

Buildings & Smart Cities – Micro to Macro

Professor Sekhar KONDEPUDI
Smart Cities, Smart Buildings & IoT Lab



Sekhar Kondepudi, Ph.D.
Associate Professor
Smart Buildings & Smart Cities

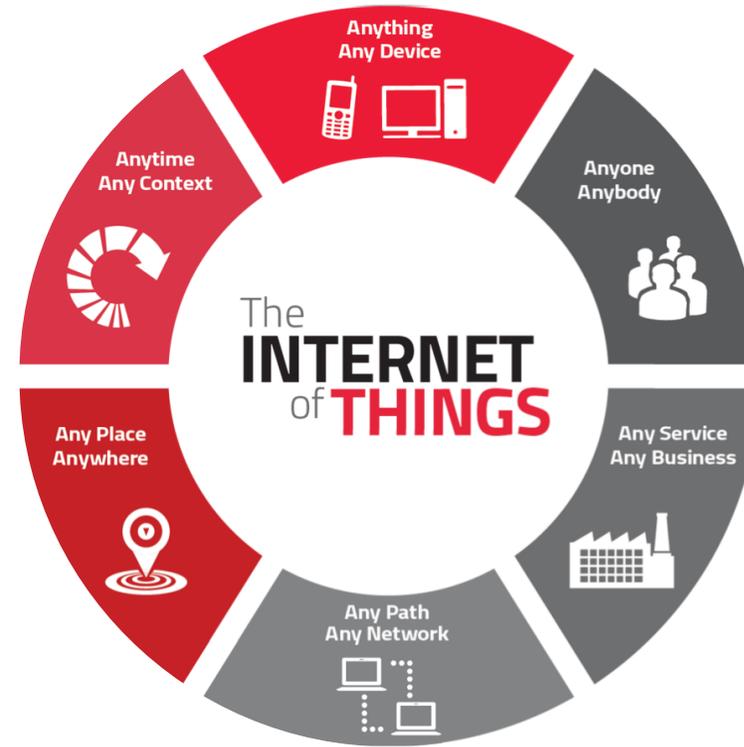
June 25 2018

Vice Chair, Focus Group on
Smart Sustainable Cities

- 1 Internet of Things - IoT
- 2 Smart Green Buildings
- 3 Smart Sustainable Cities
- 4 Big Data Meets IoT, Buildings & Cities
- 5 Food For Thought

1

Internet of Things



ICT & IoT Devices Scale (Micro)

44,000,000
MESSAGES PROCESSED
486,000
PHOTOS



26
NEW REVIEWS
POSTED ON YELP

120
NEW ACCOUNTS
OPENED ON
LINKEDIN

MORE THAN
140
SUBMISSIONS
ON REDDIT

MORE THAN
2,315,000
SEARCHES

3,12
 243,000



MORE THAN
21,000,000
MESSAGES SENT

70,000
VIDEO MESSAGES
SHARED



Share
MORE THAN
3,000,000
ITEMS ARE
SHARED

MORE THAN
18,000
MATCHES MADE

972,000
DAILY SWIPES
ON TINDER

MORE THAN
195,000
MINUTES OF AUDIO CHATTING
ON WECHAT



MORE THAN
69,500
HOURS OF
VIDEO WATCHED
ON NETFLIX

NETFLIX



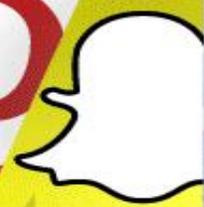
GO-Globe
CUSTOM WEB DEVELOPMENT

MORE THAN
150,000,000
E-MAILS ARE SENT



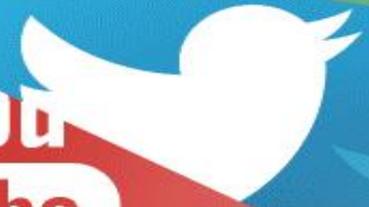
MORE THAN
48,000
APPS DOWNLOADED
ON IPHONE

MORE THAN
95,000
APPS DOWNLOADED
ON ANDROID



YouTube

MORE THAN
430,000
TWEETS SENT



AROUND
56,000
PHOTOS
UPLOADED

9,800
ARTICLES PINNED
ON PINTEREST

MORE THAN
280,000
SNAPS SENT
ON SNAPCHAT

MORE THAN
100
NEW DOMAINS
REGISTERED

MORE THAN
39,300
HOURS OF MUSIC
LISTENED

14 NEW
SONGS ADDED
ON SPOTIFY

MORE THAN
2,700,000
VIDEO VIEWS AND
139,000 HOURS
OF VIDEO WATCHED

MORE THAN
300 HOURS
OF VIDEO ARE UPLOADED

What is the Internet of Things?

Things



Connectivity



Data

10101
01010
00100

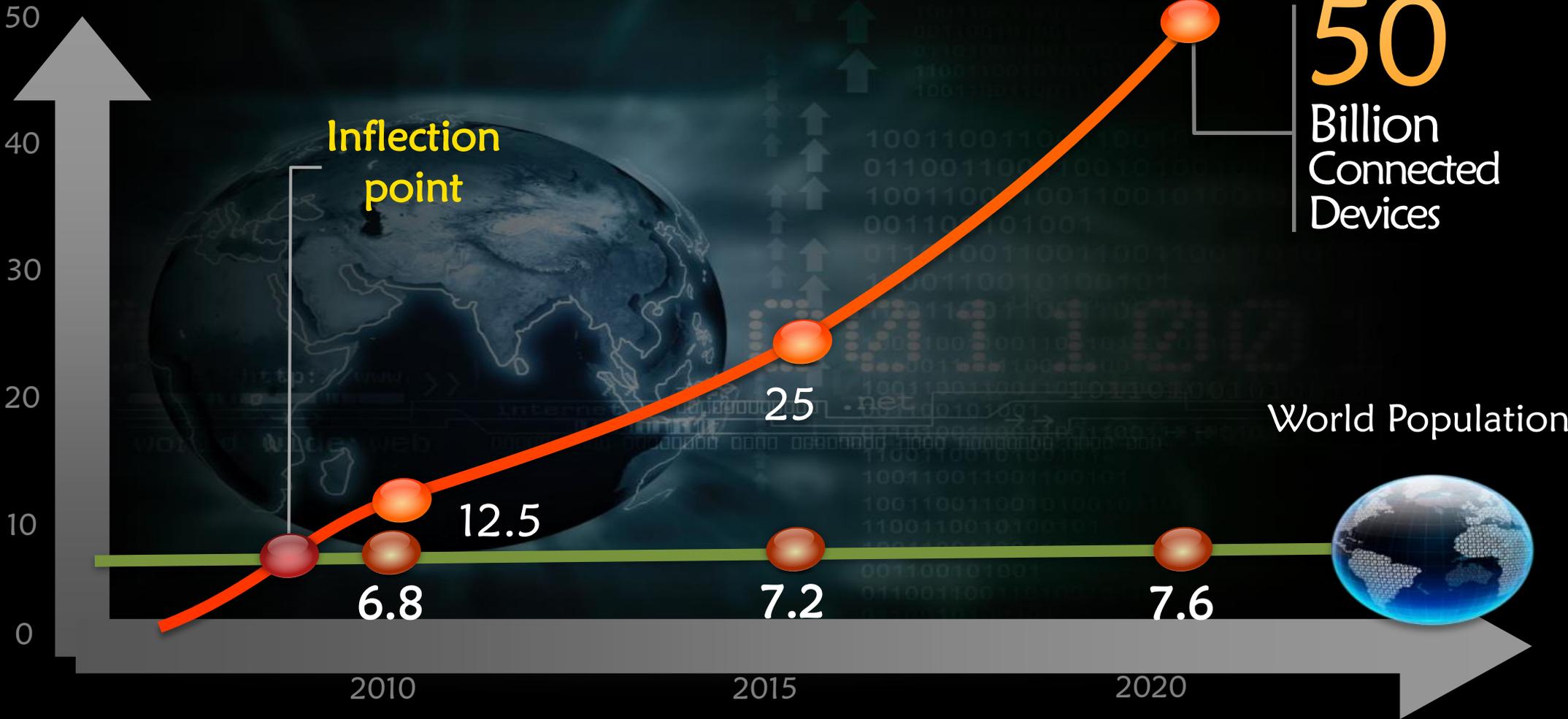
Analytics



Connected Devices

The Industrialization of the Internet is Now

Source: Cisco



The Internet of Things





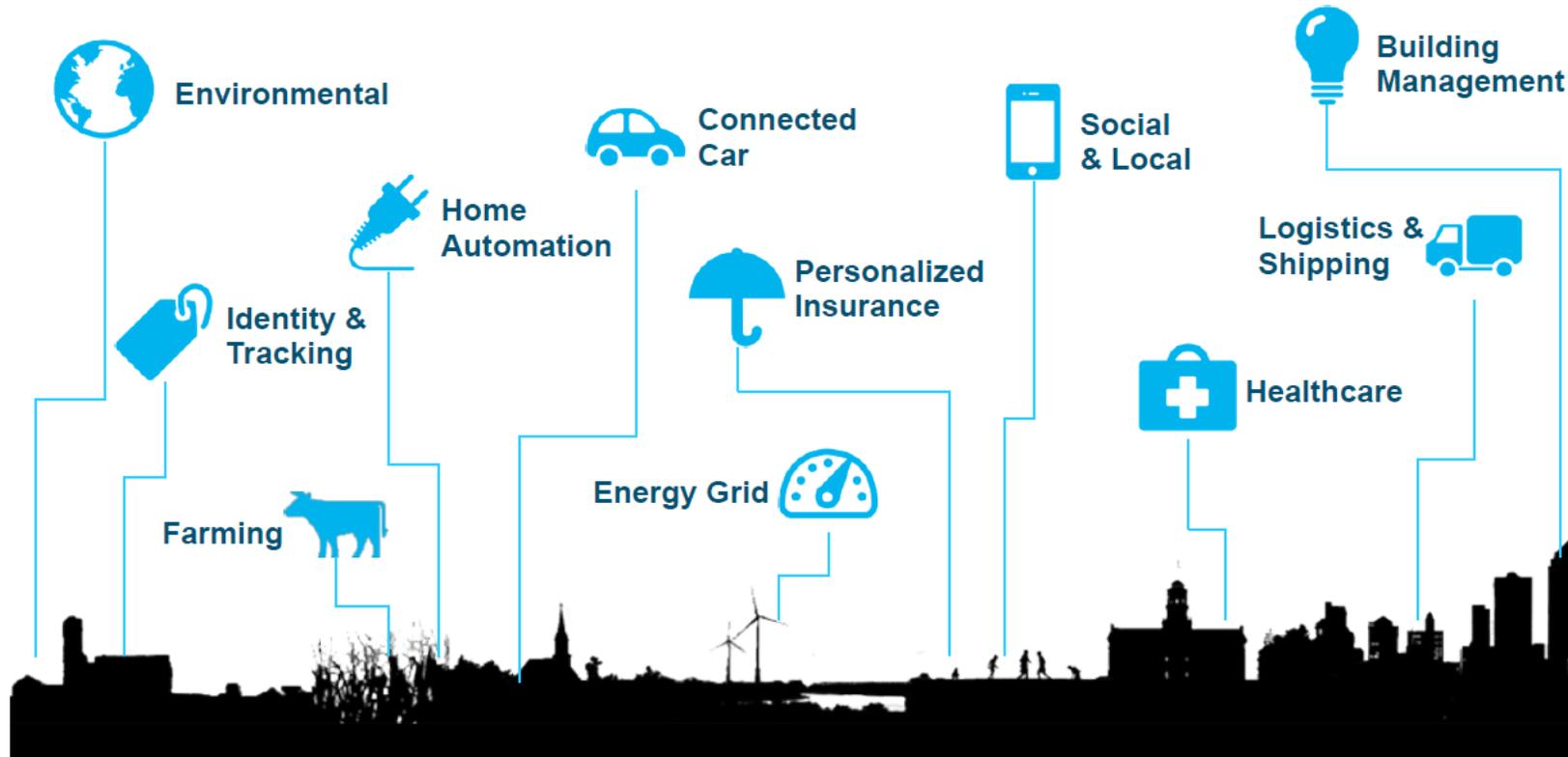


Connected Cows



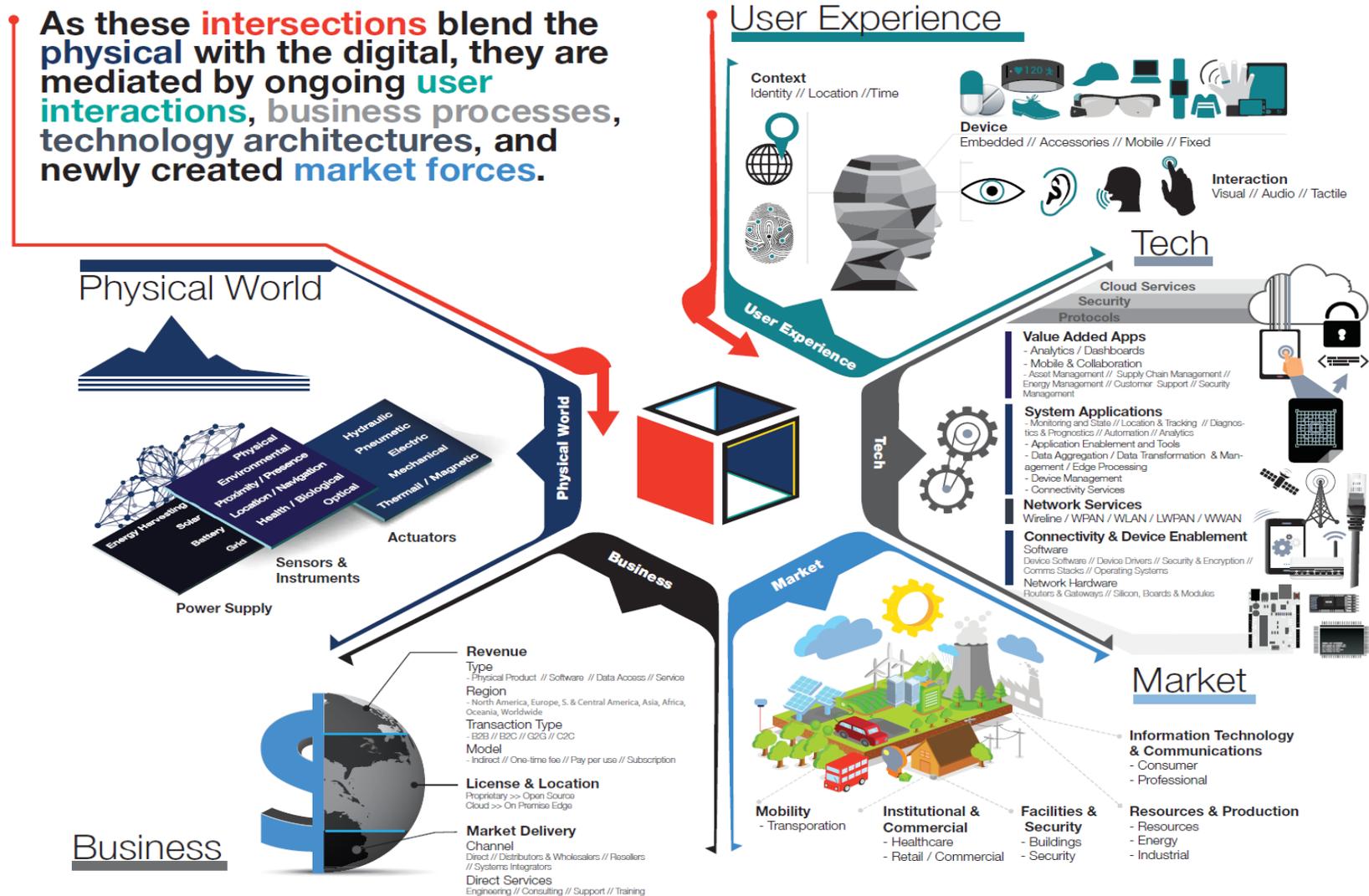
Smart Fridge

Connecting Physical World to Digital

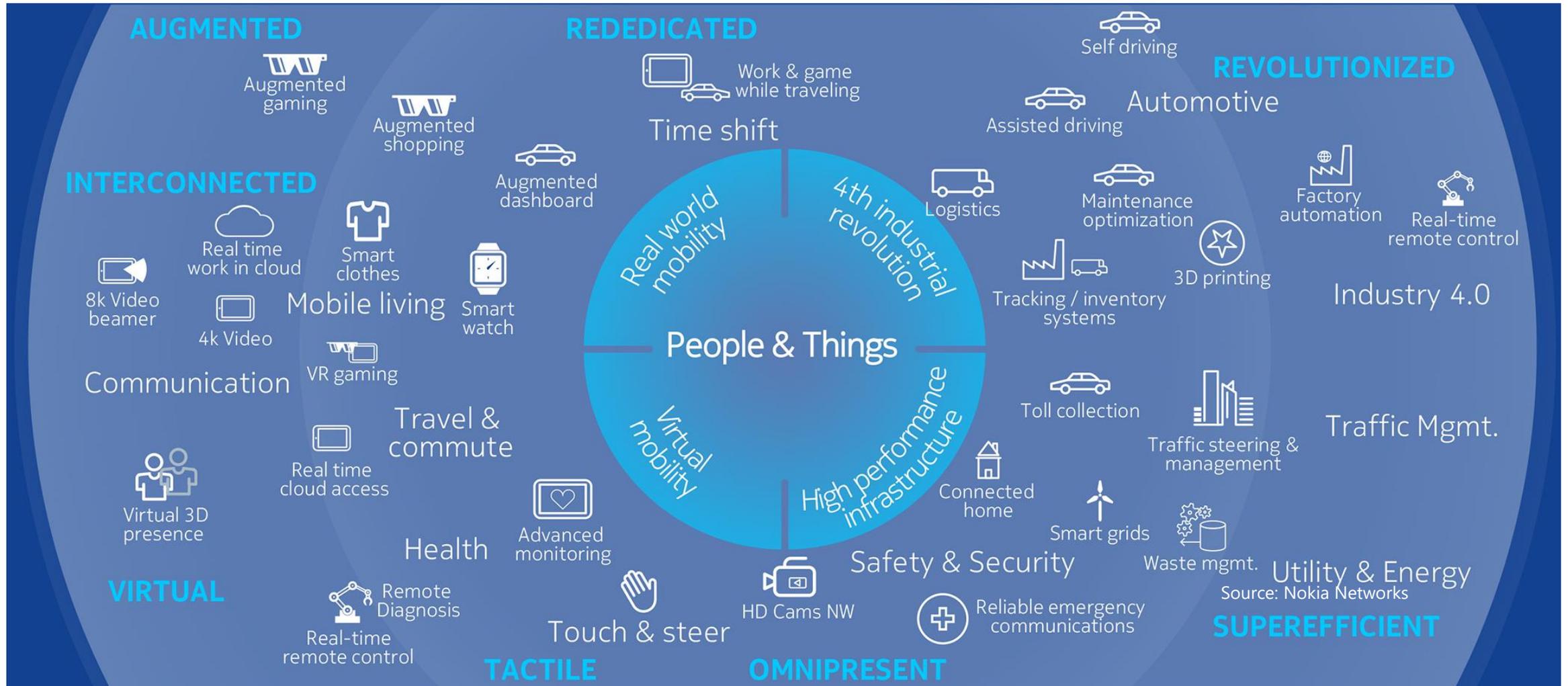


A Holistic View of IoT

As these **intersections** blend the physical with the digital, they are mediated by ongoing **user interactions**, business processes, technology architectures, and newly created **market forces**.



Endless Possibilities



2

Smart Green Buildings



Building Scale

What's *Really* Happening?



WE SPEND OVER 90% OF OUR TIME INDOORS !



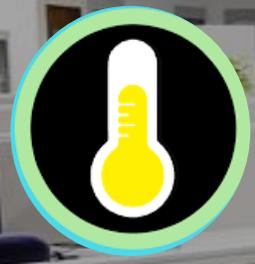
The Conditions in Buildings therefore **IMPACT** our **Comfort, Well-Being** and **Productivity** in a **BIG** Way

If You Cannot MEASURE it, You Cannot IMPROVE it

Peter F. Drucker



Energy Savings



Comfort & Well-Being

Efficiency & Productivity



Energy

Buildings Consume Over 40 % of the Energy in the World



Air-Conditioning

Contributes to 50 + % of annual usage



Lighting & Plug Load

Consume 30 % of a Building's Energy Load



Electrical Costs

1000m² of floor space, costs \$ 75,000/ year

CONFIDENTIAL



Comfort & Well-Being

Over 2/3 of office workers are uncomfortable while working



Temperature

75% of Employees Complain about it being Too HOT or Too COLD



Noise

70 % of Employees state that their work environments are too noisy



Air Quality

Polluted Indoor Environments can be 2-5 times higher than those outdoors

CONFIDENTIAL



Efficiency & Productivity



Thermal Comfort

An Office which is Too Hot or Too Cold can Cause a Drop in Productivity of up to 6 %



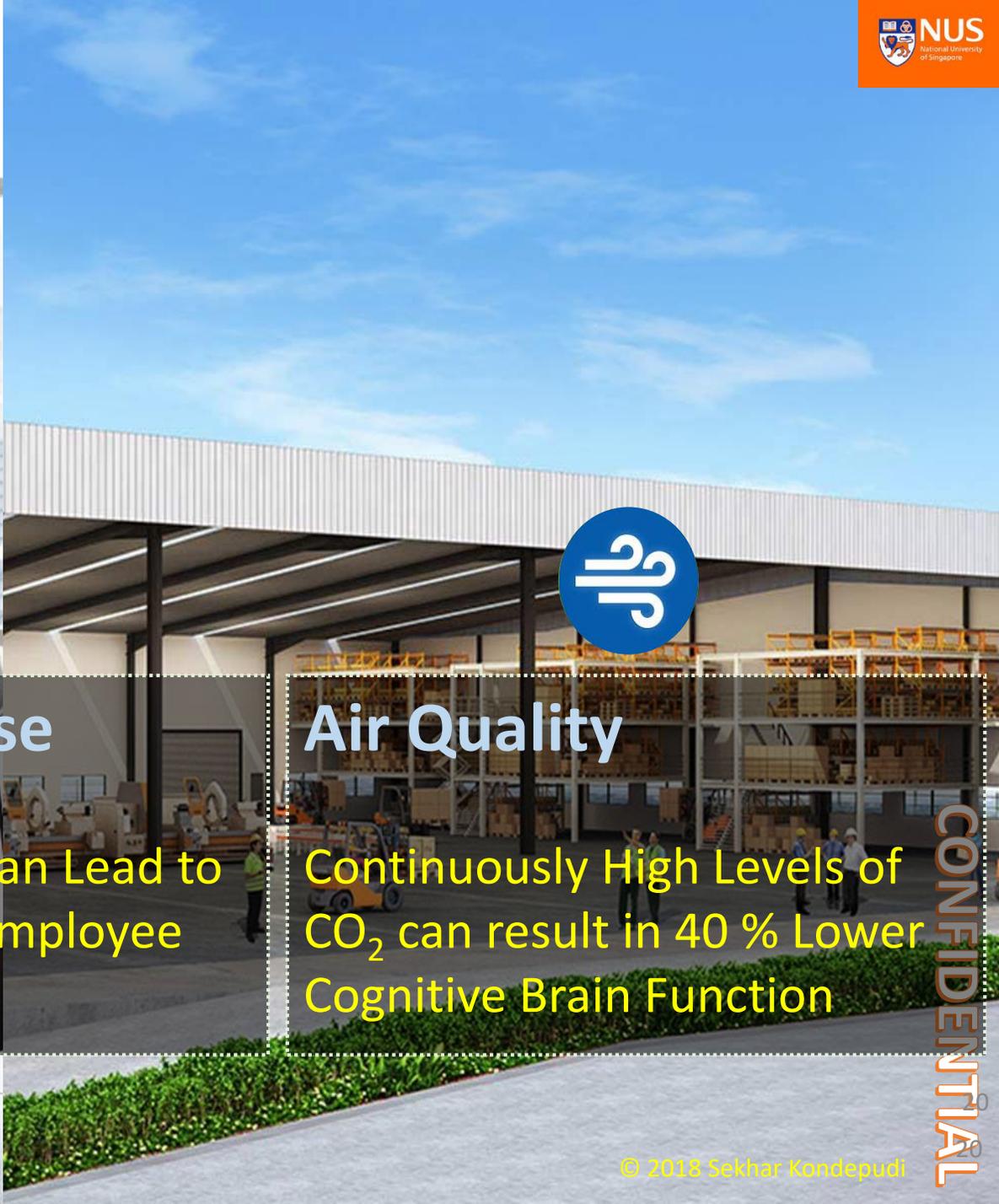
Impact of Noise

Distracting Noise Can Lead to a 66 % Decline in Employee Performance



Air Quality

Continuously High Levels of CO₂ can result in 40 % Lower Cognitive Brain Function



CONFIDENTIAL

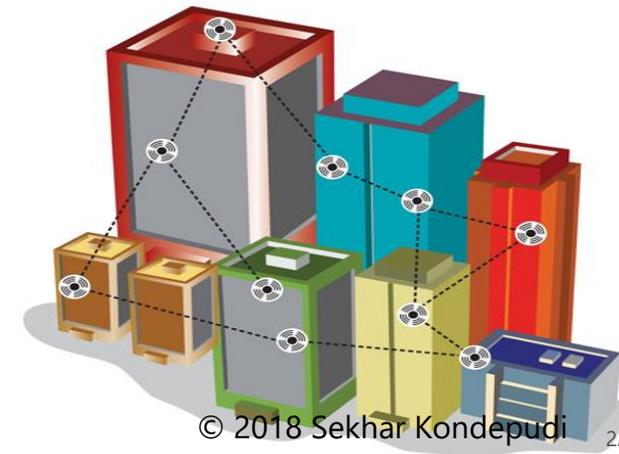
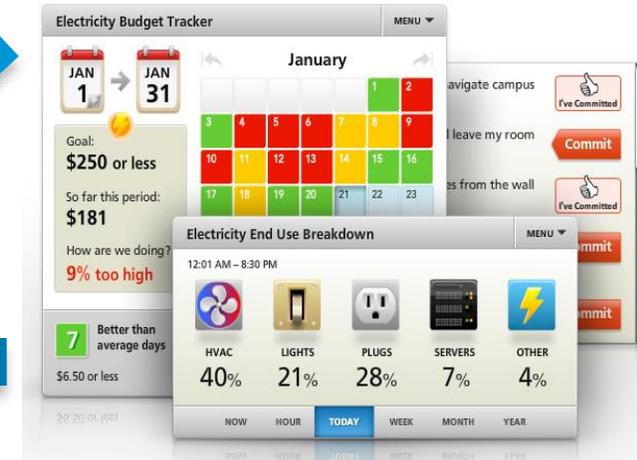
What is a Smart Building?



- A building which is sustainable – water, energy
- It enhances employee / occupancy productivity through better comfort and well being.
- It is a building that is managed comprehensively from concept to grave.
- It is well instrumented to enable monitoring and optimal operations

Analytics, Informatics & Dashboards

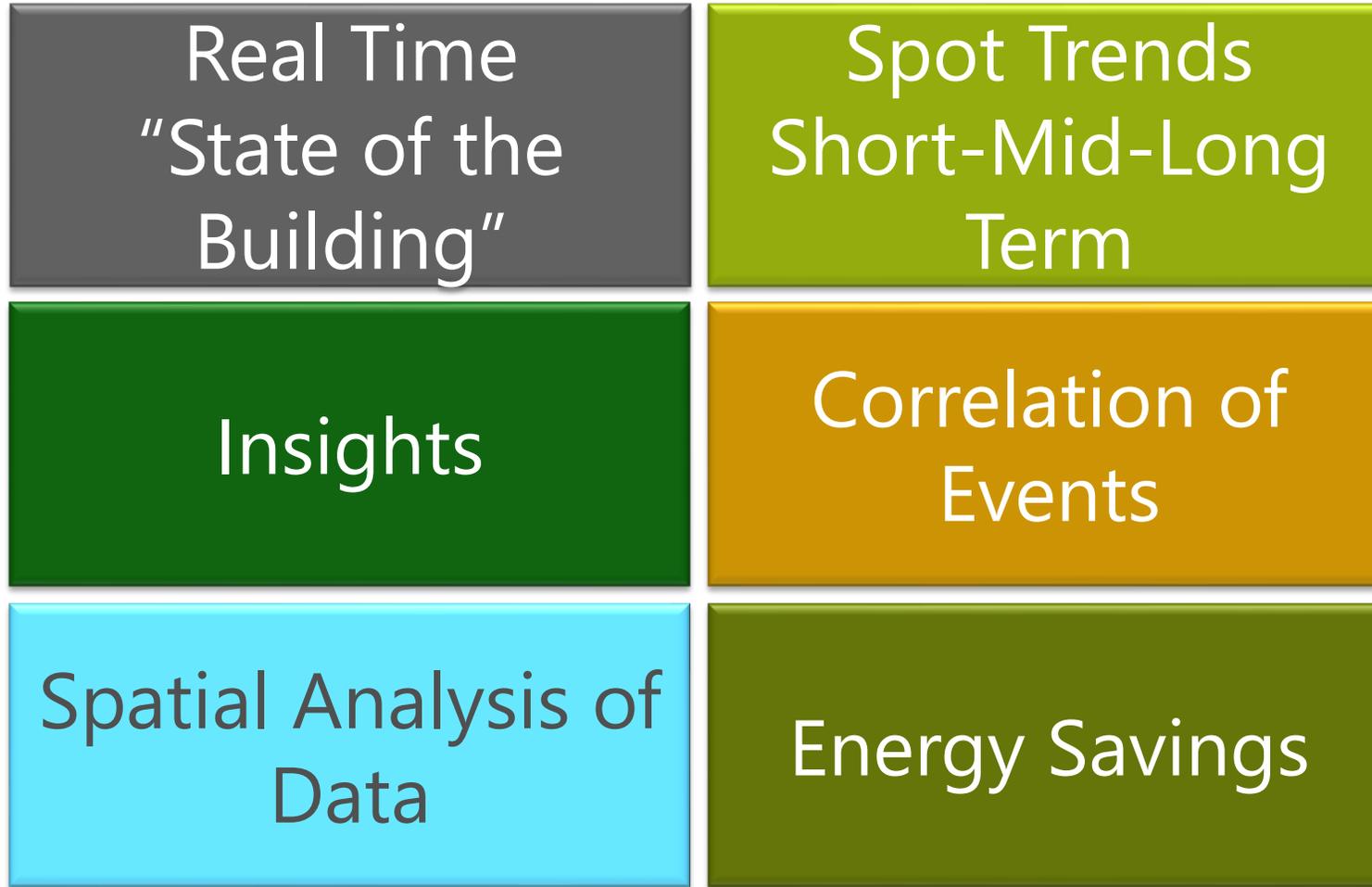
- Wireless Sensor Networks
- Energy & Environmental Data
- View, Compare, Share
- Analytics & Prediction
- Energy Savings Strategies
- Operational Optimization
- Real-time Information / "Pulse"



Visualization – What is “going on”



What is the Value



Improved Quality of Life @ Work

3

Smart Sustainable Cities

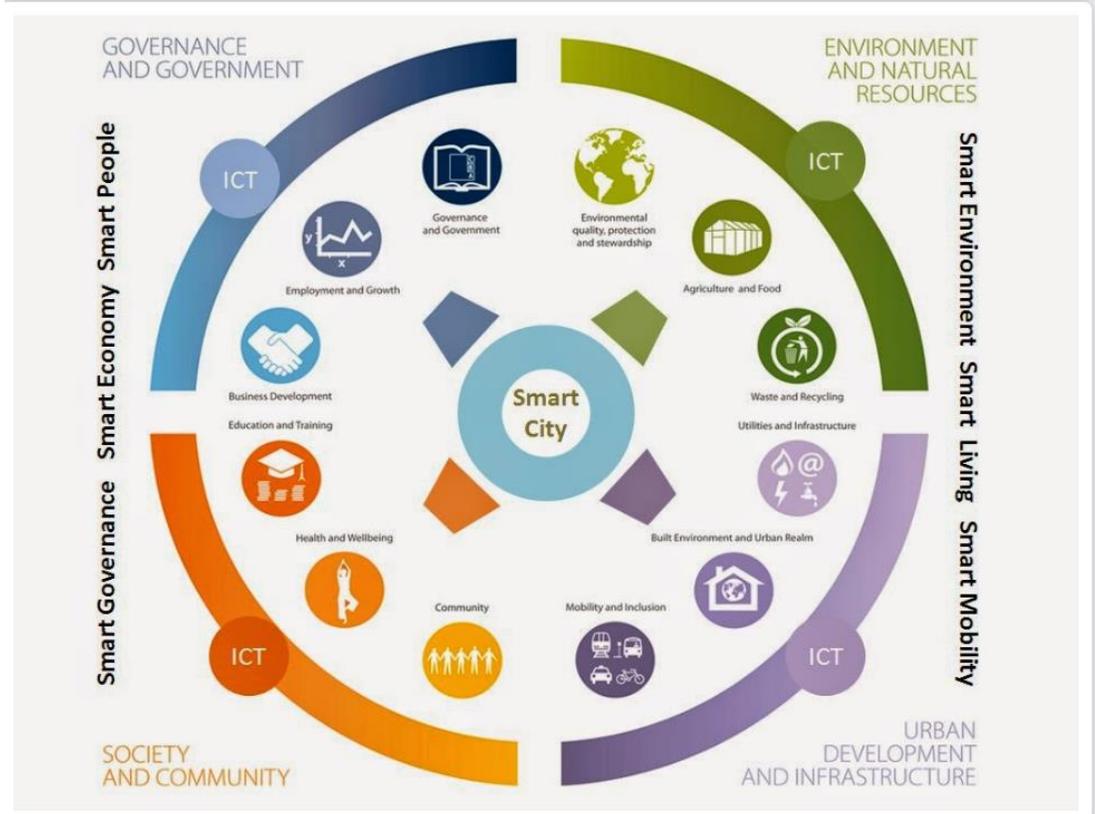


Urban or City Scale (Macro)

What is a Smart Sustainable City ?

"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 operation 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: ITU



SERVICE INFRASTRUCTURE

Leveraging on both physical & digital infrastructure to provide Smart services to end-users

PHYSICAL INFRASTRUCTURE

Physical infrastructure essential in a city that can be enhanced and made smart through digital infrastructure

DIGITAL INFRASTRUCTURE

Refers to the technology and means of measuring, collecting, storing and analyzing data for operation and improvement of the city



Utilities

INFRASTRUCTURE

- Electricity, gas, water, waste

• Electricity, gas, water, waste

Real Estate

INFRASTRUCTURE

- Conventional land uses: residential, commercial, industrial, etc
- Smart City real estate data centers, servers, etc

PHYSICAL Infrastructure

Mobility

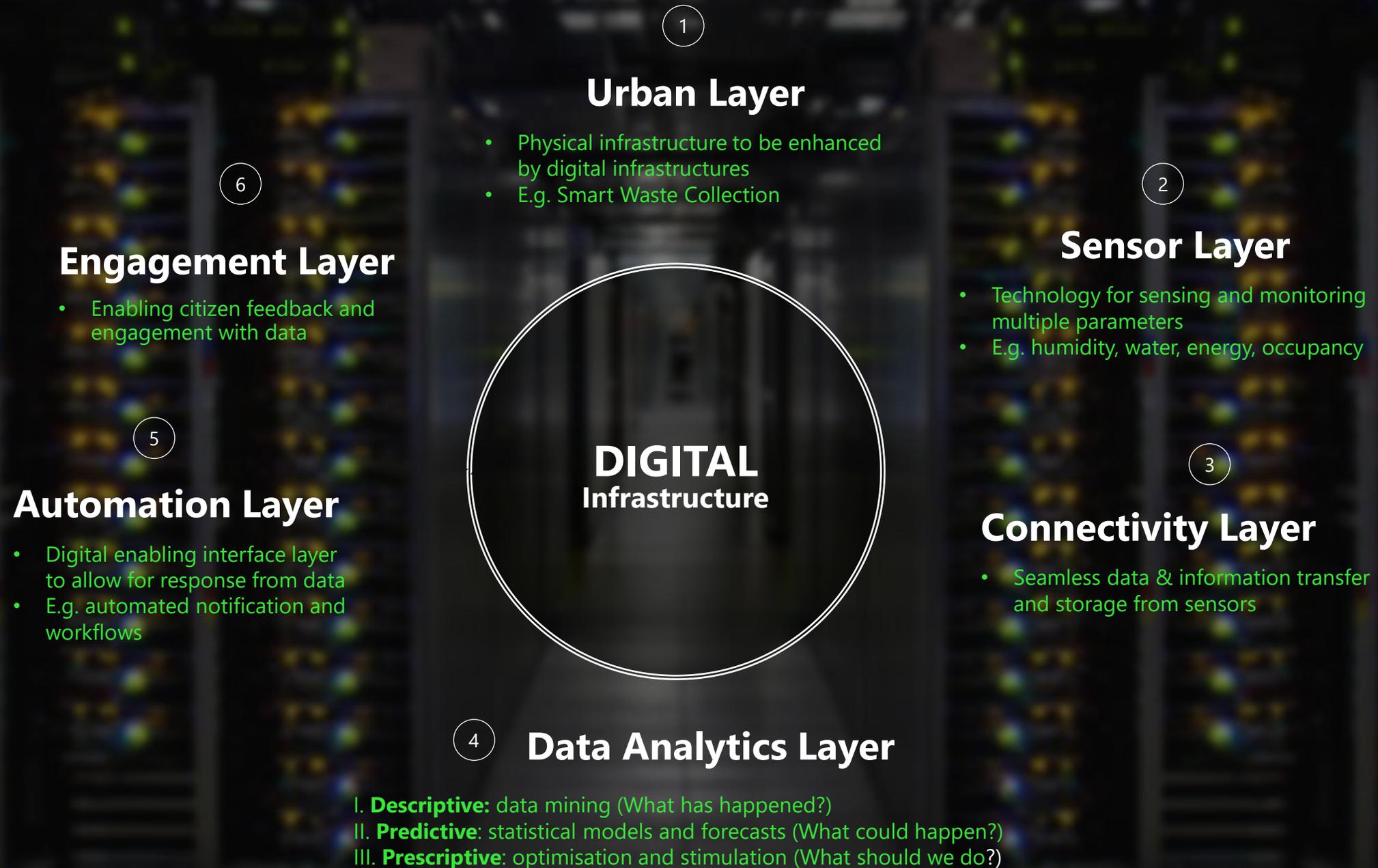
INFRASTRUCTURE

- Land, air, sea-based
- Transport, transit, logistics

Green

INFRASTRUCTURE

- Open spaces





SERVICE INFRASTRUCTURE

Leveraging on both physical & digital infrastructure to provide Smart services to end-users



PHYSICAL INFRASTRUCTURE

Physical infrastructure essential in a city that can be enhanced and made smart through digital infrastructure

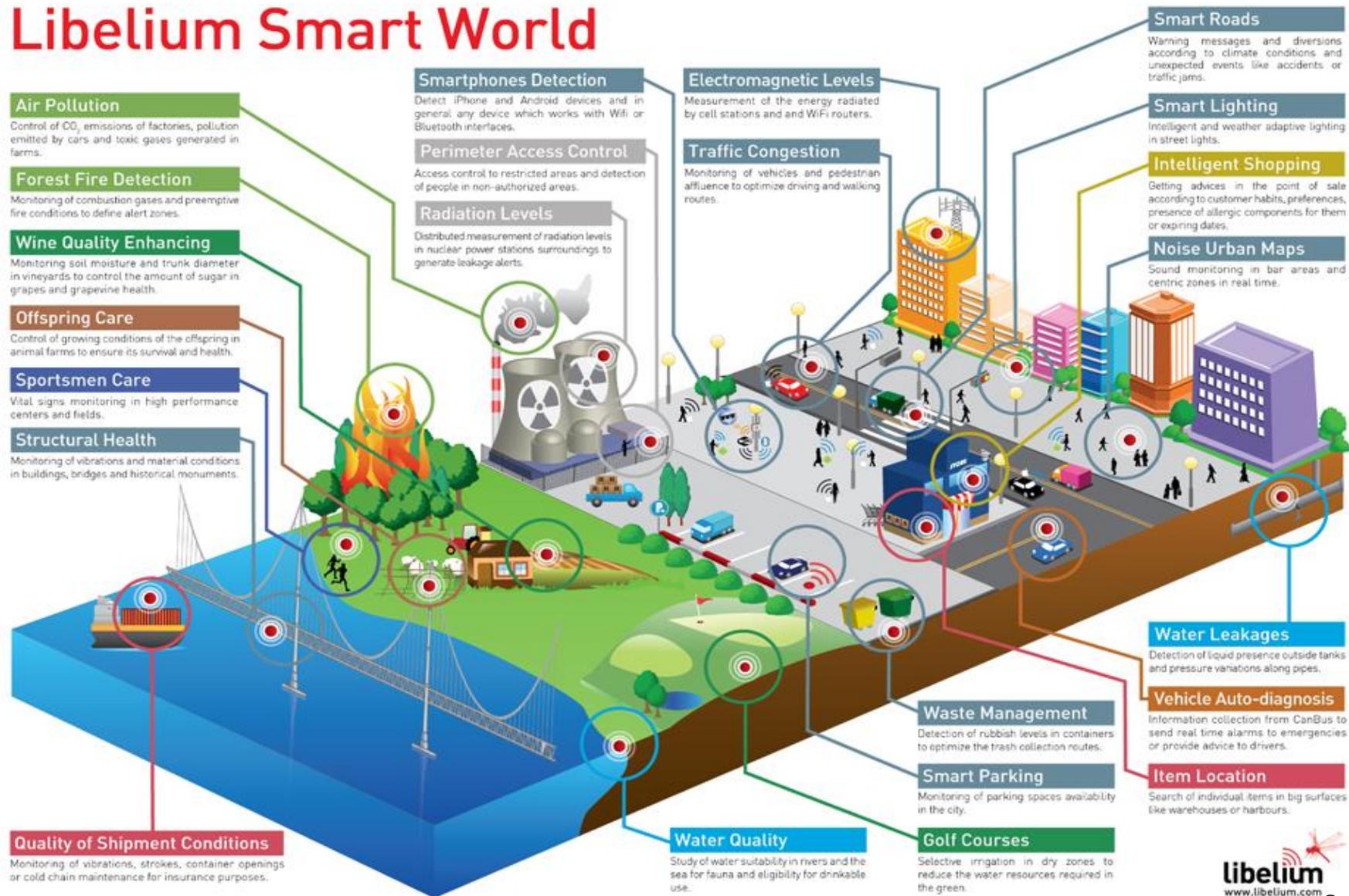
- Uses Roads and Cars (**Physical**)
- Uses the Internet / 3G-4G Data Communications (**Digital**)
- Provides a Transportation (**Service**) which runs on top of the Physical and Digital Infrastructure

DIGITAL INFRASTRUCTURE

Refers to the technology and means of measuring, collecting, storing and analyzing data for operation and improvement of the city

Smart Sensors in a City

Libelium Smart World



4



Big Data Meets IoT, Buildings & Cities



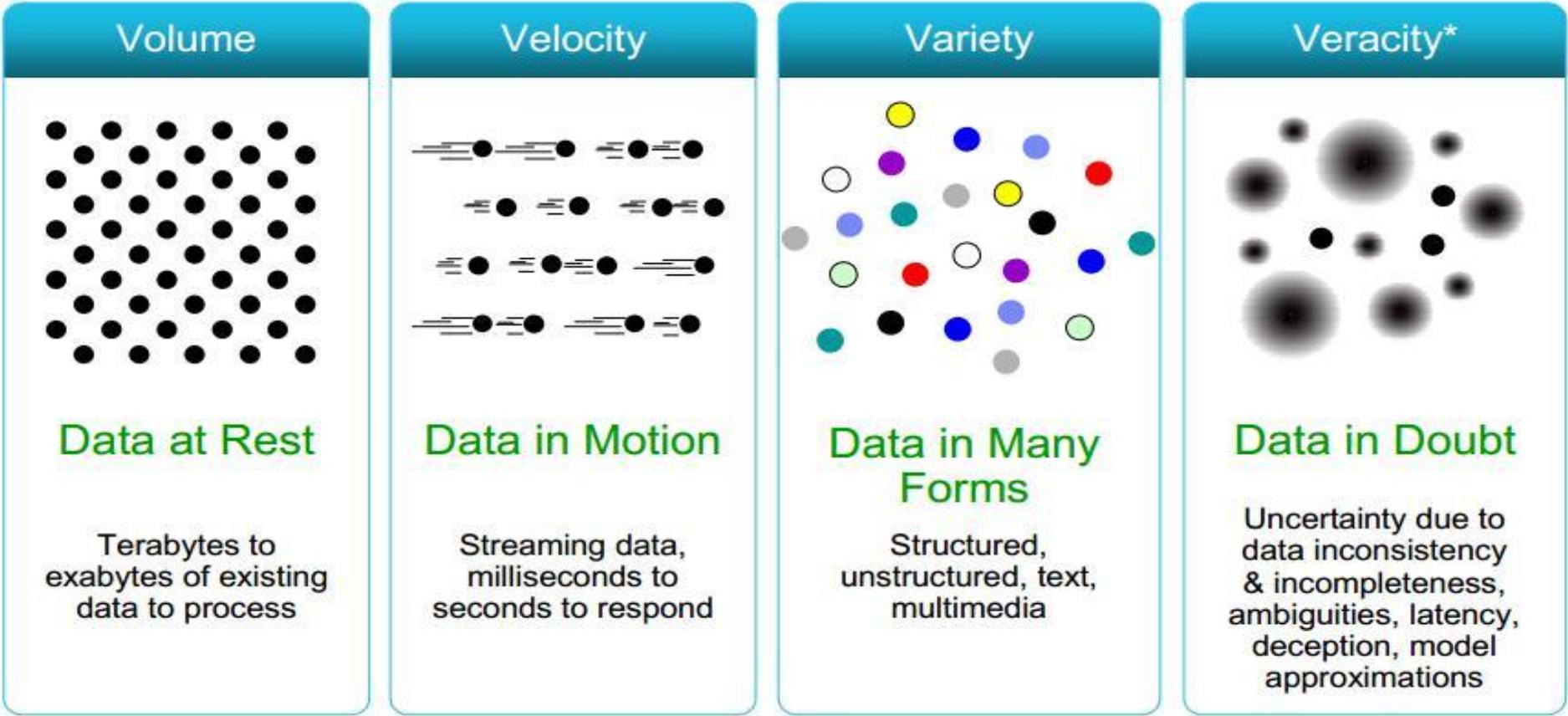
Its Yuge – Very Bigly

2,500,000,000,000,000,000

In 2012, we created 2.5 quintillion bytes of data **every day.**

90% of the world's data was created in the last two years alone.
As a society, we're producing and capturing more data each day than was seen by everyone since the beginning of time.

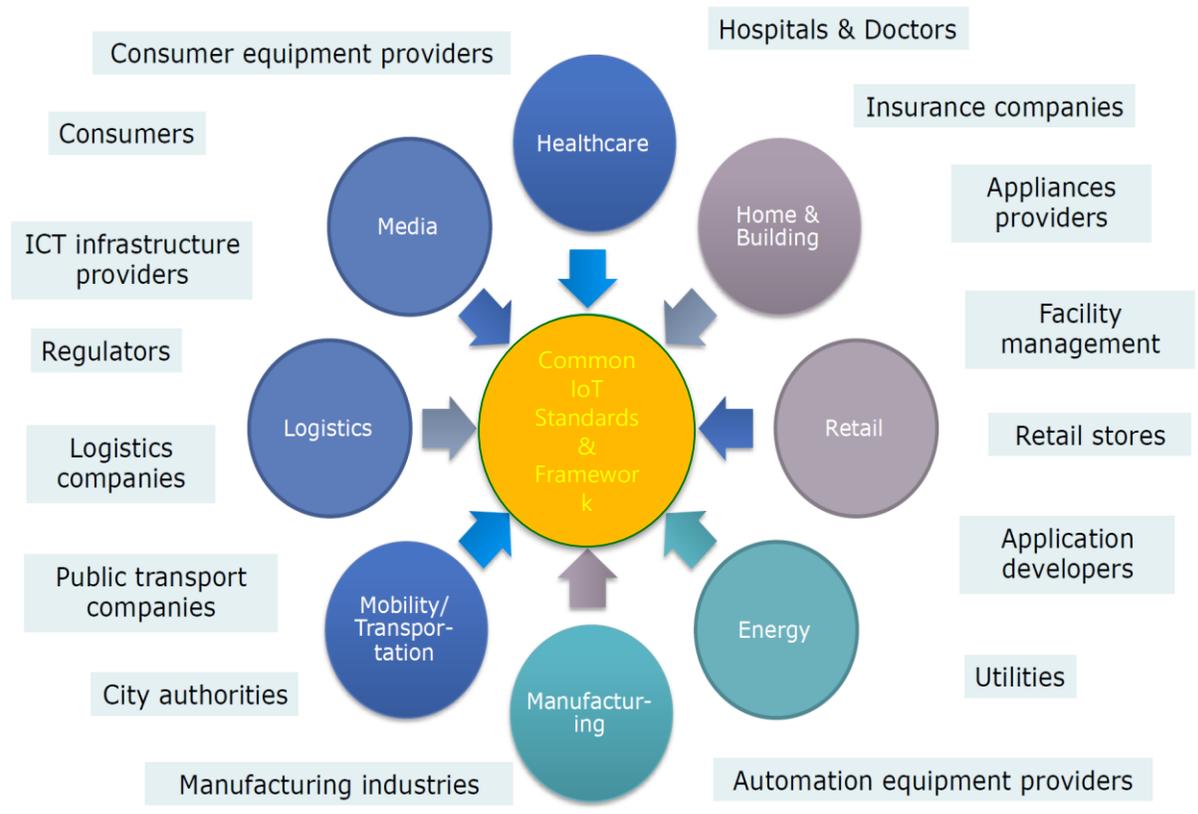
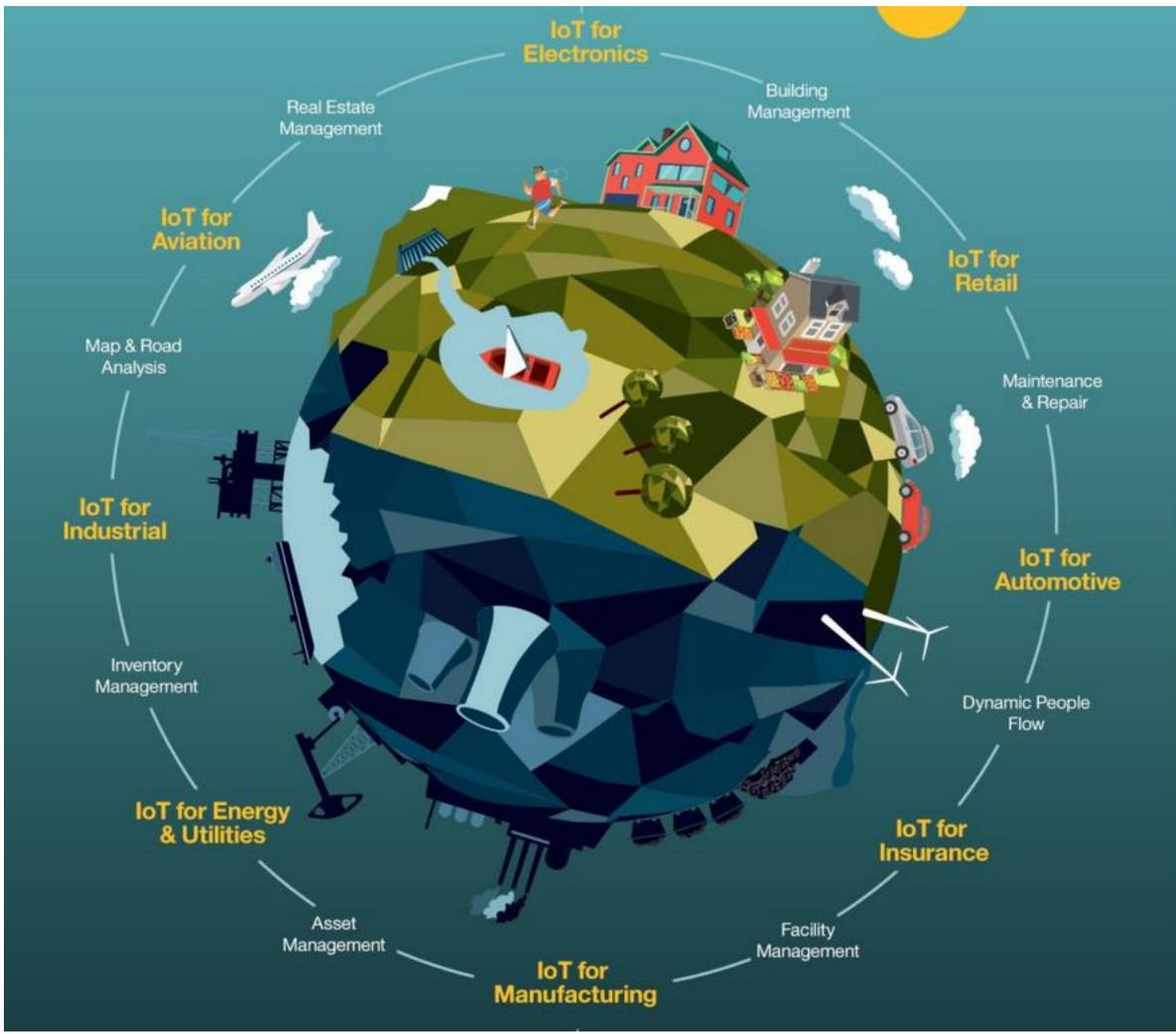
Overview of Big Data



"The goal is to turn data into information, and information into insight."

– Carly Fiorina, former chief executive of Hewlett-Packard Company.

Everything & Everyone is Generating Data



No One Knows What To Do With It



....Or if Its Any Good



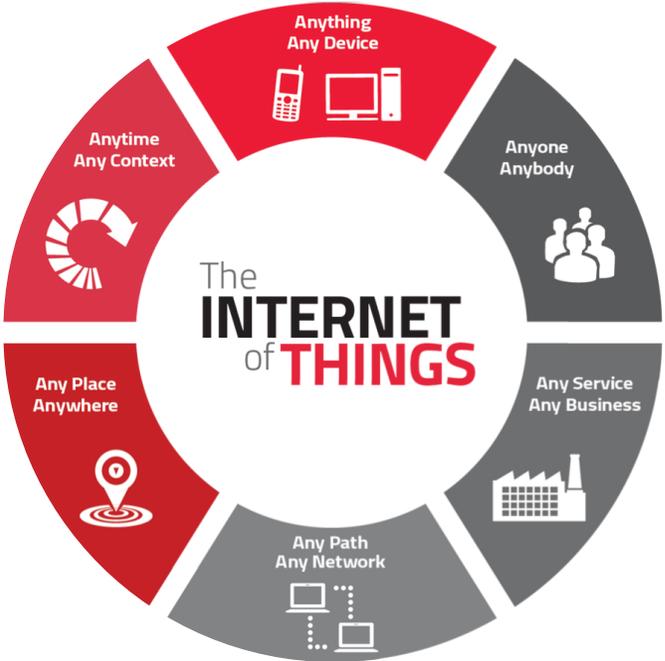
Dilbert.com DilbertCartoonist@gmail.com



5-7-14 © 2014 Scott Adams, Inc. /Dist. by Universal Uclick



IoT Meets Big Data



IoT is about data, devices, and connectivity. Data – big and small – is front and center in the IoT world of connected devices.

Big data is about data, plain and simple. Yes, you can add all sorts of adjectives when talking about “big” data, but at the end of the day, it’s all data.

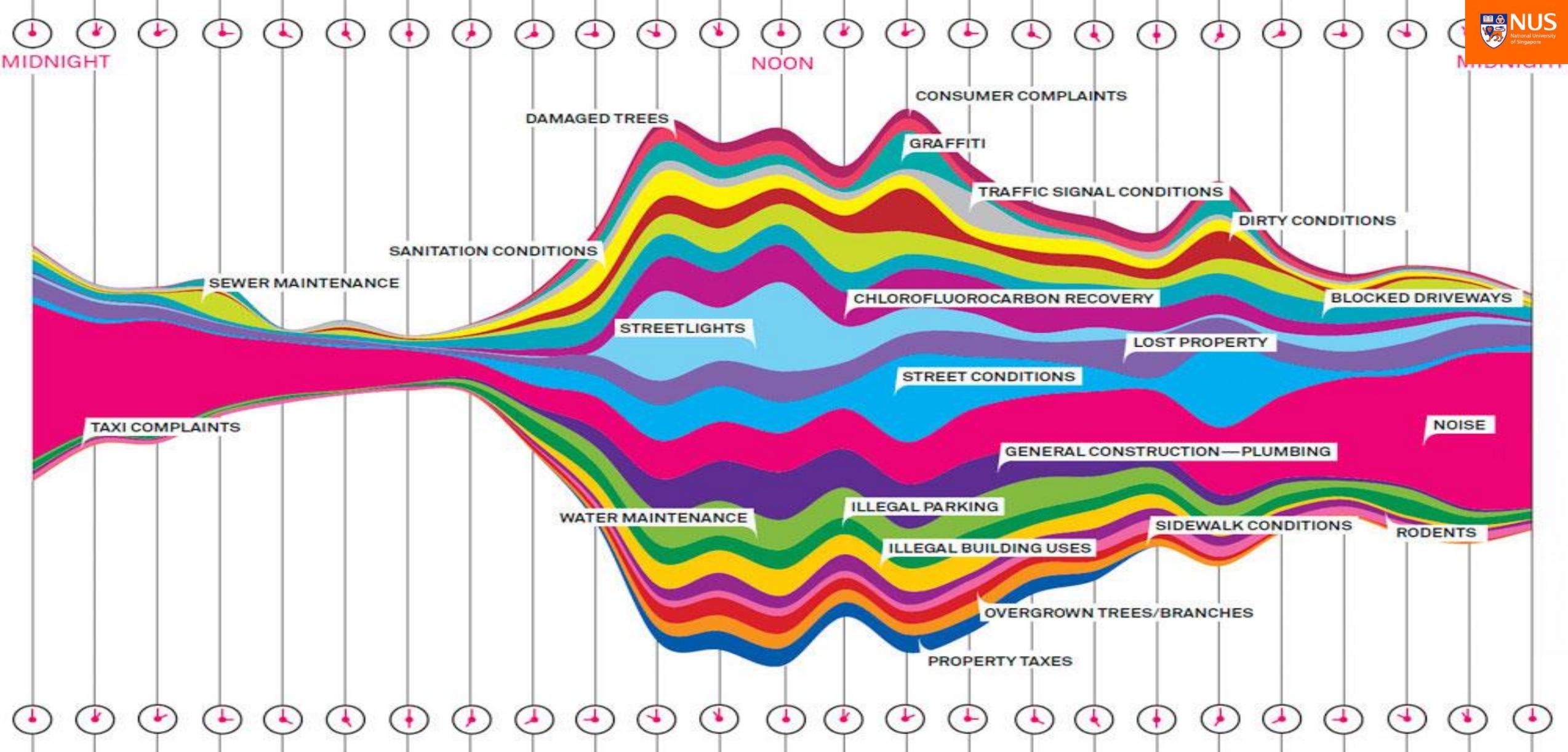
IoT will Shape Smart Cities

IoT is “The network of physical objects that contain embedded technology to communicate and sense or interact with their internal state or the external environment”.

Smart cities will need to factor in how deeply the city infrastructure and service life cycles will be impacted by their Internet of Things endpoint deployments.

City department CIOs and CTOs must plan for security and functionality upgrades as well as bandwidth requirements”

- "We are increasingly able to digitally search and interrogate the city. Social tools can be layered over the city, giving us real-time access to information about the things and people that surround us, helping us to connect in new ways and giving rise to a data-driven society.
- Cities today are vast repositories of information, endlessly collecting and archiving data. When semantically organised, the data can be exposed, shared, and interconnected. Giving people the right kind of access to this information can spark new applications and services, new ways of living, creating and being."



Possible Data Driven Services in a Smart City

SECTORS	Mobility	Energy	IT and Telecom	Security	Healthcare	Governance
Products / Services	Traffic management	Smart grids; energy management	City Cloud Computing	Identity Management	Integrated health record system	e-Services Transactions and Payments
	Electric vehicle charging infrastructure	Smart meters	Data-centric Consulting Services	Cyber Security	E-health	e-Communication Notifications and alert service
	Tolling and congestion charging	Smart home appliances	Information Management Services	Intelligent, real time security management	M-health	e-Administration Tools for public administration
	Integrated mobility management	Flow and regenerative technologies	IT Advisory Services	Sensor actuator solutions	Tele-consultation facility	e-Security Law enforcement and emergency management
	Geo Fencing & Asset Tracking	Renewable integration	Managed Security Services	Logistics / Mobility security management	Home health	e-Businesses Registration Services Patent Renewals
	Parking Management and Payment Solutions	Sensors and Smart Material	Authentication and Monitoring (Sensors, Video Surveillance)	Building security	Data and Business Analytics for Healthcare	M-Governance SMS Tax Returns SMS Utility Bills

5



Food For Thought



Big Data and Personal Identifiable Identity

Age
 Marital Status
 Name
 E-Mail
 Net Worth
 Car Owner
 Homeowner/Renter

Clicks
 Downloads
 Web-Sites Visited
 Internet Searches
 On-Line Purchases
 Average Spending
 UserNames
 Kids / Children
 Medical History
 Voting Habits
 Political Party
 Social Strata

- Privacy protections **aren't enough** any more.
- Big data analytics can compromise identity by allowing data-driven organisations to moderate and even determine who we are before we make up our own minds.
- We need to begin to think about the kind of big data predictions and inferences that we will allow, and the ones that we should not.

FACEBOOK knows more about me than I know about myself
 and I do not even have a **FACEBOOK** account ☹️

Lets Take a Look @ Consumer Devices

10 most popular IoT devices in different categories (source HP) : (1) TV, (2) webcam, (3) home thermostat, (4) remote power outlet, (5) sprinkler controller, (6) hub for controlling multiple devices, (7) door lock, (8) home alarm, (9) weighing scales, (10) garage door opener

9 collected at least one piece of personal information via the device, its cloud, or the app. For example : name, address, date of birth, health data, even credit card numbers

8 failed to require passwords of sufficient complexity or length. Most allowed eg. “1234” or “123456”

7 had unencrypted communications with Internet or local network. Half of mobile apps had unencrypted communications.

6 didn't used encryption to upload software updates. Some updates could be intercepted and the whole code viewed and changed.

"Health" IoT / Mobile App Measurements

Skin Conductance	Basis, Body Media, Empatica, Neumitra
Oxygen Level	iHealth, Withings, Owlet
Posture	Lumo, Zephyr, Jins Merne
Hydration	Corventis, MC10
Temperature	Tempdrop, Empatica, BodyMedia, Basis, Owlet, MC10
Sleep	Fitbit, Rest devices, Garmin, Nike, Amigo, BodyMedia, Withings, Samsung, Misfit, Jewborne, iHealth, Basis, Owlet
Brain activity	NeuroSky, DAQRI, Emotiv
Glucose	Google, Dexcom, Glysens Inc
Respiration	Spire, Zephyr, Rest Devices
Ingestion	Proteus
Eye Tracking	Jins Merne
Heart tracking	Zephyr, Withings, Sprouting, Proteus, iHealth, Basis, Cofventis, AliveCor, Samsung, Garmin, Empatica, Owlet

"Their goal is to turn **your** personal "health information" into \$\$\$

greentech**efficiency**:

 <p>< PREV Nest Labs Acquires MyEnergy to...</p>	<p>EFFICIENCY: Energy Management</p>	<p>NEXT > Why Your Energy Dashboard May Be...</p> 
<h3>Hackers Penetrate Google's Building Management System</h3> <p>The downside of smarter buildings: "If Google can fall victim, anyone can."</p>		

Smart Cities Are Going to Be a Security Nightmare

by Todd Thibodeaux

APRIL 28, 2017

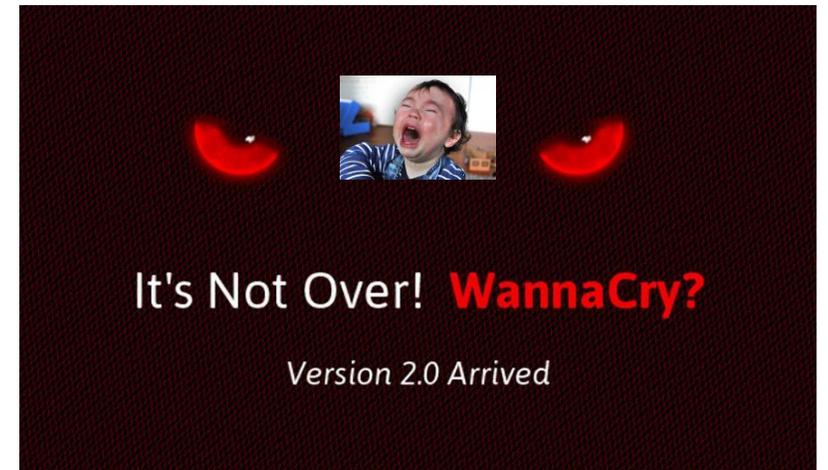
The 'Wannacry' ransomware attack

The attack has hit more than 200,000 victims in at least 150 countries, says Europol



Source: Intel.malwaretech.com

© AFP



Some Examples

- Recently, hackers set off **156 emergency sirens in Dallas, Texas**, disrupting residents and overwhelming 911 operators throughout the day. The number of attacks on critical infrastructure jumped from under **200 in 2012 to almost 300 attacks in 2015**.
- Once hackers invade smart city control systems, they can send manipulated data to servers to exploit and crash entire data centers. This is how hackers gained access to an **Illinois water utility control system in 2011**, destroying a water pump that serviced 2,200 customers.
- A hypothetical hack that triggers a blackout in North America is estimated to leave 93 million people without power and could cost insurers anywhere from **\$21 billion to \$71 billion in damages**.



5 STAGES OF DATA PRIVACY GRIEF

DOESN'T AFFECT ME. I DON'T EVEN USE FACEBOOK THAT MUCH.



TOM FISH BURNE

DENIAL

WHOA! HOW DO THEY HAVE 5GB OF DATA ON ME?

#DELETE



ANGER

IS IT WORTH LETTING COMPANIES COLLECT SO MUCH OF MY DATA FOR FREE SERVICES?



BARGAINING

FACEBOOK IS ONLY THE TIP OF THE ICEBERG.



DEPRESSION

THERE'S A SPECIAL ON MINT CHIP ICE CREAM THAT MIGHT CHEER YOU UP.



ACCEPTANCE



Brussels, Belgium



"Nothing Ever Exists Entirely Alone;
Everything is in Relation to Everything Else"

"All Things are Interconnected & Not Separate.
At the Same Time All Things Retain their Individuality".

Thank You

Prof. Sekhar Kondepudi
IoT, Smart Buildings & Smart Cities,
National University of Singapore
E sekhar.kondepudi@nus.edu.sg
M : +65 9856 6472