Smart Cities - Demystified

Keynote – MAMI 2017

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More Info: http://www.smohanty.org

- “India is to be found not in its few cities, but in its 700,000 villages.”

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

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

Source: http://www.urbangateway.org

"First true cities arose in Mesopotamia, and in the Indus and Nile valleys sometime around 3500 BCE."
-- LeGates and Stout 2016, The City Reader

Issues Challenging Sustainability

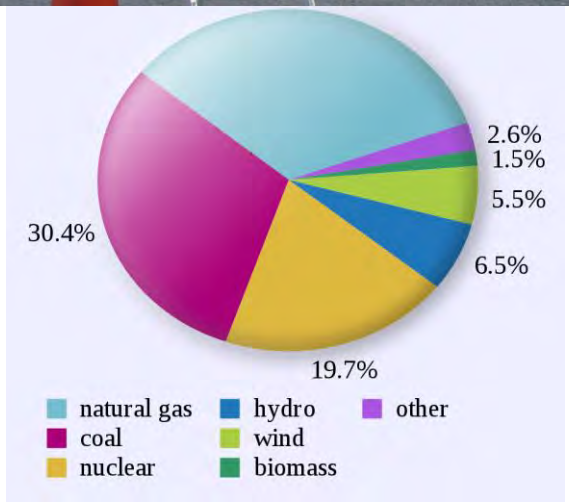
- Pollutions

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

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

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

The Solution – Smart Cities

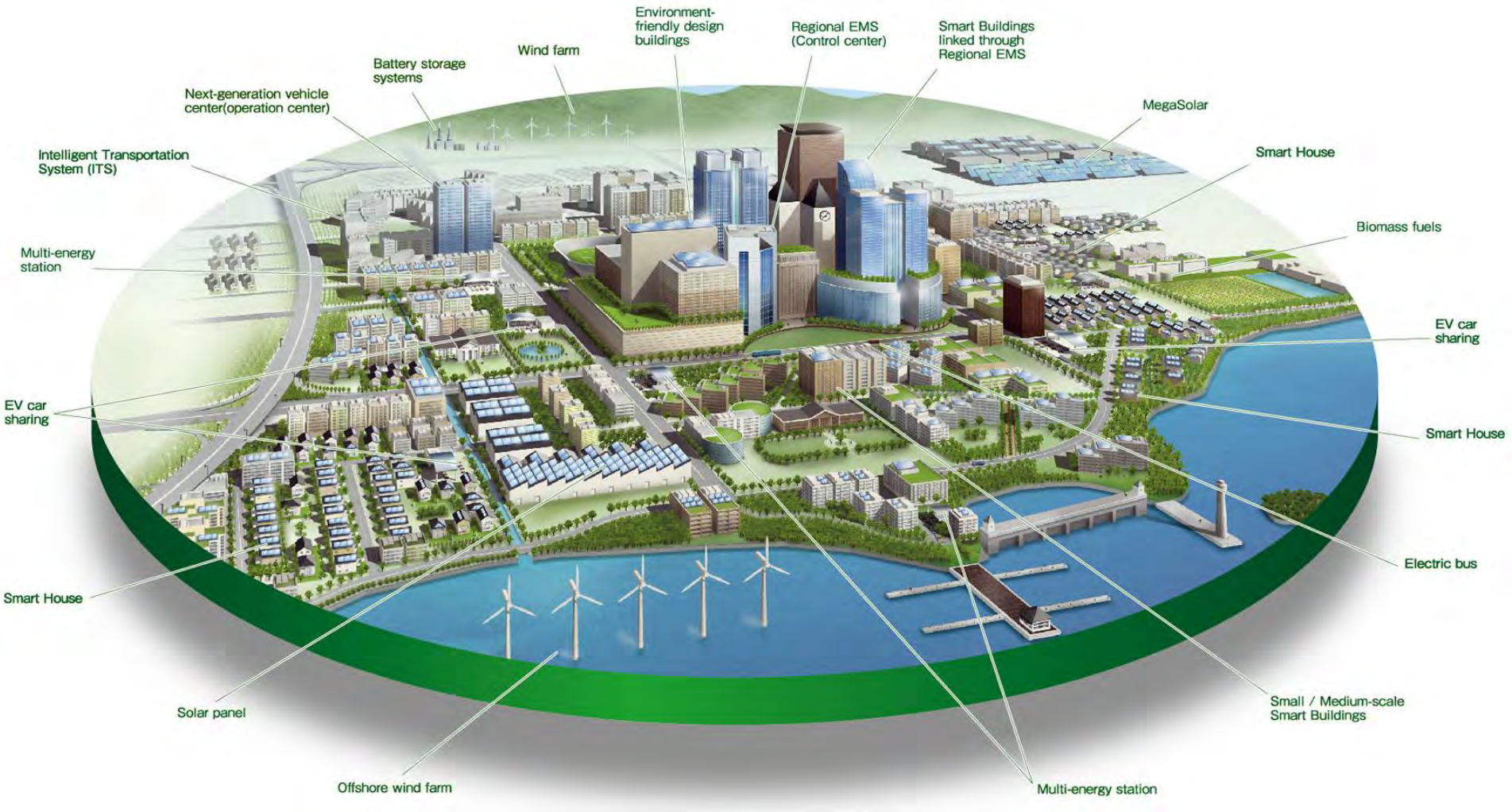
- Smart Cities: For effective management of limited resource to serve largest possible population to improve:
  - Livability
  - Workability
  - Sustainability

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

Smart Cities – A Broad View



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

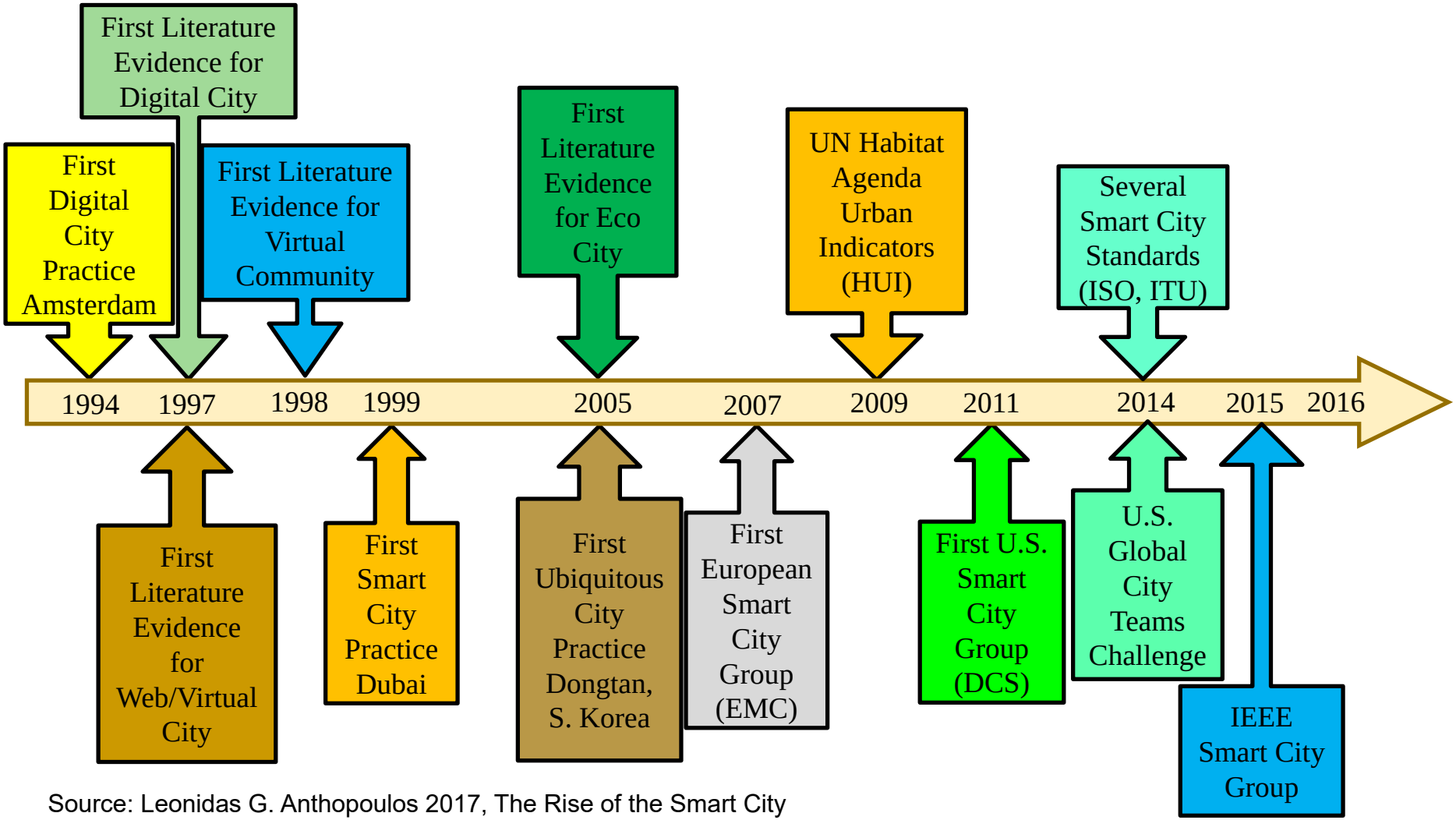
Smart Cities - Formal Definition

- 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

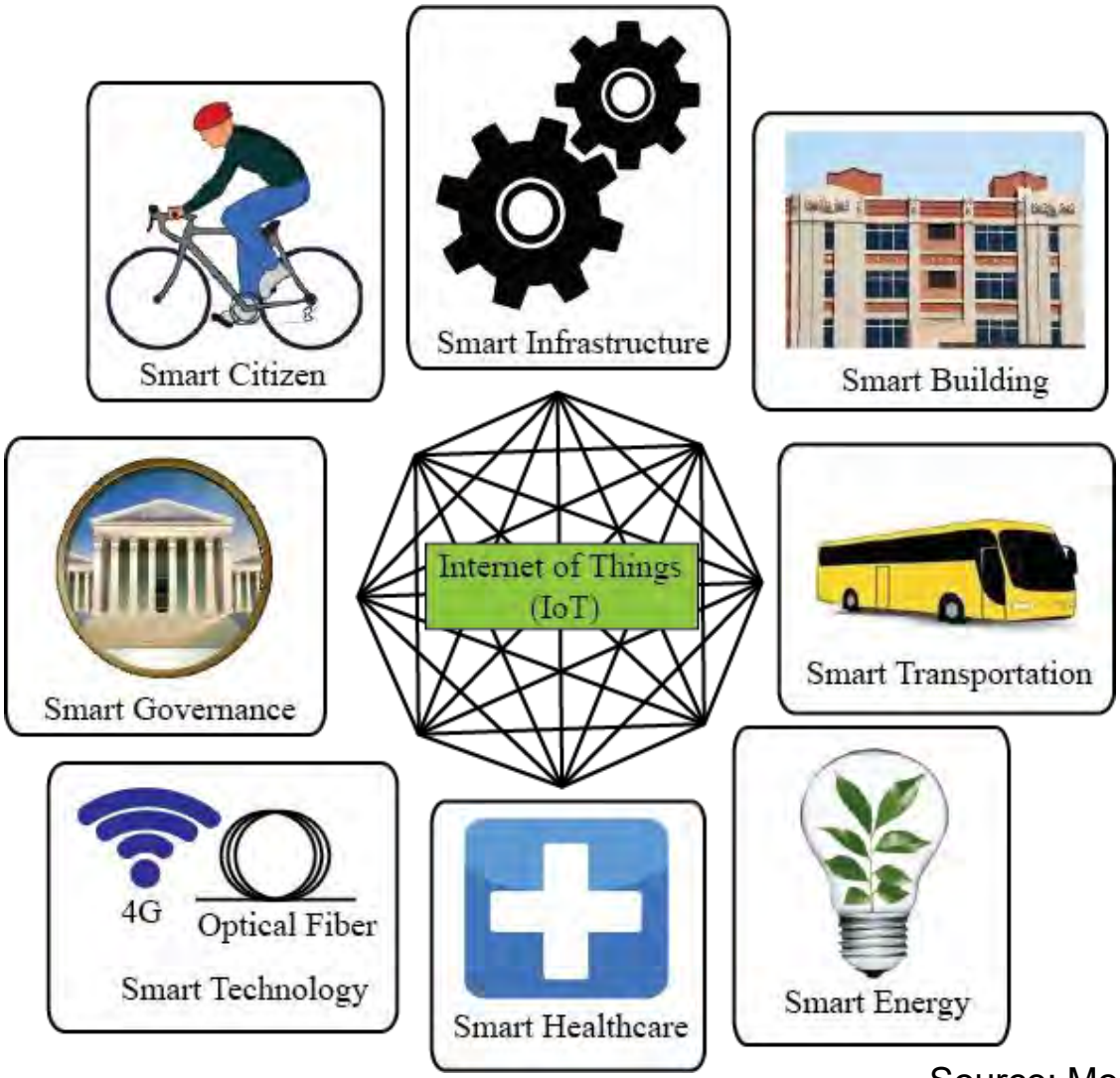
Smart Cities - History



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

Components

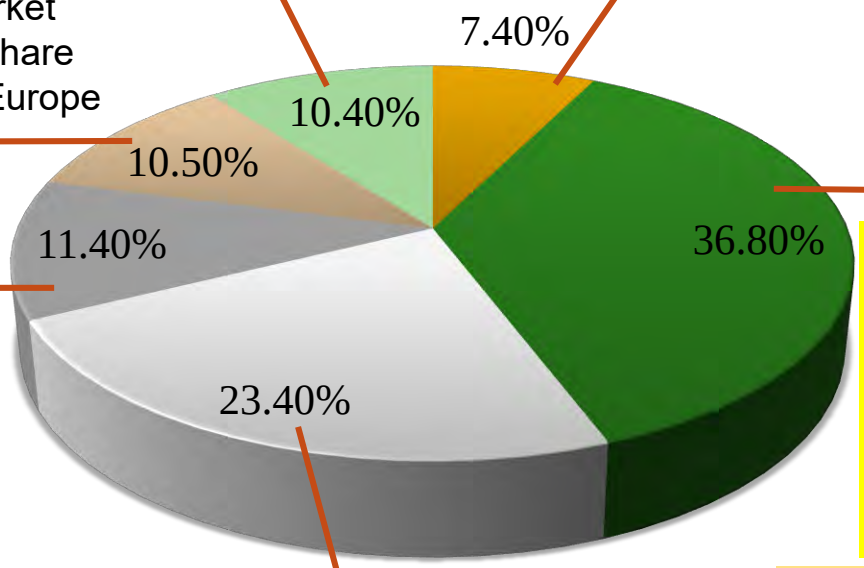
Smart Cities - Components



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

Source: Mohanty 2016, CE Magazine July 2016

Smart City Market Segments – by 2025



5

Smart Healthcare
Market Value: $348.5Billion
CAGR: 8.8% (2012-2025)
North America to dominate Smart Healthcare market with more than 50% share by 2025 followed by Europe

6

Smart Building
Market Value: $248.65Billion
CAGR: 4.1% (2012-2025)
China and India are fastest growing markets followed by Japan and Korea

4

Smart Transportation
Market Value: $351.13Billion
CAGR: 19.6% (2012-2025)
Market growth in Latin America, Middle East, Africa, CIS + Eastern Europe

1

Smart Governance and Smart Security
Market Value: $1230.26 Billion
CAGR: 11.6% (2012-2025)
More Projects coming up in North America, Middle East and European regions

3

Smart Infrastructure
Market Value: $381.53 Billion
CAGR: 12.0% (2012-2025)
Highest growth in North America and Asia

2

Smart Energy
Market Value: $781.66 Billion
CAGR: 28.7% (2012-2025)
Highest growth in North America

Source: Frost & Sullivan

Source: https://www.slideshare.net/IoTTunisia/farouk-kamoun-smart-cities-innovative-applications-iot-tunisia-2016

Smart Transportation

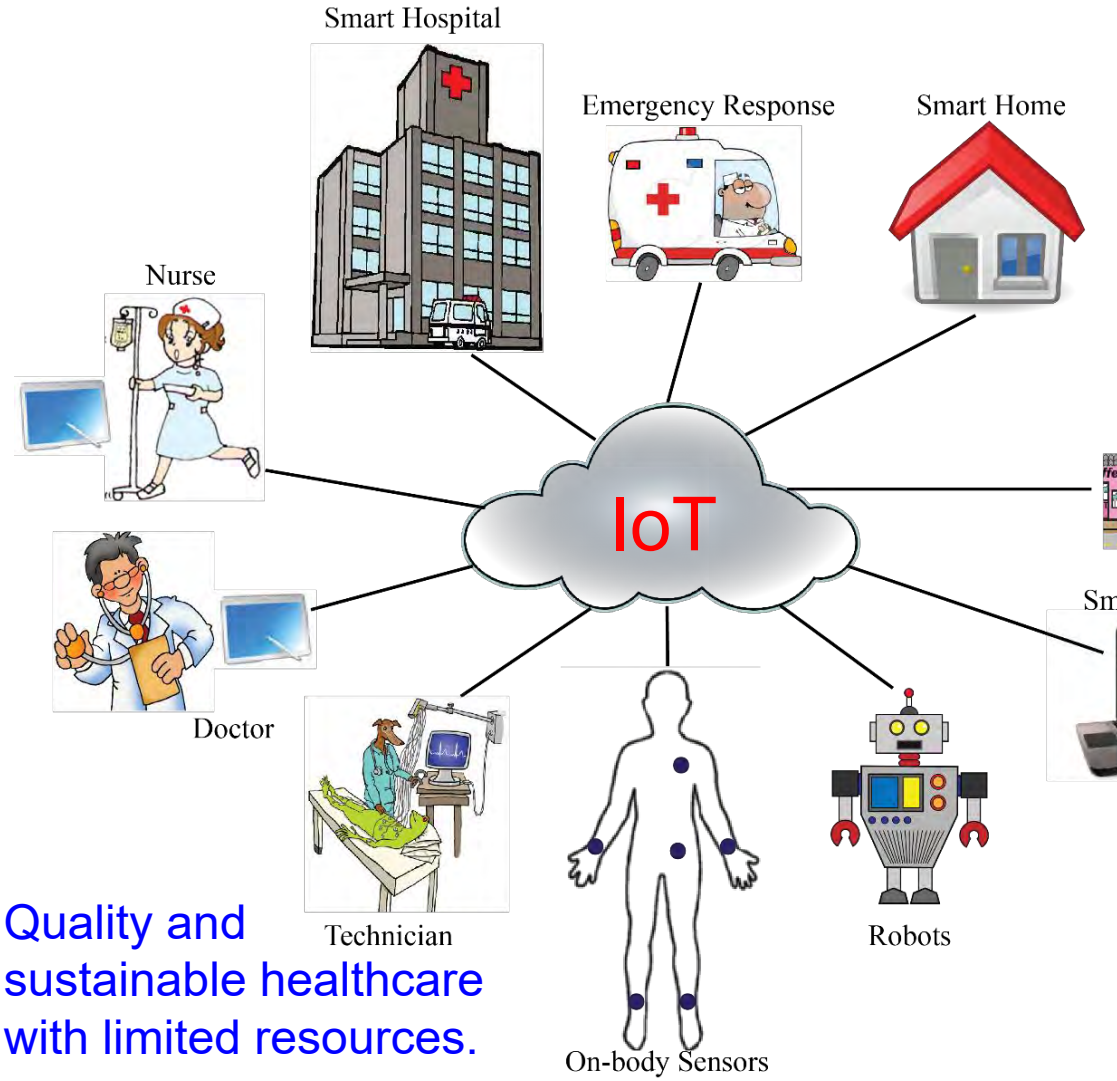
Smart Transportation Features:

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

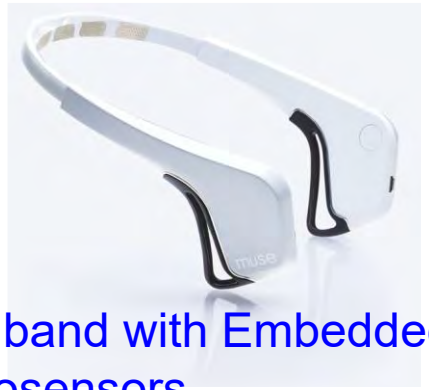
"The smart transportation system allows passengers to easily select different transportation options for lowest cost, shortest distance, or fastest route."

Source: Mohanty 2016, CE Magazine July 2016

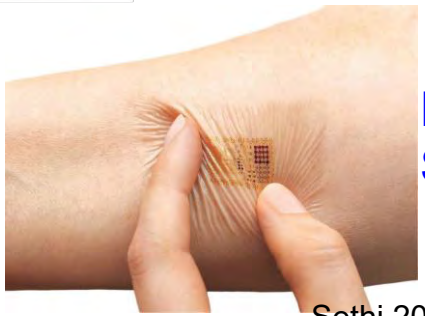
Smart Healthcare



Fitness Trackers



Headband with Embedded Neurosensors



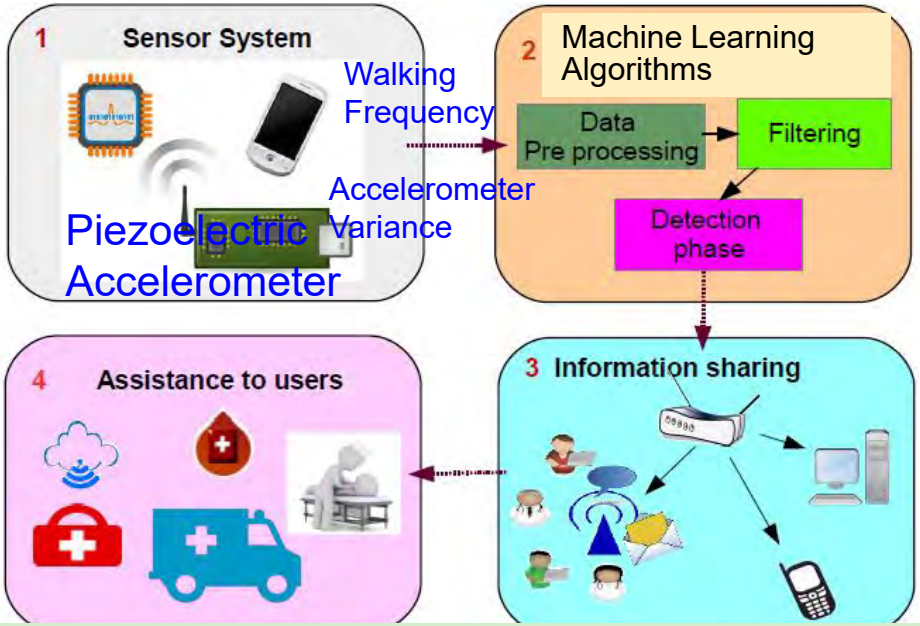
Embedded Skin Patches

Quality and sustainable healthcare with limited resources.

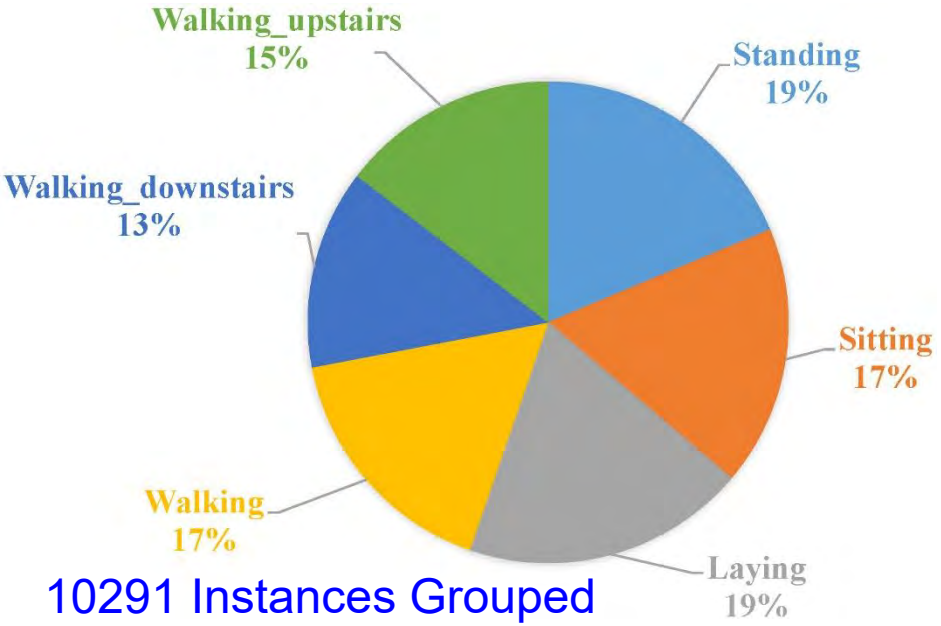
Source: Mohanty 2016, CE Magazine July 2016

Sethi 2017: JECE 2017

Smart Healthcare - Smart-Walk



Automated Physiological Monitoring System



10291 Instances Grouped Under 6 Activities - Kaggle

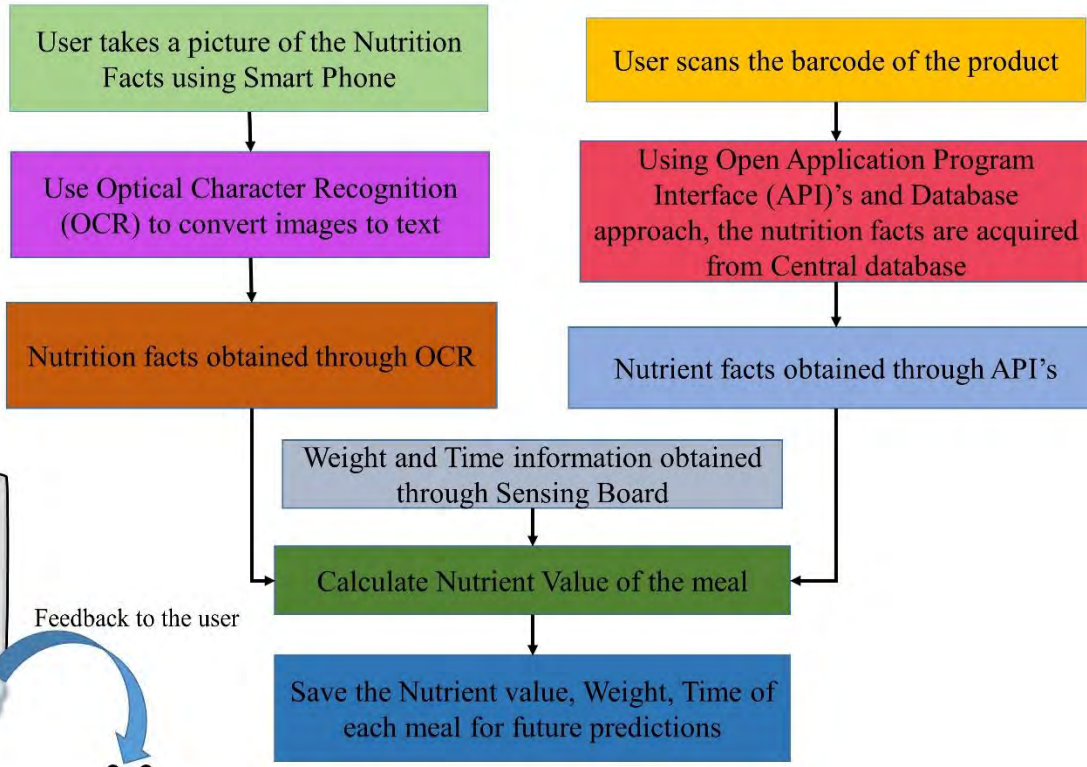
Research Works	Method	Features considered	Activities	Accuracy (%)
This Work	Adaptive algorithm based on feature extraction (WEKA)	Step detection and Step length estimation	Walking, sitting, standing, etc.	97.9

Source: Mohanty ICCE 2018

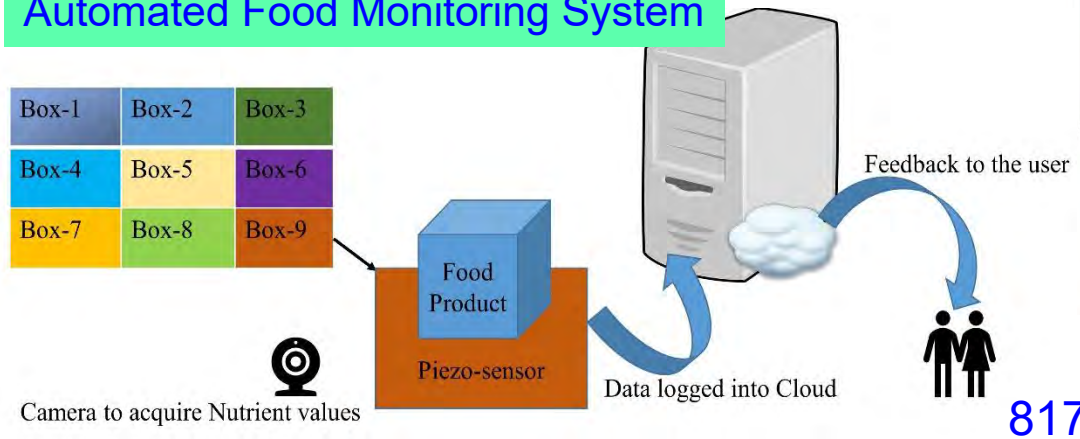
Smart Healthcare - Smart-Log

- 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

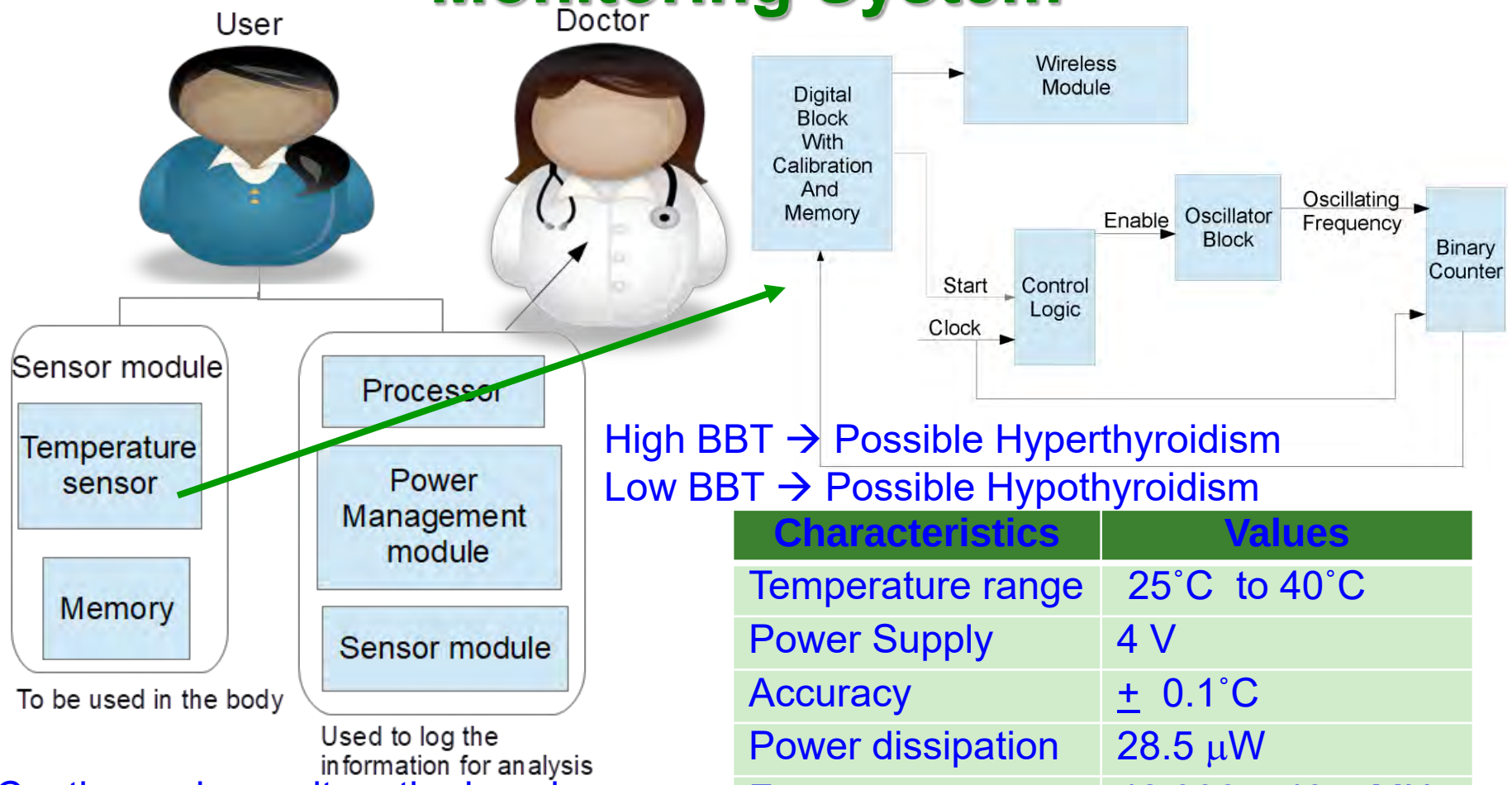


8172 user instances were considered

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

Source: Mohanty ICCE 2018

Smart Healthcare - Thyroid Monitoring System



High BBT → Possible Hyperthyroidism

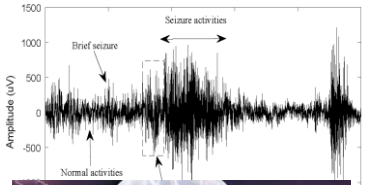
Low BBT → Possible Hypothyroidism

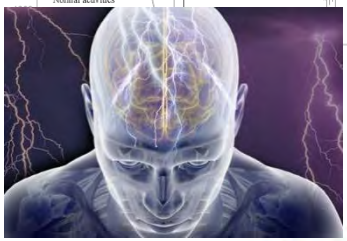
Characteristics	Values
Temperature range	25˚C to 40˚C
Power Supply	4 V
Accuracy	± 0.1˚C
Power dissipation	28.5 μW
Frequency range	42.906 – 43.5 MHz

Continuously monitors the basal body temperature (BBT)

Source: Mohanty EuroSimE 2016

Smart Healthcare – Efficient Epileptic Seizure Detector





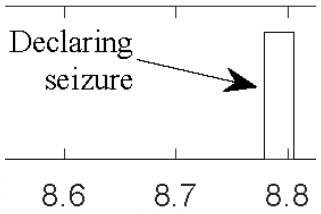
EEG Signal

Input Signal

Clock

Over-excitation Threshold

Signal Rejection Algorithm (SRA)

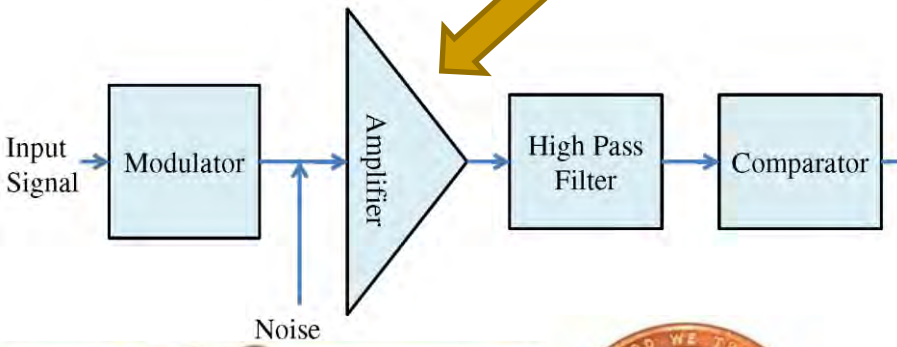


Over-excitation Detection Circuit

Count Seizure Activity

Declare Seizure Event

Seizure prediction

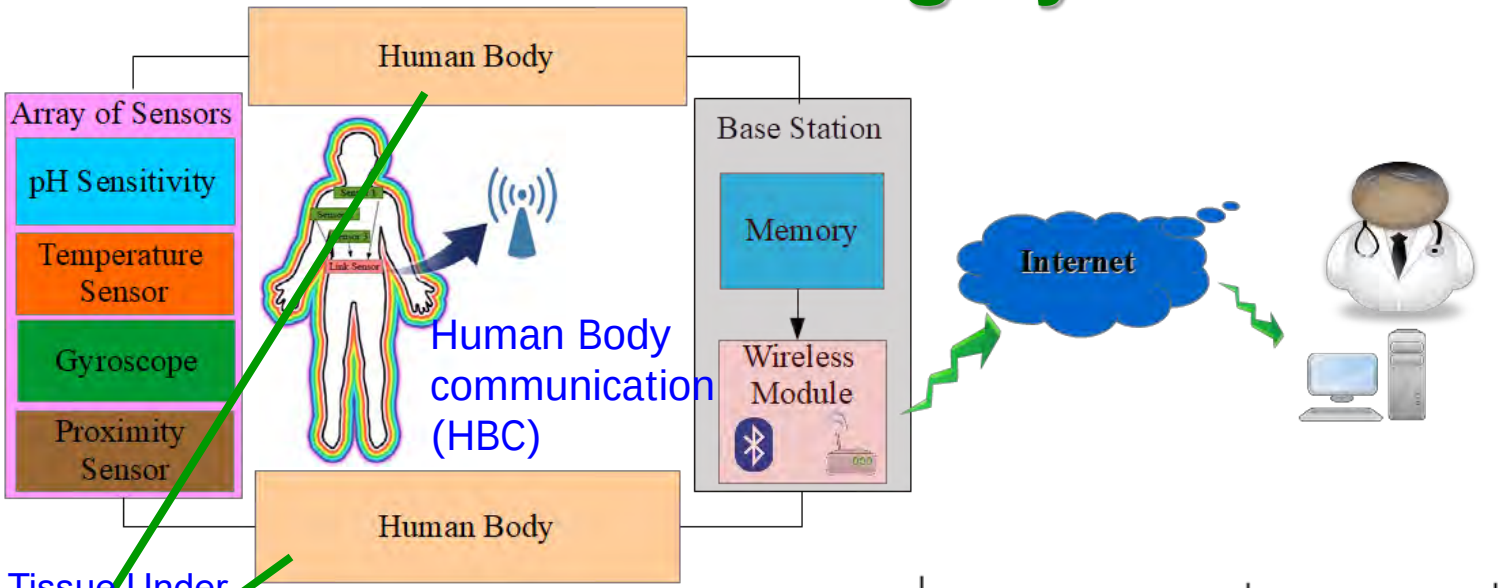


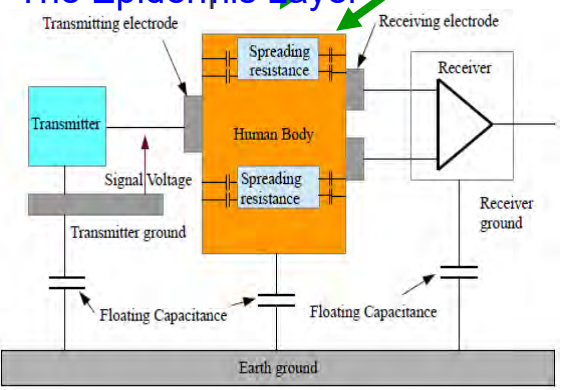
Source: Zaveri, Yale University

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 Healthcare – Ambulatory Health Monitoring System

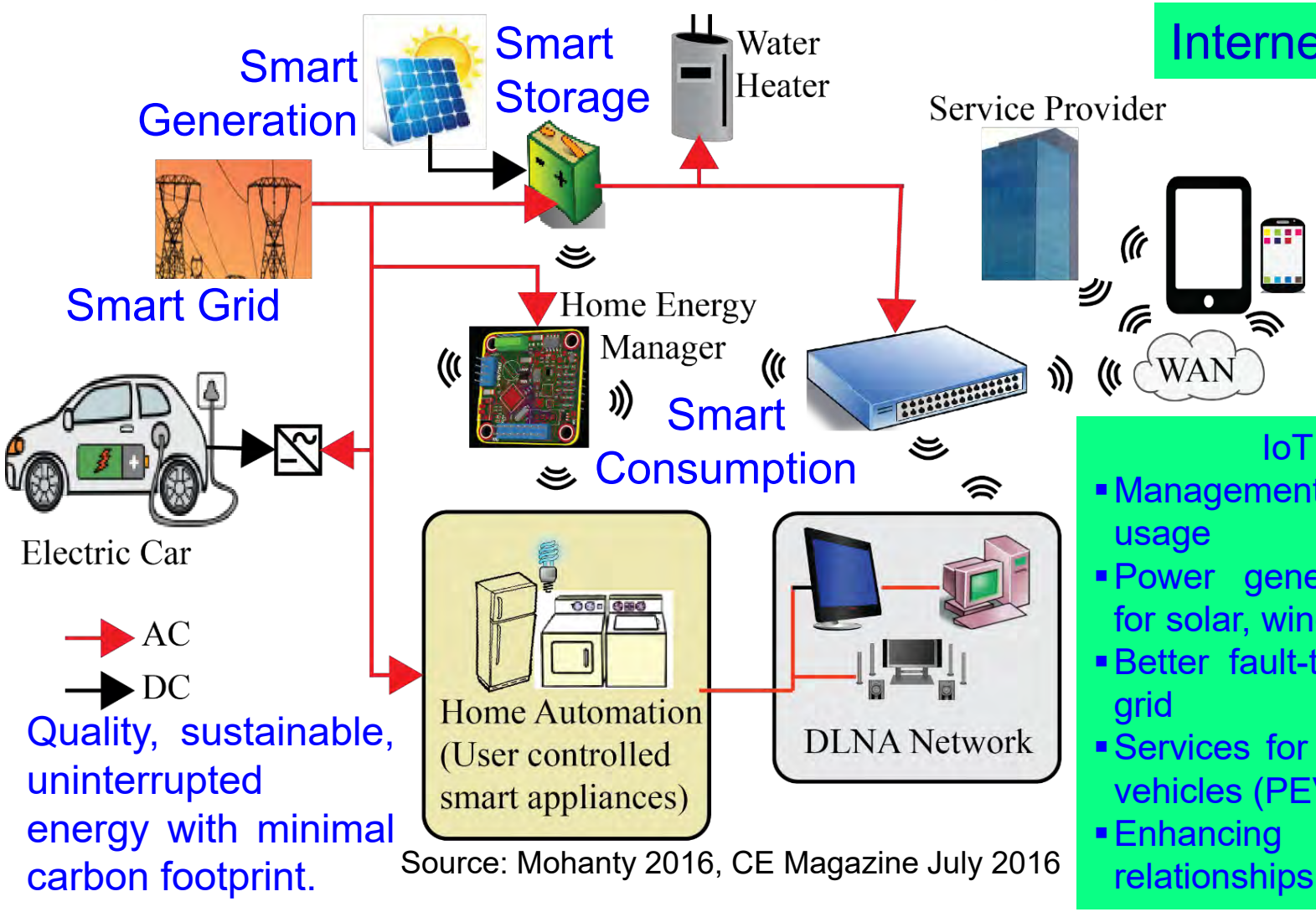




Characteristics	Values
Communication Environment	Intra Body Communication
BCC Coupling method	Capacitively coupled
Frequency range of operation	1 – 100 MHz
Power consumption	3.14 mW (31% less)

Source: Mohanty iNIS 2016

Smart Energy



Source: Mohanty 2016, CE Magazine July 2016

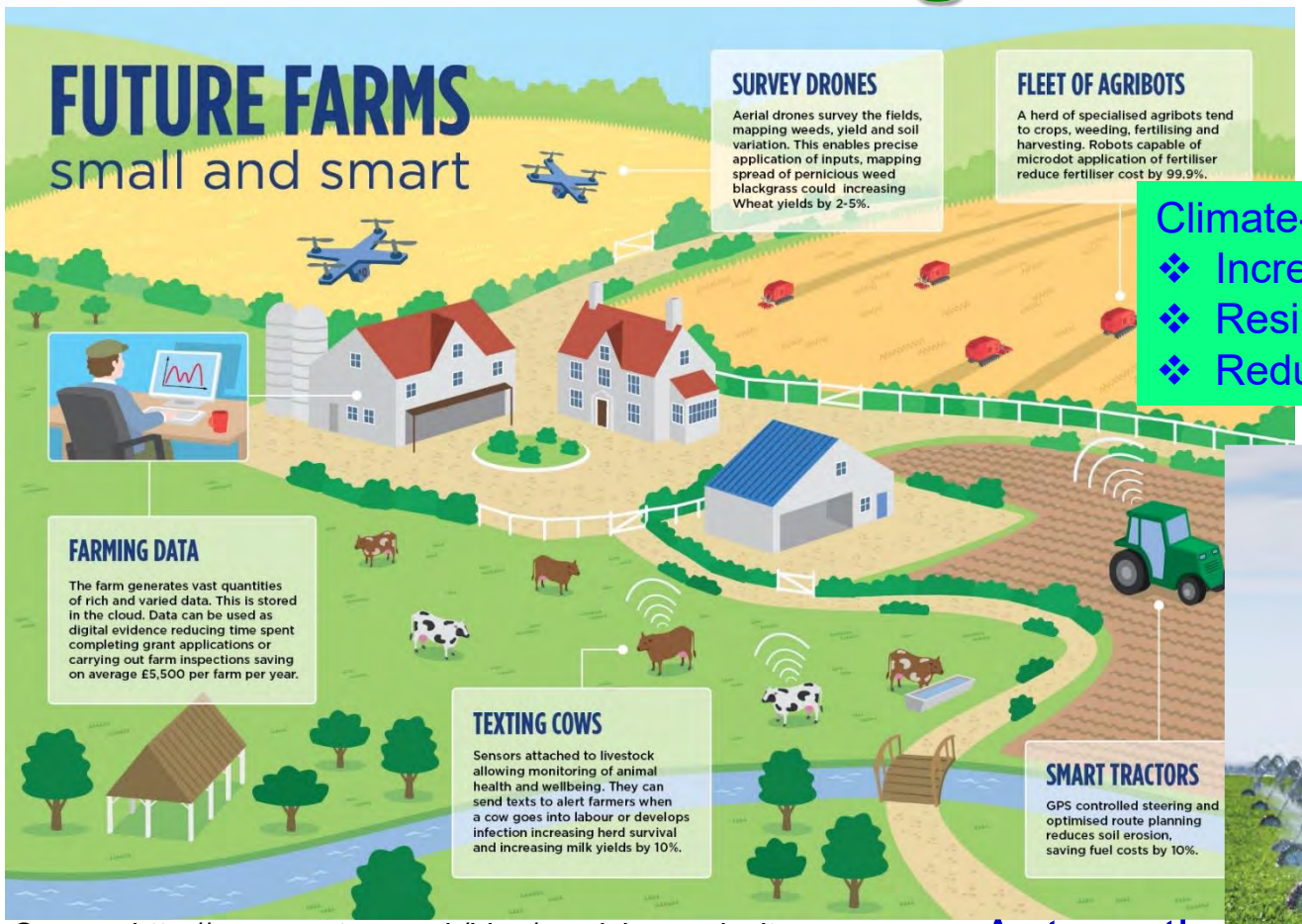
Quality, sustainable, uninterrupted energy with minimal carbon footprint.

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

Smart Agriculture



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

Climate-Smart Agriculture Objectives:

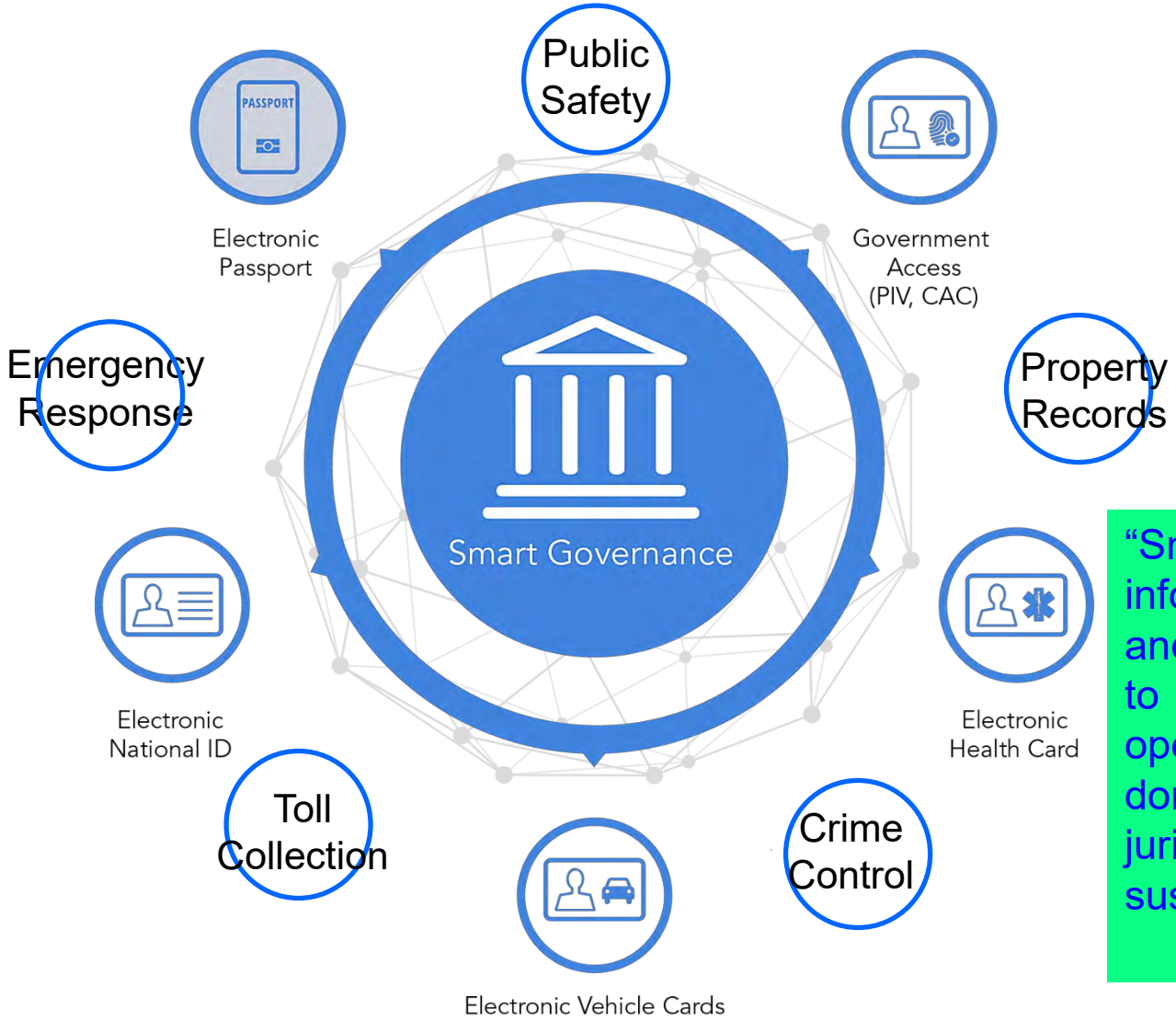
- Increasing agricultural productivity
- Resilience to climate change
- Reducing greenhouse gas

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

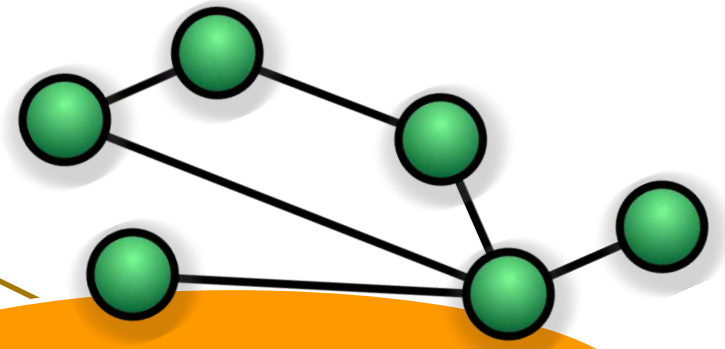
+ Smart Technologies

Smart Cities - 3 Is

Instrumentation

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

Smart Cities



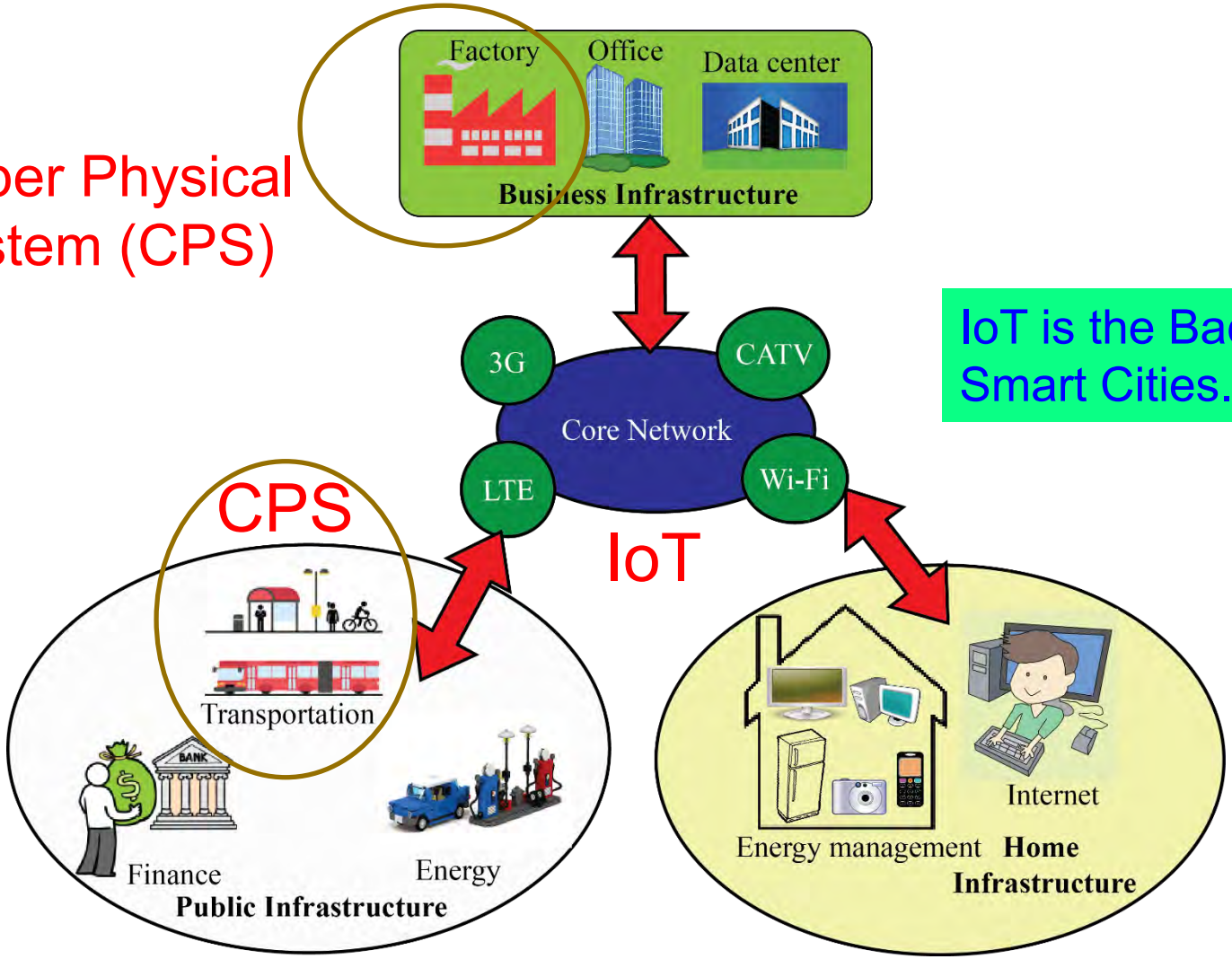
Intelligence

Interconnection

Source: Mohanty 2016, EuroSimE 2016 Keynote Presentation

Smart Infrastructure

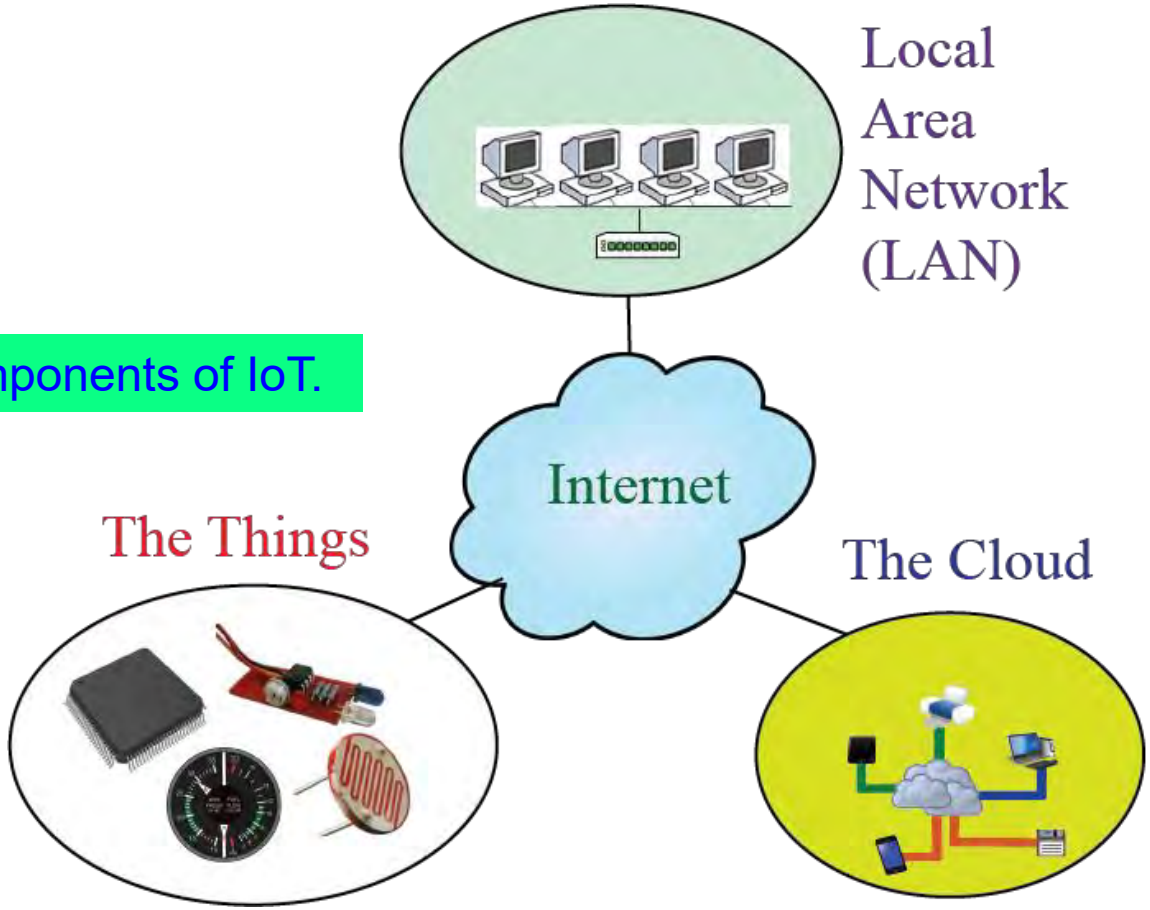
Cyber Physical System (CPS)



IoT is the Backbone Smart Cities.

Source: Mohanty 2016, CE Magazine July 2016

IoT - Architecture



Four Main Components of IoT.

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

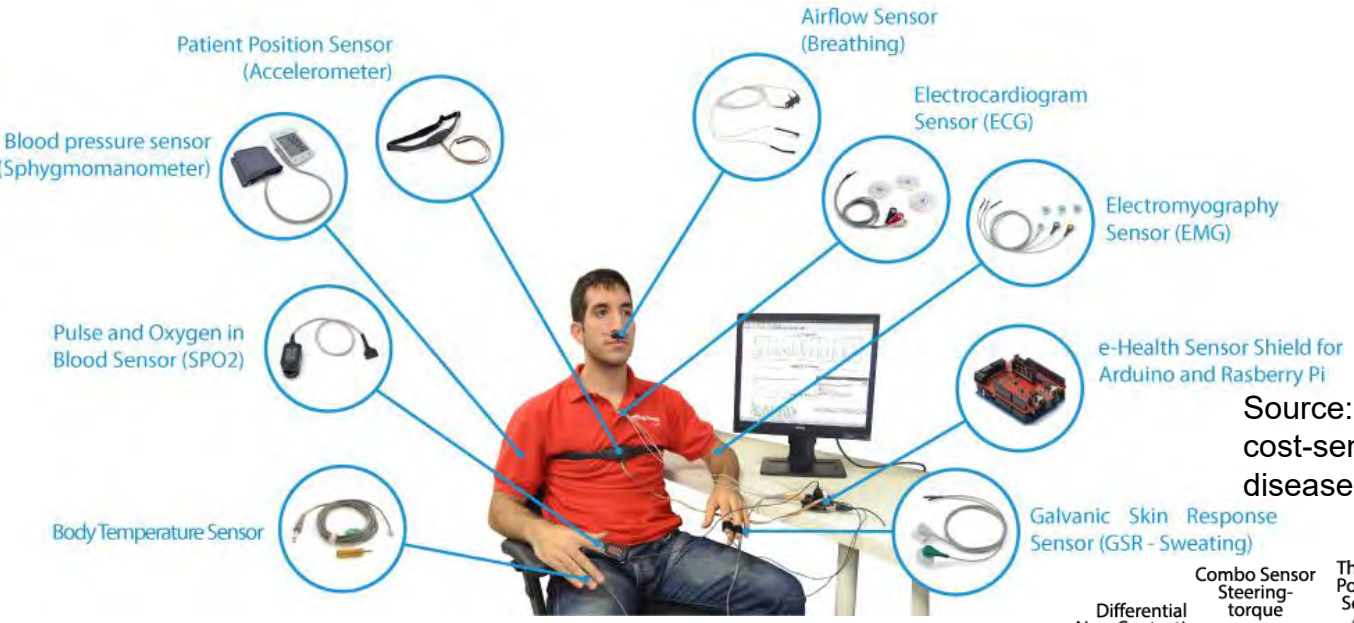
Source: Mohanty 2016, EuroSimE 2016 Keynote Presentation

IoT - The Things

- EveryTHING is connected
- EveryTHING emits signals
- EveryTHING communicates

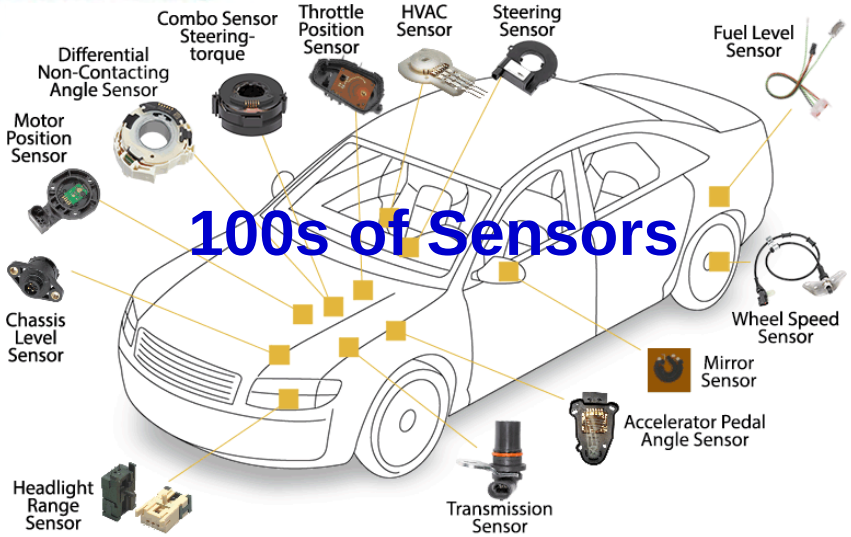
The “Things” refer to any physical object with a device that has its own IP address and can connect and send/receive data via network.

Sensor Technology – Variety of Them



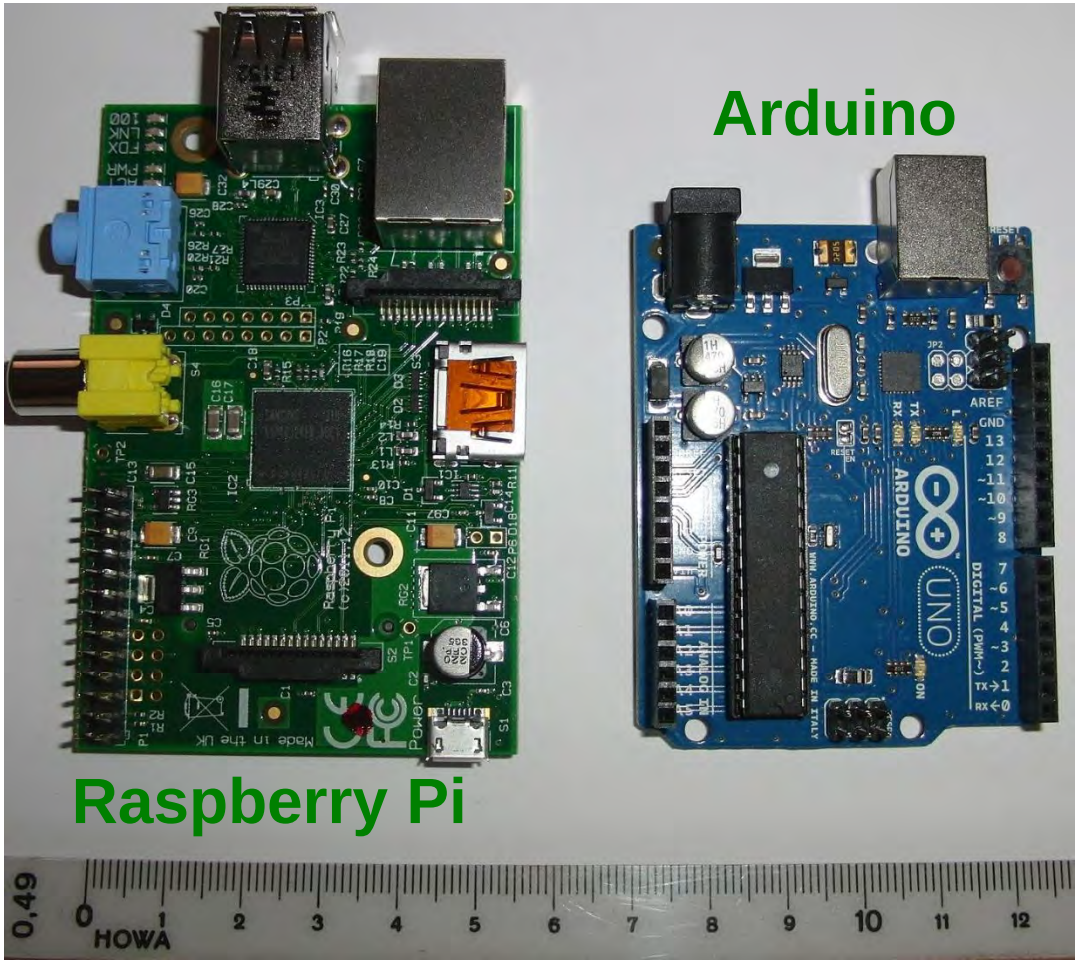
Source: http://www.libelium.com/e-health-low-cost-sensors-for-early-detection-of-childhood-disease-inspire-project-hope/

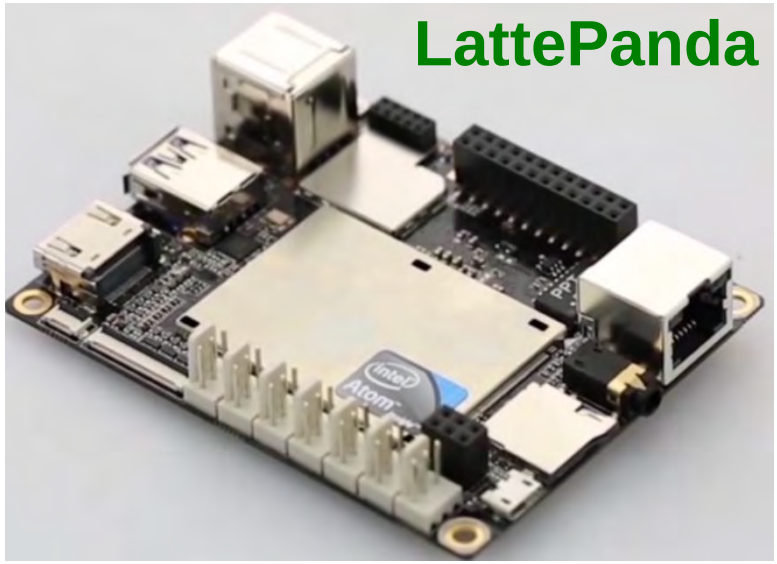
Thing ← Sensor
+ Device with its own IP address



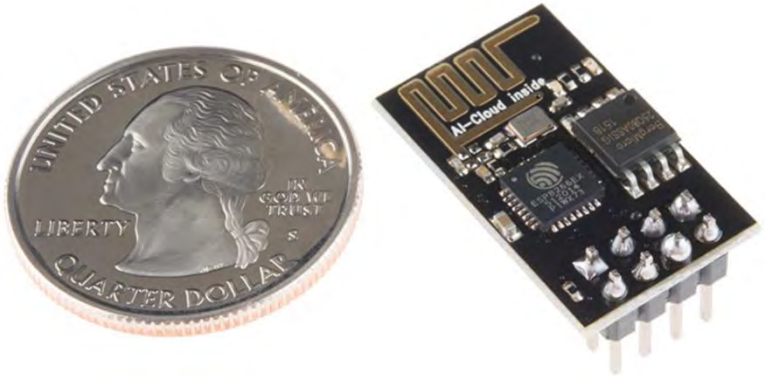
Communications Technology - Wide Variety

Computing Technology - Cheaper



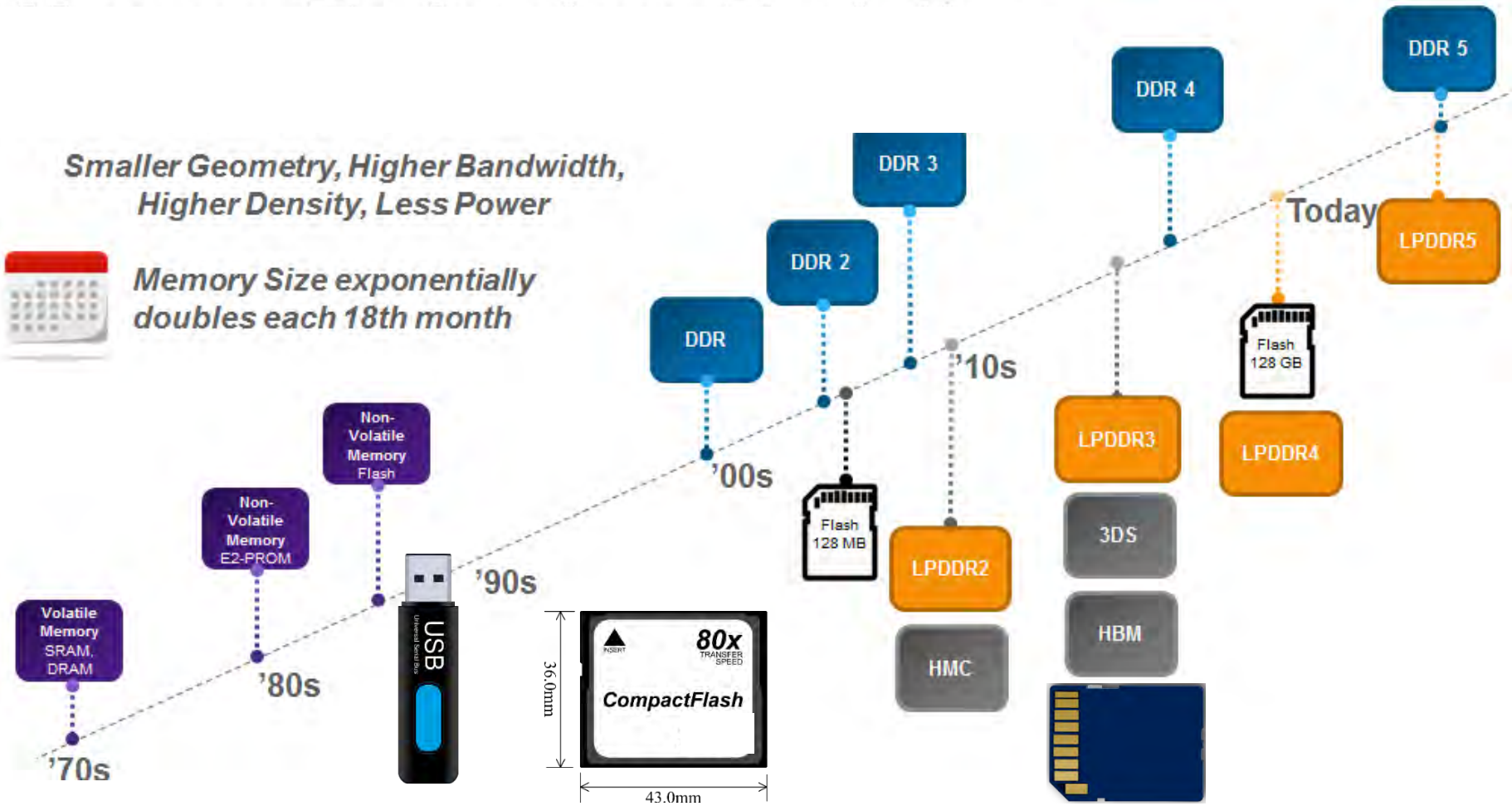


Source: http://www.lattepanda.com



Source: https://www.sparkfun.com/products/13678

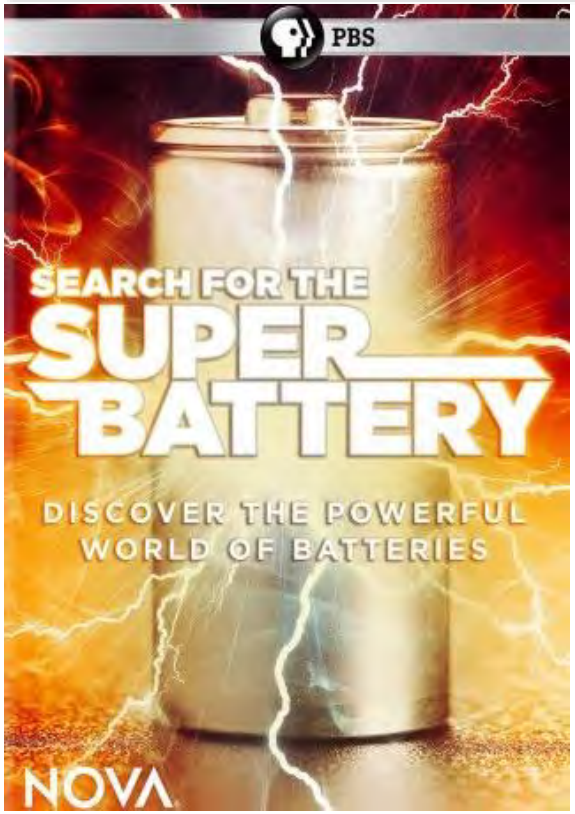
Memory Technology - Cheaper, Larger, Faster, Energy-Efficient



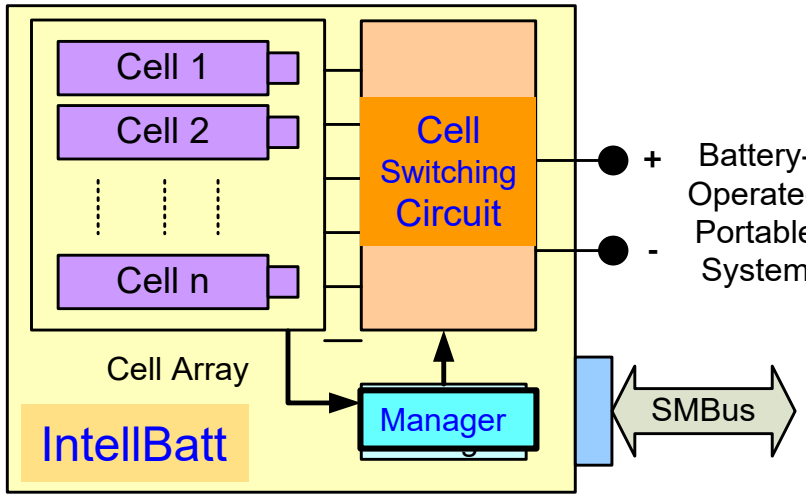
Source: https://blogs.synopsys.com/vip-central/2015/12/01/keeping-pace-with-memory-technology-using-advanced-verification/

Energy Storage - High Capacity & Efficiency

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



Intelligent Battery

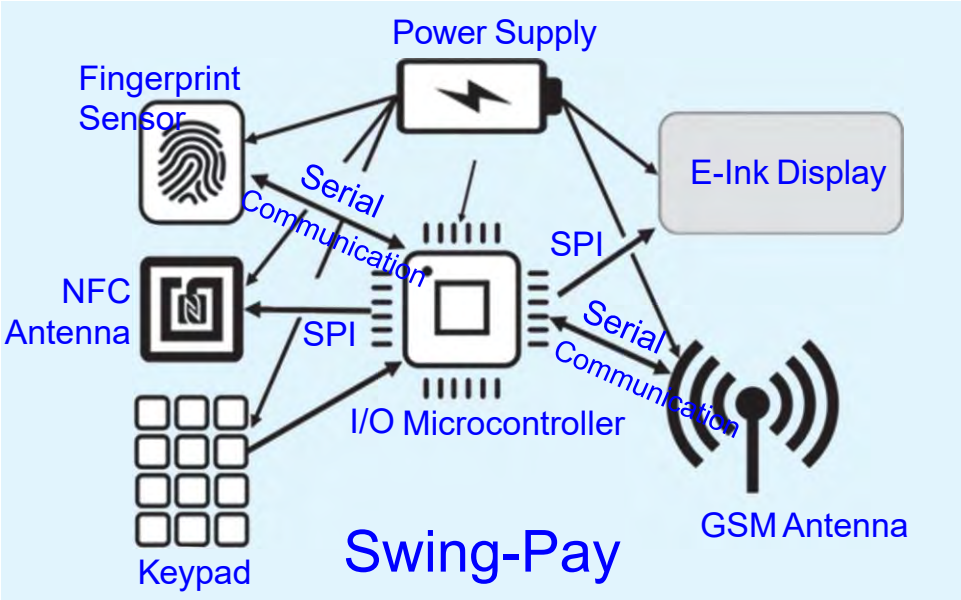


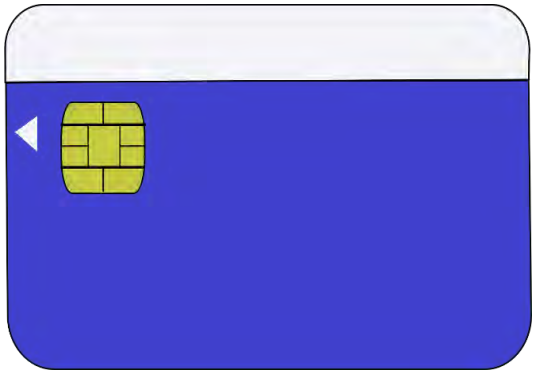
Mohanty 2010: IEEE Computer, March 2010
Figure 1: IntelliBatt Architecture
Mohanty 2018: ICCE 2018

Lithium Polymer Battery

Supercapacitor

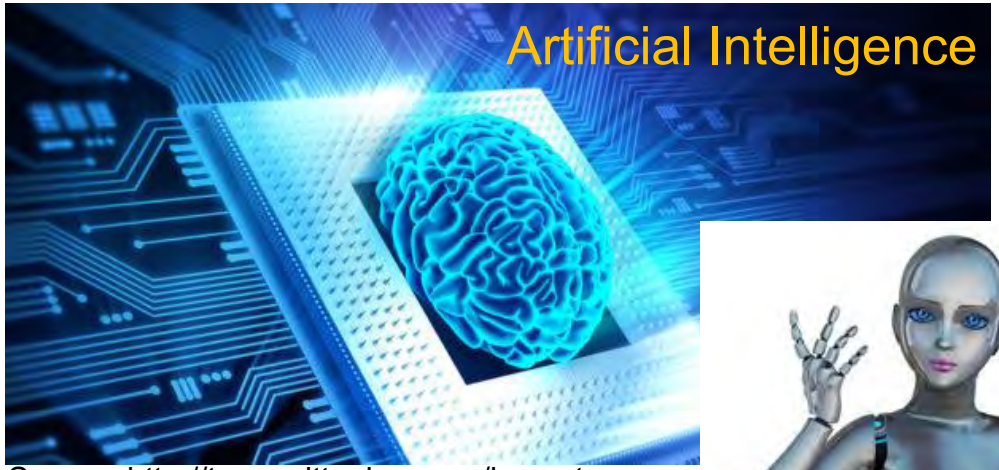
Cashless Payment Technology – An Example



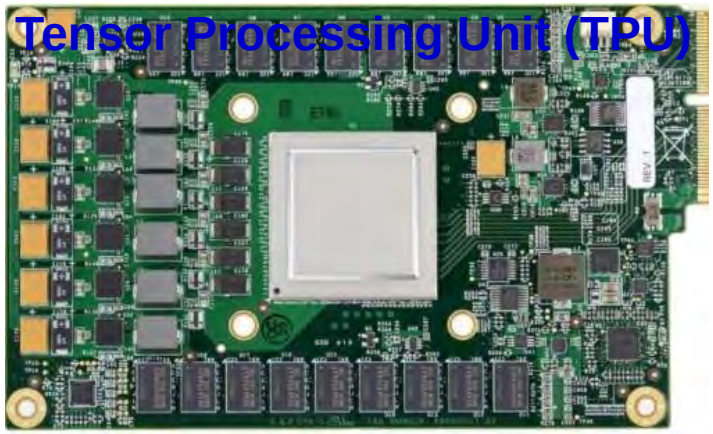


Source: Mohanty 2017, CE Magazine Jan 2017

Machine Learning Technology

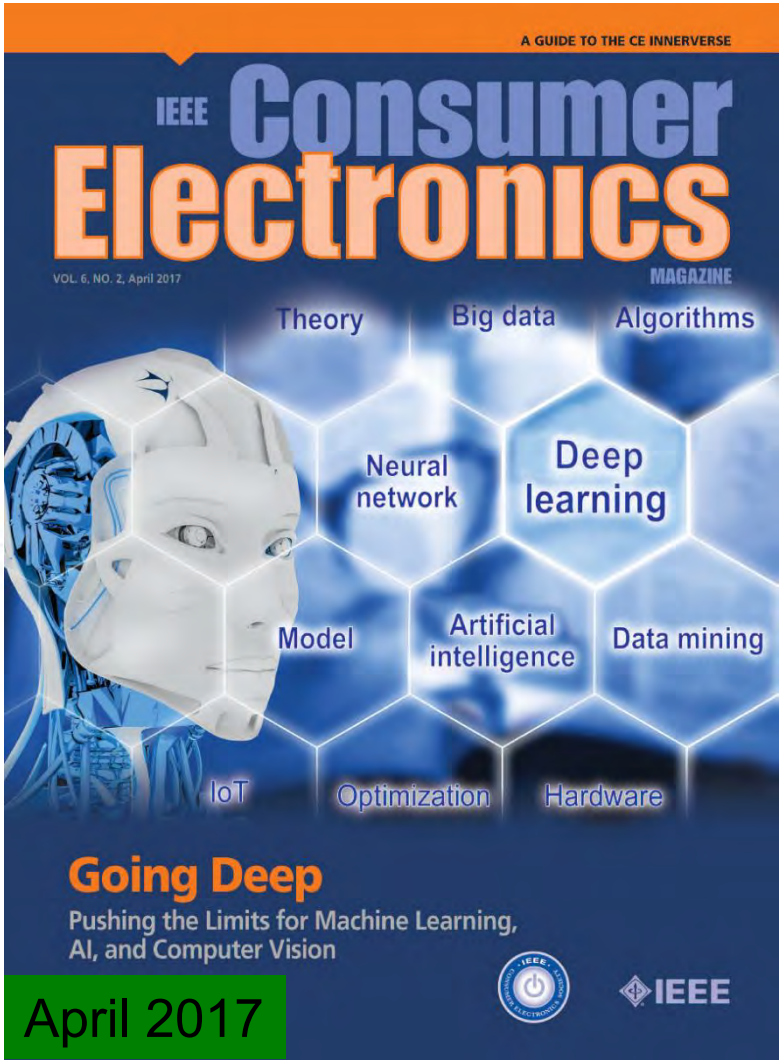


Source: http://transmitter.ieee.org/impact-aimachine-learning-iot-various-industries/



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

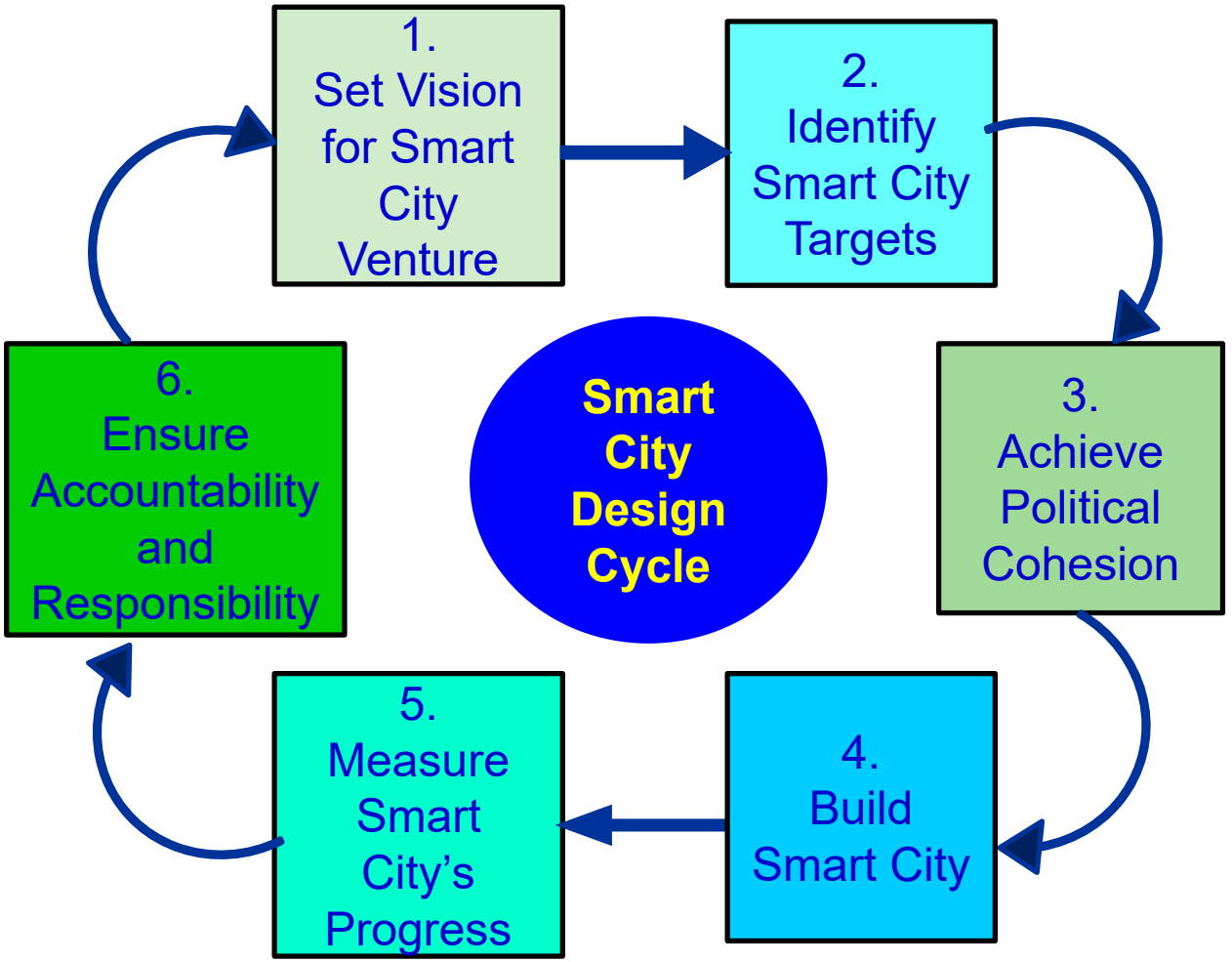
Technology in Smart Cities

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 Cities - Design Cycle

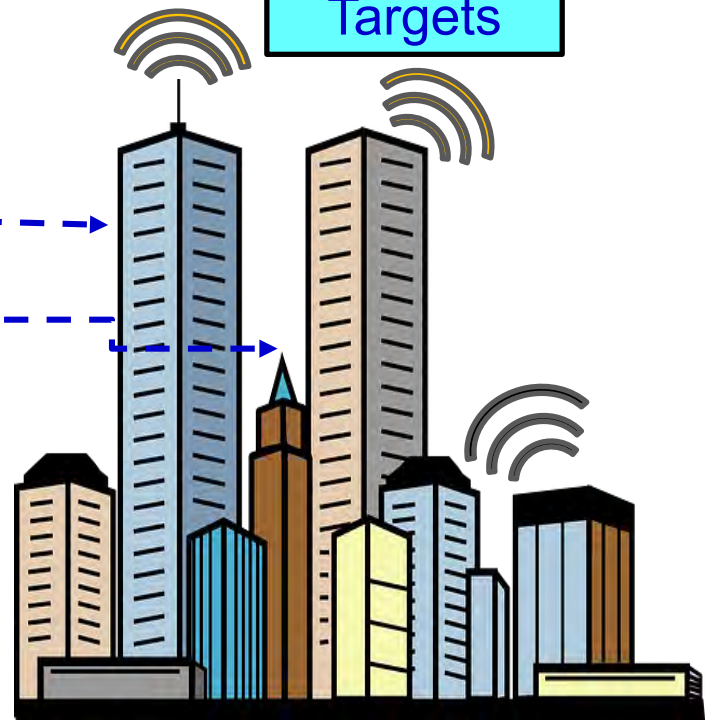


Source: Paolo Gemma 2016, ISC2 2016

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

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

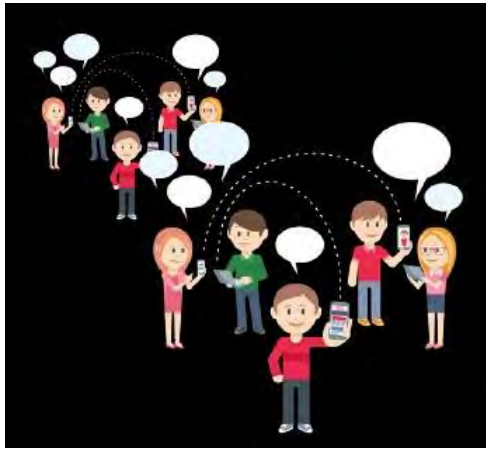
Cost Effective

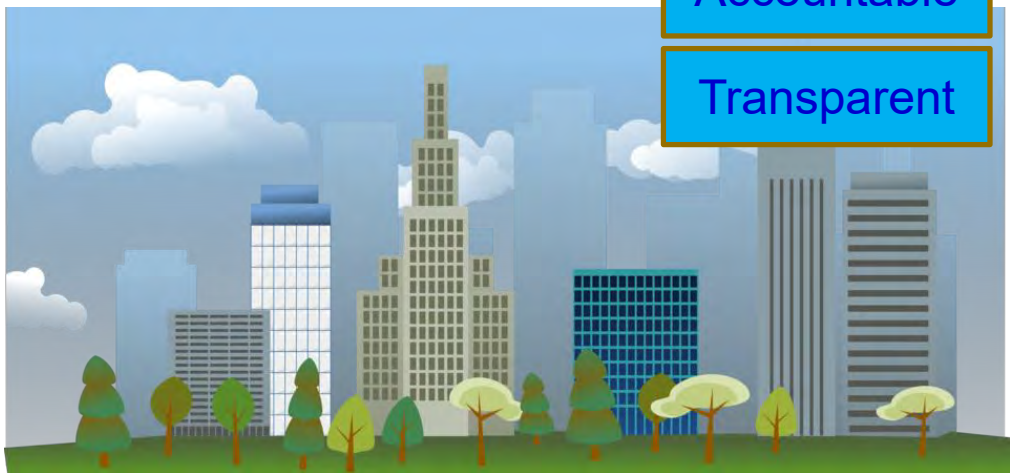
Collaborative

Responsive

Accountable

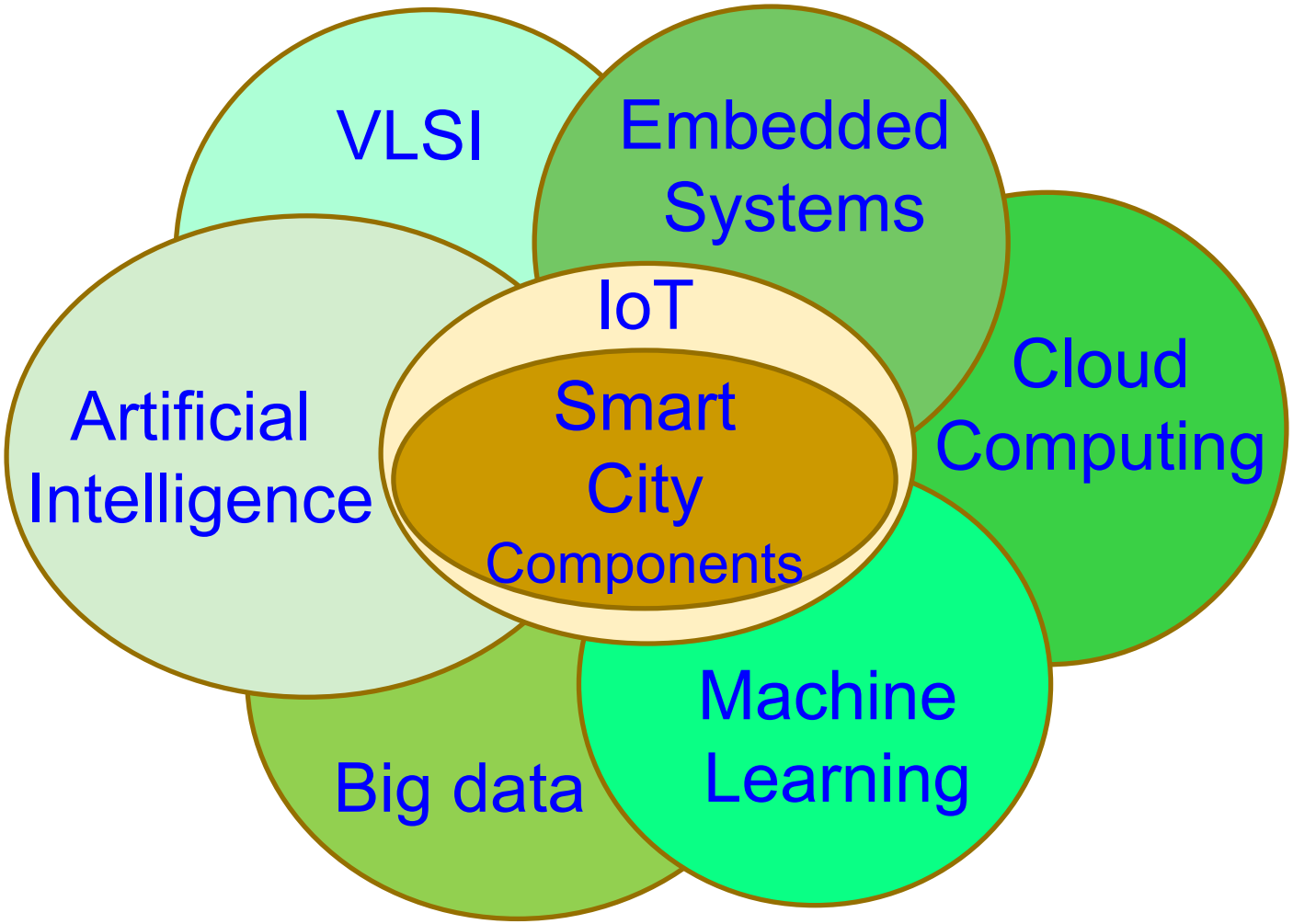
Transparent





Source: Paolo Gemma 2016, ISC2 2016

Smart City Design - Verticals

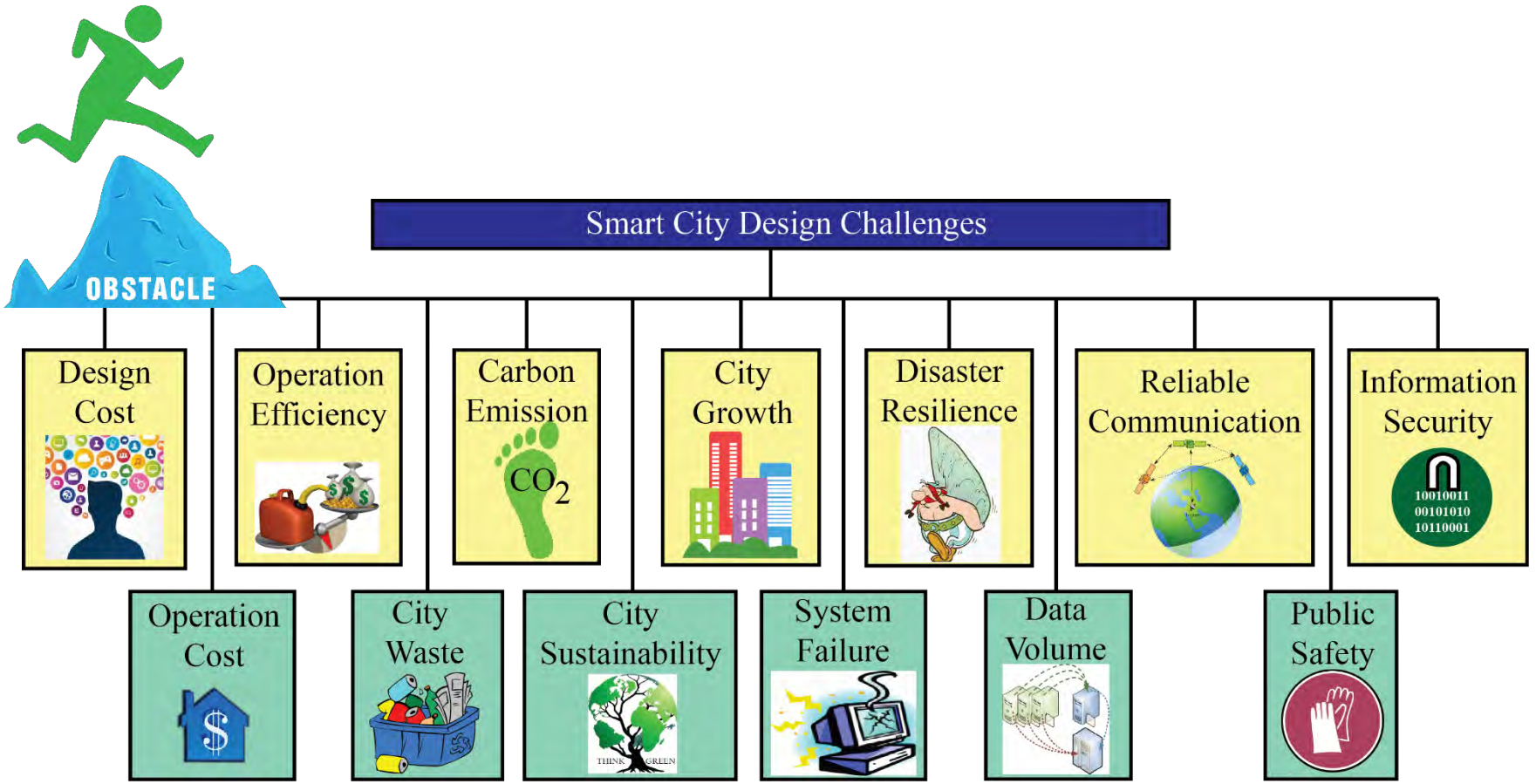


Smart City Design – IoT is Key

Source: https://www.pinterest.com/source/hitachi.com/

Challenges and Research

Smart City - Selected Design Challenges



Source: Mohanty 2016, CE Magazine July 2016

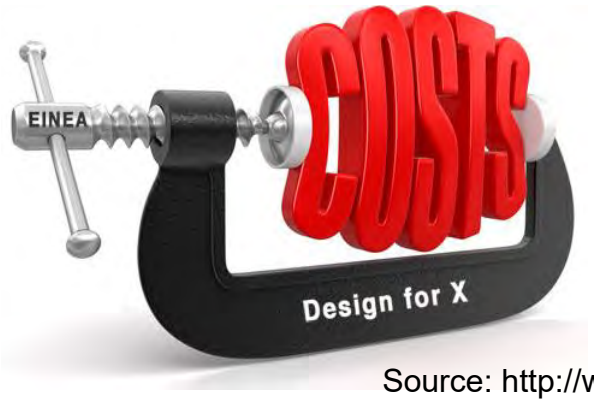
Cost

- "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

Design Cost

- The design cost is a one-time cost.
- Design cost needs to be small to make a smart city realization possible.



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

Operational Cost

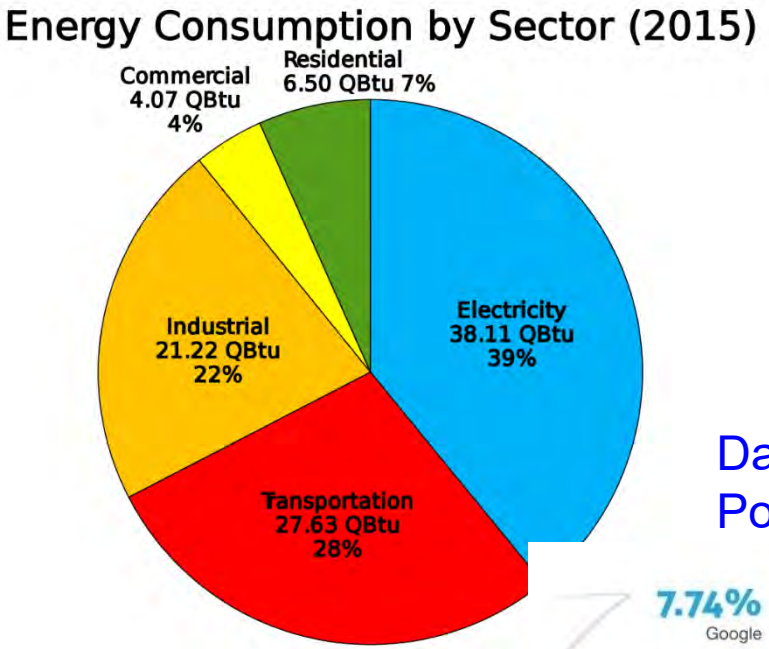
- The operations cost is that required to maintain the smart city.
- A small operations cost will make it easier for cities to operate in the long run with minimal burden on the city budget.

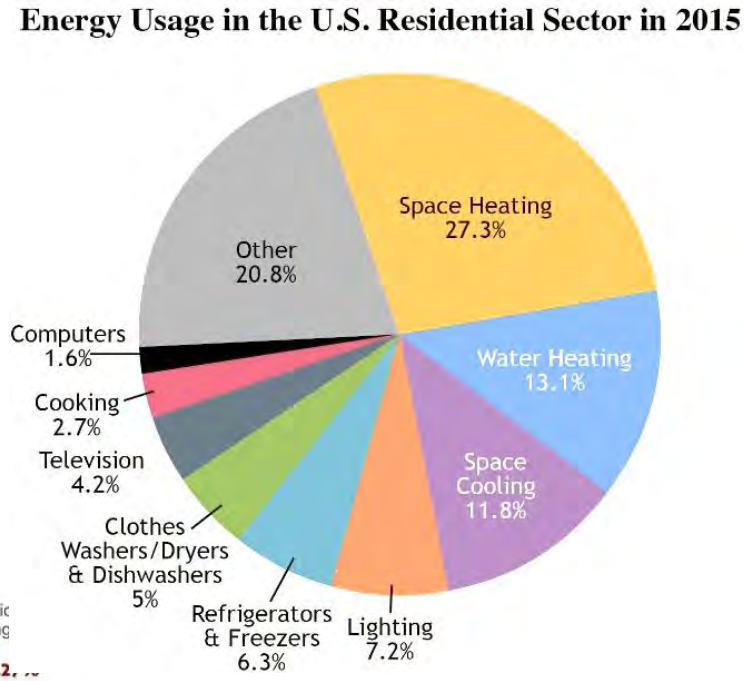
Cost - Technology

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

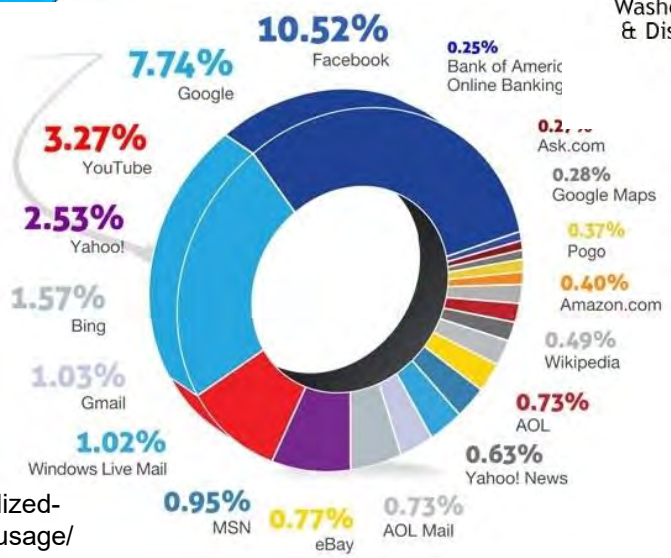
Source: http://www.cnbc.com/2016/10/25/spending-on-smart-cities-around-the-world-could-reach-41-trillion.html

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 Storage Efficiency and Safety

One 787 Battery: 12 Cells / 32 V DC

Source: http://www.newairplane.com

- Boeing 787's across the globe were grounded.

Smartphone Battery

Security, Privacy, and Copyright

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

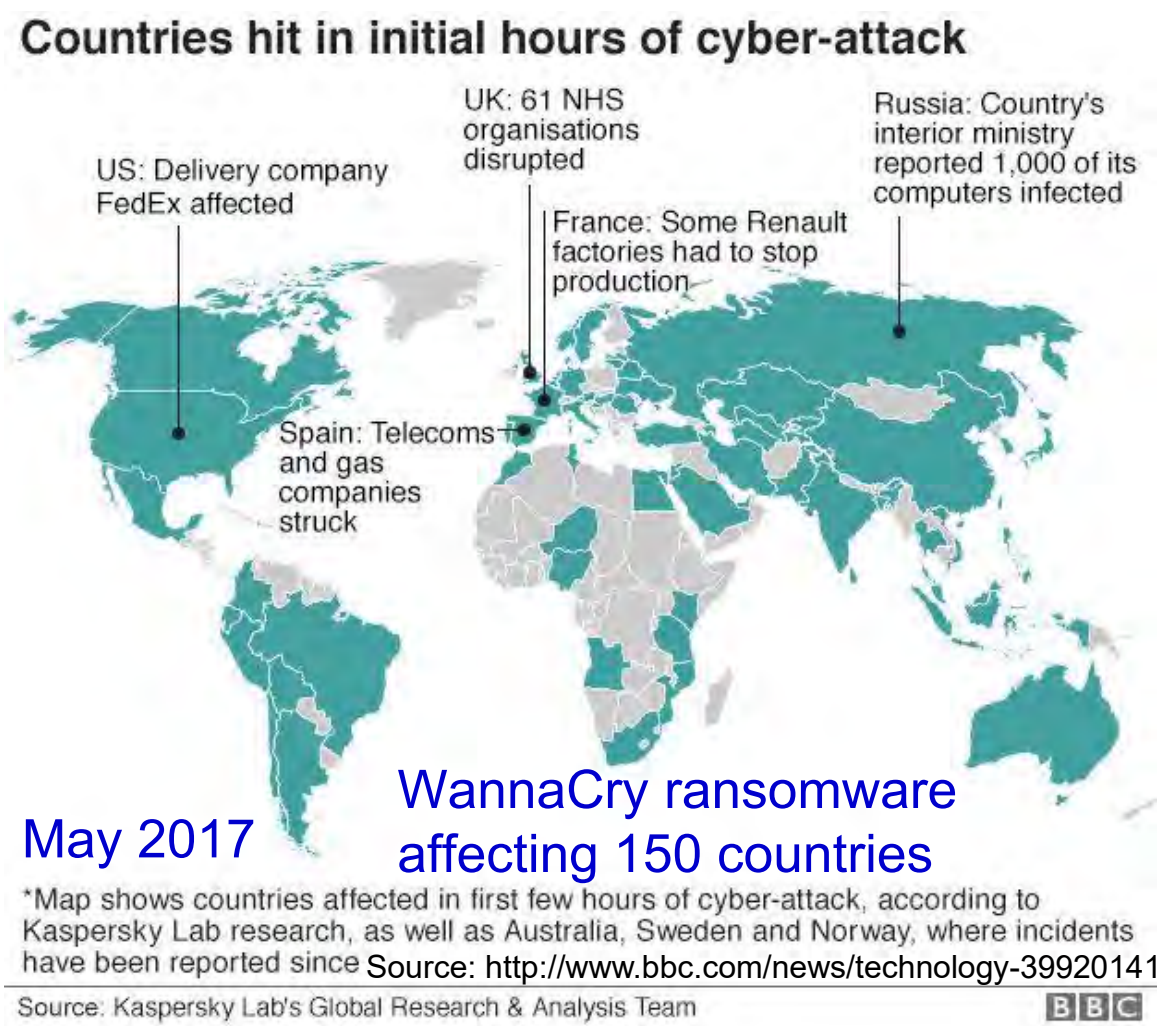
YAHOO!

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

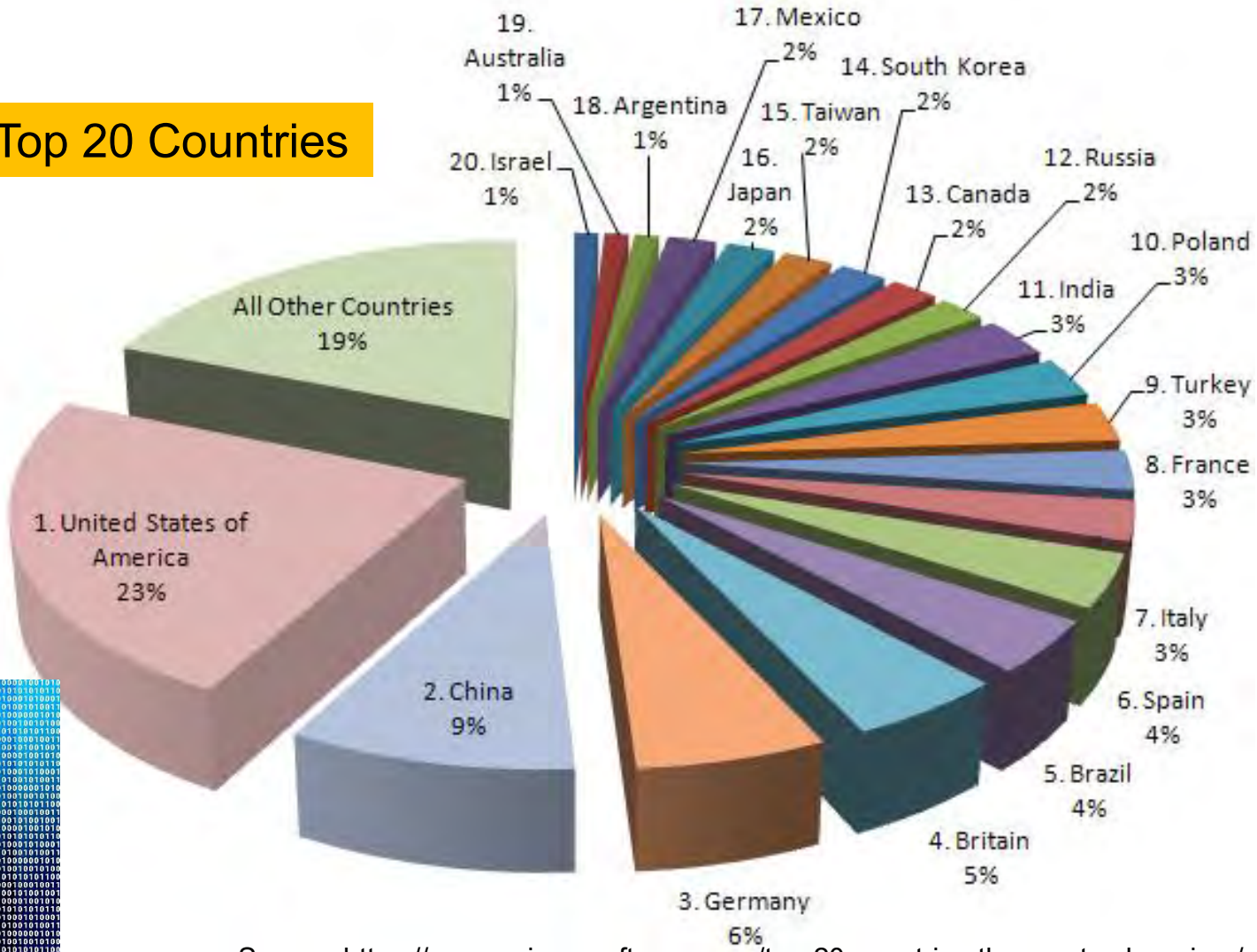
WannaCry ransomware affecting 150 countries

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

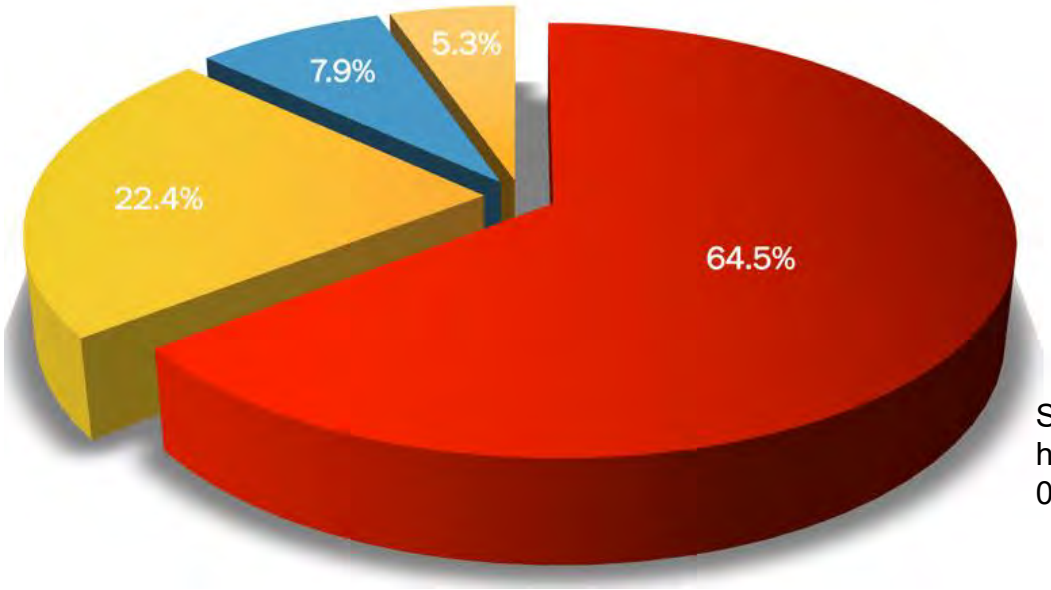
Security - Information, System …

Cybercrime – Top 20 Countries



Source: https://www.enigmasoftware.com/top-20-countries-the-most-cybercrime/

Security - Information, System …

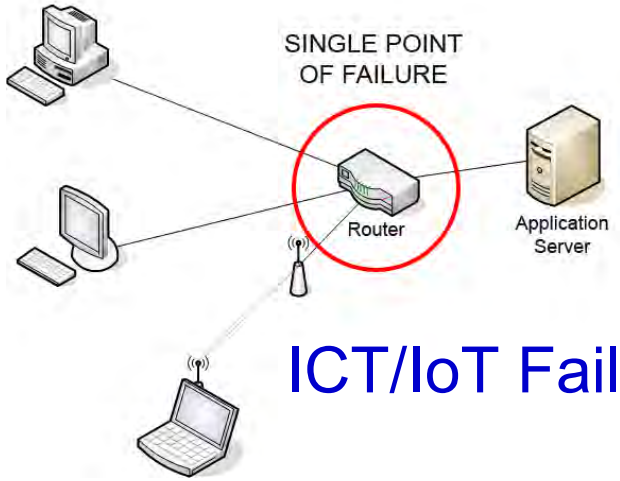


Source: http://www.hackmageddon.com/2017/03/20/february-2017-cyber-attacks-statistics/

- Cybercrime damage costs to hit $6 trillion annually by 2021
- Cybersecurity spending to exceed $1 trillion from 2017 to 2021

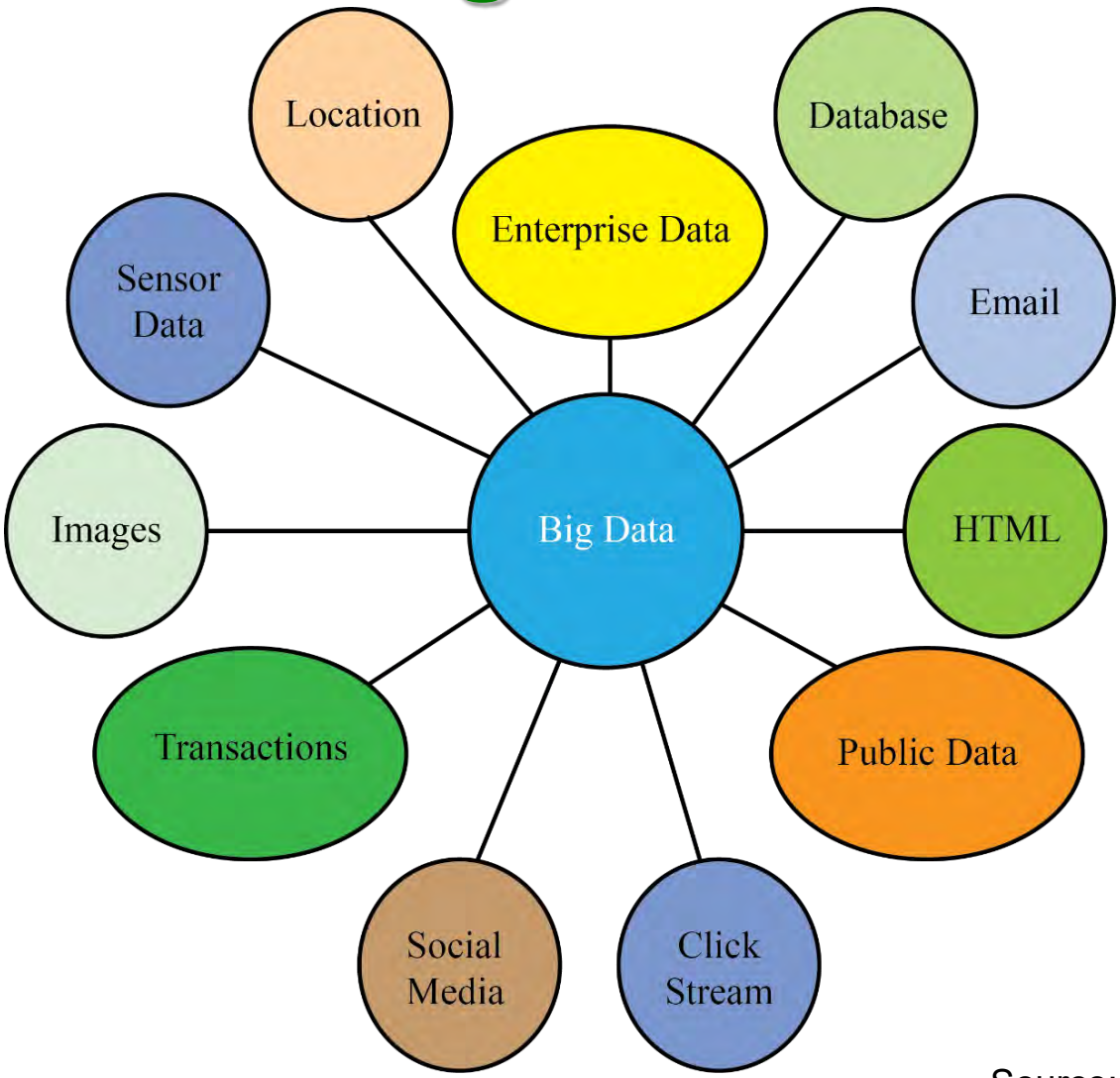
Source: http://www.csoonline.com/article/3153707/security/top-5-cybersecurity-facts-figures-and-statistics-for-2017.html

Failure Tolerance and Resilience



ICT/IoT Failure

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

Tools and Solutions

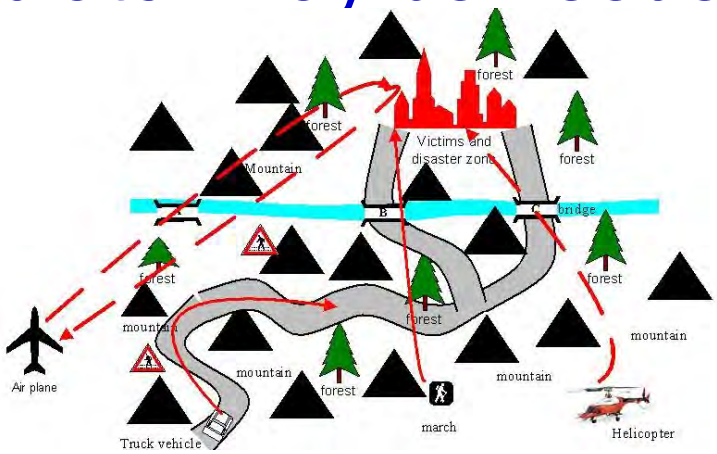
Market Opportunities

- "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.



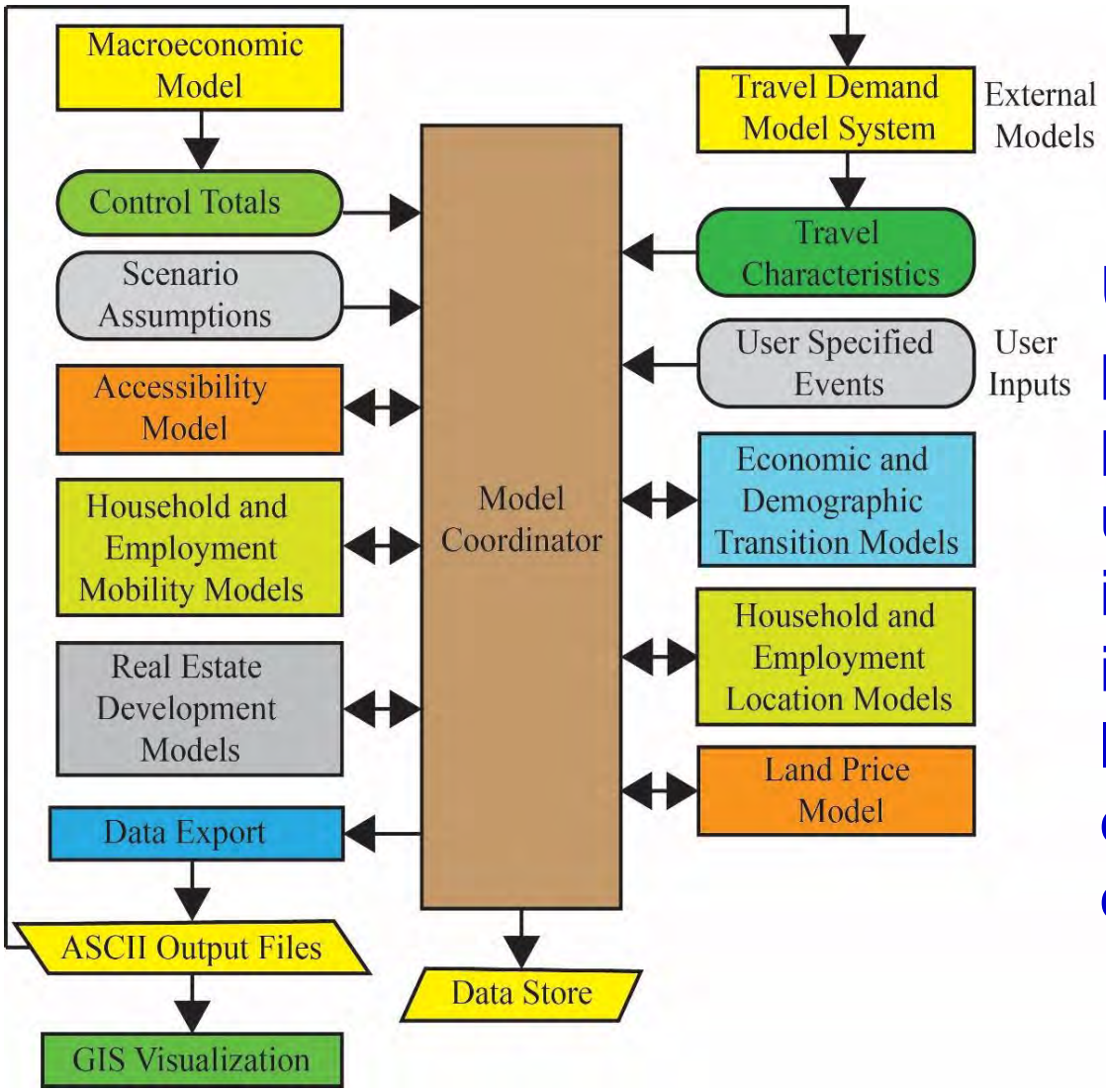
Smart Cities Simulator - CUPCARBON

- **About**
  - CUPCARBON is a smart city and Internet of Things Wireless sensor network simulator (SCI-WSN)

Source: http://www.cupcarbon.com/

- **Objective**
  - Design, Visualize, Debug
  - Validate distributed algorithms
  - Create environmental scenarios
- **Environments**
  - Design of mobility scenarios and the generation of natural events such as fires and gas as well as the simulation of mobiles such as vehicles and flying objects (e.g. UAVs, insects, etc.).
  - A discrete event simulation of WSNs which takes into account the scenario designed on the basis of the first environment.

Smart Cities Simulator - UrbanSim



UrbanSim is a simulation platform for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, economy, and environment.

Source: http://www.urbansim.com/home

Industry Solutions - IBM

IBM has tools to:

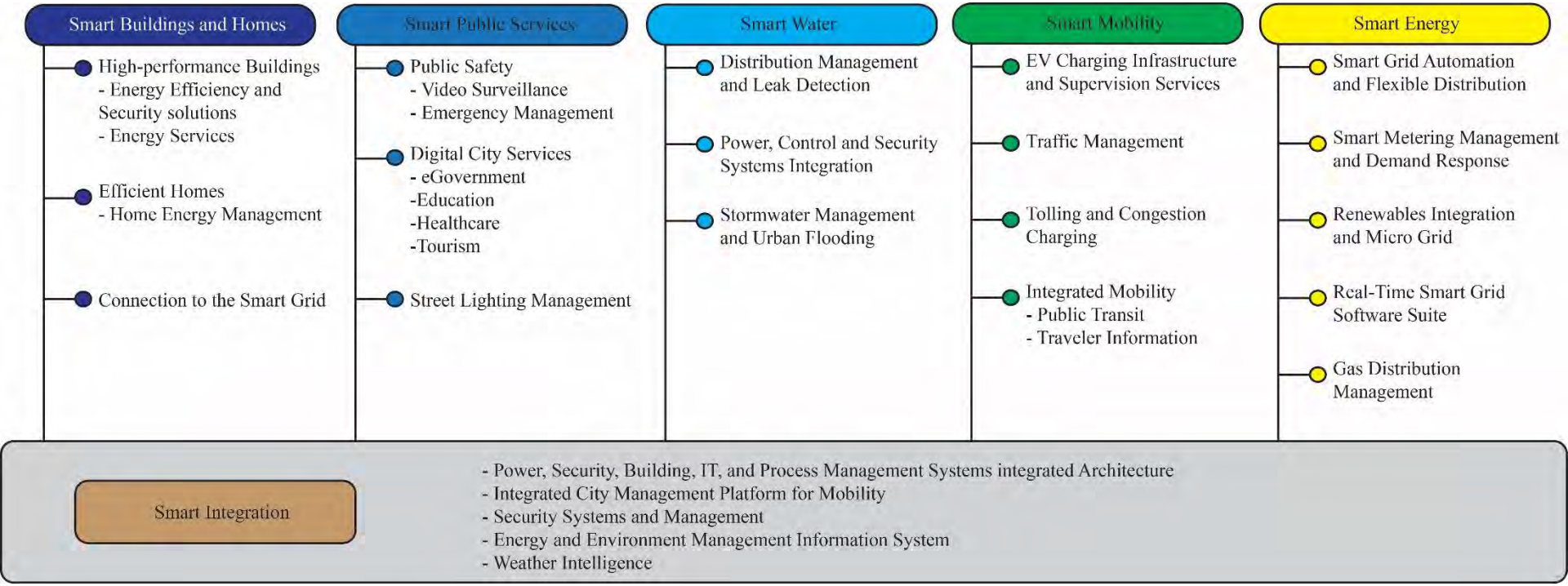
- termine top goals and jectives
- derstand the relationships ong systems
- mpare the performance of es to each other
- aluate operational maturity
- velop actionable roadmaps

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

- ISO 37120 Sustainable development & resilience of communities - Indicators for city services & quality of life
- ISO/TR 37150 Smart community infrastructures - Review of existing activities relevant to metrics
- ISO 37101 Sustainable development of communities -- Management systems -- Requirements with guidance for resilience and smartness
- ISO 37102 Sustainable development & resilience of communities – Vocabulary
- ISO/TR 37121 Inventory & review of existing indicators on sustainable development & resilience in cities
- ISO/TS 37151 Smart community infrastructures -- Principles and requirements for performance metrics
- ISO/TR 37152 Smart community infrastructures -- Common framework for development & operation

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

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-

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)

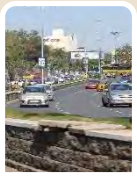
Source: https://www.nsf.gov

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

Odisha Towards Smart Infrastructure

- Odisha Road Asset Management System (ORAMS) - A web-based application that integrates Geographic Information System (GIS) technology into the mapping of Odisha's road and bridge network.
- ORAMS can help Odisha Works Department (OWD) for effective decision-making in planning, programming, funding, procurement, and allocation of resources.
- Data collected by IWD for the 14,000 km of roads and 1,300 bridges using GPS-based survey and spatial layer creation, inventory and condition surveys.
- Asset Wise Transportation Intelligence Gateway (TIG) was used to interface with project and strategy analysis.

ORAMS is the first-of-its-kind in India.

Source: http://india.smartcitiescouncil.com/article/mapping-indias-biggest-road-network-odisha-takes-lead

Bhubaneswar as Smart City

- 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

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

2018 IEEE CONSUMER ELECTRONICS SOCIETY NEW MEMBER APPLICATION

Society Website: https://cesoc.ieee.org/

Membership Fee: $20
Student Membership Fee: $10

These offers apply to full conference and full conference attendees during the conference only.

Free CE Society memberships are open to all current IEEE members. Membership periods end Dec 31 2018 and must be renewed by the member through IEEE.

Incomplete or illegible applications cannot be processed. Write legibly
Enter your name as you want it to appear on you membership card and IEEE correspondence.

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Male ☐ Female ☐ Date of Birth (DD/MM/YYYY) / / _____

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Street Address

City State/Province

Postal Code Country

Home Phone

Home Email

Your Professional Experience

(circle your choices below)

I have graduated from a three-to-five-year academic program

This academic institution or program is accredited in the country where the institution is located.
Yes No Do not know

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

Engineering

Computer Sciences and Information Technologies

Physical Sciences

Biological and Medical Sciences

Mathematics

Technical Communications, Education, Management, Law and Policy
Other (please specify): _____

Are you or were you ever a member of the IEEE? Yes No
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Grade _____

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2) Discount in conference registration
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Smart Electronic Systems Laboratory (SESL)
UNT

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.

Key People

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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.

Thank You !!!

Slides Available at: http://www.smohanty.org