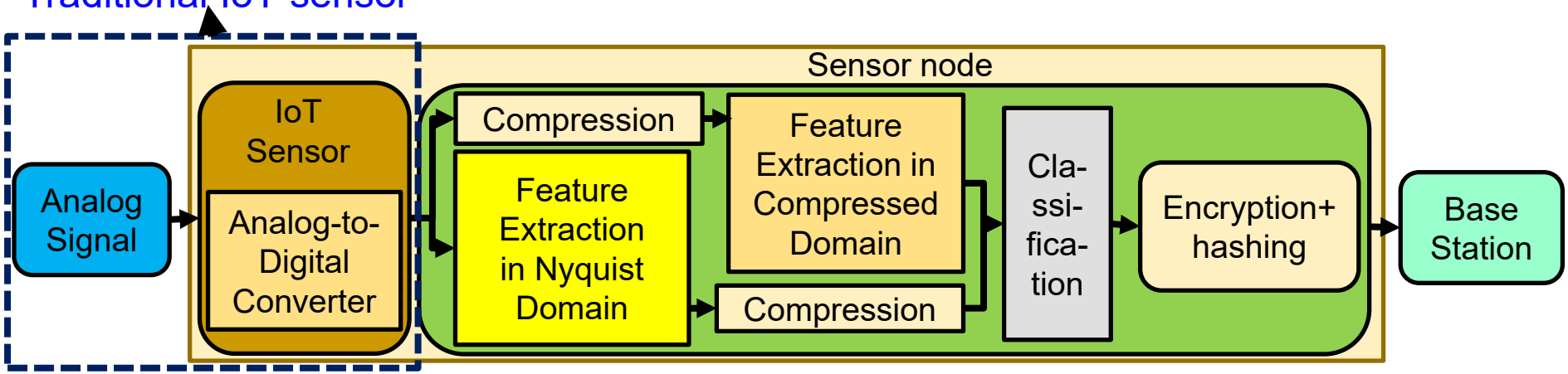
Include additional/alternative hardware/software components and uses DVFS like technology for energy and performance optimization.

Source: Mohanty 2006, TCAS-II May 2006; Mohanty 2009, JSA Oct 2009; Mohanty 2016, Access 2016

Security & Energy Tradeoff - Sensor



Scenarios in IoT sensor data processing



Smart, secure, and energy-efficient IoT sensor architecture

Source: Akmandor 2018: CICC 2018

Tools and Solutions

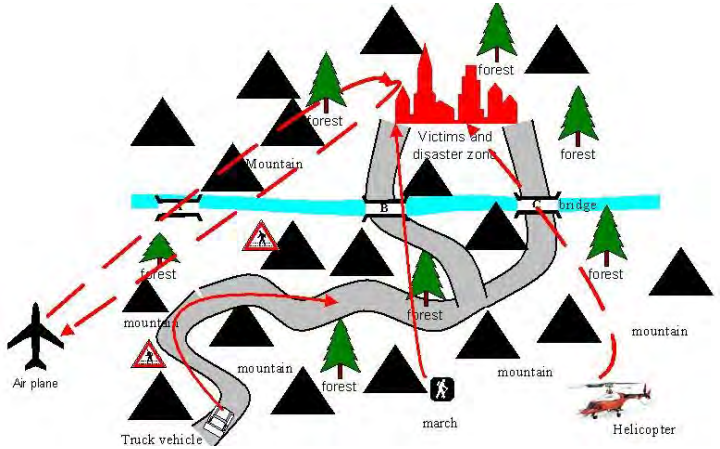
Market Opportunities

- "The 100 largest cities in the world produce 25 per cent of the planet's wealth, which will be smart cities".
- "New research predicts that global urbanization will fuel smart cities market growth by nearly 19% over the next 10 years."
- Together these 4 sectors make up 70 per cent of the total opportunity (This is trillions of dollars opportunity):
  - Energy
  - Building automation
  - Transportation and logistics
  - Financial services.

Source: https://www.em360tech.com/tech-news/tech-features/smart-cities-trillion-dollar-opportunity-according-new-report/

Smart Cities Simulator

- Simulator is needed to verify and characterize a smart city component (or a cyber physical system (CPS)), before deployment.
- Smart city is too large, complex, and diverse.
- For different components of smart cities, different simulator may be needed.



Industry Solutions - IBM

IBM has tools to:

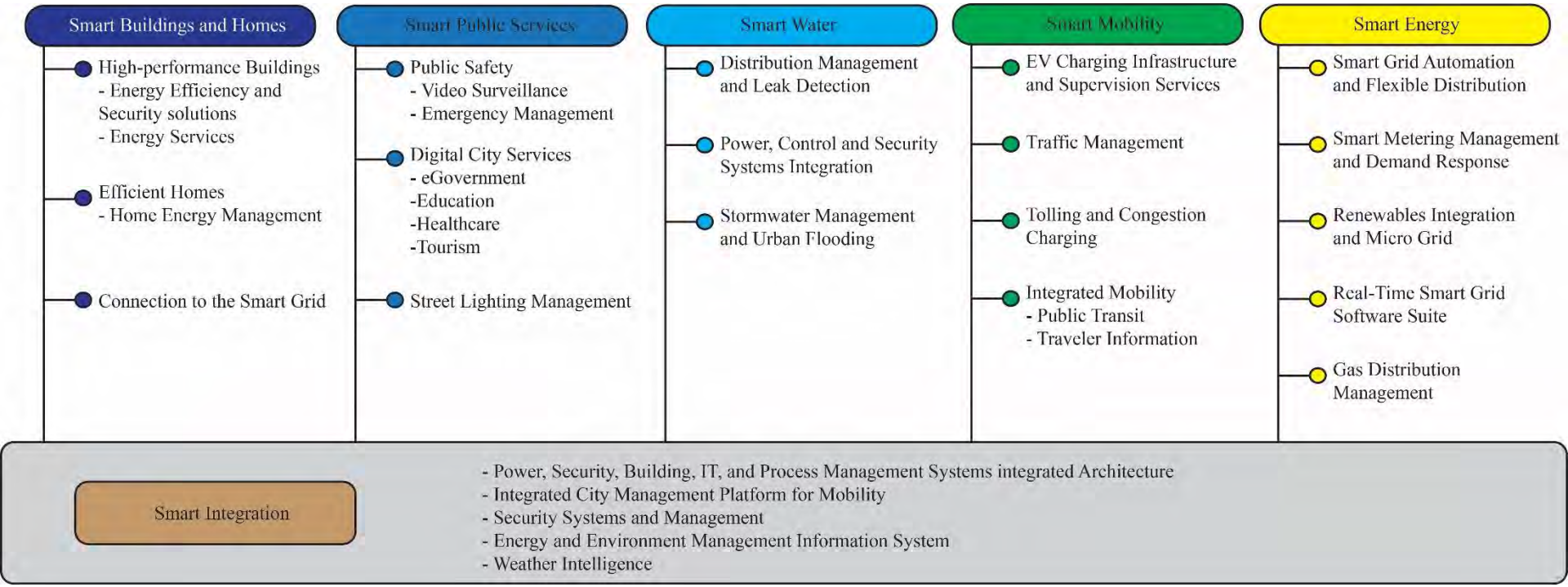
- Determine top goals and objectives
- Understand the relationships among systems
- Compare the performance of cities to each other
- Evaluate operational maturity
- Develop actionable roadmaps

IBM Intelligent Operations Center for Smarter Cities

Industry Solutions - Cisco

- Cisco Smart+Connected Communities have solutions along 8 tracks:
  - Smart+Connected Real Estate
  - Smart+Connected Utilities
  - Smart+Connected Transportation
  - Smart+Connected Safety & Security
  - Smart+Connected Learning
  - Smart+Connected Health
  - Smart+Connected Government
  - Smart+Connected Sports and Entertainment

Industry Solutions - Schneider Electric



Source: http://www.digital21.gov.hk/sc/relatedDoc/download/2013/079%20SchneiderElectric%20(Annex).pdf

Standards

Standards - Why

- To determine entry points for investment in city markets and make informed decisions through data analysis
- To benchmark investments and monitor progress
- To evaluate the “impact” of infrastructure projects on the sustainability and efficiency of the city
- To build smart and sustainable cities
- To evaluate the investment in comparative perspective across cities nationally and globally
- To strengthen the effectiveness of city governance

Source: https://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2015/SSC/S6-MrDWelsh_MrFDadaglio.pdf

Standards - What

- International Organization for Standards (ISO) initiatives.
- International Telecommunication Union (ITU), United Nations specialized agency on ICT has been working.
- International Electrotechnical Commission (IEC) has initiatives.
- IEEE has been developing standards for smart cities for its different components including smart grids, IoT, eHealth, and intelligent transportation systems (ITS).
- Selected indicators: economy, education, energy, and environment.

Standards - ISO 37120

- ISO 37120 defines 100 city performance indicators which include 46 core and 54 supporting indicators.
- 2 Core Indicators for Transportation:
  - Kilometers of high capacity public transportation per 100,000 population
  - Annual number of public transport trips per capita
- 2 Core Indicators for Economy:
  - City's unemployment rate
  - Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties
- 2 Core Indicators for Energy:
  - Total electrical energy use per capita (kWh / year)
  - Average number of electrical interruptions per customer per year

Source: http://smartcitiescouncil.com/article/dissecting-iso-37120-why-new-smart-city-standard-good-news-cities

Standards - IEEE

- Standards activities are underway:
  - Smart Grid
  - Cloud Computing
  - Internet of Things (IoT)
  - Intelligent Transportation
  - eHealth

Source: http://standards.ieee.org/develop/msp/smartcities.pdf

Initiatives

Smart Cities - Case Study - Barcelona

Source: http://www.ioti.com/smart-cities/world-s-5-smartest-cities

- Sensors monitor traffic levels, road pollution, crowds
- Sensors monitor the weather
- Sensors measure rainfall & analyze irrigation levels in the ground
- LED lighting arrangements

Source: http://luxreview.com/article/2017/02/-what-are-the-top-five-smart-cities-in-the-world-

Smart Cities - Case Study - San Francisco

Source: http://www.ioti.com/smart-cities/world-s-5-smartest-cities

- LEED-certified buildings than any other in the United States and a connected city initiative
- Smart transportation: Smart parking, Contactless payments
- LED lighting arrangements.

Source: http://luxreview.com/article/2017/02/-what-are-the-top-five-smart-cities-in-the-world-

Smart Cities - Case Study - Singapore

- Smart transport with traffic lights/management, smart parking
- Visible Light Communication (VLC) or LiFi for indoor positioning in malls
- Smart waste management.

Source: http://luxreview.com/article/2017/02/-what-are-the-top-five-smart-cities-in-the-world-

Top Smart Cities Using 4 KPIs in 2018

	Mobility	Health	Safety	Productivity
1	Singapore	Singapore	Singapore	Singapore
2	San Francisco	Seoul	New York	London
3	London	London	Chicago	Chicago
4	New York	Tokyo	Seoul	San Francisco
5	Barcelona	Berlin	Dubai	Berlin
6	Berlin	New York	Tokyo	New York
7	Chicago	San Francisco	London	Barcelona
8	Portland	Melbourne	San Francisco	Melbourne
9	Tokyo	Barcelona	Rio de Janeiro	Seoul
10	Melbourne	Chicago	Nice	Dubai
11	San Diego	Portland	San Diego	San Diego
12	Seoul	Dubai	Melbourne	Nice
13	Nice	Nice	Bhubaneswar	Portland
14	Dubai	San Diego	Barcelona	Tokyo
15	Mexico City	Wuxi	Berlin	Wuxi
16	Wuxi	Mexico City	Portland	Mexico City
17	Rio de Janeiro	Yinchuan	Mexico City	Rio de Janeiro
18	Yinchuan	Hangzhou	Wuxi	Yinchuan
19	Hangzhou	Rio de Janeiro	Yinchuan	Hangzhou
20	Bhubaneswar	Bhubaneswar	Hangzhou	Bhubaneswar

Source: https://newsroom.intel.com/wp-content/uploads/sites/11/2018/03/smart-cities-whats-in-it-for-citizens.pdf

IEEE Smart Cities

- IEEE Technical Community created: http://smartcities.ieee.org
- The IEEE International Smart Cities Conference (ISC2) is the flagship event of the IEEE Smart Cities Initiative.
- IEEE Smart Cities initiative: IEEE Core Smart Cities program recognizes/helps cities which establish and invest both human/financial capital into smart city plans.
- Current IEEE Core Smart Cities: Casablanca, Morocco; Guadalajara, Mexico; Kansas City, USA; Trento, Italy; and Wuxi, China.
- IEEE Affiliated Smart Cities program: Allow more cities to participate in and enjoy benefits of the IEEE Smart Cities program and network.

Source: http://smartcities.ieee.org/

UN Initiative - United 4 Smart Sustainable Cities (U4SSC)

U4SSC is a global platform for smart city stakeholders which advocates for public policy to encourage the use of ICTs to facilitate the transition to smart sustainable cities.

WG 01 – Setting the Framework
- Urban Planning
- Policy, Standards and Regulation
- Key Performance Indicators

WG 02 – Connecting Cities and
- Smart Living
- Smart Mobility
- Smart Environment

WG 03 – Enhancing Innovation and Participation
- Smart Governance
- Smart People
- Smart Economy

Source: http://wftp3.itu.int/pub/epub_shared/TSB/2016-ITUT-SSC-Brochure/en/index.html Source: Paolo Gemma 2016, ISC2 2016

Smart Cities Council

- The Smart Cities Council is a network of leading companies advised by top universities, laboratories and standards bodies.
- Help cities become smarter through a combination of advocacy and action:
  - Readiness Guides
  - Financing templates and case studies
  - Policy frameworks and case studies
  - Visibility campaigns
  - Regional networking events

Source: http://smartcitiescouncil.com/

Smart Cities Connect

- Smart Cities Connect is the largest city-first membership organization for global smart city leaders.
- This group is advancing the growth of smart cities by working together, discussing projects, and sharing common goals and challenges.
- Smart Cities Connect Conference and Expo brings together over 200 cities and their respective leadership.

Source: http://smartcitiesconnect.org/

USA - National Science Foundation (NSF)

- Smart and Connected Communities (S&CC)
- Smart and Connected Health (SCH)
- Smart and Autonomous Systems (S&AS)

Source: https://www.nsf.gov

US Department of Transportation

- The USDOT encouraged cities to put ideas to answer the questions raised in Beyond Traffic 2045: Trends and Choices
  - How will we move things?
  - How will we move?
  - How will we adapt?
  - How will we move better?
  - How will we align decisions and dollars?

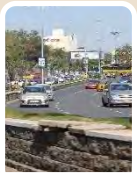
Source: https://www.transportation.gov/smartcity

India Smart Cities Mission

- By Ministry of Urban Development, Govt. of India
- With increasing urbanization, urban areas are expected to house 40% of India's population and contribute 75% of India's GDP by 2030.
- 20 Smart Cities in 1st round: Bhubaneswar, Pune, Jaipur, Surat, Kochi, Ahmedabad, Jabalpur, Visakhapatnam, Solapur, Davanagere, Indore, New Delhi Municipal Council, Coimbatore, Kakinada, Belagavi, Udaipur, Guwahati, Chennai, Ludhiana, Bhopal
- Two Type of Value Capture
  - Project-based
  - Area-based
- Statistics:
  - Total Urban Population Impacted - 72,266,232
  - Total Cost of Projects - INR 1,317,620 Million
  - Total Area Based Development Cost - INR 1,056,210 Million

Source: http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf

India Smart Cities Mission – Livability Index

Institutional	Social	Economic	Physical
			
Governance	- Health - Education - Identity and Culture - Safety and Security	- Economy and Employment	- Housing and Inclusiveness - Public Open Spaces - Mixed Land Use and Compactness - Power Supply - Transportation and Mobility - Assured Water Supply - Waste Water Management - Reduced Pollution - Solid Waste Management

Source: http://smartcities.gov.in/upload/uploadfiles/files/SCM_Presentation(1).pdf

India Smart Cities Mission – Planned for Bhubaneswar

- Bhubaneswar can take pride:
  - Only Tier-2 city in India to host the top five Indian IT companies
  - Ranked 3rd Best Place to "Do Business in India" by World Bank
  - One of the planned 4 "IT Investment Regions" in India
- Plans under India Smart Cities Mission
  - Centralized command and control center
  - Transit operations system (maintenance & tracking)
  - Smart parking system
  - Common card (payment and operations)
  - Area based traffic control
  - Emergency response
  - Automatic fare collection system (transport)
  - City buses

Source: http://smartcities.gov.in/upload/uploadfiles/files/BMC_projects.pdf

Smart City- Bhubaneswar

Bhubaneswar Operation Center (BOC)

- Envisioned:
  - Traffic management
  - City surveillance
  - Emergency services
  - Disaster management

- Facilities:
  - Large volume CCTV data monitoring
  - Large volume sensor data processing
  - Adaptive Traffic Signal System
  - Grievance Redressal System

Smart City- Bhubaneswar

- Transportation: Public transit can be significantly benefitted if made smart.
- Tourism: Has the pride of temple city with monuments from 200 BC to 1200 AD. Tourists can be made access to city maps, historic perspectives, VR/AR experiences.
- Mines: Global market for smart mining expected to be $ 16B by 2022. Odisha is rich in minerals including Chromite, Iron, Bauxite, and Coal.

Source: http://www.smartcitybhubaneswar.gov.in/

Source: https://www.nmdc.co.in/

Conclusions

Smartness

- Ability to take decisions based on the data, circumstances, situations?

Conclusions

- Smart cities is not a technological trend, rather it is a necessity.
- Smart cities technology is an ongoing R & D.
- Multi-Front research on smart cities from academia and industries are in full swing.
- Smart cities still need significant maturity for effective design and operation.
- R & D seems to be in right direction.

Future Research

- Accurate and scalable smart city simulator
- Energy-efficient, accurate sensors
- Security
- Privacy
- IP or content protection
- Energy efficiency
- Big data processing
- Efficient, Safer Battery
- Larger, cheaper, faster memory

Can Any Smartness/Intelligence Solve?

Source: https://www.wilsoncenter.org/article/building-slum-free-mumbai

2018 IEEE CONSUMER ELECTRONICS SOCIETY NEW MEMBER APPLICATION

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Your Professional Experience

(circle your choices below)

I have graduated from a three-to-five-year academic program with a university-level degree.

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Yes No Do not know

I have _____ years of professional experience in teaching, creating, developing, practicing, or managing within the following field:

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Other (please specify): _____

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IEEE Consumer Electronics Magazine

The IEEE Consumer Electronics Magazine (CEM) is the flagship award-winning magazine of the consumer electronics (CE) society of IEEE. From 2018, the magazine is published on a bimonthly basis and features a range of topical content on state-of-art consumer electronics systems, services and devices, and associated technologies.

The CEM won an Apex Grand Award for excellence in writing in 2013. The CEM is the winner in the Regional 2016 STC Technical Communication Awards - Award of Excellence! The CEM is indexed in Clarivate Analytics (formerly IP Science of Thomson Reuters). The 2017 impact factor of CEM is 1.434.

Aim and Scope

- Consumer electronics magazine covers the areas or topics that are related to "consumer electronics".
- Articles should be broadly scoped – typically review and tutorial articles are well fit for a magazine flavor.
- Technical articles may be suitable but these should be of general interest to an engineering audience and of broader scope than archival technical papers.
- Topics of interest to consumer electronics: Video technology, Audio technology, White goods, Home care products, Mobile communications, Gaming, Air care products, Home medical devices, Fitness devices, Home automation and networking devices, Consumer solar technology, Home theater, Digital imaging, In-vehicle technology, Wireless technology, Cable and satellite technology, Home security, Domestic lighting, Human interface, Artificial intelligence, Home computing, Video Technology, Consumer storage technology. Studies or opinion pieces on the societal impacts of consumer electronics are also welcome.

Have questions on submissions or ideas for special issues, contact EiC at: saraju.mohanty@unt.edu

Submission Instructions

Submission should follow IEEE standard template and should consist of the following:

I. A manuscript of maximum 6-page length: A pdf of the complete manuscript layout with figures, tables placed within the text, and

II. Source files: Text should be provided separately from photos and graphics and may be in Word or LaTeX format.

- High resolution original photos and graphics are required for the final submission.
- The graphics may be provided in a PowerPoint slide deck, with one figure/graphic per slide.
- An IEEE copyright form will be required. The manuscripts need to be submitted online at the URL: **http://mc.manuscriptcentral.com/cemag**

Editorial Board

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Technical Committee on VLSI (TCVLSI), IEEE-CS

http://www.ieee-tcvlsi.org

IEEE computer society

The IEEE Computer Society Technical Committee on VLSI

What is TC-VLSI?

A technical committee of IEEE-CS serves as the focal point of the various technical activities within a technical discipline.

TCVLSI is a constituency of the IEEE-CS that oversees various technical activities related to VLSI.

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Technical Scope Various aspects of VLSI design including design of system-level, logic-level, and circuit-level, and semiconductor processes

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Hardwares are the drivers of the civilization, even softwares need them.