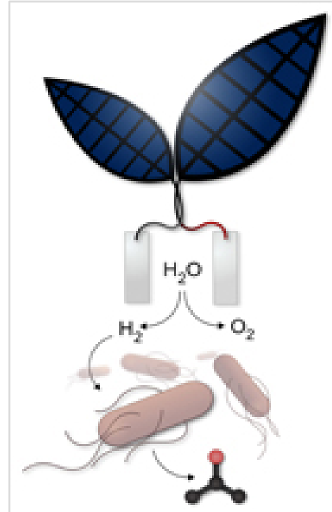


Bohr,

to Pauli and Heisenberg

"We are all agreed that your theory is crazy. The question that divides us is whether it is crazy enough to have a chance of being correct."

Internet of Systems

From Things to System of Things – Internet of Things evolves to Internet of Systems

Internet of Systems

Table of Contents

Solving The World's Biggest Problems

Takes Ensembles, Not Soloists

According to the laws of aerodynamics the bumble bee cannot fly as the span of its wings are not proportional to the size of its body.

Paradox to Paradigms

IMPERFECTLY CATALYZED BY CYBERPHYSICAL SYSTEMS AND INTERNET OF SYSTEMS

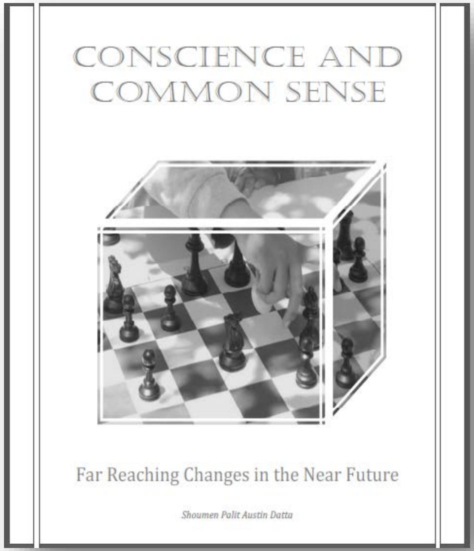
Dr Shoumen P Austin Datta ● Research Affiliate, School of Engineering, MIT ● SVP, Industrial Internet Consortium ● shoumen@mit.edu

Internet of Systems ● http://bit.ly/MIT-IOT

- Vision, Mission and Opportunities

  https://hbr.org/2014/11/setting-standards-for-the-internet-of-things

- Challenges
  - ☑ Autonomous Transportation (SDV)
  - ☑ Global Smart Cities
  - ☑ Healthcare
  - ☑ Data



System of Systems ● Transdisciplinarity

Hard Systems (1950s onward)

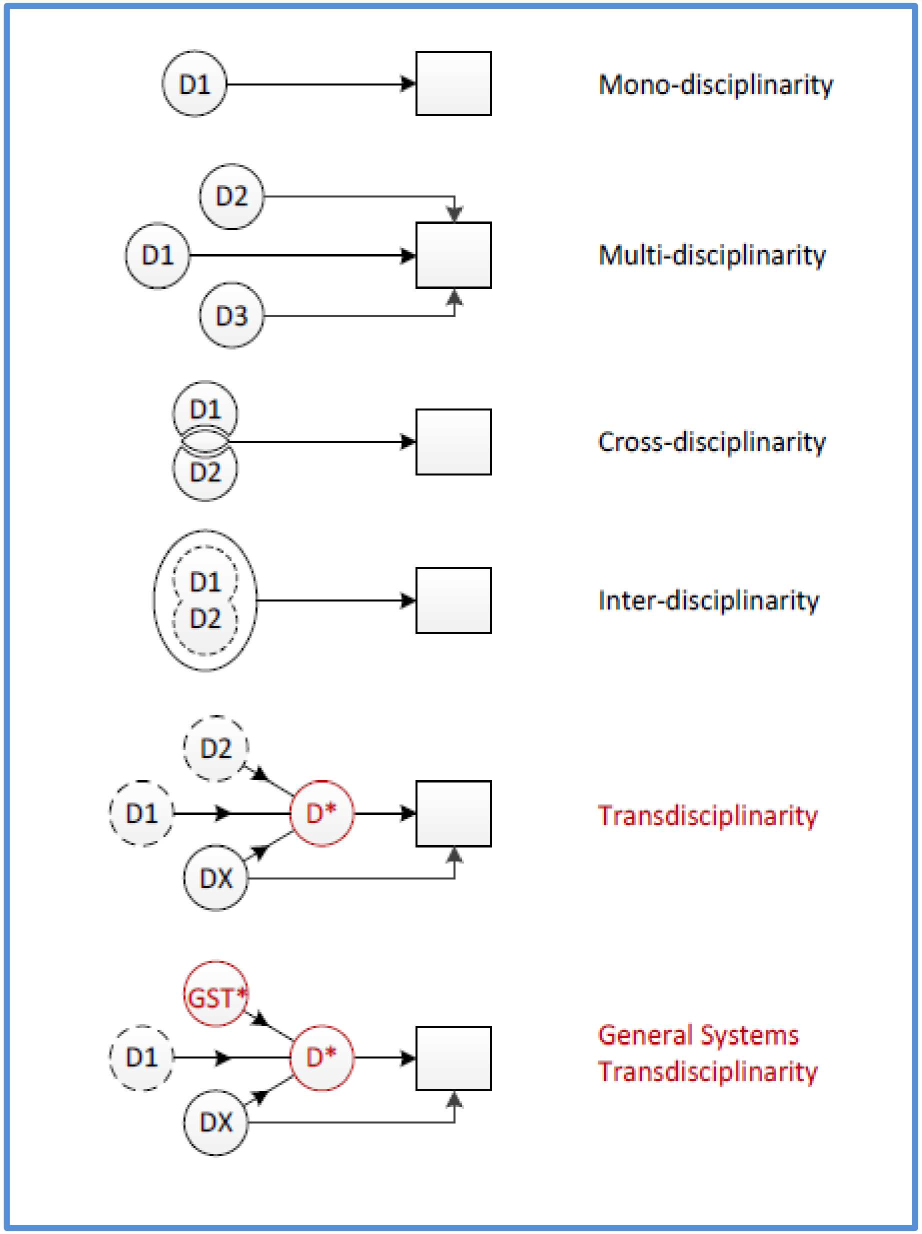
- General Systems Theory (Bertlanffy 1956)
- Cybernetics (Wiener 1948, Ashby 1956)
- Operations Research (Churchman et al. 1957)
- Systems Engineering (Hall 1962)
- Socio-Technical Systems (Trist et al. 1963)
- RAND- Systems Analysis (Optner 1965)
- System Dynamics (Forrester 1971; Meadows et al. 1972)

Soft Systems (1970s onward)

- Inquiring Systems Design (Churchman 1971)
- Second-order Cybernetics (Bateson 1972)
- Soft Systems Methodology (Checkland 1972)
- Strategic Assumption Surfacing & Testing (Mason and Mitroff 1981)
- Interactive management (Ackoff 1981)
- Strategic Options Development and Analysis (Eden 1988)

Critical Systems (1980s onwards)

- Critical Systems Heuristics (Ulrich 1983)
- System of Systems Methodologies (Jackson 1990)
- Liberating Systems Theory (Flood 1990)
- Interpretive Systemology (Fuenmayor 1991)
- Total Systems Intervention (Flood and Jackson 1991)
- Systemic Intervention (Midgley 2000)



What are we connecting?

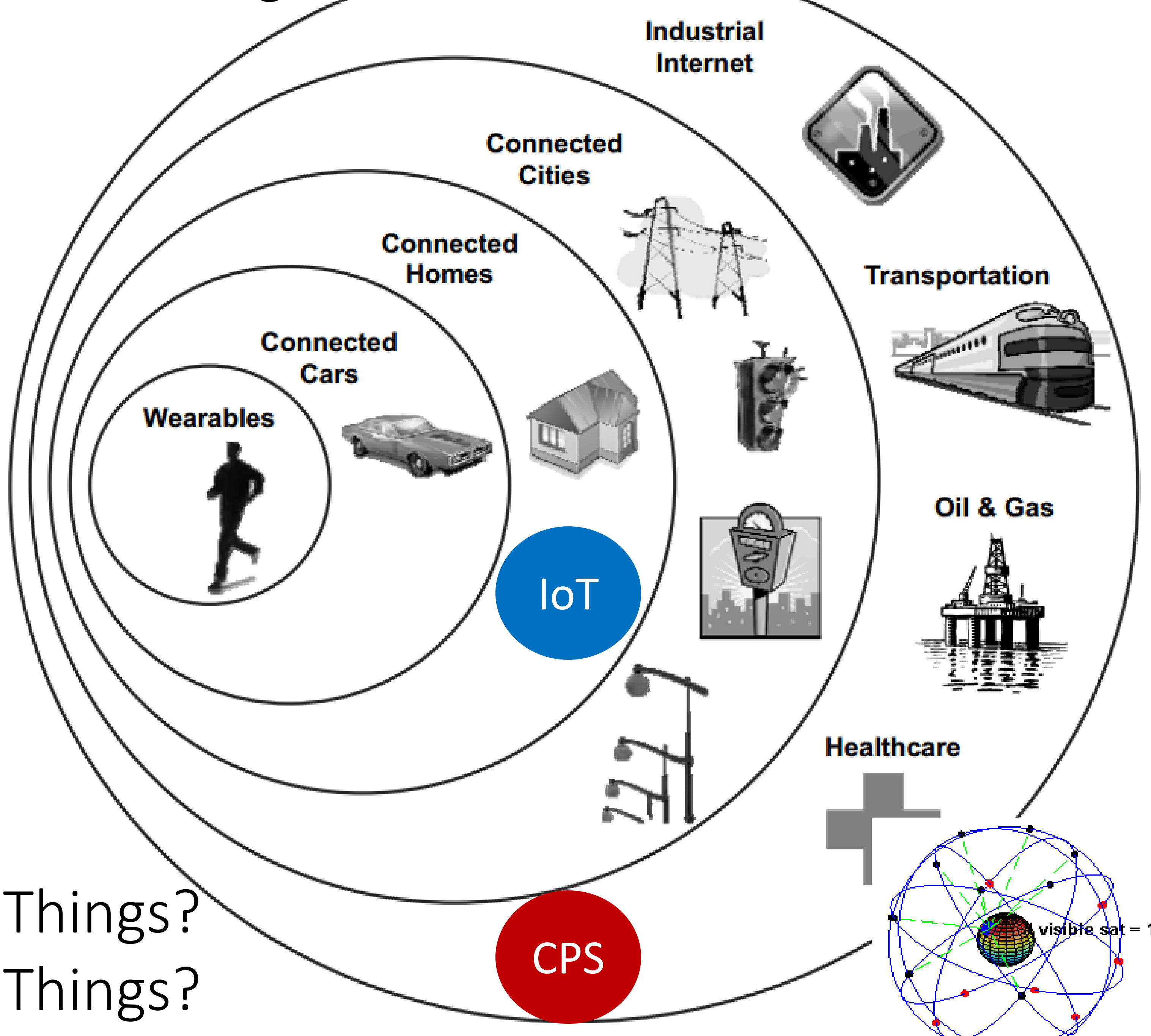
Concentric concentration of confusion.

www.goldmansachs.com/our-thinking/outlook/internet-of-things/iot-report.pdf

Things?

Atoms?

Bits?



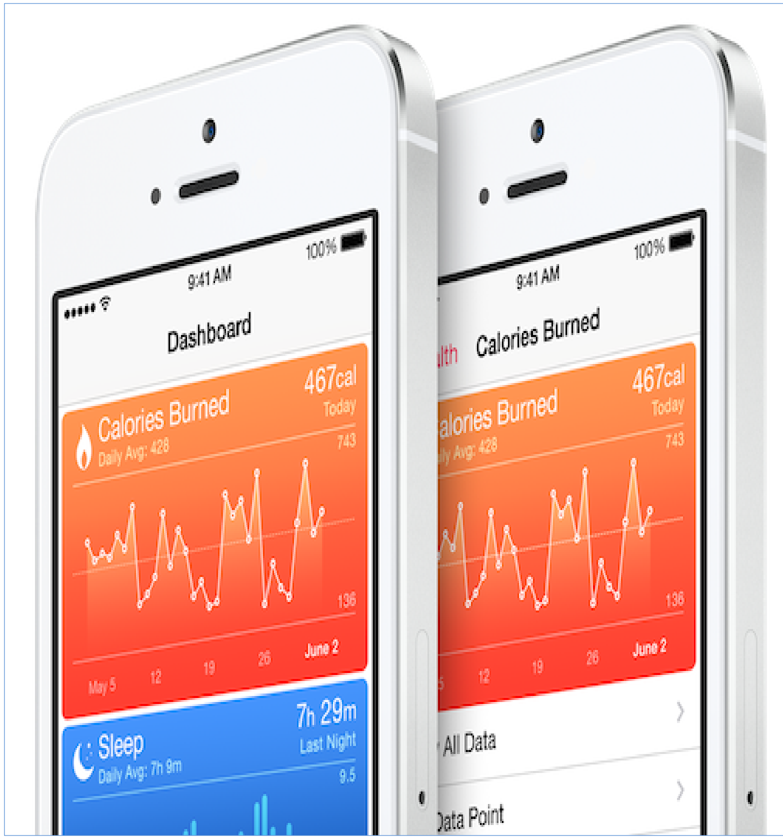
Data of Things?

Big Data of Things?

What are we connecting? *At a granular level – bits to atoms*

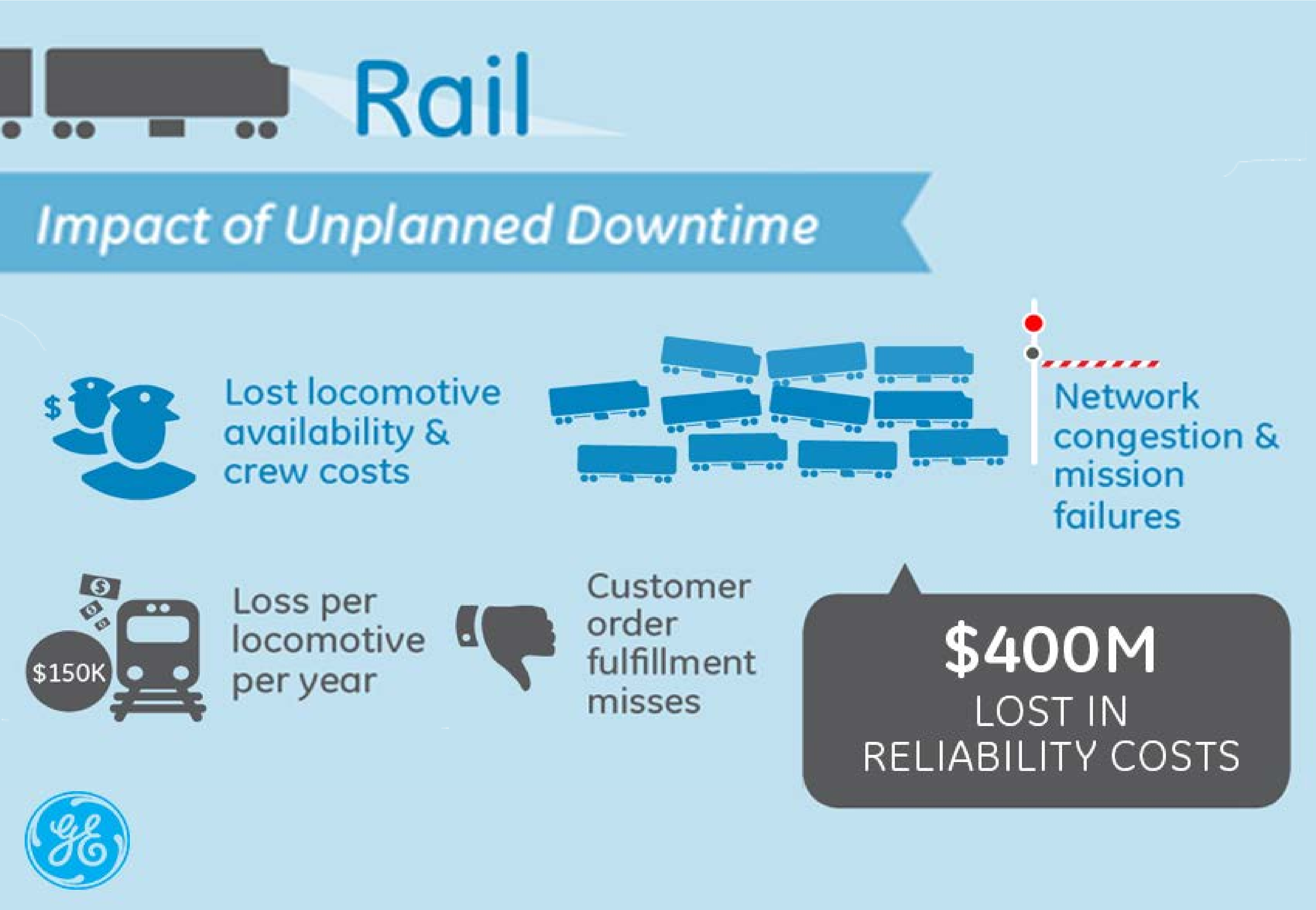
SYSTEMS

- Manufacturing Systems
- Transportation Systems
- Cyberphysical Systems
- Health Care Systems
- Emergency Systems
- Financial Systems
- [Supply Chains]
- [Security]

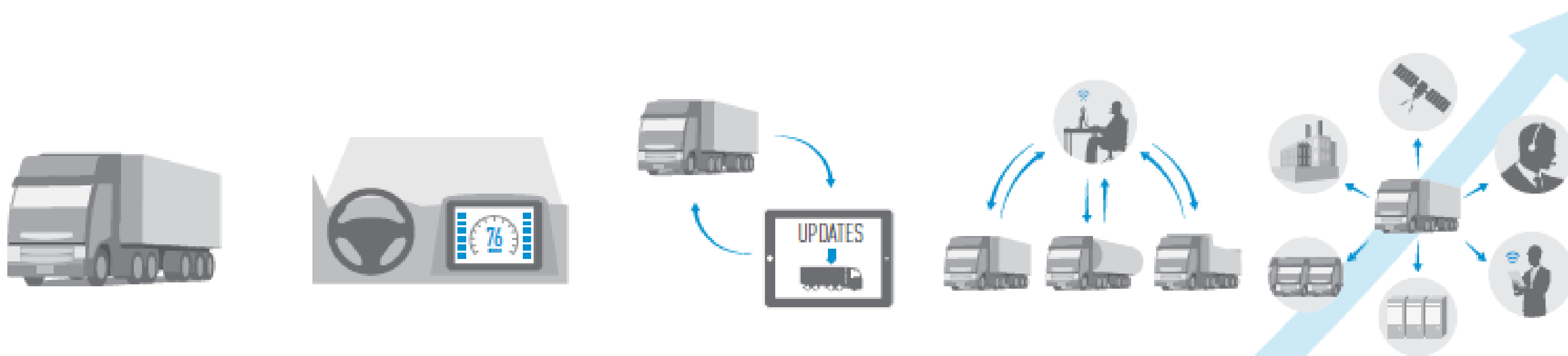


Internet of Systems, therefore, is a convergence of system of systems from a systems engineering perspective along with CPS, IoT, WoT, IoE, industrial internet (IIoT) applications

What is the value of connectivity? *Savings/gain $400 million*



Exponential Growth in Value by Connecting System of Systems – Internet of Systems



VALUE

	Physical	Smart	Smart and Connected	Product System	System of Systems
Product	Product is physical (i.e., mechanical, electrical)	Product incorporates software, sensors, processor	Product incorporates wired or wireless connectivity	Product is integrated in a product system	Product is coordinated across other systems
Product Capabilities	Core product capabilities	Enable personalization, enhanced functionality, and user interface	Enable remote monitoring, control, and service	Enhance product features, operation, and optimize system performance	Expand system capabilities and automate/coordinate with other systems
Systems Integration	Digitization of product definition	Hardware and software product definition are integrated	IT, product, and service systems are integrated	Other enterprise systems are integrated	Third-party systems across industries are integrated
Data Analytics	None	Batch analysis of historical product data	Ongoing analysis of product condition and use	Perform real time analytics and predictive algorithms	Machine learning and predictive analytics across systems
Business Opportunity	Product sale	Enhance product and service capabilities	Expand product and service capabilities and optimize existing process	Enable new process, and expand product and service capabilities	Transform business model and enable new business

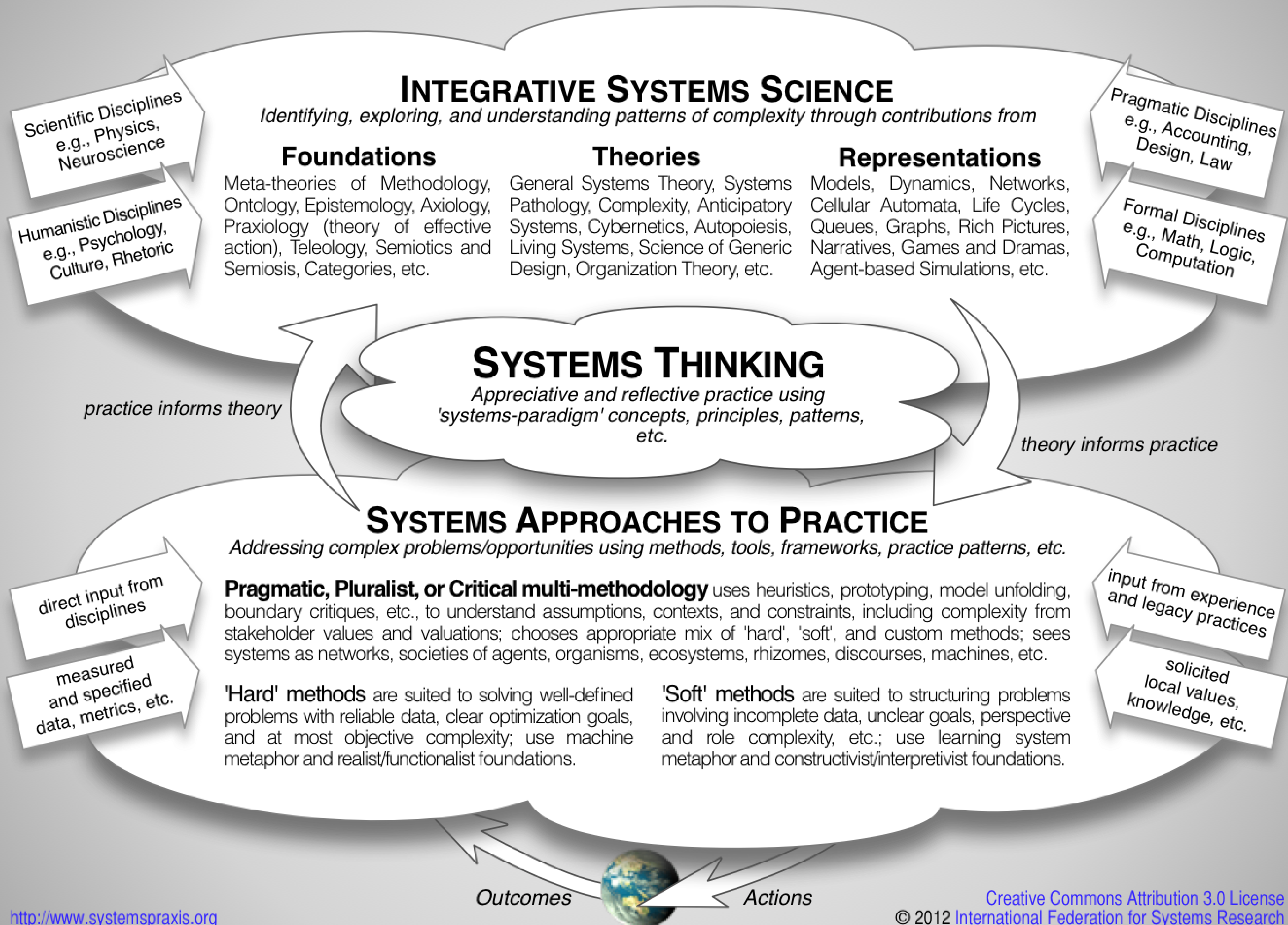
EVOLUTION

Systems Science

- Chaos theory
- Complex systems
- Complex system
- Cybernetics
  - Biocybernetics
  - Engineering cybernetics
  - Management cybernetics
  - Medical cybernetics
  - New Cybernetics
  - Second-order cybernetics
- Control theory
  - Affect control theory
  - Control engineering
  - Control systems
  - Dynamical systems
  - Perceptual control theory
- Operations research
- Systems biology
  - Computational systems biology
  - Synthetic biology
  - Systems immunology
  - Systems neuroscience
- System dynamics
  - Social dynamics
- Systems ecology
  - Ecosystem ecology
- Systems engineering
  - Biological systems engineering
  - Earth systems engineering and management
  - Enterprise systems engineering
  - Systems analysis
- Systems theory in anthropology
- Systems psychology
  - Ergonomics
  - Family systems theory
  - Systemic therapy
- Systems theory
  - Biochemical systems theory
  - Ecological systems theory
  - Developmental systems theory
  - General systems theory
  - Living systems theory
  - LTI system theory
  - Sociotechnical systems theory
  - Mathematical system theory
  - World-systems theory
- Systems theory in sociology
  - Talcott Parsons
  - John N. Warfield
  - Niklas Luhmann
- Etc

IoS

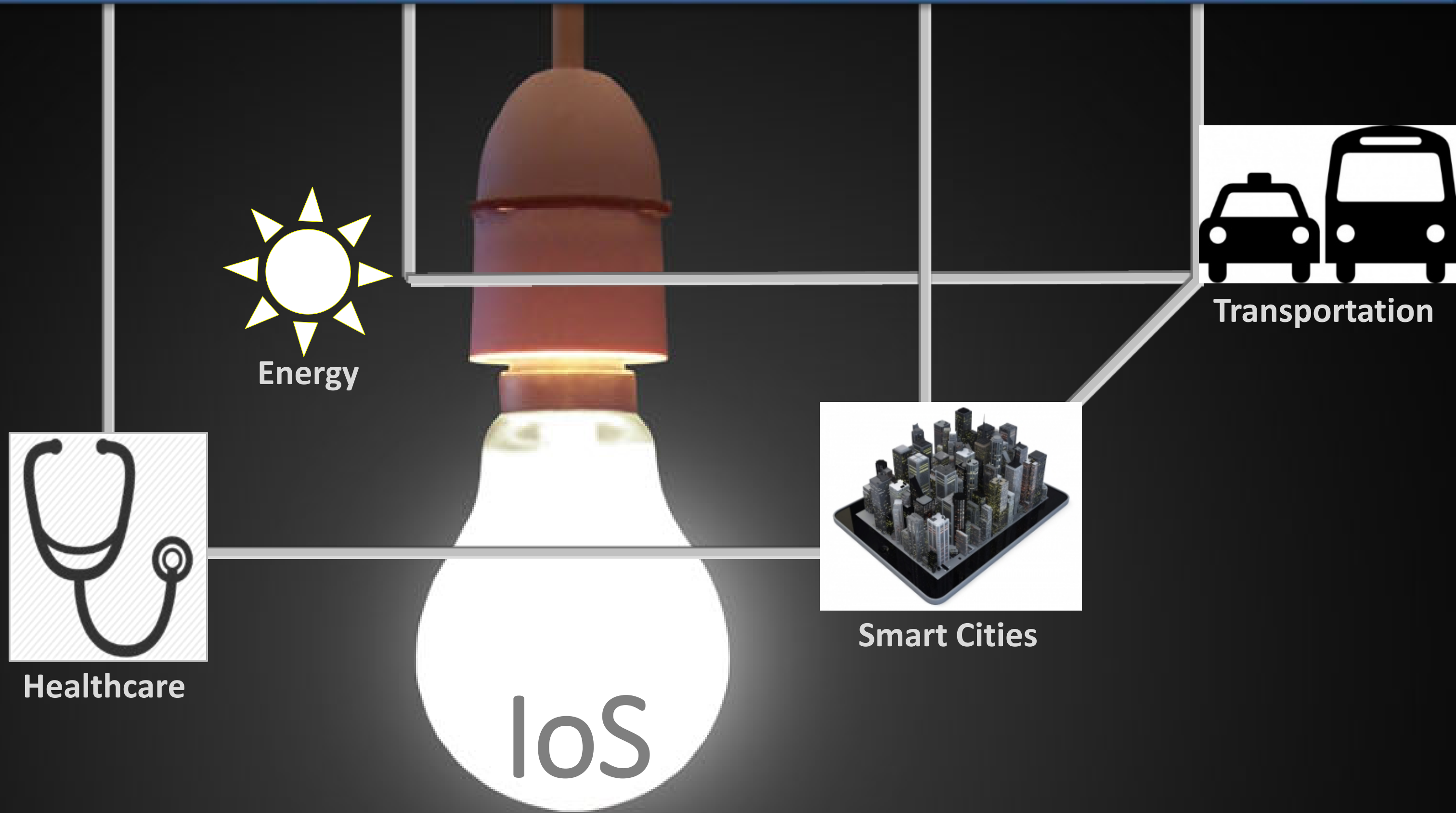
The Systems Praxis Framework, a joint project of the International Council on Systems Engineering and the International Society for the Systems Sciences



http://www.systemspraxis.org

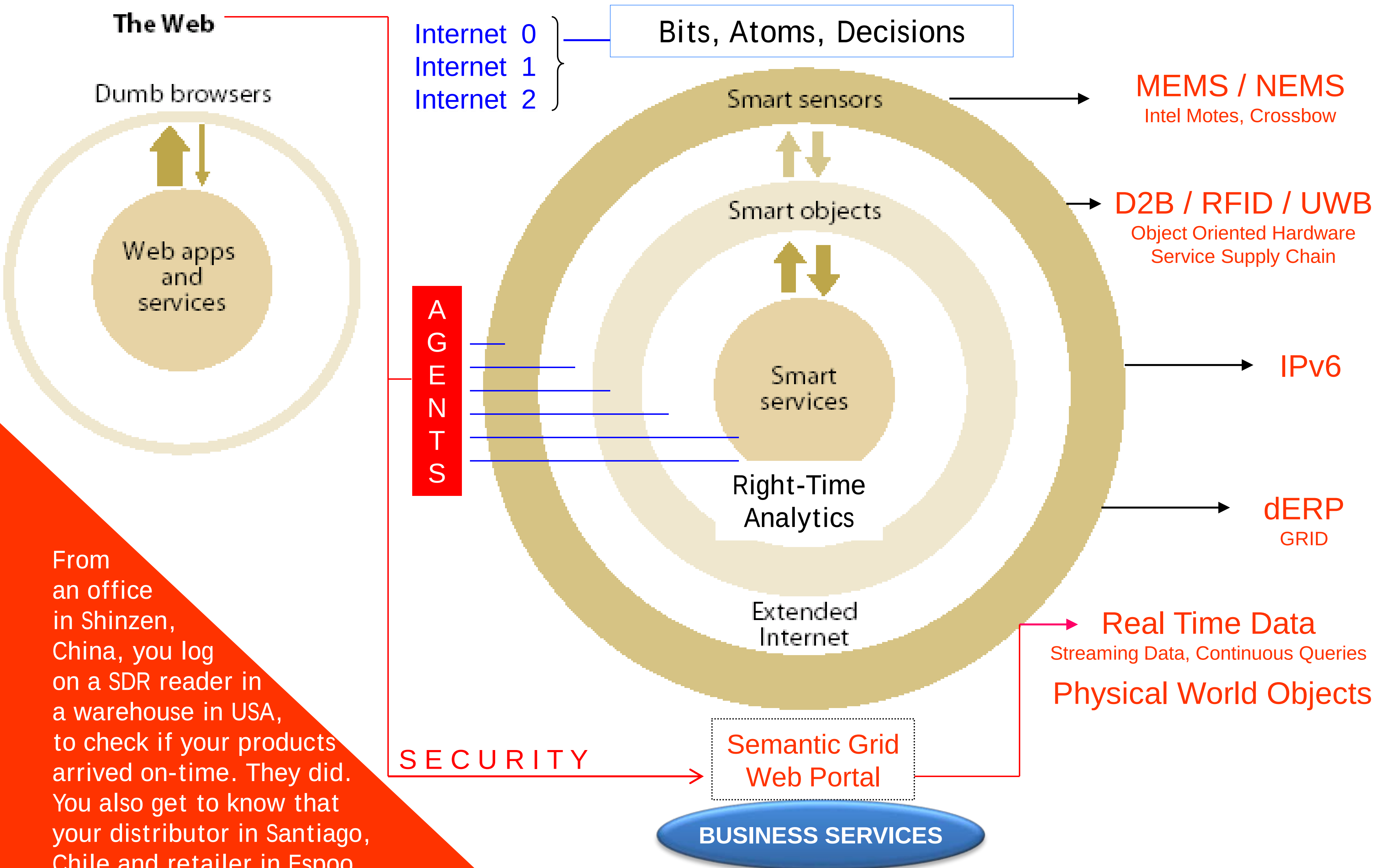
Creative Commons Attribution 3.0 License
© 2012 International Federation for Systems Research

System of Systems ● Transdisciplinarity



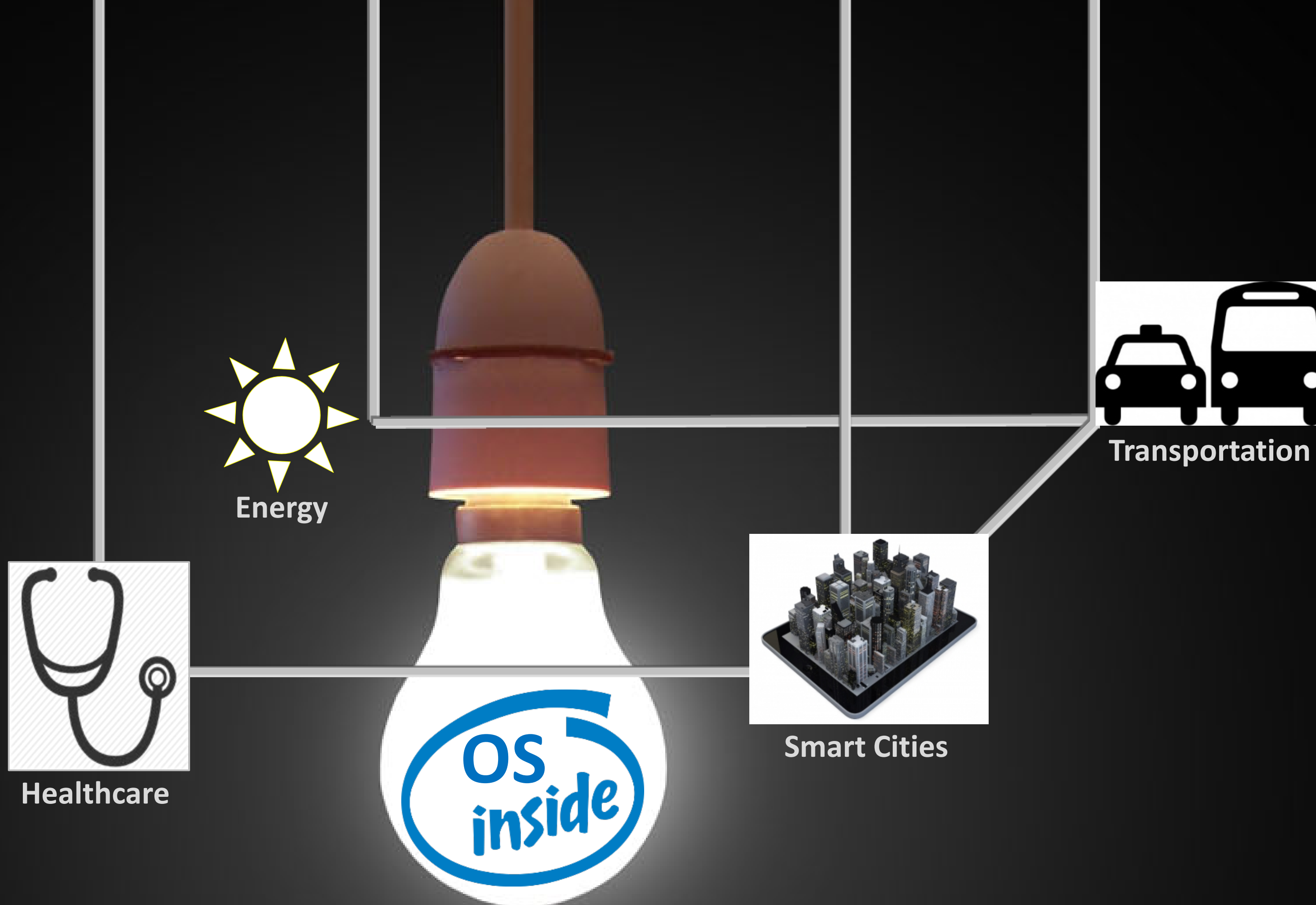
Grand Challenges

Integrating Ubiquitous Analytics in Real-Time with Data, Information, Application



From an office in Shinzen, China, you log on a SDR reader in a warehouse in USA, to check if your products arrived on-time. They did. You also get to know that your distributor in Santiago, Chile and retailer in Espoo, Finland also checked the delivery status, moments before you logged on.

SDR Data Interrogators as Ubiquitous Internet Appliances in IoT (2003)



Grand Platforms

From Things to System of Things – Internet of Things evolves to Internet of Systems

P
L
A
T
F
O
R
M
S

The Economist | World politics | Business & finance | Economics | Science & technology | Culture

Special report: Tech startups

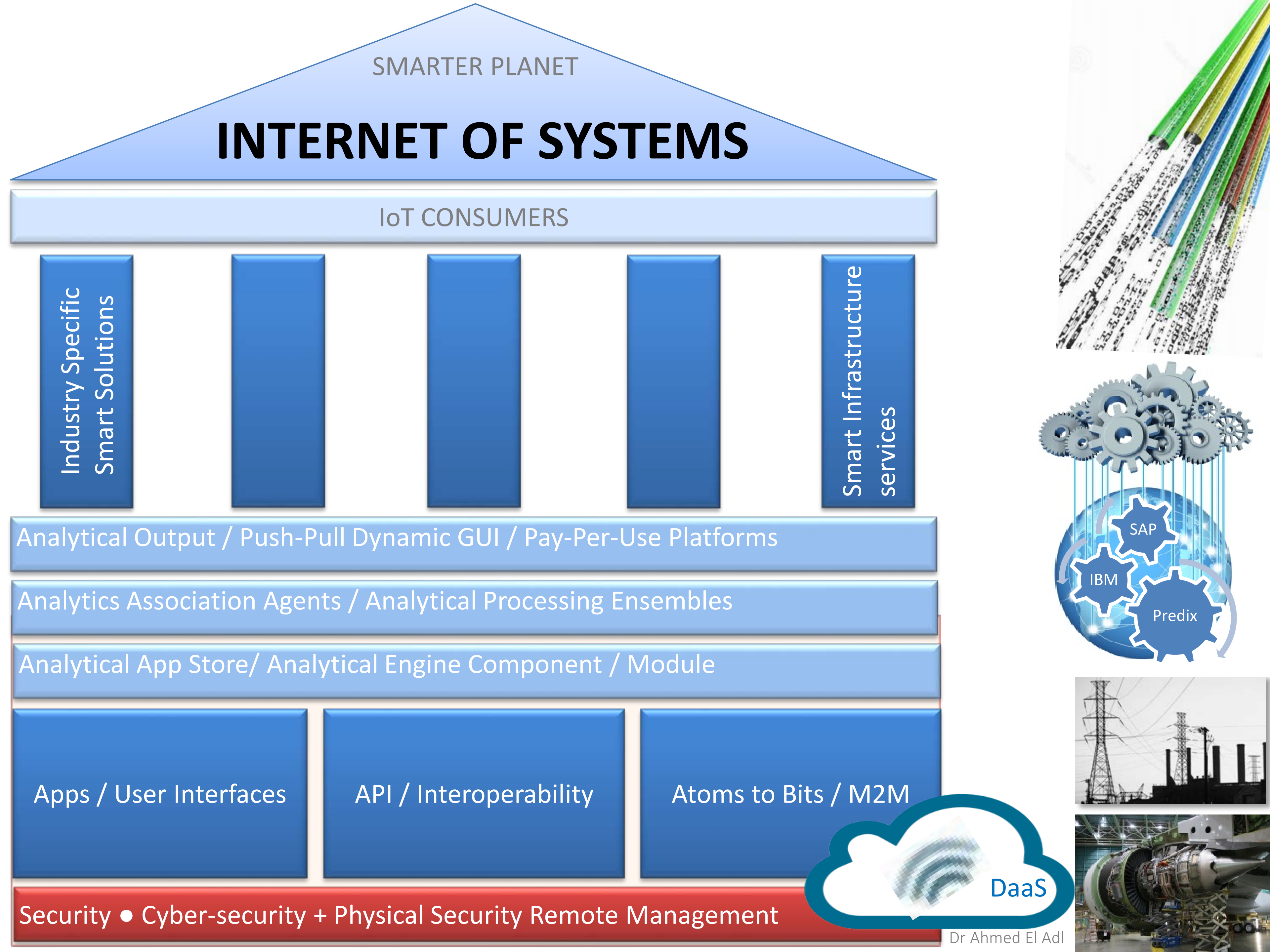
Platforms

Something to stand on

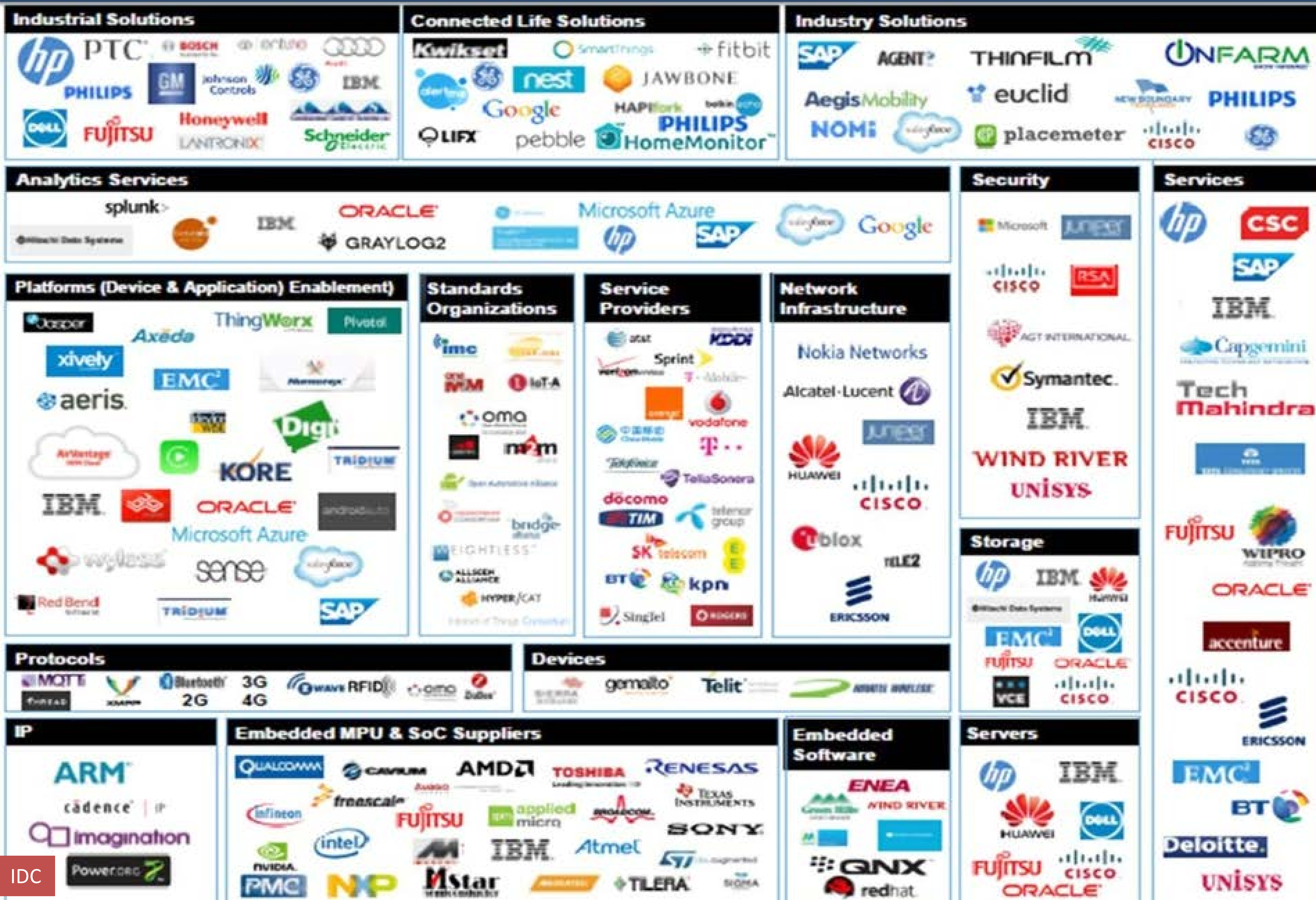
Proliferating digital platforms will be at the heart of tomorrow's economy, and even government

Jan 18th 2014 | From the print edition

www.economist.com/news/special-report/21593583-proliferating-digital-platforms-will-be-heart-tomorrows-economy-and-even


SMARTER PLANET
INTERNET OF SYSTEMS
IoT CONSUMERS
Industry Specific Smart Solutions
Smart Infrastructure services
Analytical Output / Push-Pull Dynamic GUI / Pay-Per-Use Platforms
Analytics Association Agents / Analytical Processing Ensembles
Analytical App Store/ Analytical Engine Component / Module
Apps / User Interfaces
API / Interoperability
Atoms to Bits / M2M
Security ● Cyber-security + Physical Security Remote Management
SAP
IBM
Predix
DaaS
Dr Ahmed El Adl

IoS ● Business Ecosystem ● http://bit.ly/MIT-IOT



IDC

Internet of Systems ● Functional Ecosystem

Sensors & connectivity

Underlying components allowing intelligence and communication to be embedded in objects.

SENSORS Temperature, location, sound, motion, light, vibration, pressure, torque, electrical current.
ACTUATORS Valves, switches, power, embedded controls, alarms, intra-device settings.
COMMUNICATION From near- to far-field: RFID, NFC, ZigBee, Bluetooth, Wi-Fi, WiMax, cellular, 3G, LTE, satellite.

Device ecosystem

New connected and intelligent devices across categories making legacy objects smart.

CONSUMER PRODUCTS Smartphones, tablets, watches, glasses, dishwashers, washing machines, thermostats.
INDUSTRIAL Construction machines, manufacturing and fabrication equipment, mining equipment, engines, transmission systems, warehouses, smart homes, microgrids, mobility and transportation systems, HVAC systems.

Ambient services

The building blocks of ambient computing and services powered by sensors and devices.

INTEGRATION Messaging, quality of service, reliability.
ORCHESTRATION Complex event processing, rules engines, process management and automation.
ANALYTICS Baselining and anomaly monitoring, signal detection, advanced and predictive modeling.
SECURITY Encryption, entitlements management, user authentication, nonrepudiation.

Business use cases[a]

Representative scenarios by industry to harness the power of ambient computing.

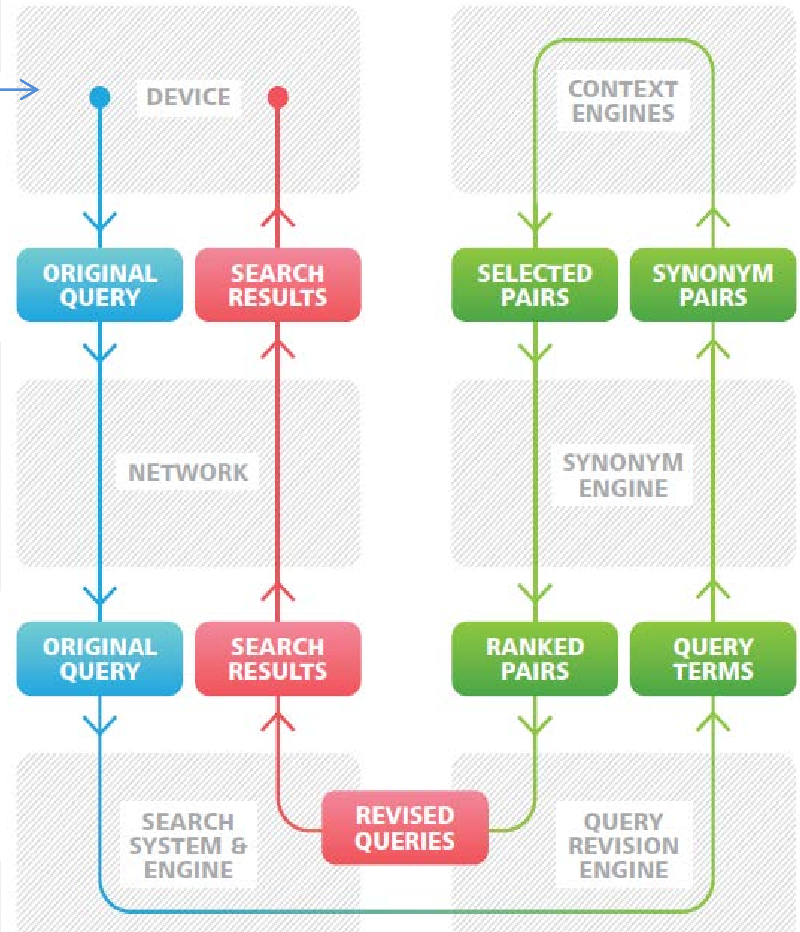
BASIC Efficiency, cost reduction, monitoring and tuning, risk and performance management.
ADVANCED Innovation, revenue growth, business insights, decision making, customer engagement, product optimization, shift from transactions to relationships and from goods to outcomes.

LOGISTICS Inventory and asset management, fleet monitoring, route optimization.

HEALTH & WELLNESS Personalized treatment, remote patient care.

MECHANICAL Worker safety, remote trouble-shooting, preventative maintenance.

MANUFACTURING Connected machinery, automation.



Deloitte Cartoon

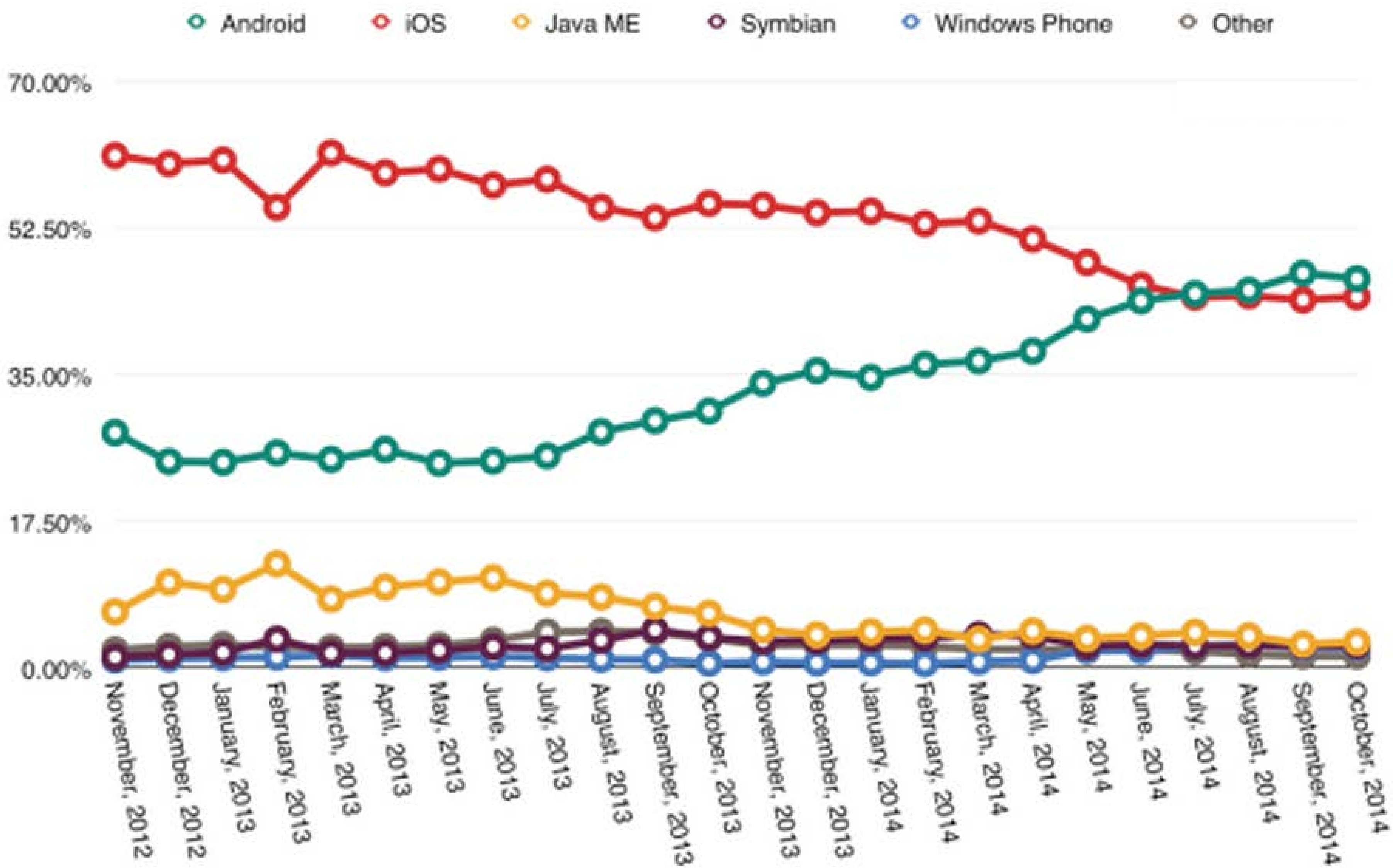
www.google.com/patents/US8538984

DAWN OF THE HELLABYTE ERA • GLOBAL IP TRAFFIC

	2013	2014	2015	2016	2017	2018	CAGR 2013–2018
By Type (Petabytes [PB] per Month)							
Fixed Internet	34,952	42,119	50,504	60,540	72,557	86,409	20%
Managed IP	14,736	17,774	20,898	23,738	26,361	29,305	15%
Mobile data	1,480	2,582	4,337	6,981	10,788	15,838	61%
By Segment (PB per Month)							
Consumer	40,905	50,375	61,439	74,361	89,689	107,958	21%
Business	10,263	12,100	14,300	16,899	20,016	23,595	18%
By Geography (PB per Month)							
Asia Pacific	17,950	22,119	26,869	32,383	39,086	47,273	21%
North America	16,607	20,293	24,599	29,377	34,552	40,545	20%
Western Europe	8,396	9,739	11,336	13,443	16,051	19,257	18%
Central and Eastern Europe	3,654	4,416	5,443	6,666	8,332	10,223	23%
Latin America	3,488	4,361	5,318	6,363	7,576	8,931	21%
Middle East and Africa	1,074	1,546	2,174	3,027	4,108	5,324	38%
Total (PB per Month)							
Total IP traffic	51,168	62,476	75,739	91,260	109,705	131,553	21%

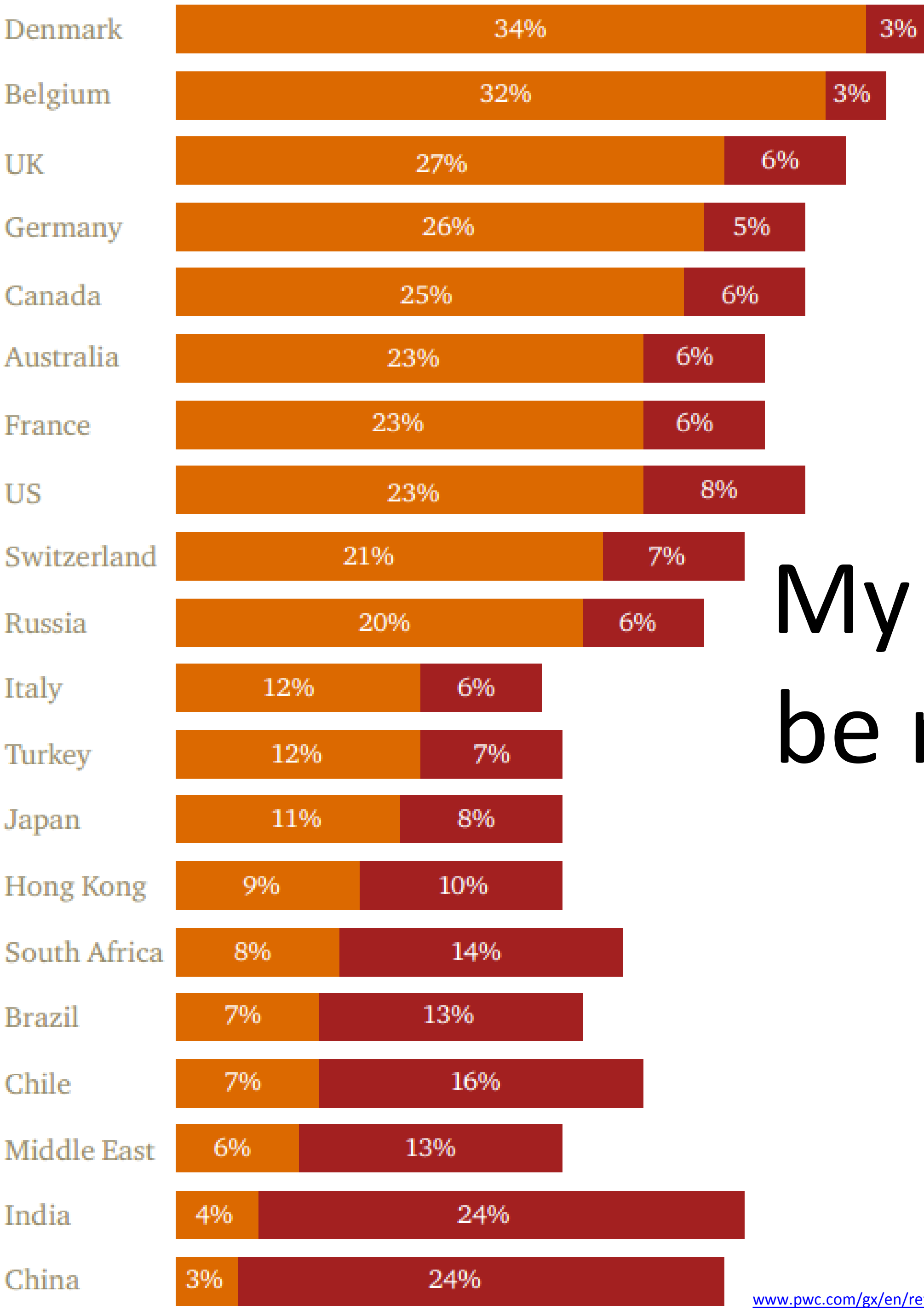
http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.pdf

The Next MOB ● Mobile Only Billion



http://time.com/3589909/internet-next-billion-mobile/

Apply ABCDEF Principle
Analyses based on context, demographics and economic future

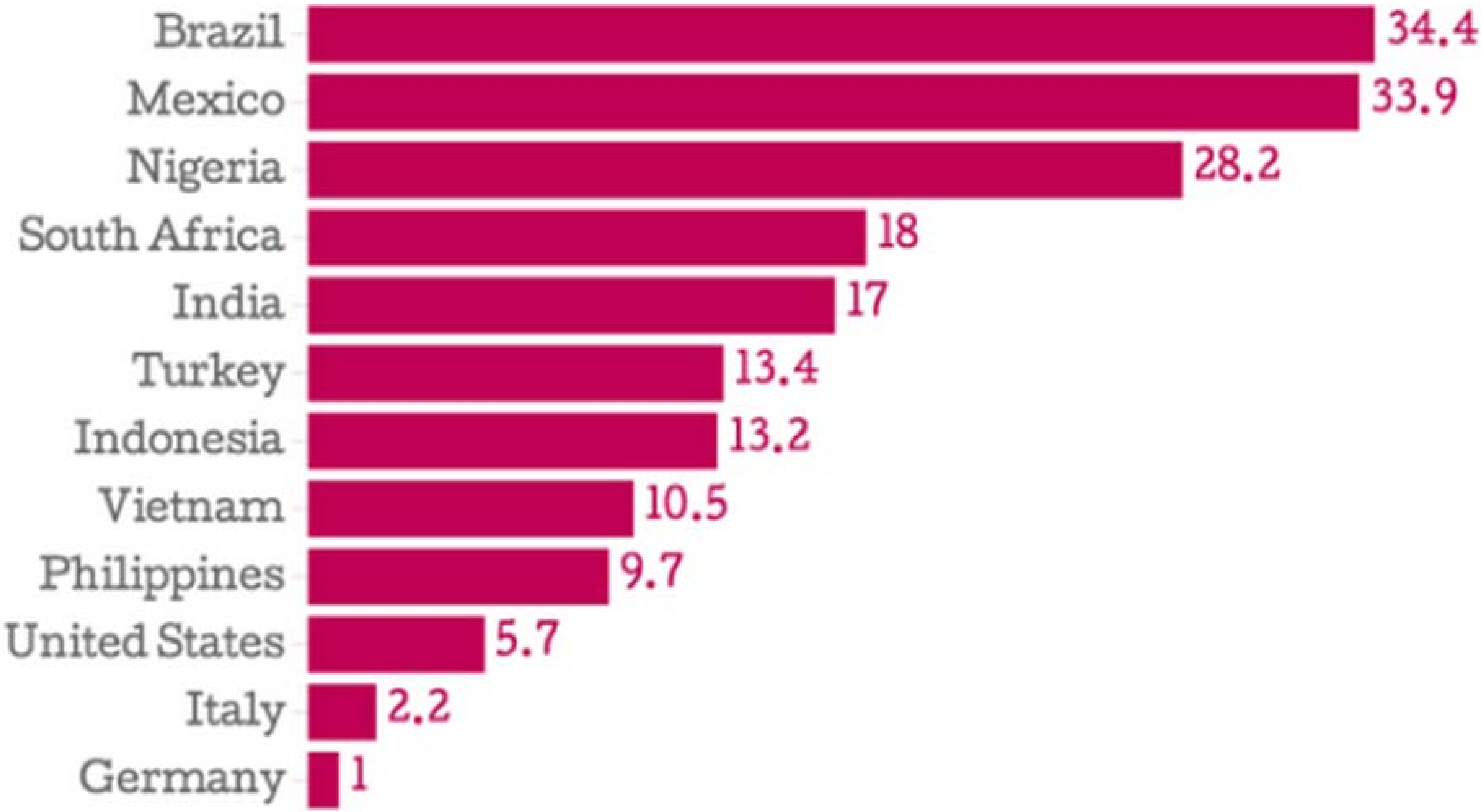


My mobile phone will be my purchasing tool

Strongly disagree Strongly agree

www.pwc.com/gx/en/retail-consumer/retail-consumer-publications/global-multi-channel-consumer-survey/assets/pdf/total-retail-2015.pdf

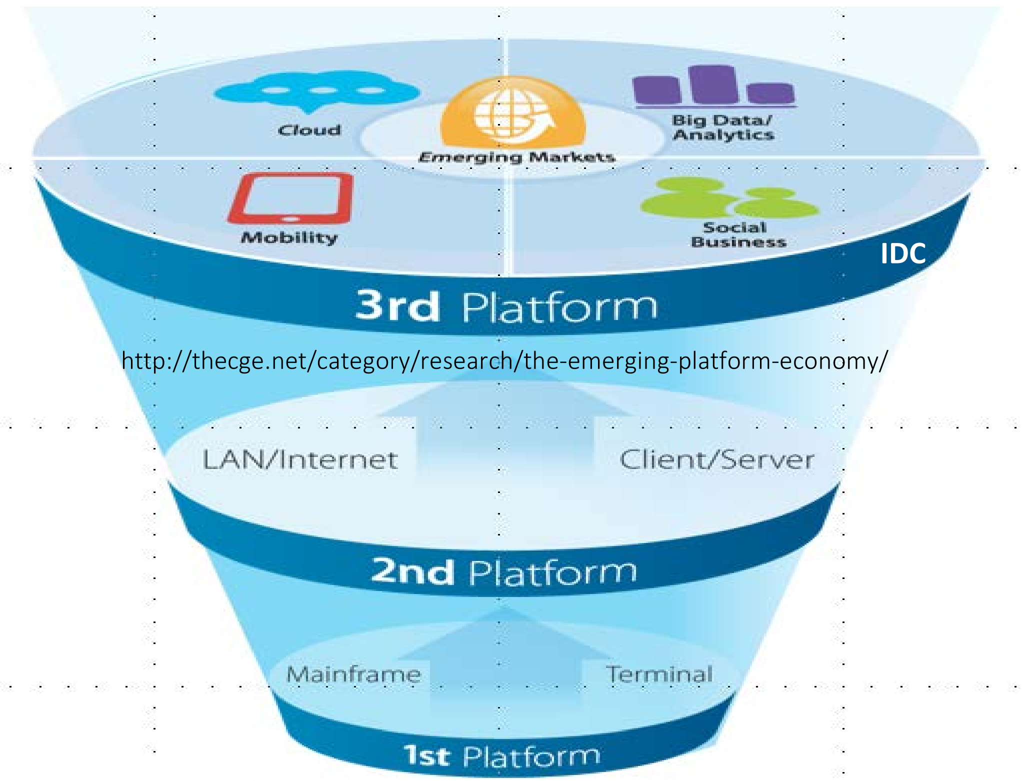
Hours at minimum wage needed to pay for 500MB Mobile Data Plan

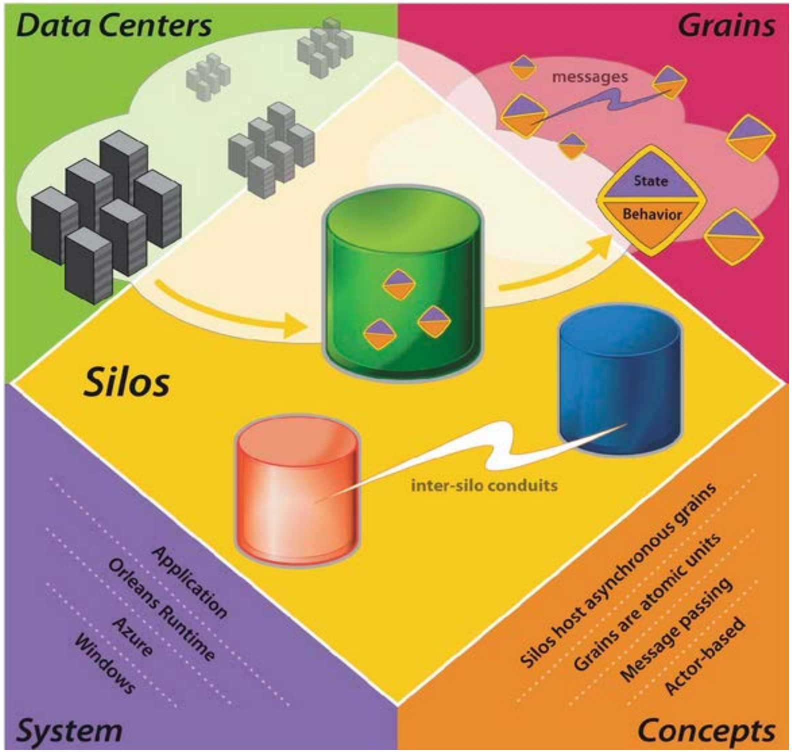


http://time.com/3589909/internet-next-billion-mobile/

Paradox to Paradigms to Platforms

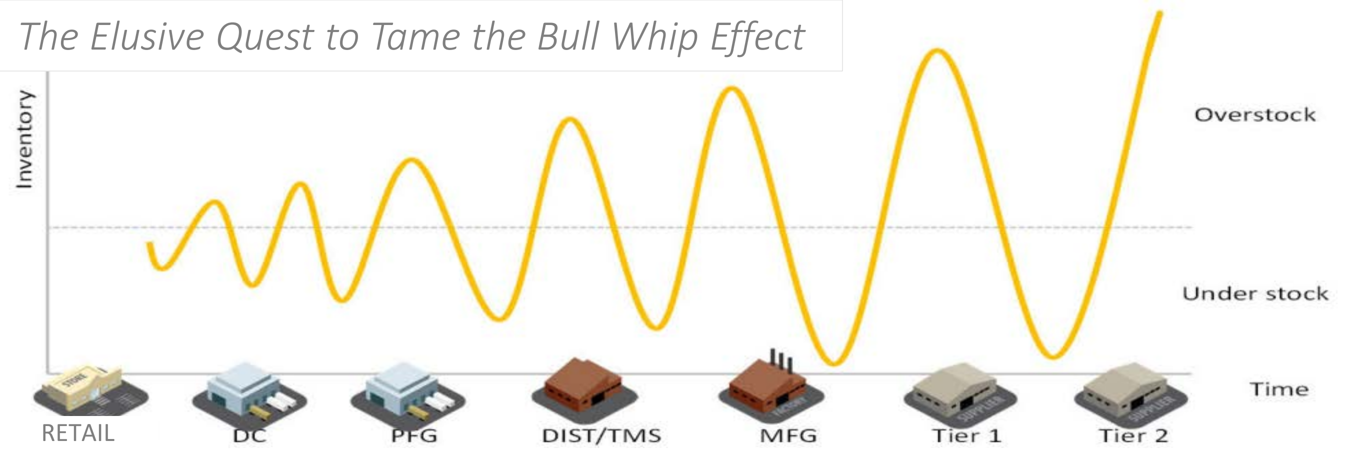
Platforms

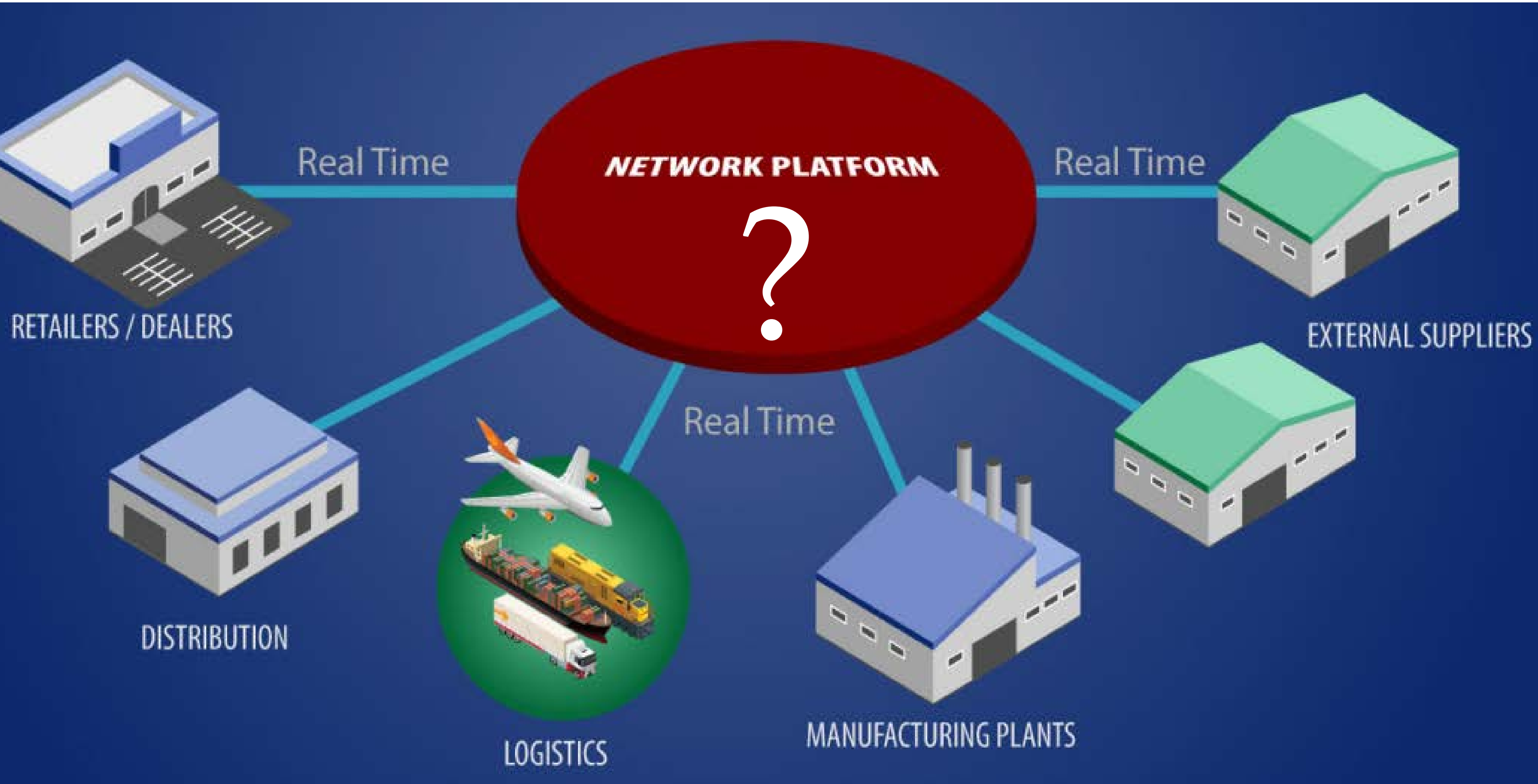


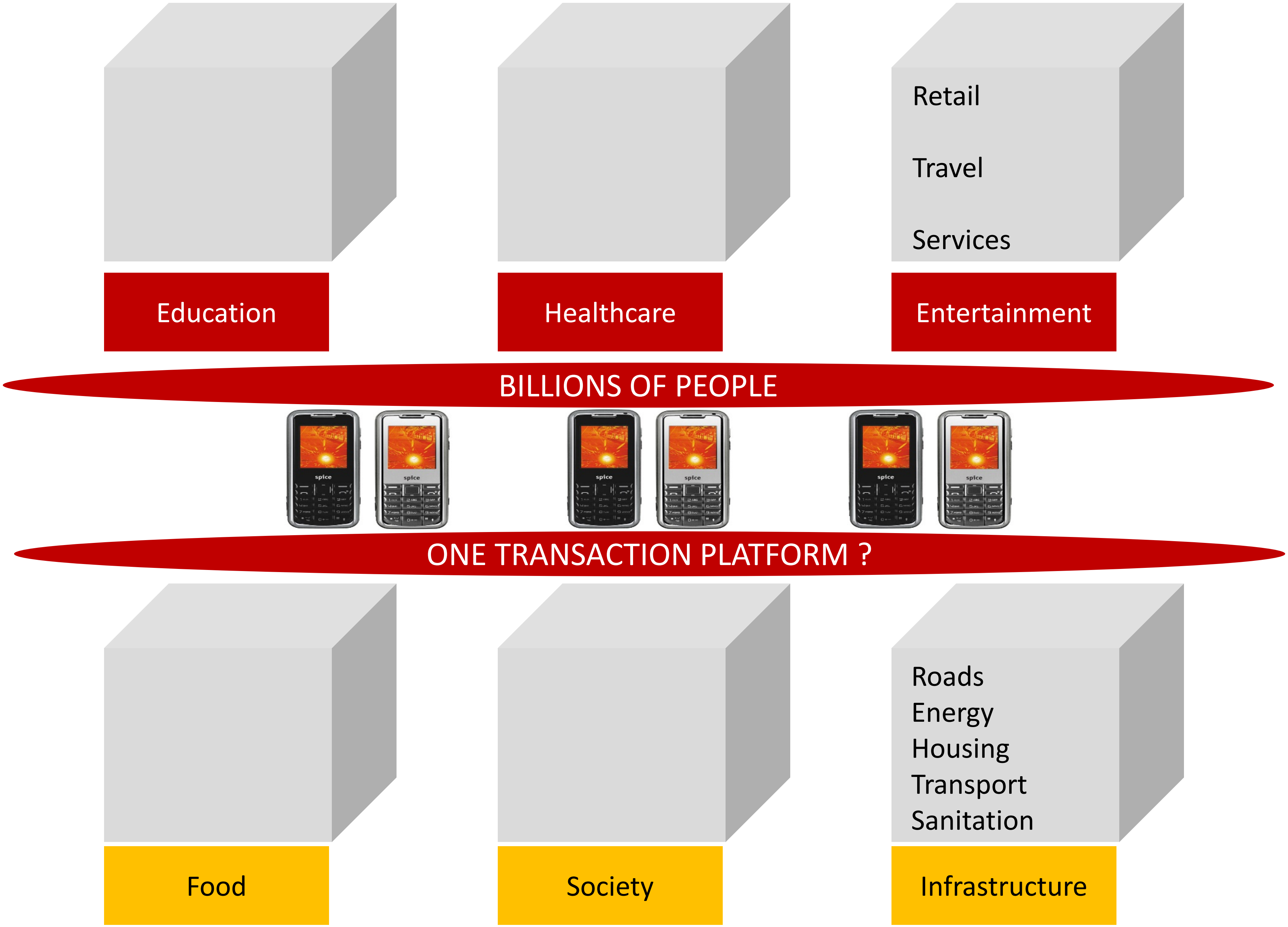


PaaS, SaaS, IaaS, DaaS must generate revenue for IoS Platforms Business

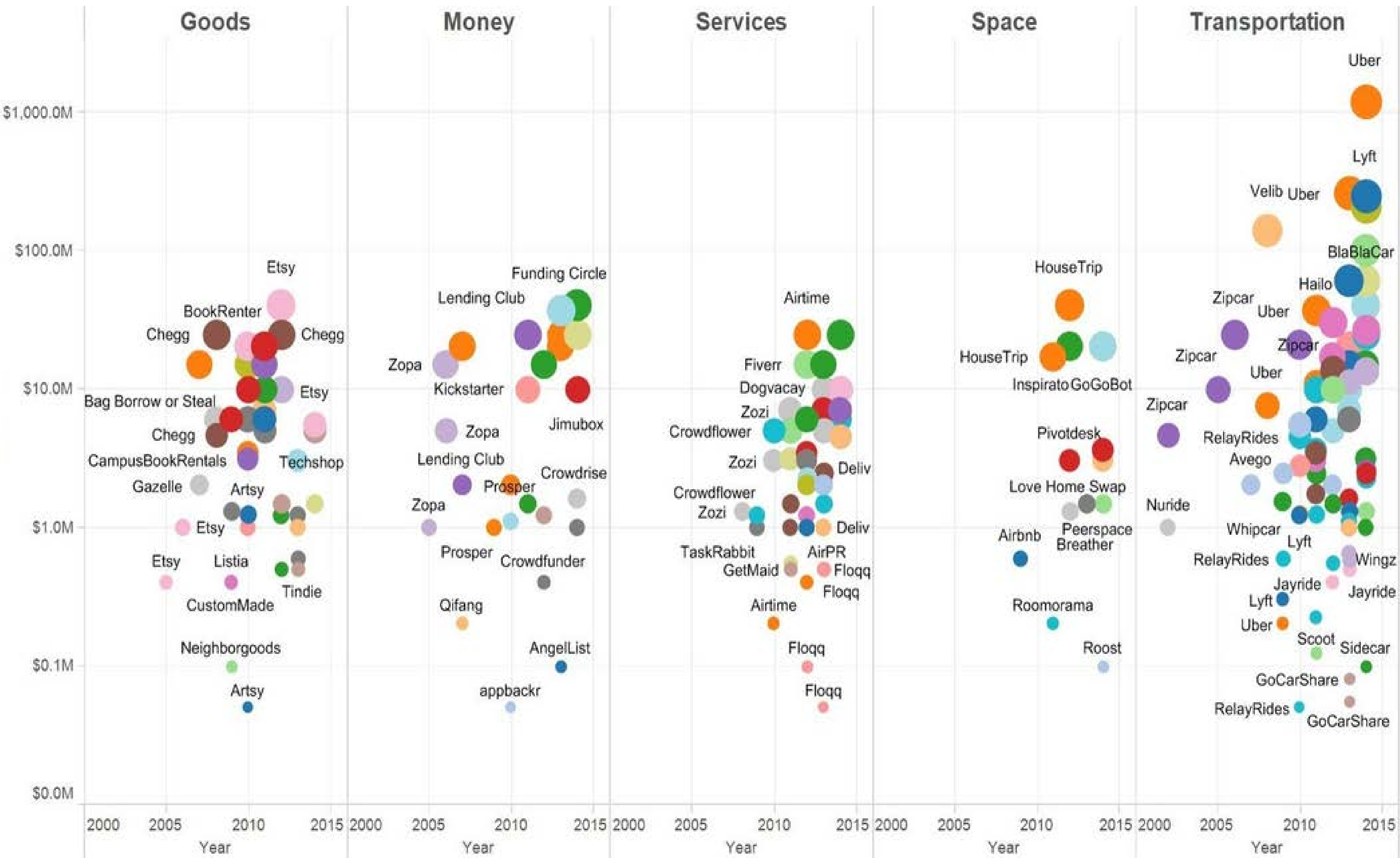
SUPPLY CHAIN





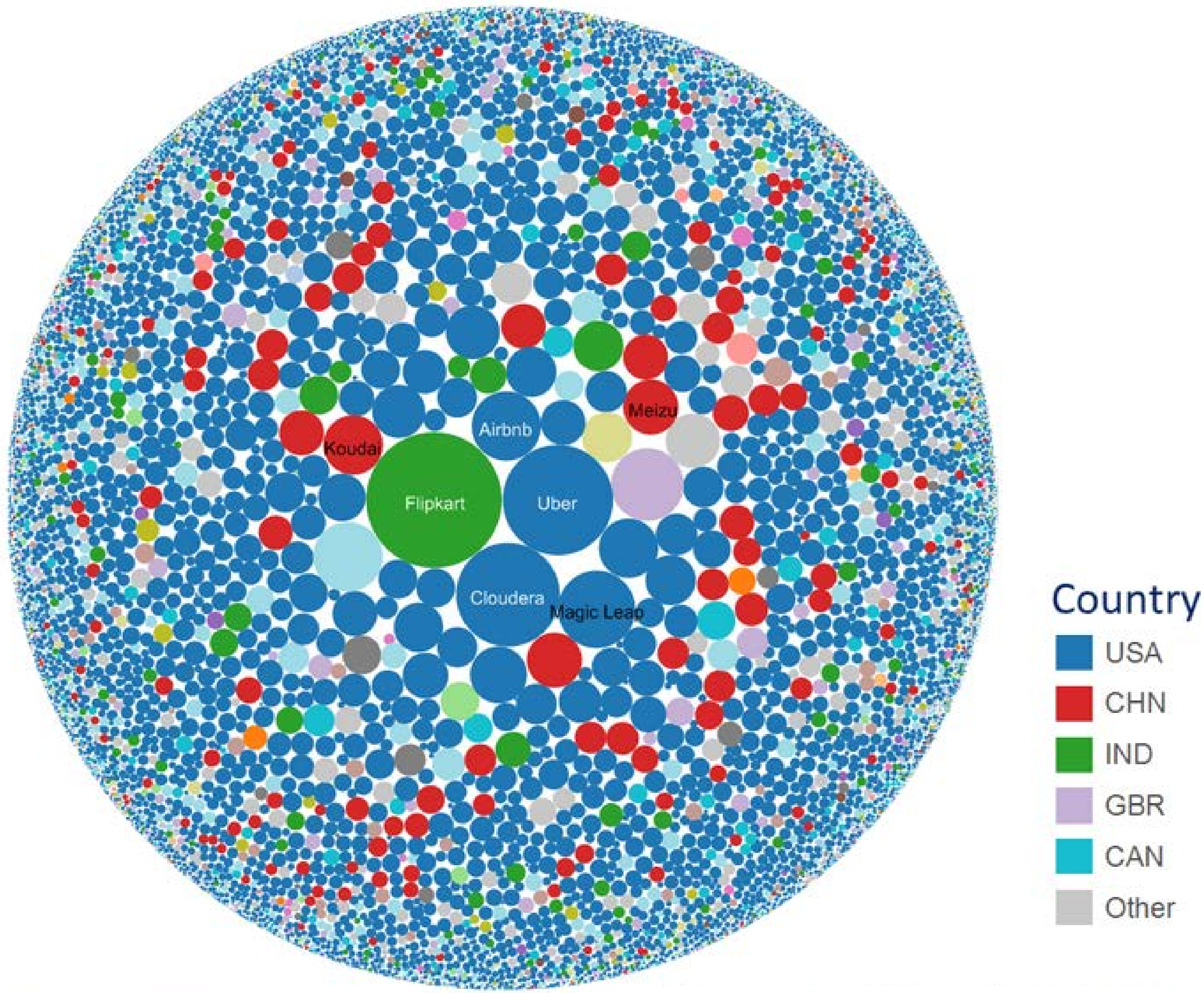

Retail
Travel
Services
Education
Healthcare
Entertainment
BILLIONS OF PEOPLE
spice
ONE TRANSACTION PLATFORM ?
Roads
Energy
Housing
Transport
Sanitation
Food
Society
Infrastructure

Platform Economy – VC Funding for Collaborative Enterprises



Source: Mesh Directory, Lisa Gansky, 2014

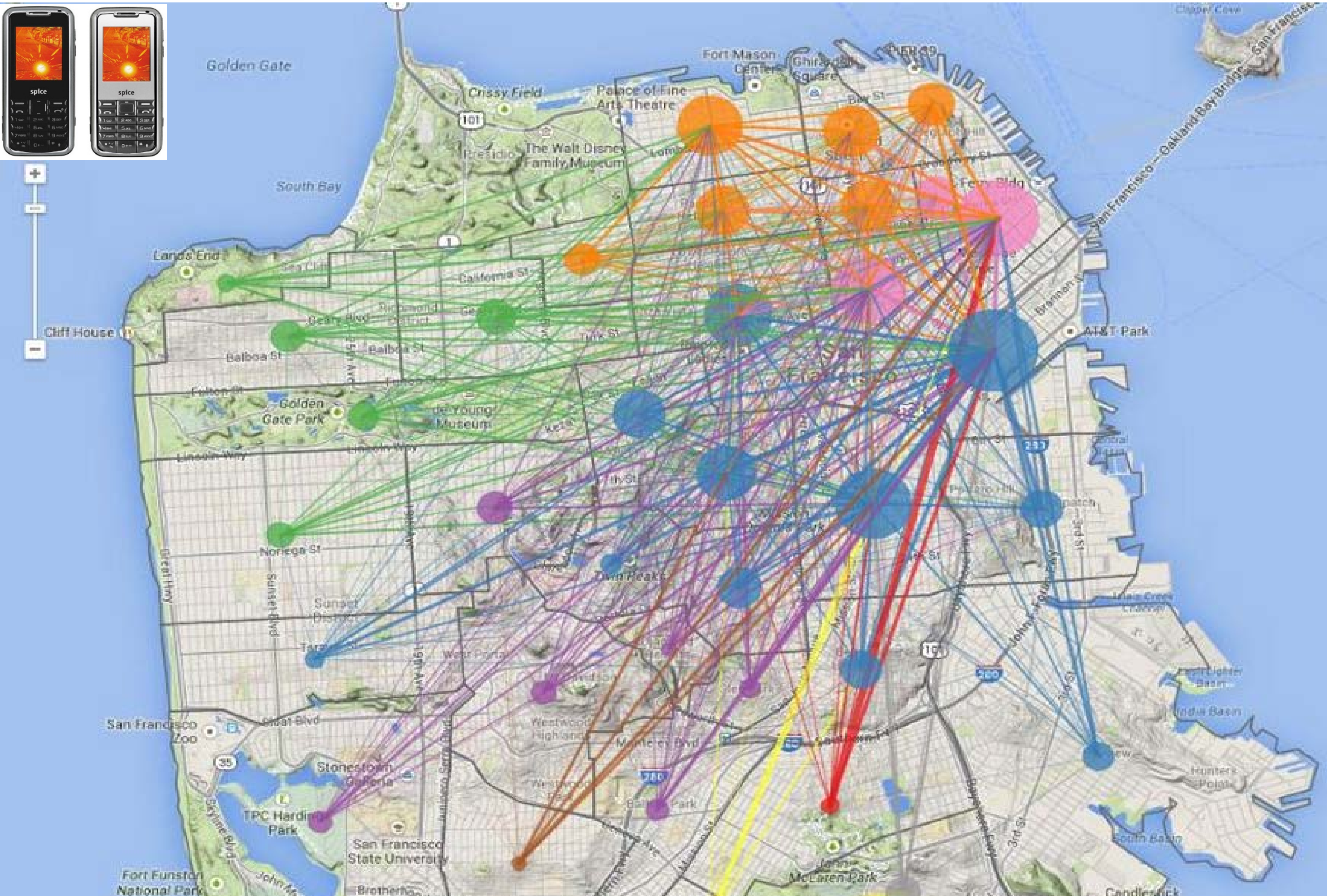
Over 10,000 companies were able to raise over US$80 billion in 2014. In the lead are Flipkart (India); Airbnb, Uber, Cloudera (US); Koudai, Meizu (China)



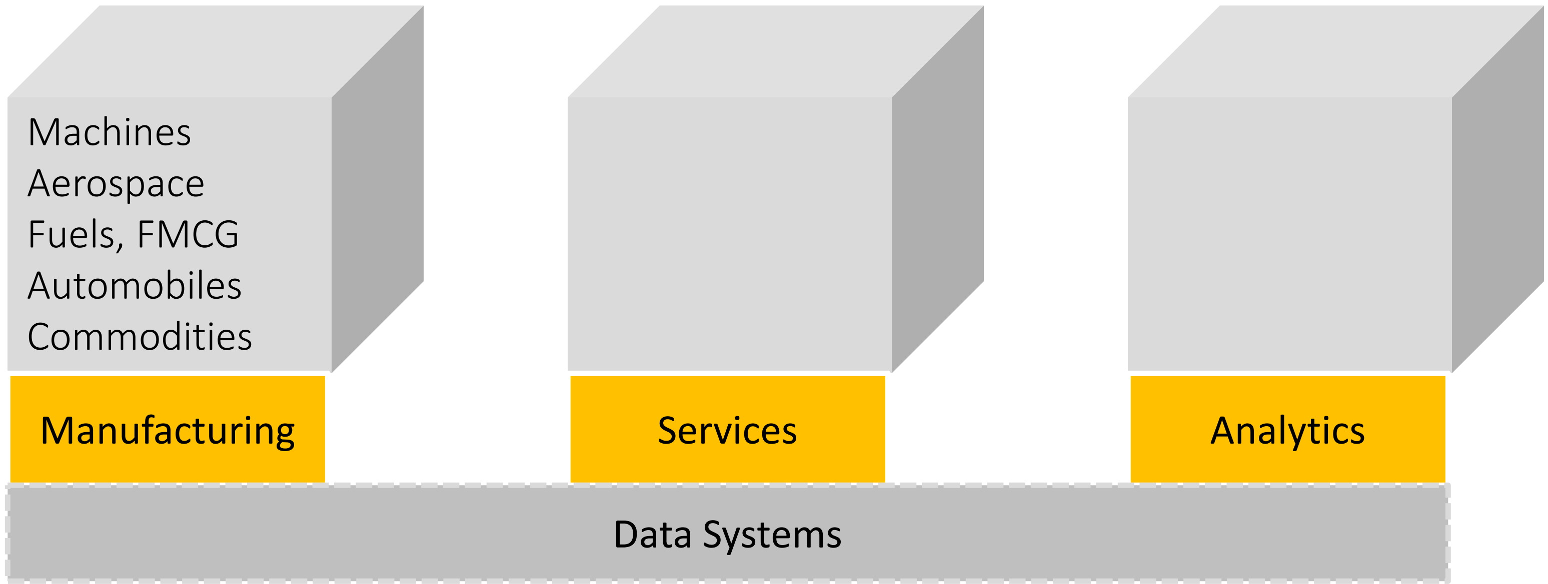
Source: Crunchbase, 2014

Mobile IoS Economy

Uber's Information Flow



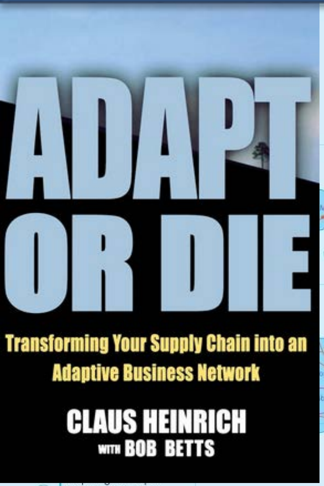
Makes Money – Generates Revenue

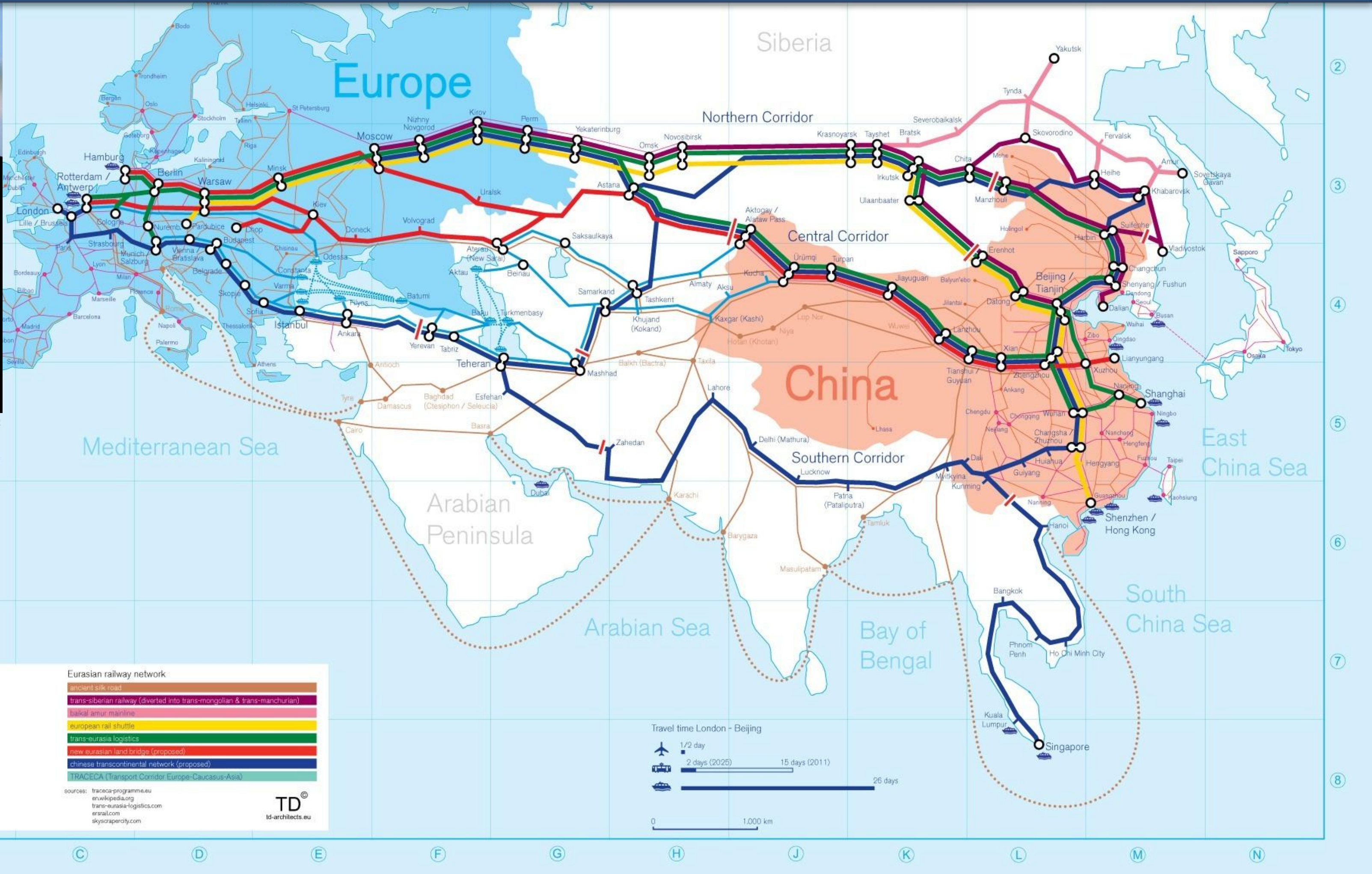


The Hyper-Horizontal Function

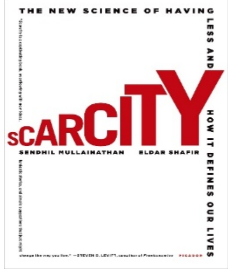
Coal was a huge industry that fueled other huge industries during the latter part of the Industrial Revolution. A purpose-built infrastructure was required to deliver coal from mines to manufacturers. In the age of the industrial internet and the internet of things, is data the new coal?

Adapt or Die – Changes on the road ahead

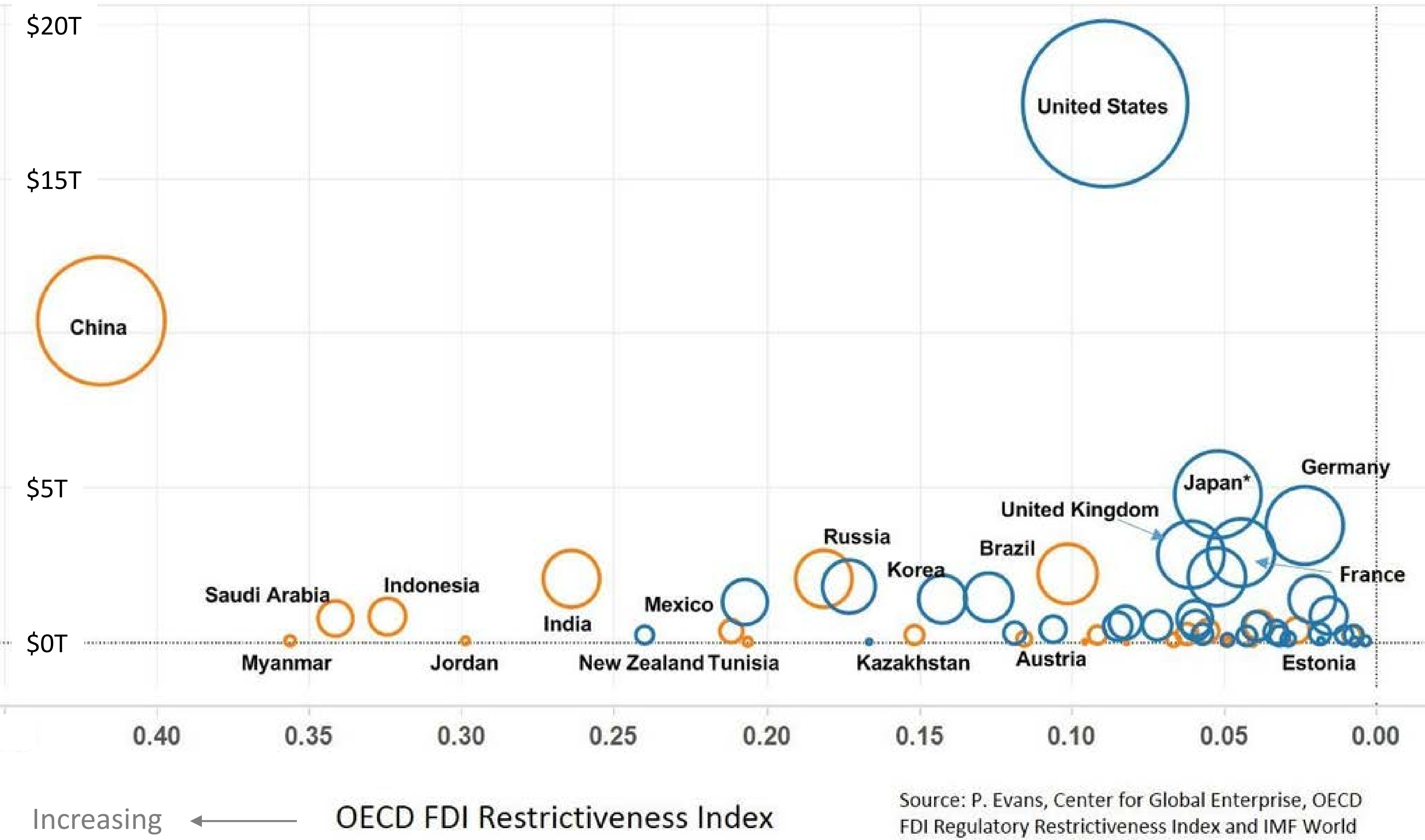




MONEY

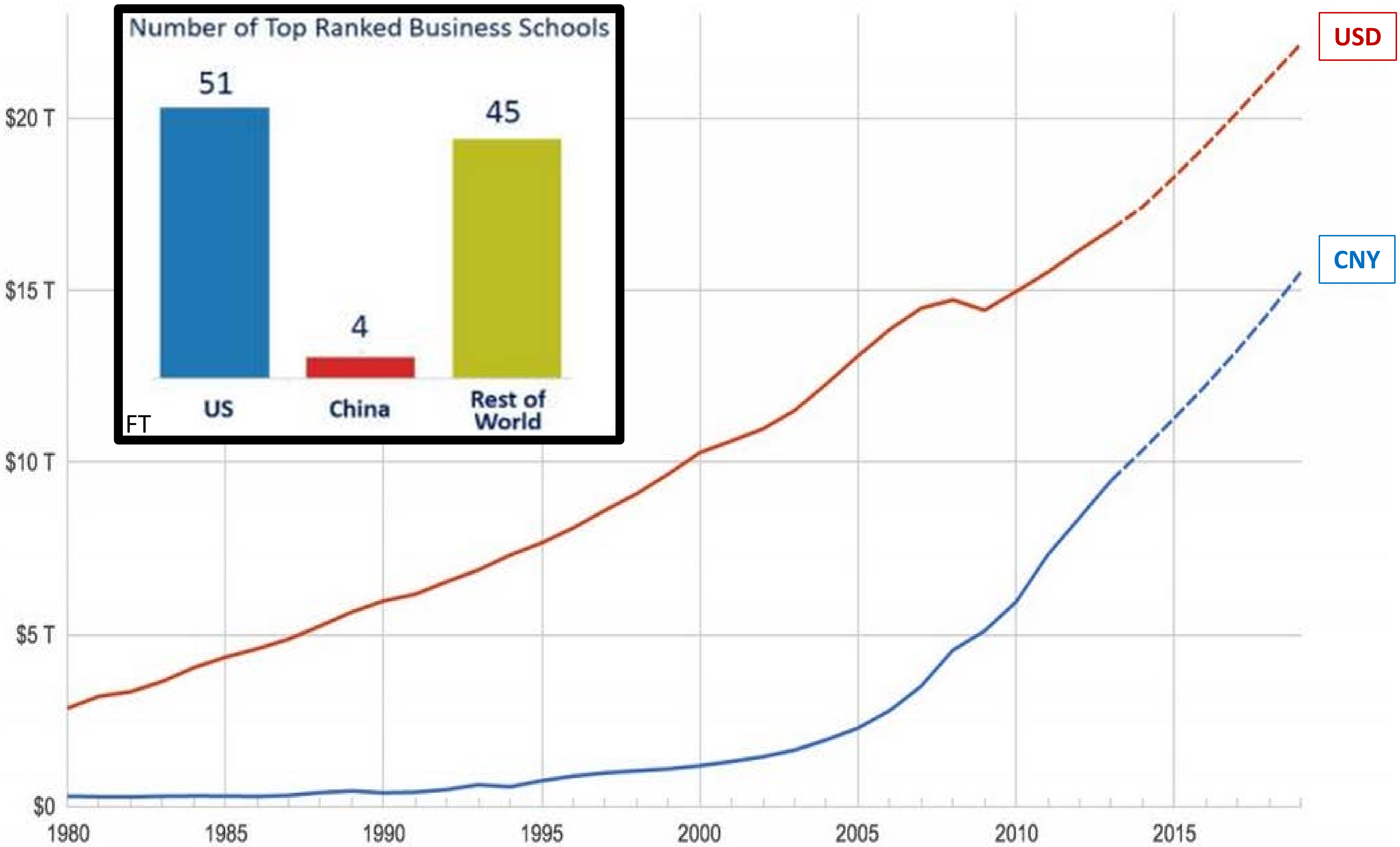


Economic Growth fueled by the Middle Class ● Can Modinomics reduce FDI restrictions in India?



Source: P. Evans, Center for Global Enterprise, OECD FDI Regulatory Restrictiveness Index and IMF World Economic Outlook, Oct. 2014

According to IMF the CNY has a long way to go to catch up to the USD

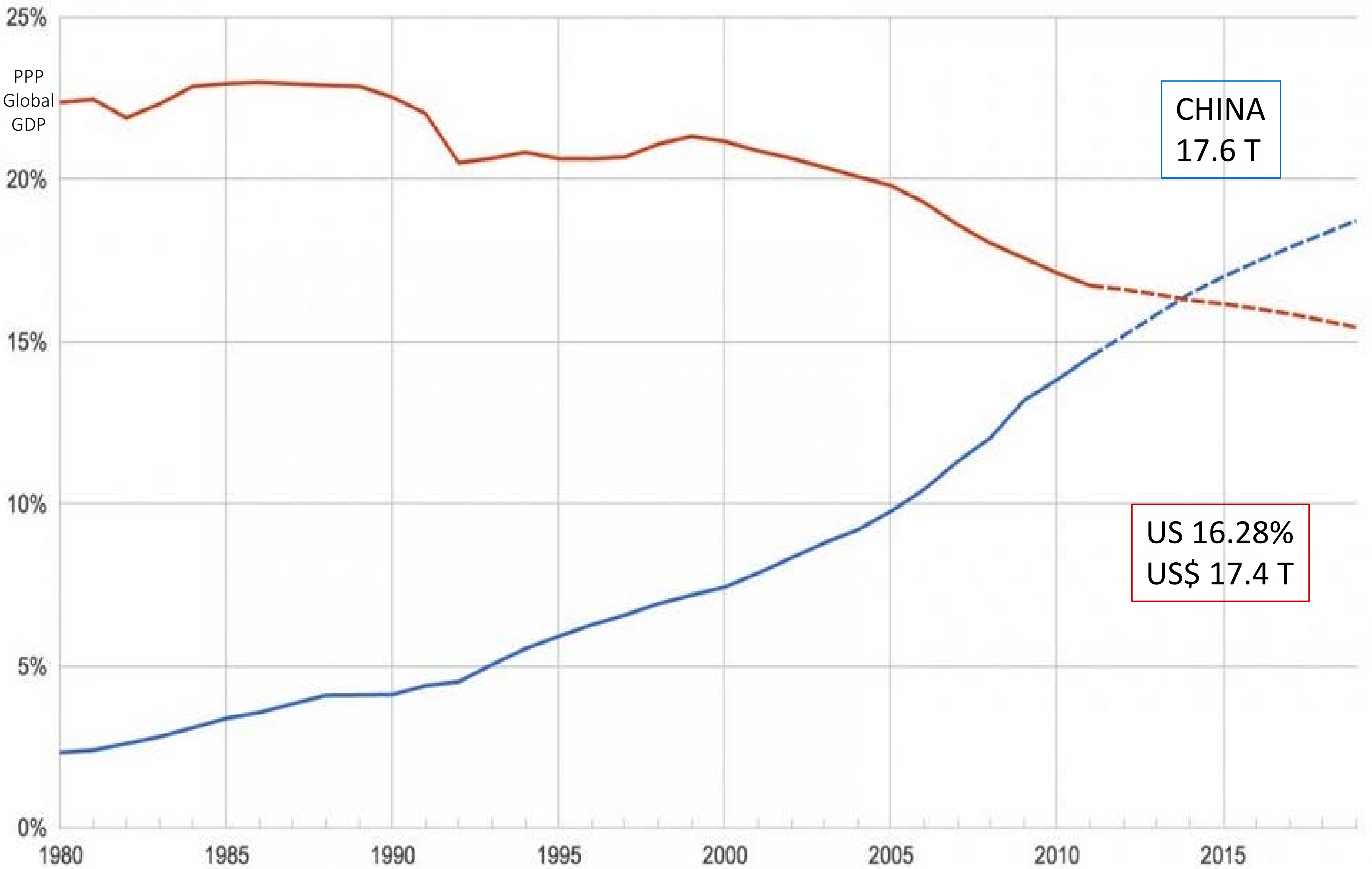


http://bit.ly/Silk-Road

US States renamed for countries with similar GDP (2012)

www.aei-ideas.org/2014/02/americas-ridiculously-large-16t-economy/

BUT THE ECONOMIC CONTEXT HAS EVOLVED AS MEASURED BY PPP



http://bit.ly/Silk-Road

BEIJING to CAPE TOWN by RAIL

As suggested in 2008, Yiwu to Madrid is a prelude to the next phase in freight transportation → Beijing to Cape Town.

(The Washington Post)

On Nov. 18, an 82-container freight train left the eastern Chinese industrial city of Yiwu. It was embarking on a landmark journey that is supposed to end 21 days later, in December, in Madrid. The distance the train covers — more than 6,200 miles — marks the longest route taken by a freight train, longer still than Russia's famed Trans-Siberian Railway, as the map above shows.

http://dspace.mit.edu/bitstream/handle/1721.1/41897/WiFi%20Meet%20FuFi%20_%20MIT%20ESD%20WP.pdf?sequence=1

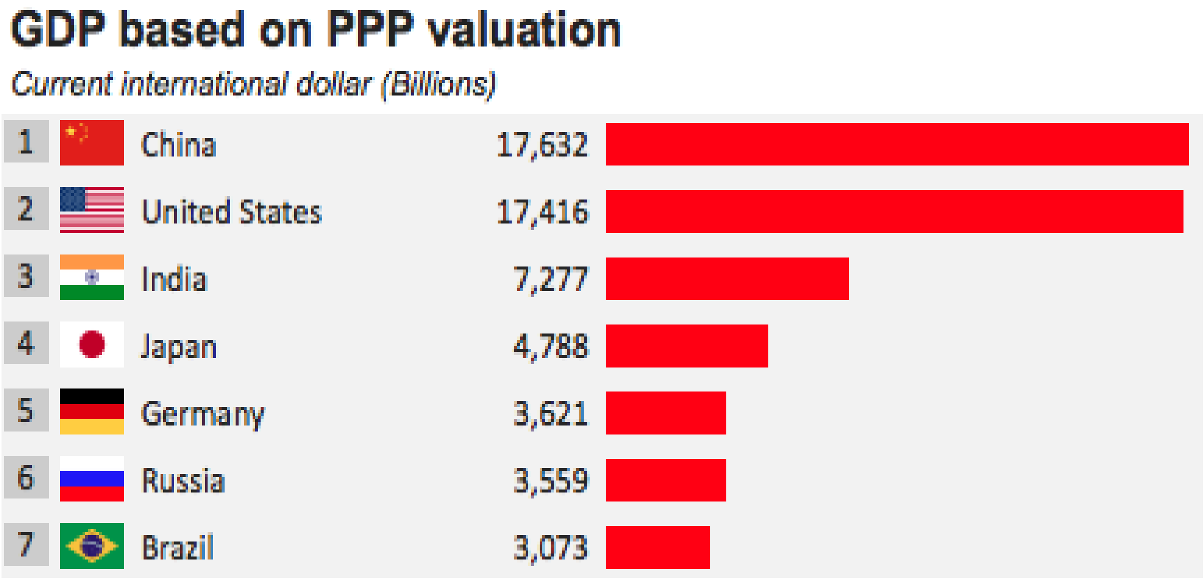
Yiwu is the largest wholesale center for small consumer goods in China, making it home to a curious mix of foreign businessmen and petty traders, including a large community of Arabs. Now it's plugged into a far larger project: China's zeal to deepen the links between its booming economy and markets in Europe.

Asia-Africa Goods Transport ● South-South Business Development

Xinhuanet.com

To Cape Town, South Africa

http://dspace.mit.edu/bitstream/handle/1721.1/41897/WiFi%20Meet%20FuFi%20_%20MIT%20ESD%20WP.pdf?sequence=1



Internet of Systems (Me) Economy

Think different • *Re-think security*

Alibaba and Forty Drones

Kathleen Fisher and DARPA HACMS

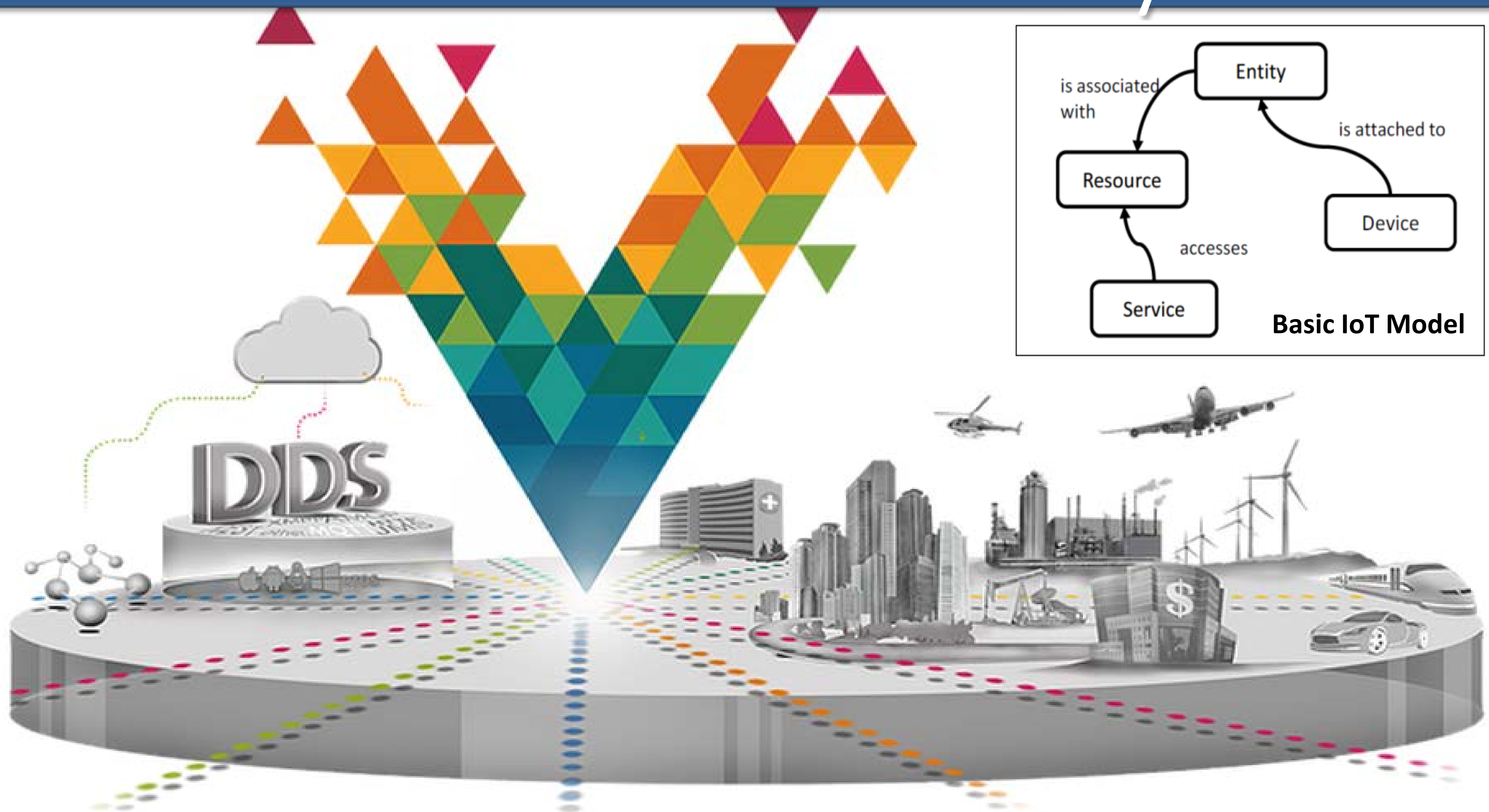
• The IoS Economy •

Level 6 Conceptual Interoperability	Full assumptions and constraints of meaningful abstraction of reality. Fully specified but independent model
Level 5 Dynamic Interoperability	Maintains state changes between systems during run time. Includes assumptions and constraints that effect data interchange
Level 4 Pragmatic Interoperability	Systems are aware of methods & procedures of other systems. Context is understood by all participating systems
Level 3 Semantic Interoperability	Meaning of data is exchanged through use of a common information model. The meaning of information is shared and unambiguously defined.
Level 2 Syntactic Interoperability	Common structure or common data format for exchanging information. The format of the information exchange is unambiguously defined
Level 1 Technical Interoperability	Communication protocol for exchanging data. Bits & Bytes are exchanged in an unambiguous manner
Level 0 No Interoperability	Stand alone systems that have no interoperability

Interoperability

VMASC

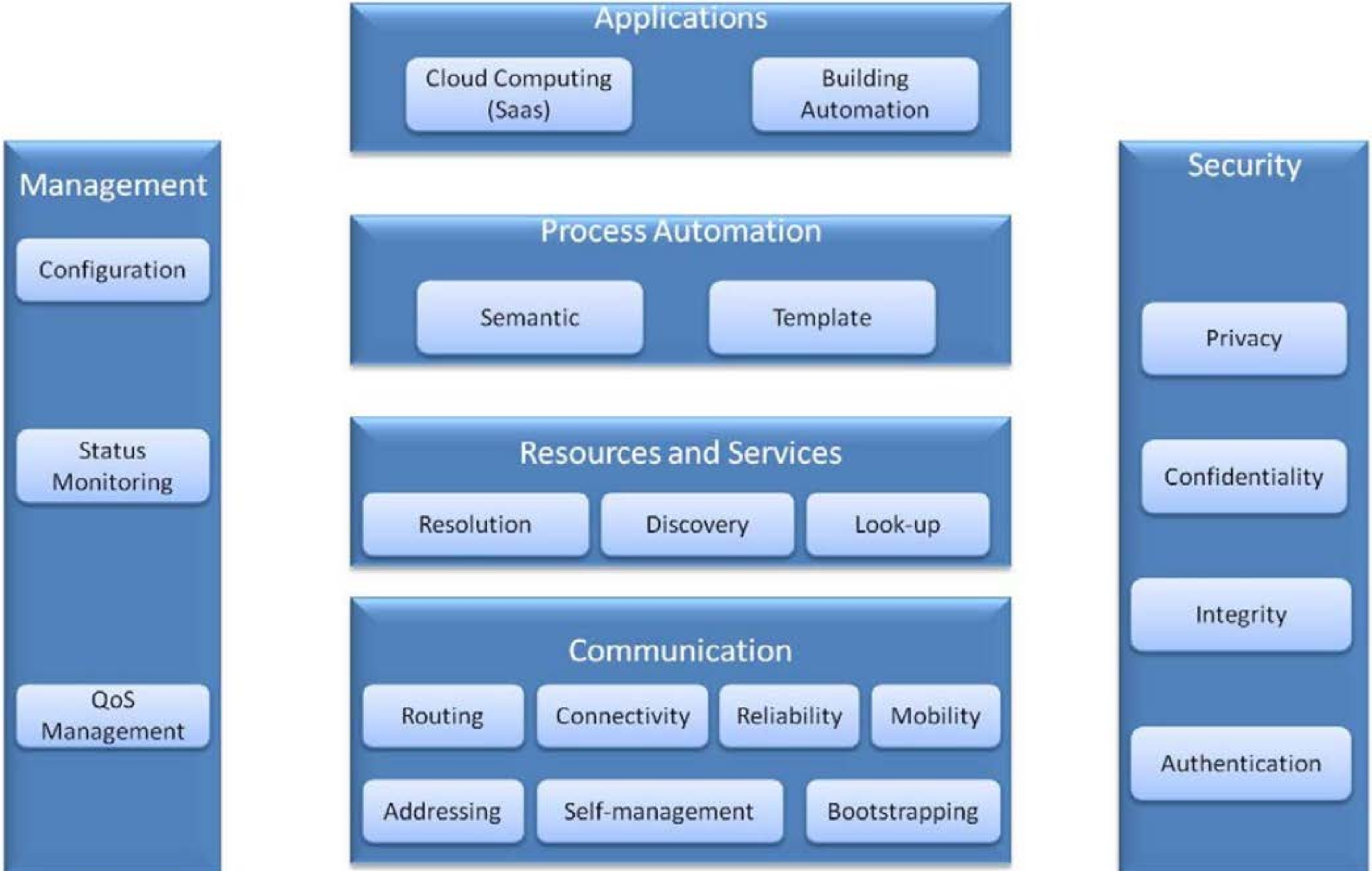
The IoS Economy



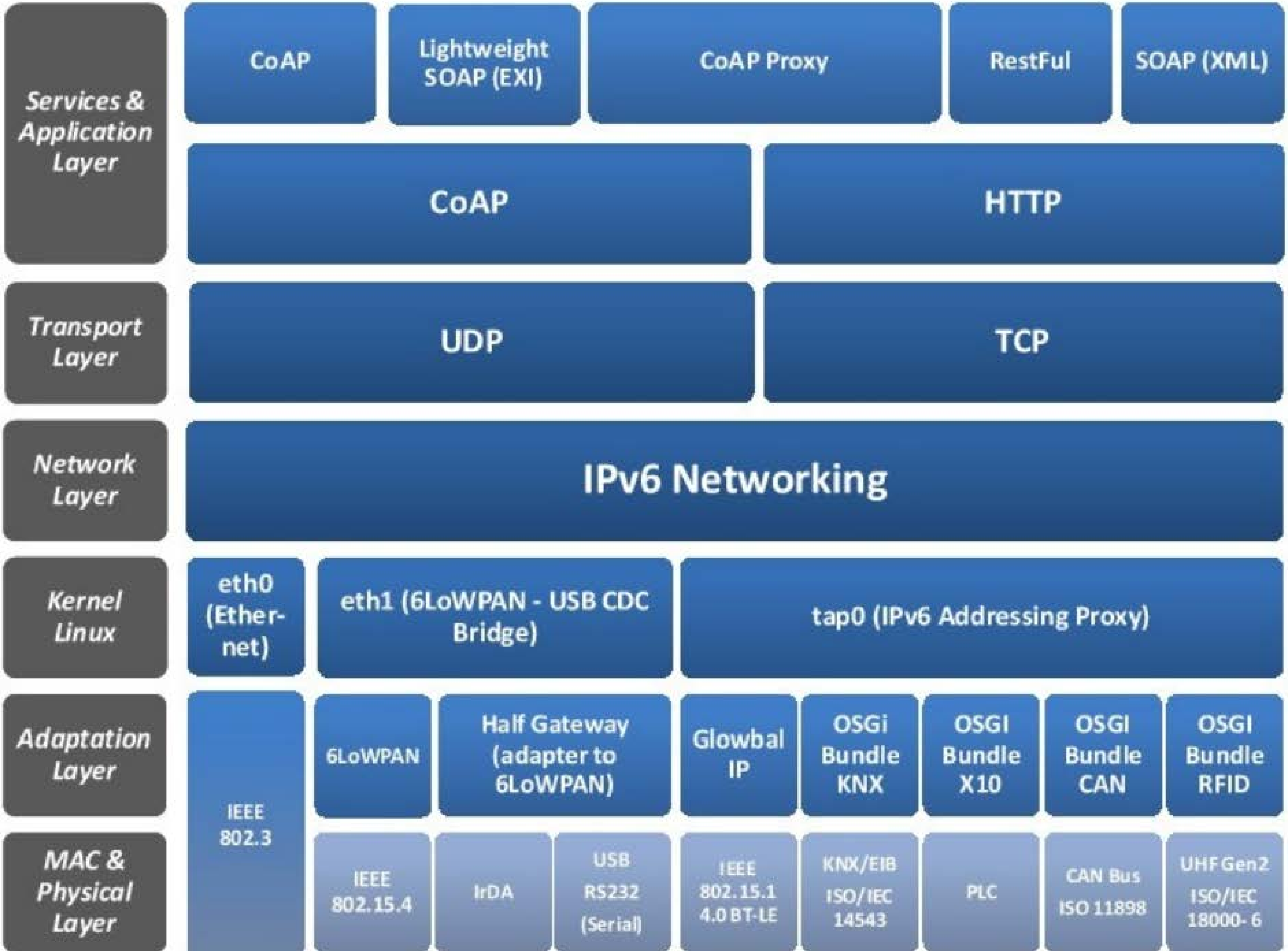
Basic IoT Model

Grand Platforms

IoT Architecture



http://www.iot6.eu/sites/default/files/IoT6%20-%20D1.3.pdf



IoT Architecture ● Protocol Stack Mapping ● http://www.iot6.eu/sites/default/files/IoT6%20-%20D1.3.pdf

Communication Standards ?

- 802.11 (for WiFi)
- 802.15.4 (Used for a variety of wireless protocols, including Zigbee)
- I^2C (sensor interconnect)
- SPI (sensor interconnect)
- Ethernet
- IP (in particular, IPv6 and 6LoWPAN)
- TCP
- UDP
- **WiFi**
- **Bluetooth**
- **Zigbee**
- HTTP
- CoAP (based on HTTP; for constrained applications)
- MQTT (messaging)
- **Thread**
- **IPSO SmartObjects**
- **IEEE 2700** (sensor parameters)

I3C (actual standard available to members only)

LoRa

LWM2M

http://eejournal.com/archives/articles/20150209-protocols/

Weightless

Insteon

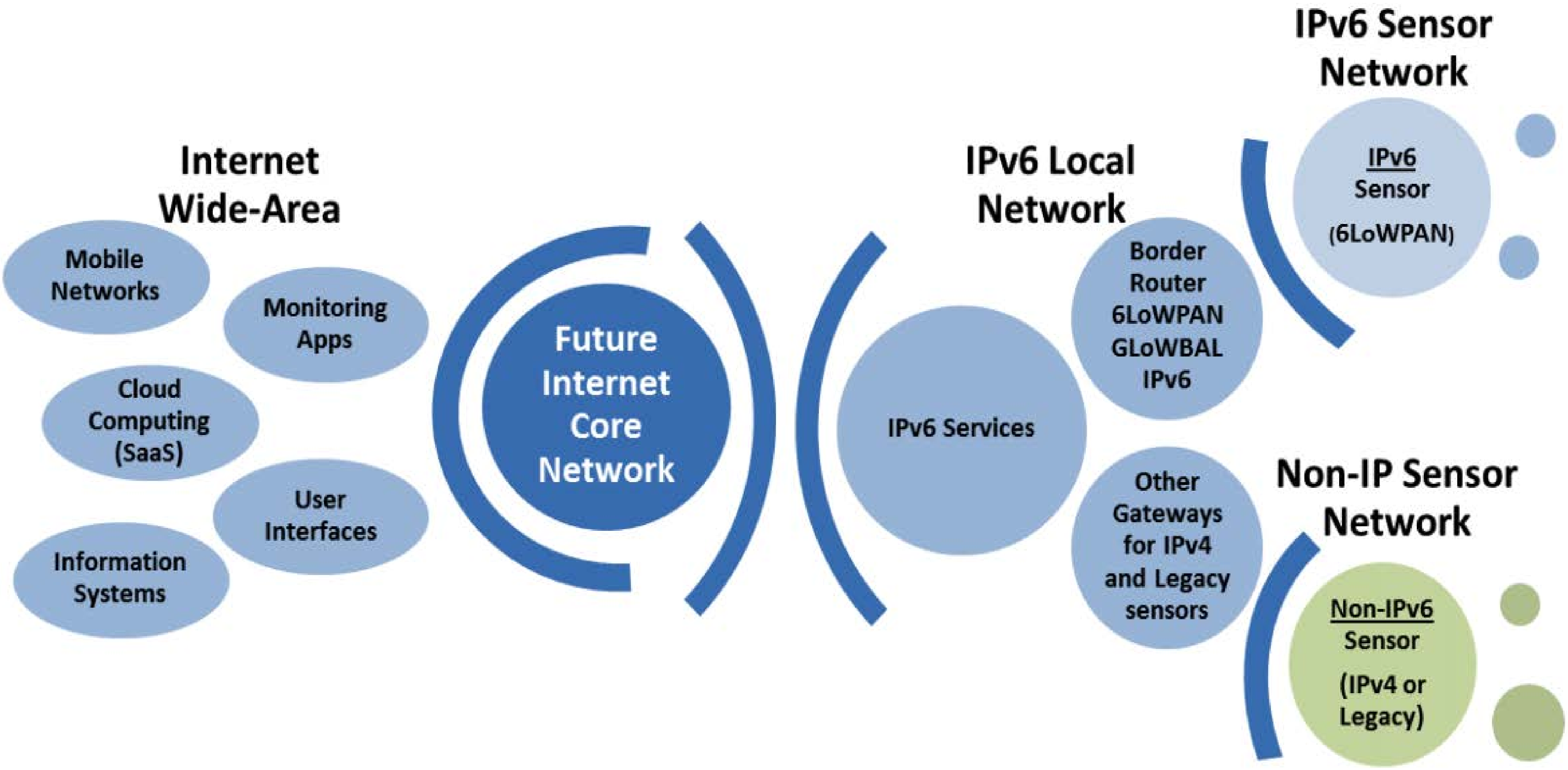
Nivis

ISA100

WirelessHART

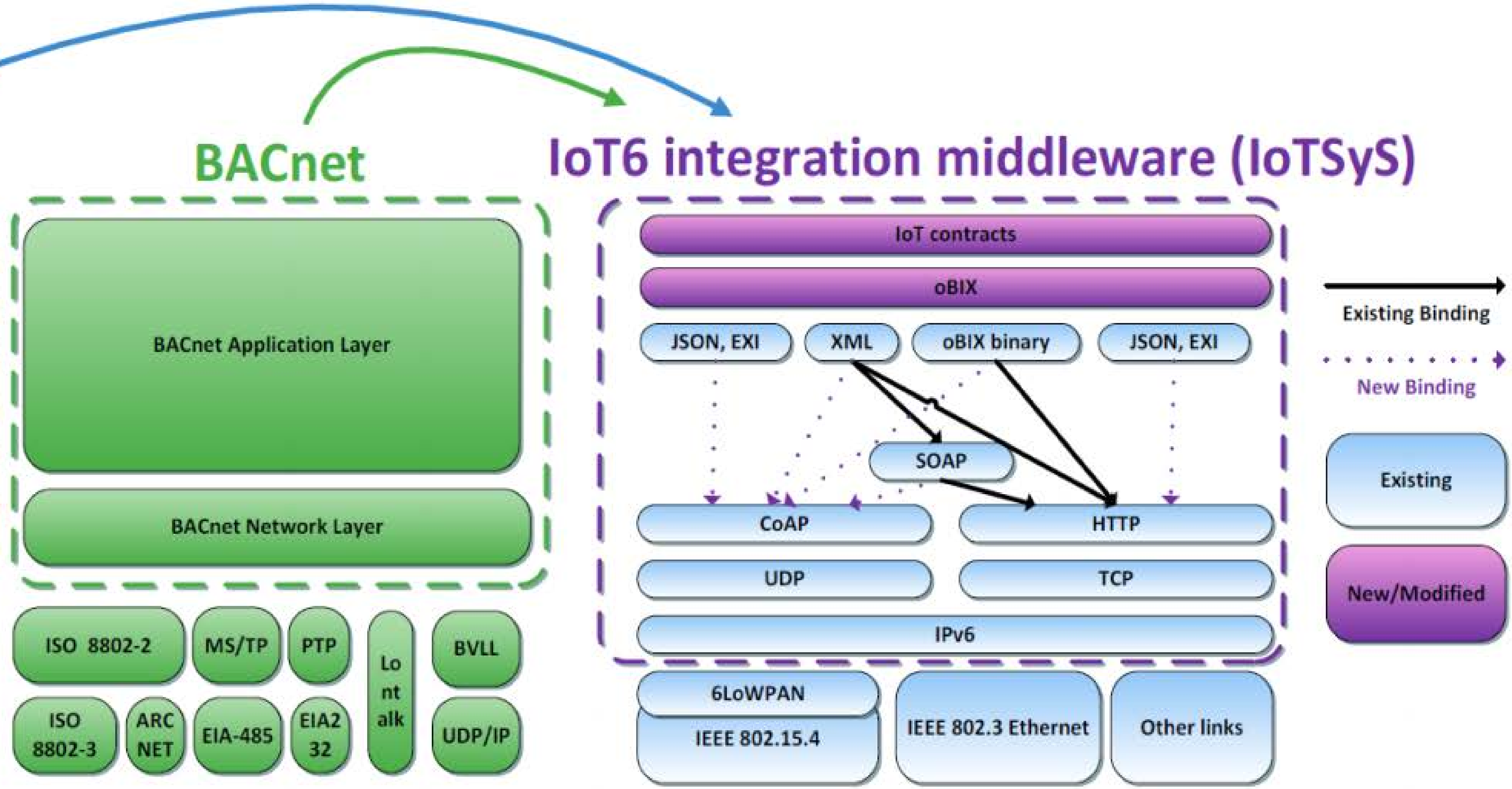
IEEE 1451 (behind a paywall)

IoT Communication



www.iot6.eu/sites/default/files/IoT6%20-%20D1.3.pdf

● Legacy IoT Integration ●



www.iot6.eu/sites/default/files/IoT6%20-%20D1.3.pdf

● IoT Design Metaphor ●

The Sanjay Sarma Conjecture

- Star topologies often trump mesh topologies
- Design and debugging tools are as important as the technology
- A retrograde step eschewing more convenience but less scalable architectures

Other less known conjectures of lesser importance -

The Riemann hypothesis, proposed by Bernhard Riemann (1859), is a conjecture that the non-trivial zeros of the Riemann zeta function all have real part 1/2.

Golbach's conjecture is one of the oldest and best-known unsolved problems in number theory and in all of mathematics. It states: every even integer greater than 2 can be expressed as the sum of two primes.

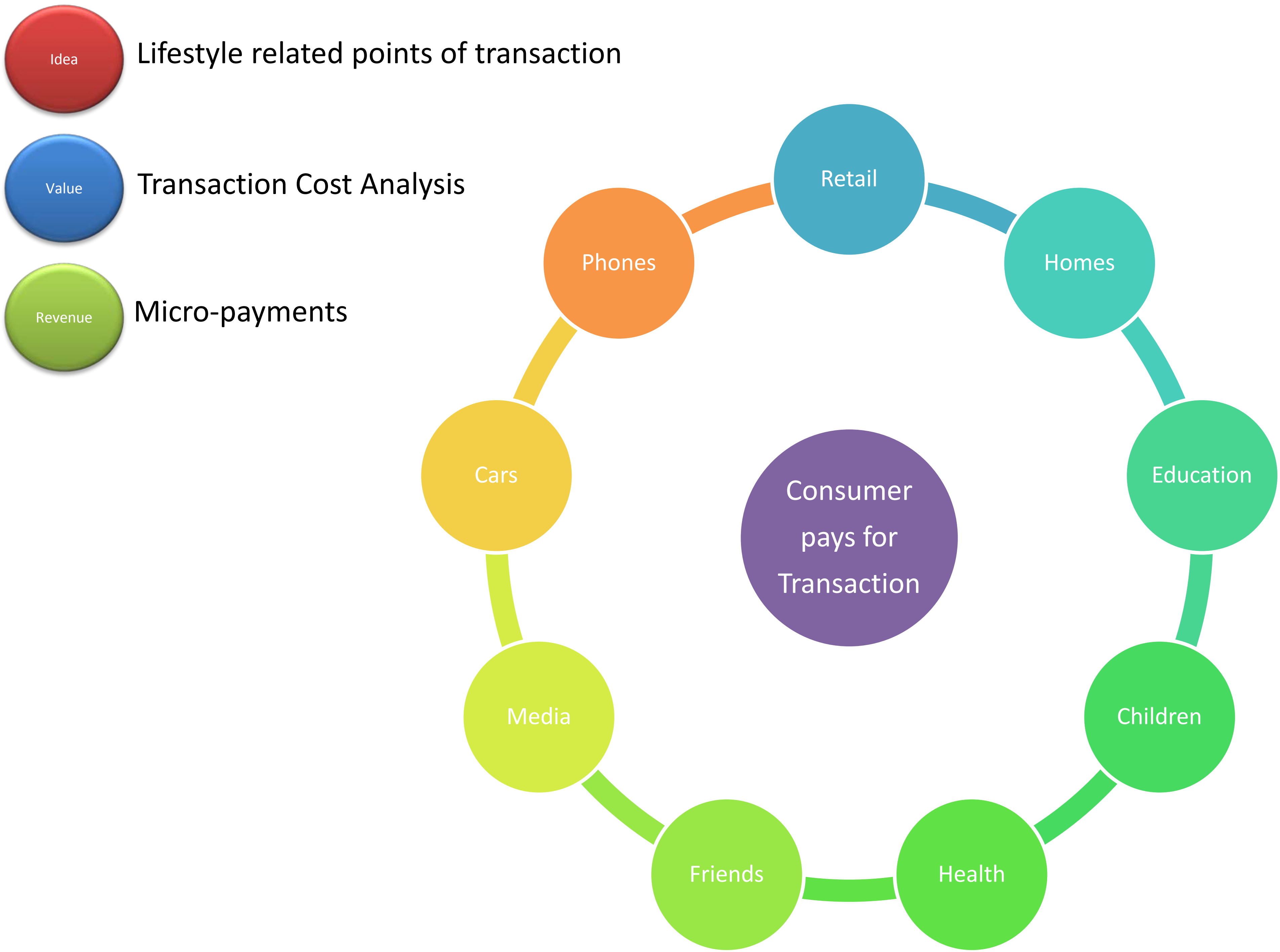
Dr Shoumen P Austin Datta ● Research Affiliate, School of Engineering, MIT ● SVP, Industrial Internet Consortium ● shoumen@mit.edu

Macro-economics of micro-revenue

[*Think different*](#) ● [*Re-think security*](#)

Alibaba and Forty Drones

Kathleen Fisher and DARPA HACMS


Idea
Lifestyle related points of transaction
Value
Transaction Cost Analysis
Revenue
Micro-payments
Retail
Homes
Education
Children
Health
Friends
Media
Cars
Phones
Consumer pays for Transaction

MONEY MAKING IDEAS

Connect (telematics software) with personal automobile id (IPv6) to bill distance data.

Internet of Systems ● Growth potential from pay per mile car insurance

Estimated number of personal automobiles in India and China 30 million

Estimated average distance 6000 miles or 180 billion car-miles per year

Charge (average) 2 cents per mile (age adjusted) for car insurance *

Revenue pa with 10% share **$360 million**

Pay Per Mile insurance reduces barrier to entry and improves economies of scale

* US average for low risk, low cost insurance for middle-age individuals approximates 5 cents per mile based on 12,000 miles per year.

MONEY MAKING IDEAS

Connect (domestic telematics SaaS) with WSN - IPv6 (self-organizing motion sensors ad hoc mesh)

IoS Growth potential from security - pay per hour home insurance

Estimated number of personal homes in India and China 250 million

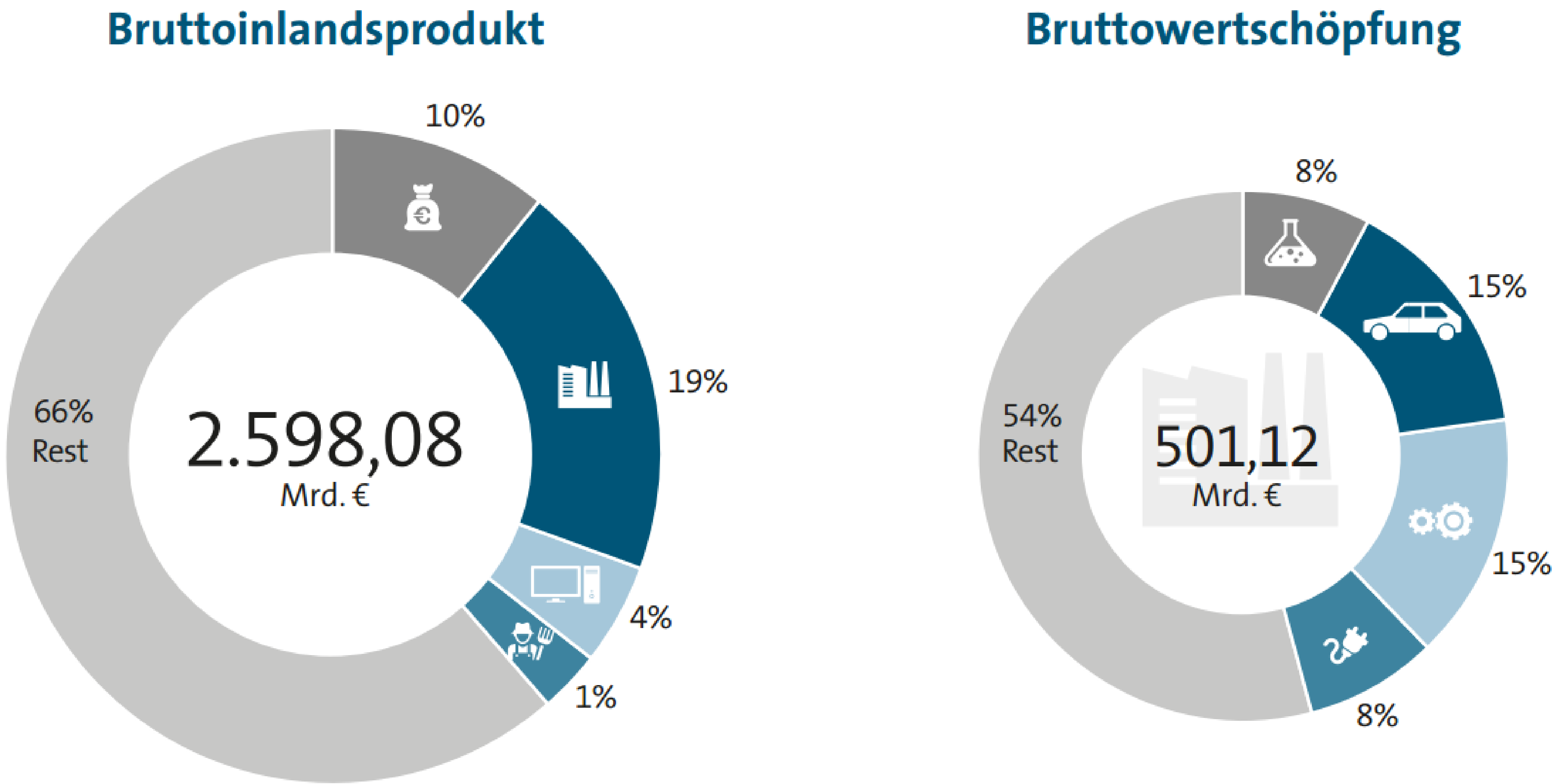
Estimated average 4 hours unoccupied or 365 billion home-hours pa

Charge (average) 1 cent per hour

Revenue pa with 10% share **$365 million**

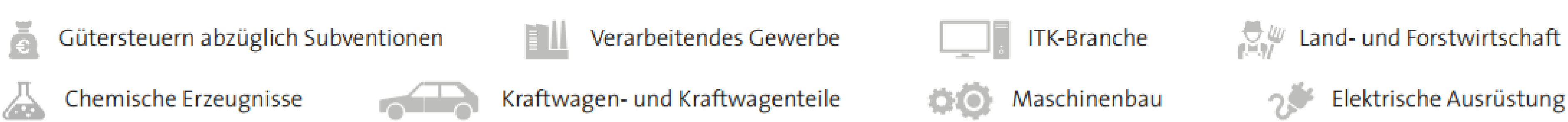
Pay Per Hour insurance reduces barrier to entry and improves penetration

Industrie 4.0 Projections about Products & Service Sector Growth due to the Industrial Internet



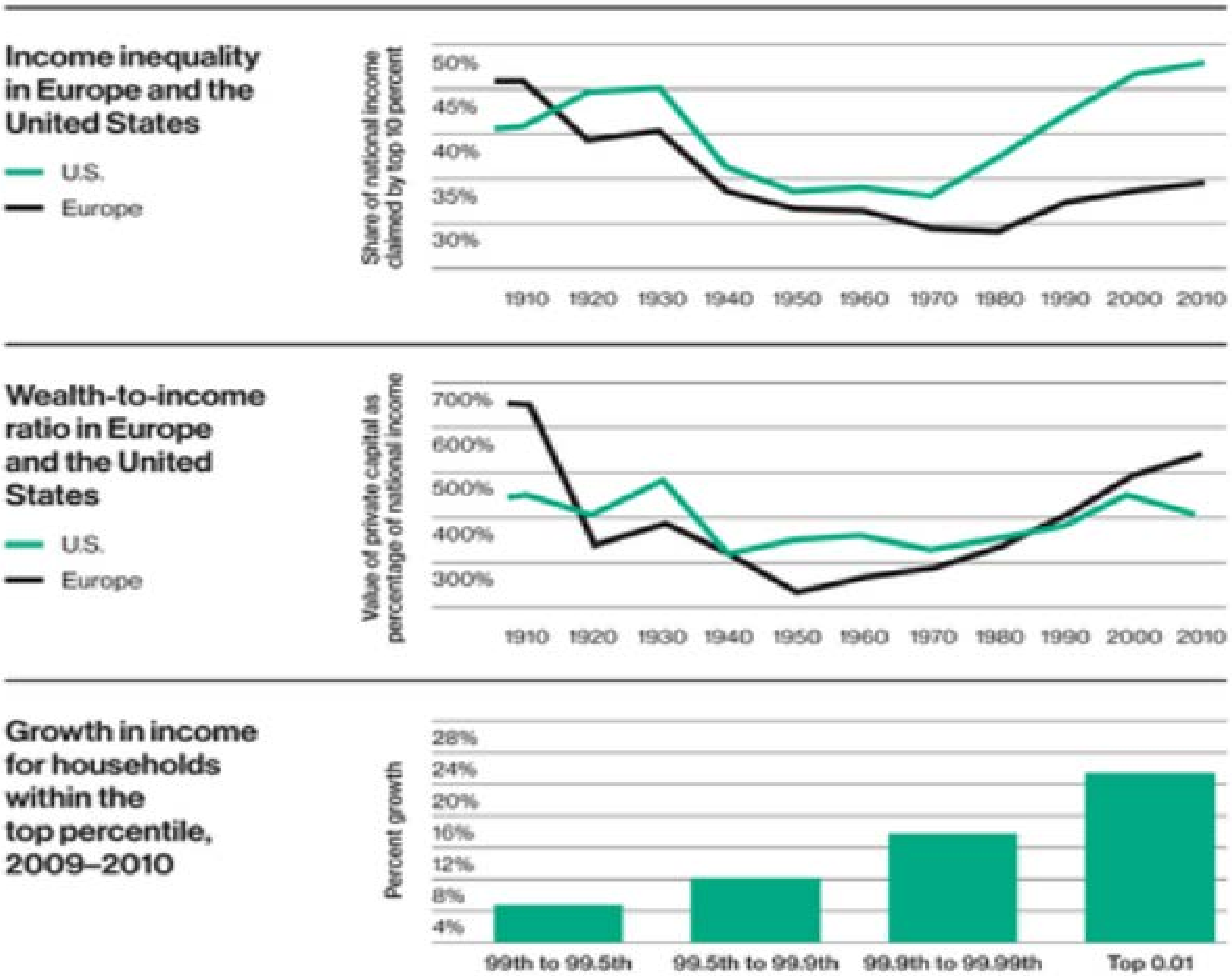
Bezugsjahr 2013*

BIP = Bruttowertschöpfung + Gütersteuern abzüglich Subventionen



http://www.bitkom.org/files/documents/Studie_Industrie_4.0.pdf

Paradox to Paradigms to Platforms to Populations



MIT Tech Review ▪ Nov 2014

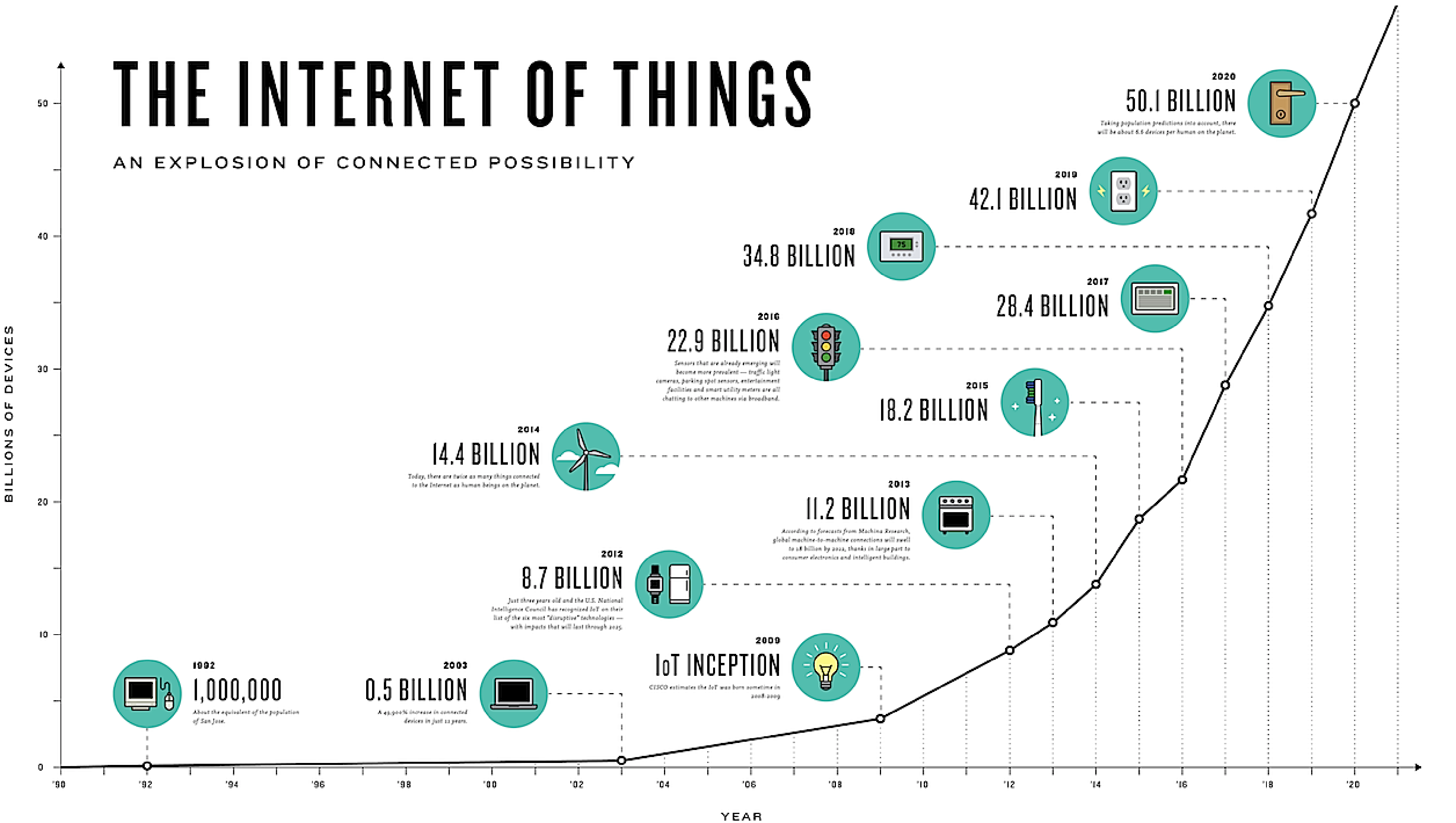
Average U.S. income
(in 2012 dollars)

1970	Top 10%	$137,223
	Bottom 90%	$33,135
1975	10%	$138,384
	90%	$31,759
1980	10%	$142,808
	90%	$32,413
1985	10%	$150,599
	90%	$32,120
1990	10%	$184,843
	90%	$32,345
1995	10%	$194,933
	90%	$31,768
2000	10%	$244,153
	90%	$35,799
2005	10%	$247,452
	90%	$33,688
2010	10%	$239,813
	90%	$30,840
2012	10%	$254,449
	90%	$30,439

Paradox to Paradigms to Platforms to Populations

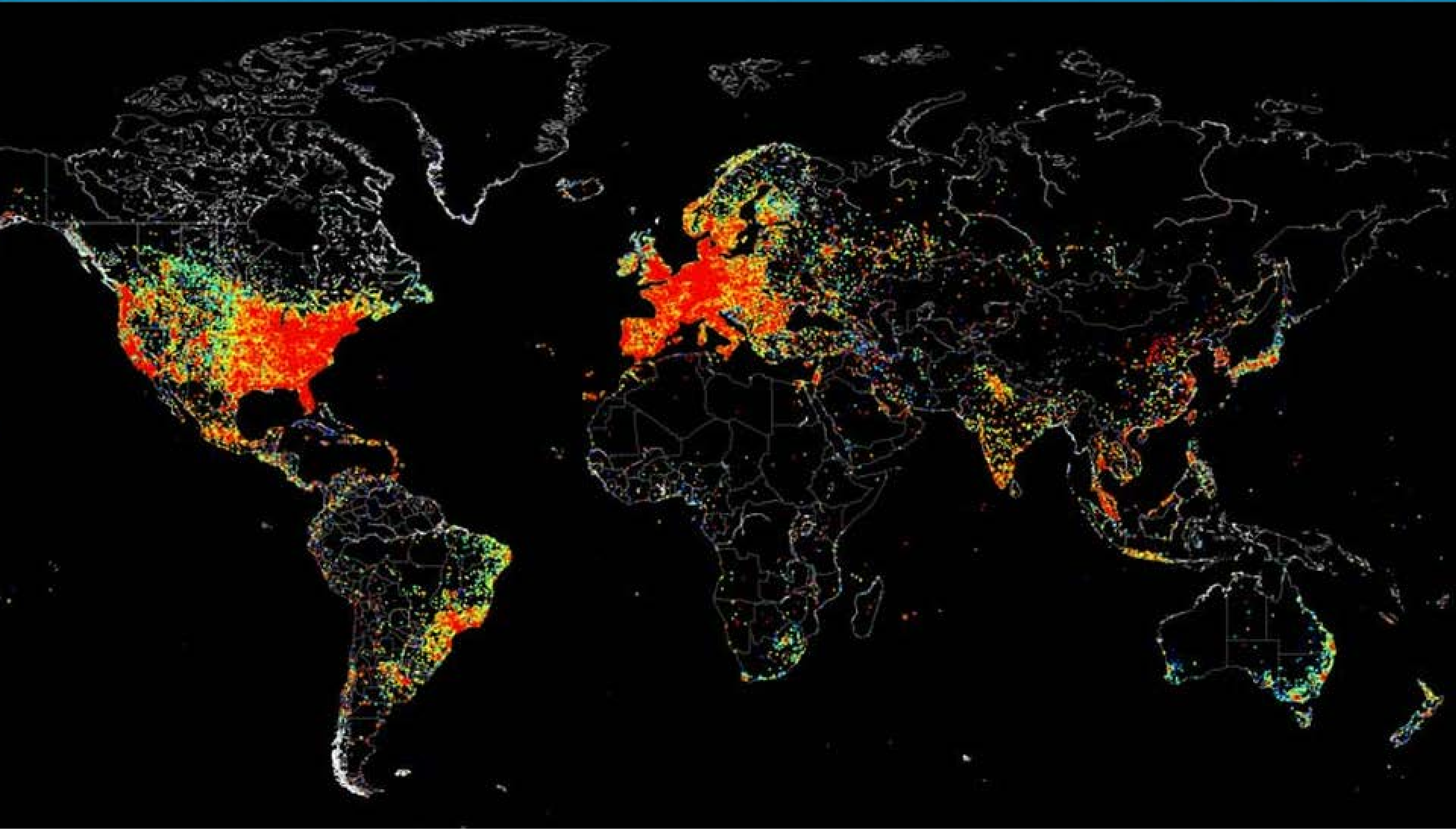
Chinese New Year
February 16, 2015

THE NETWORKED PHYSICAL WORLD



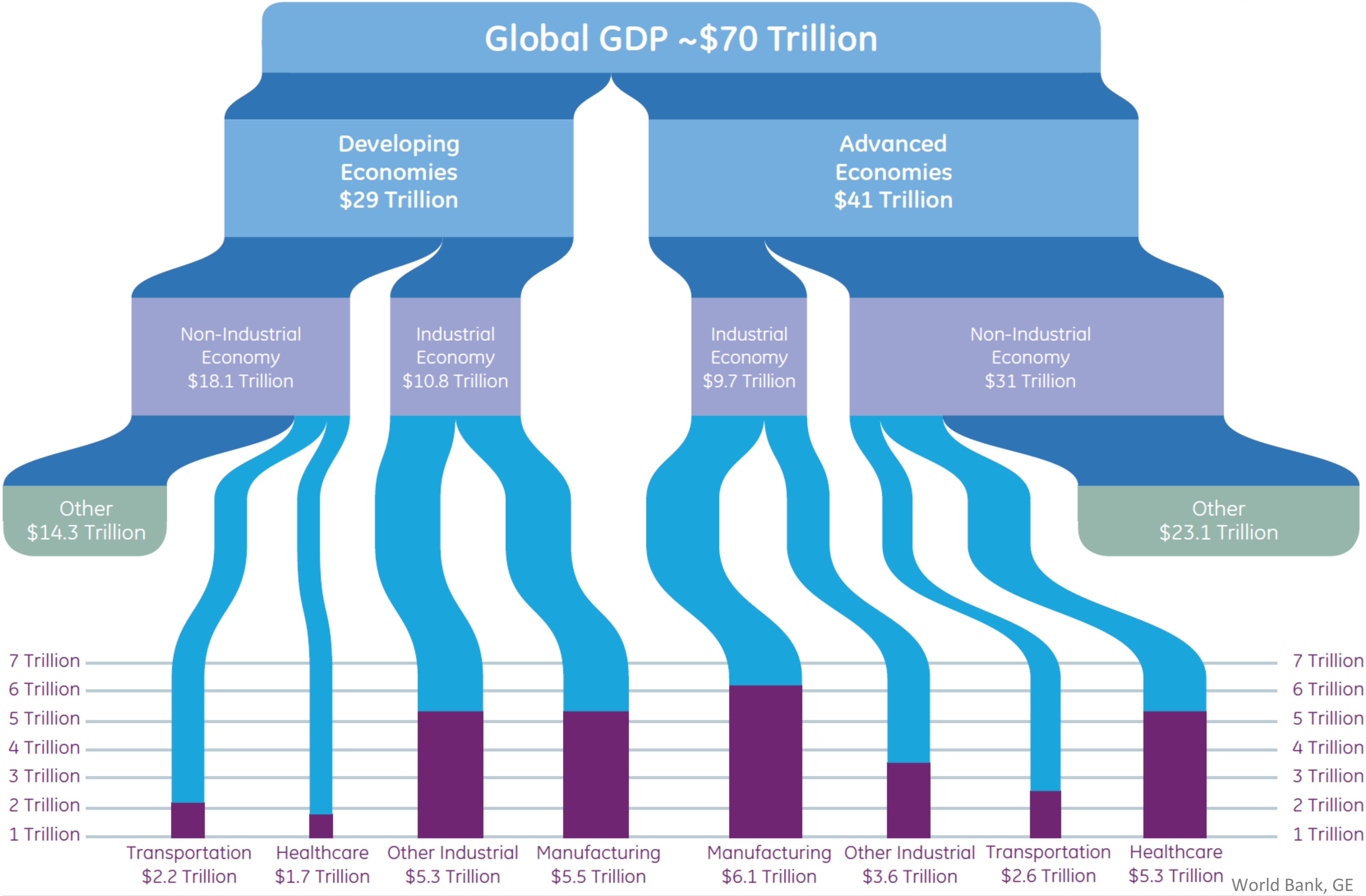
ECONOMIC GROWTH ENGINE - IoS

THE NETWORKED PHYSICAL WORLD



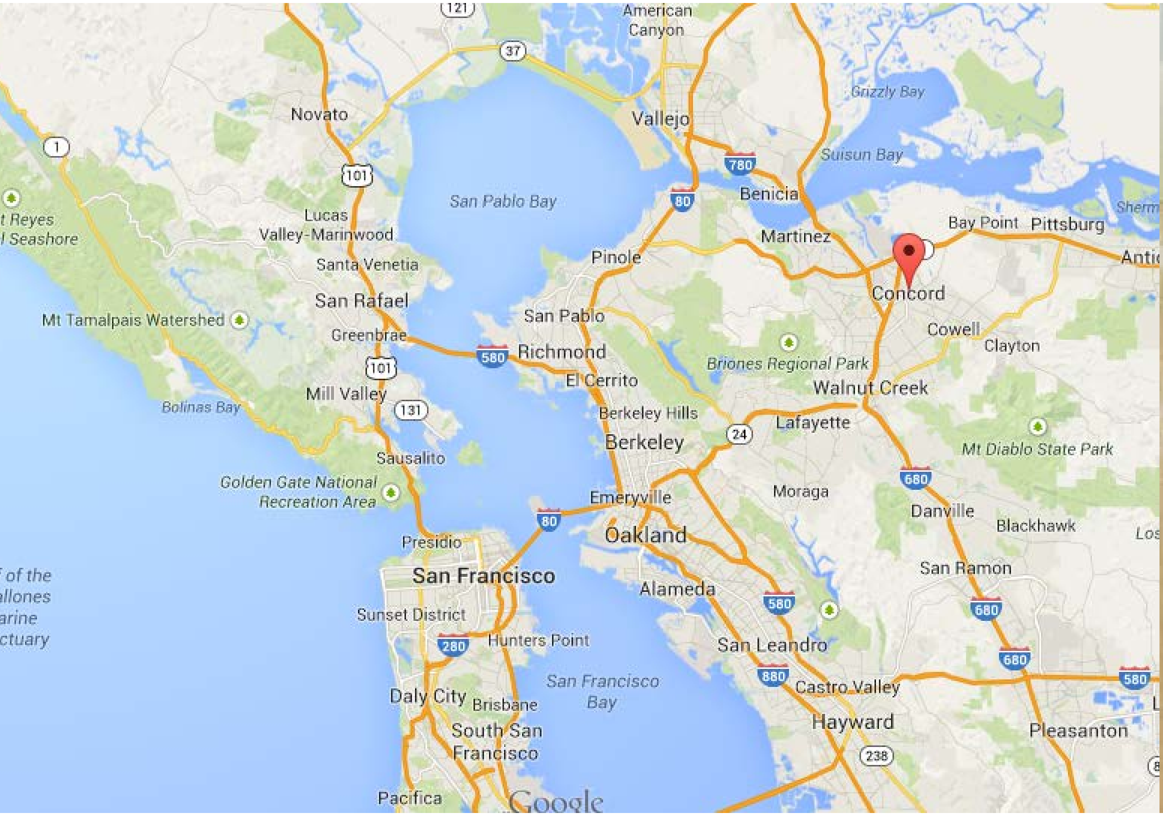
Map of every device connected to the internet on the evening of 2 August 2014 ([Shodan]). John Matherly pinged all IP addresses of devices online on 2 August (11pm UK). It took about 5 hours. Map represents all the devices (red = many) that pinged back in 12 hours using [matplotlib].

Projected Economic Impact of The Industrial Internet



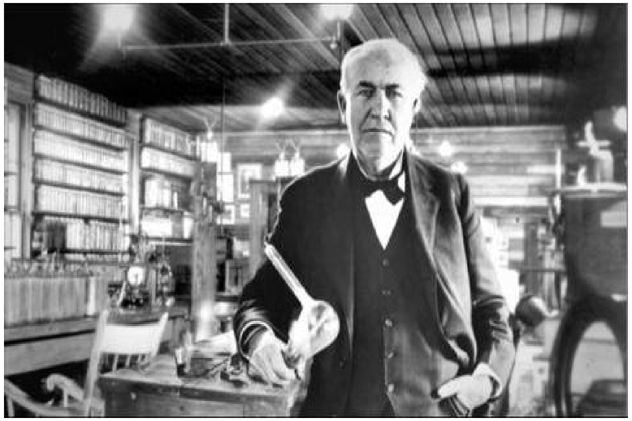
Industrial Internet opportunity ($32.3 Trillion) 46% share of global economy today

Diffusion of the Internet - NetDay 1996



President Bill Clinton installing computer cables with Vice President Al Gore on NetDay at Ygnacio Valley High School (Concord, CA - Mar 9, 1996)

Total energy under the curve



The concept of energy under the curve is directly analogous to an economy's money supply at a given time. Both the energy and the money supply are known amounts. The money is going to be spent by someone (device is going to output its energy). The key is for the money to be spent where it has the most benefit (the light bulb must produce visible light).

In engineering parlance, there is a phrase called 'energy under the curve.' This refers to the total energy output of a device—light bulb, acoustic transducer —as measured on a graph across a range of frequencies. While every effort is made to maximize the amount of energy output from that device, in the end it's still a finite amount. The key to best performance is getting the device to deliver energy that is ***usable***. A light bulb may produce x lumens of energy, but it won't do much good if its output is predominately at ultraviolet frequencies that are invisible to the human eye. An acoustic transducer (speaker) can be modified to produce more or less energy at different frequencies, but the total acoustic energy produced by that specific speaker is finite. The engineers can move the energy output from one frequency region to another, but the 'total energy under the curve' remains the same. The key to a speaker's useful performance, of course, is for it to produce its energy at frequencies that are audible and useful to humans, not bats.

www.americanthinker.com/2004/09/the_light_bulb_economy.html

Re-engineer Transaction Cost

TRANSACTION COST THEORY

Ronald Coase (1937) posed two Nobel-prize puzzles :

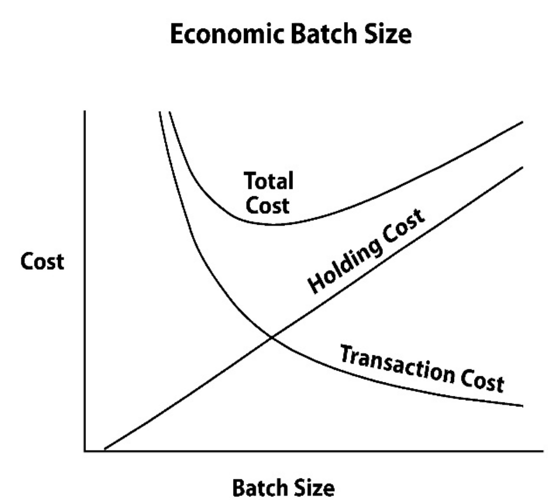
- Why do <u>any</u> firms emerge in a market economy?
- Why not just One Big Firm for whole economy?

Neoclassical economics treats the firm as a production function that efficiently transforms land, labor & capital inputs into goods & services. Competitive markets coordinate buyer-seller exchanges via price signals.

Coase argued that market mechanism not cost-free, but involves transaction costs: time & money to search for sellers & buyers, negotiate exchange terms, write contracts, inspect results, enforce deals

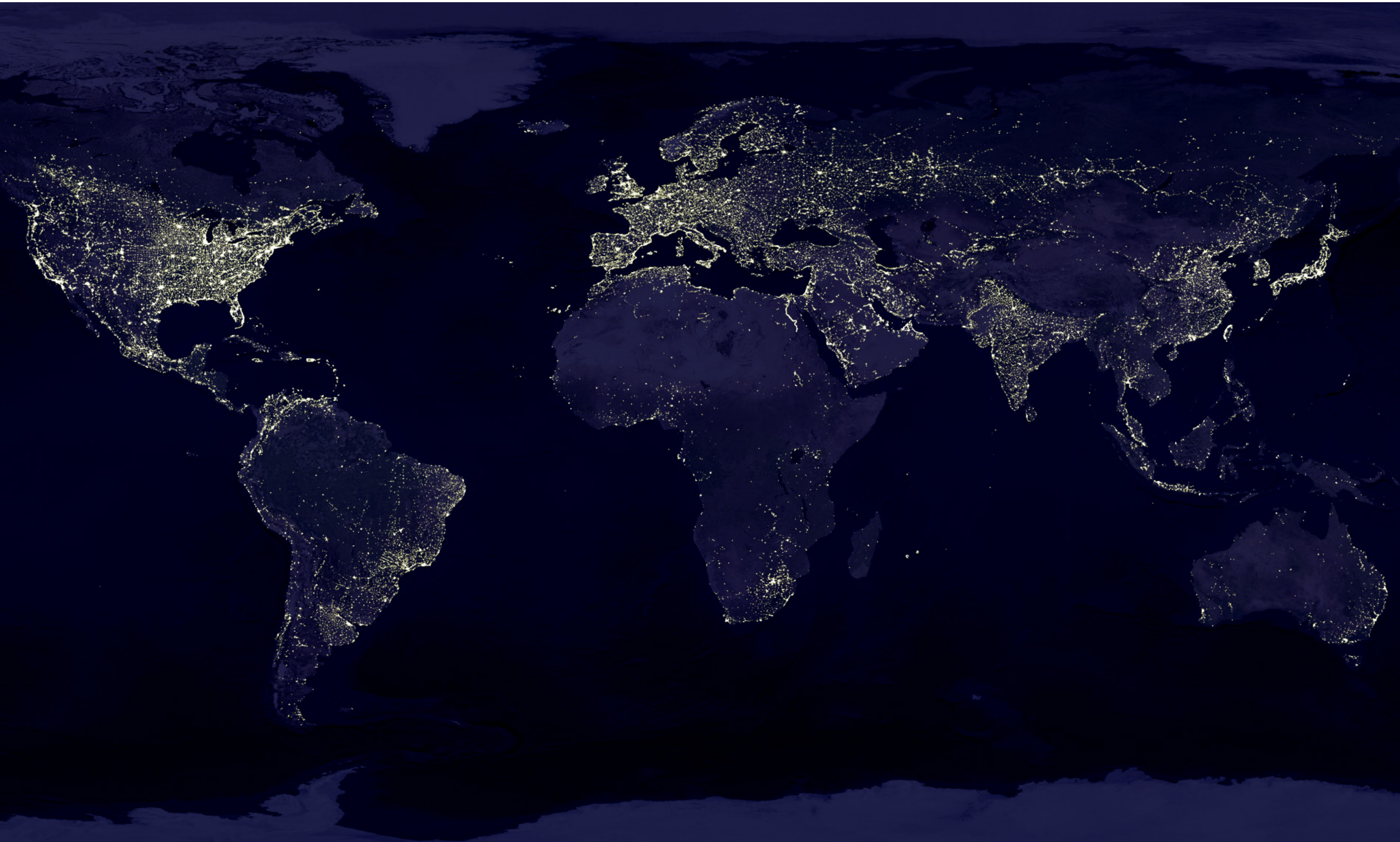
> Firms will emerge if an "economizing" organization can reduce its production + transaction costs < market prices
>
> Firm expansion halts when intra-org'l TC > market prices

Transaction Cost Economics

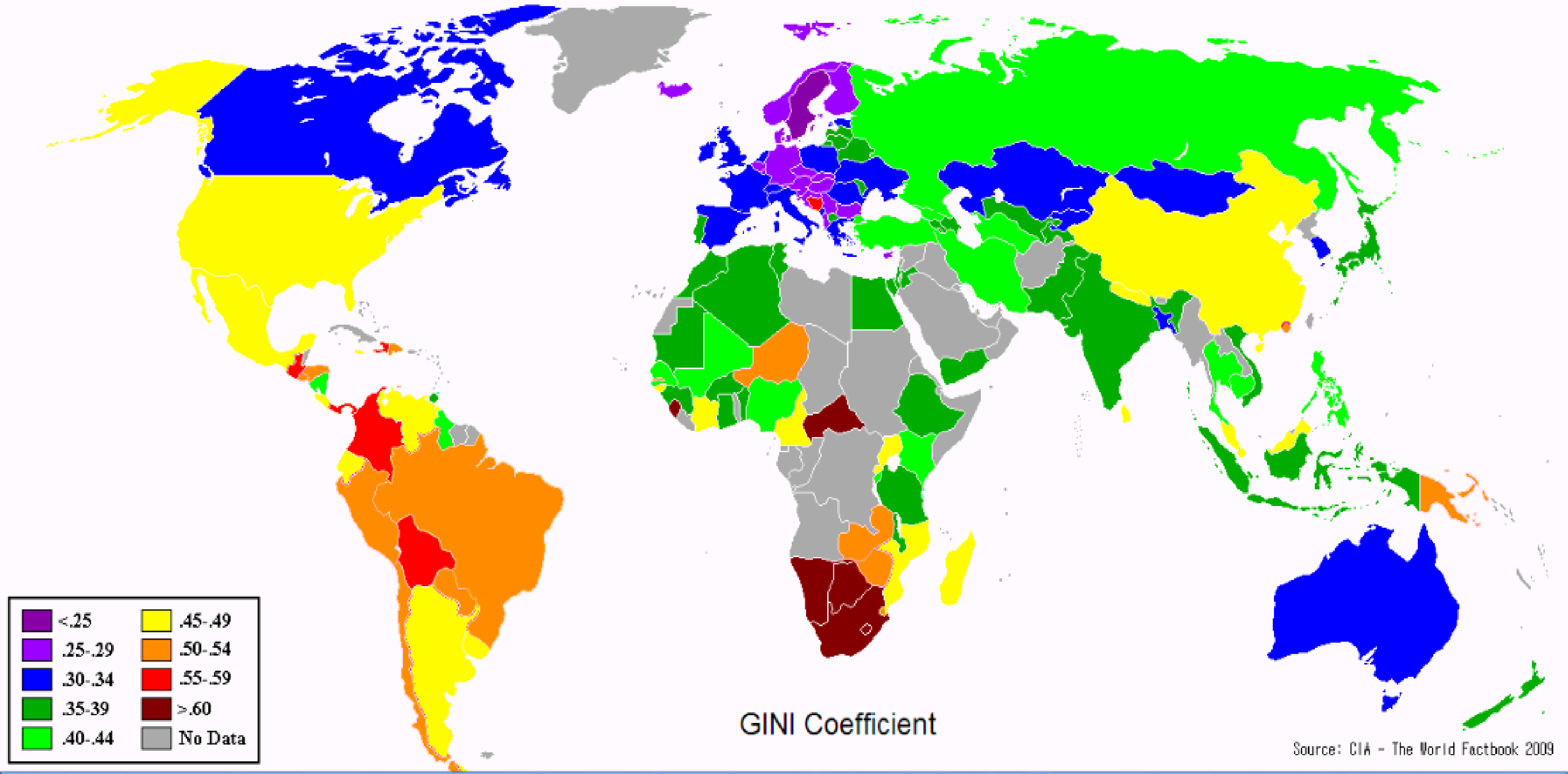


From "The Principles of Product Development Flow," by Donald G. Reinertsen. Celeritas Publishing: 2009. Copyright 2009, Donald G. Reinertsen

Re-engineer Resource Utilization

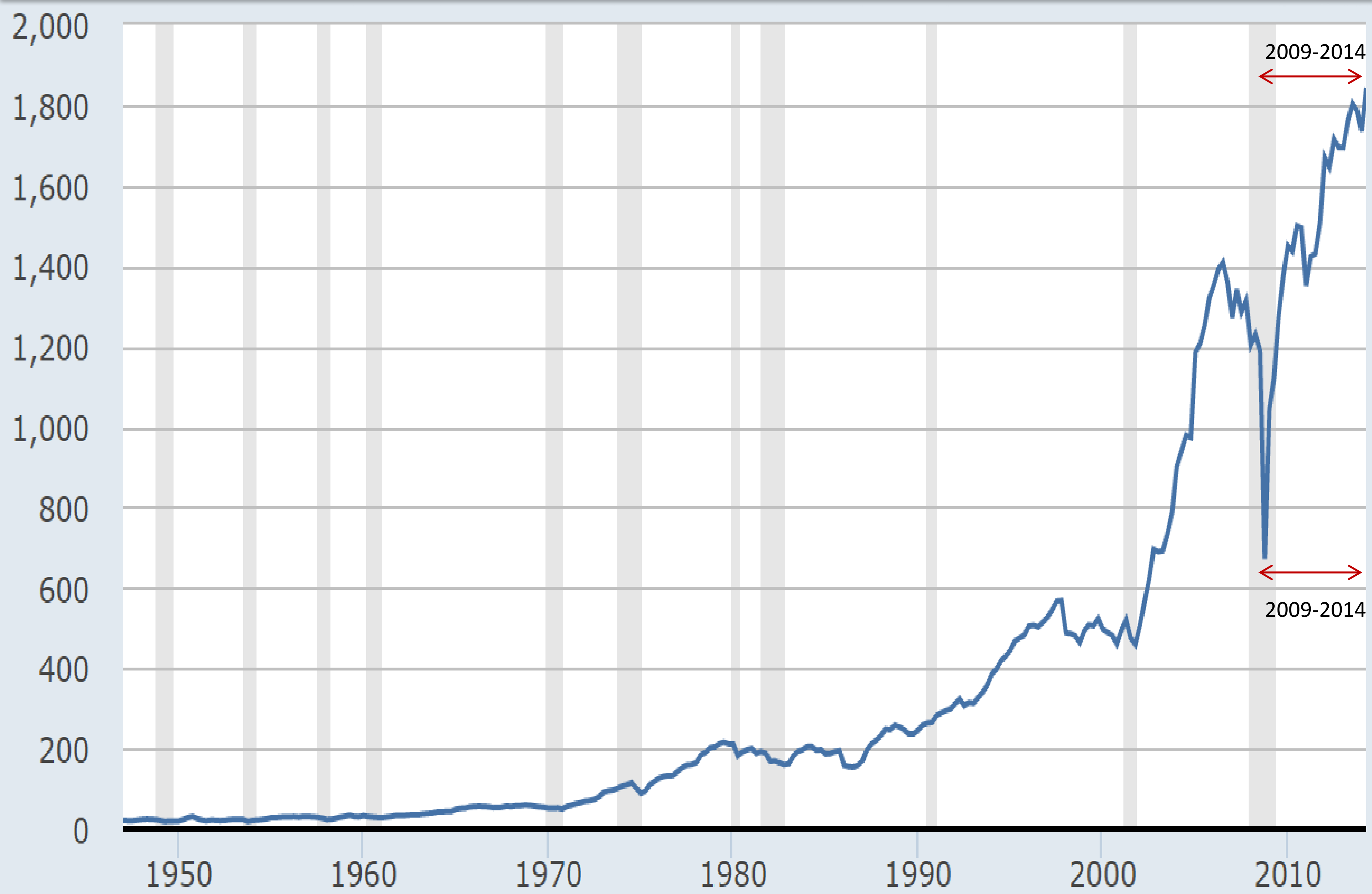


Re-engineer GINI Coefficient



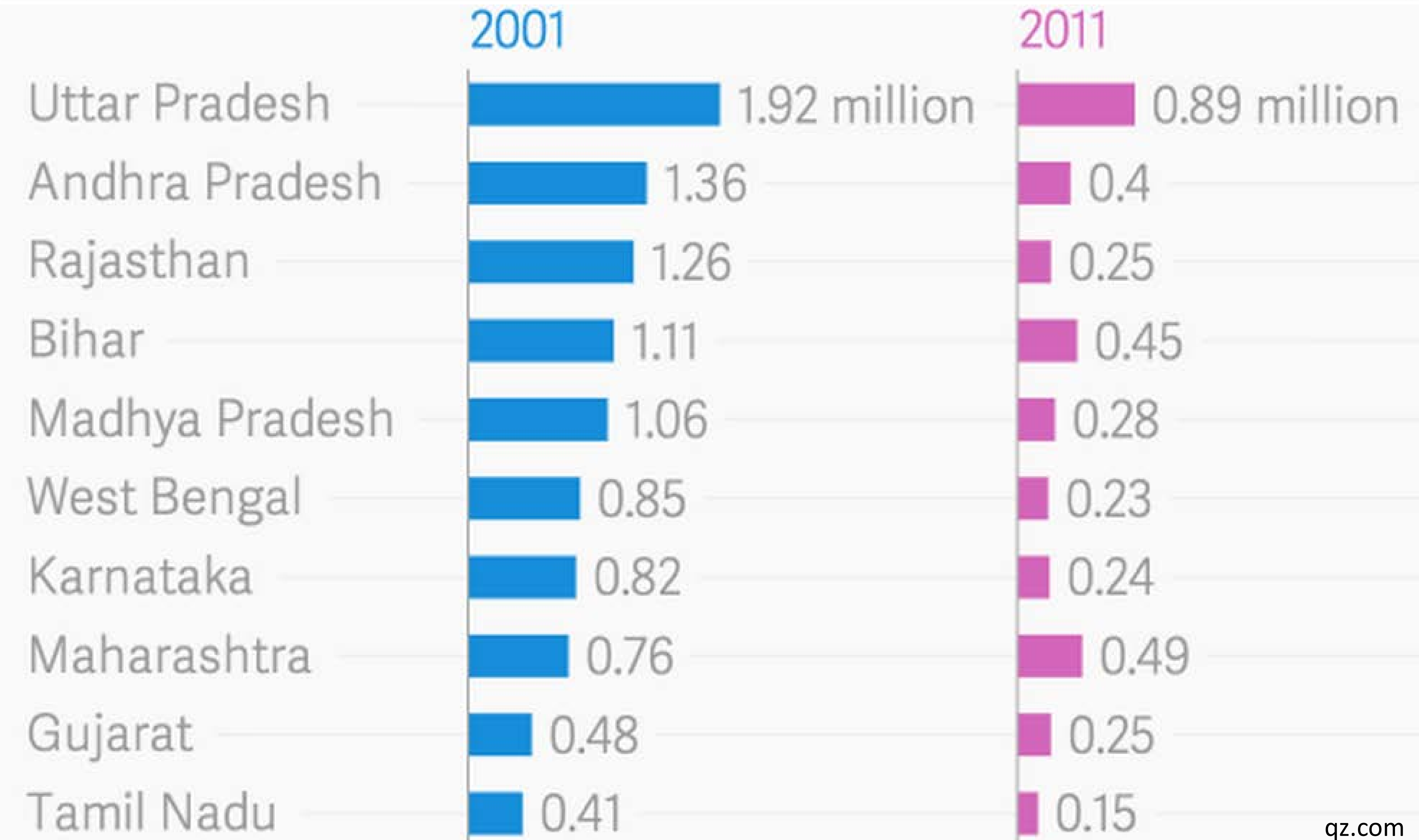
Gini coefficient measures the inequality among values of a frequency distribution (for example levels of income). Coefficient = zero expresses perfect equality (everyone has an exactly equal income). Coefficient = 1 expresses maximal inequality (where only 1 person has all the income).

US Corporate Profits after Tax ($B) · Greatest increase in a 5 year period 2009-2014



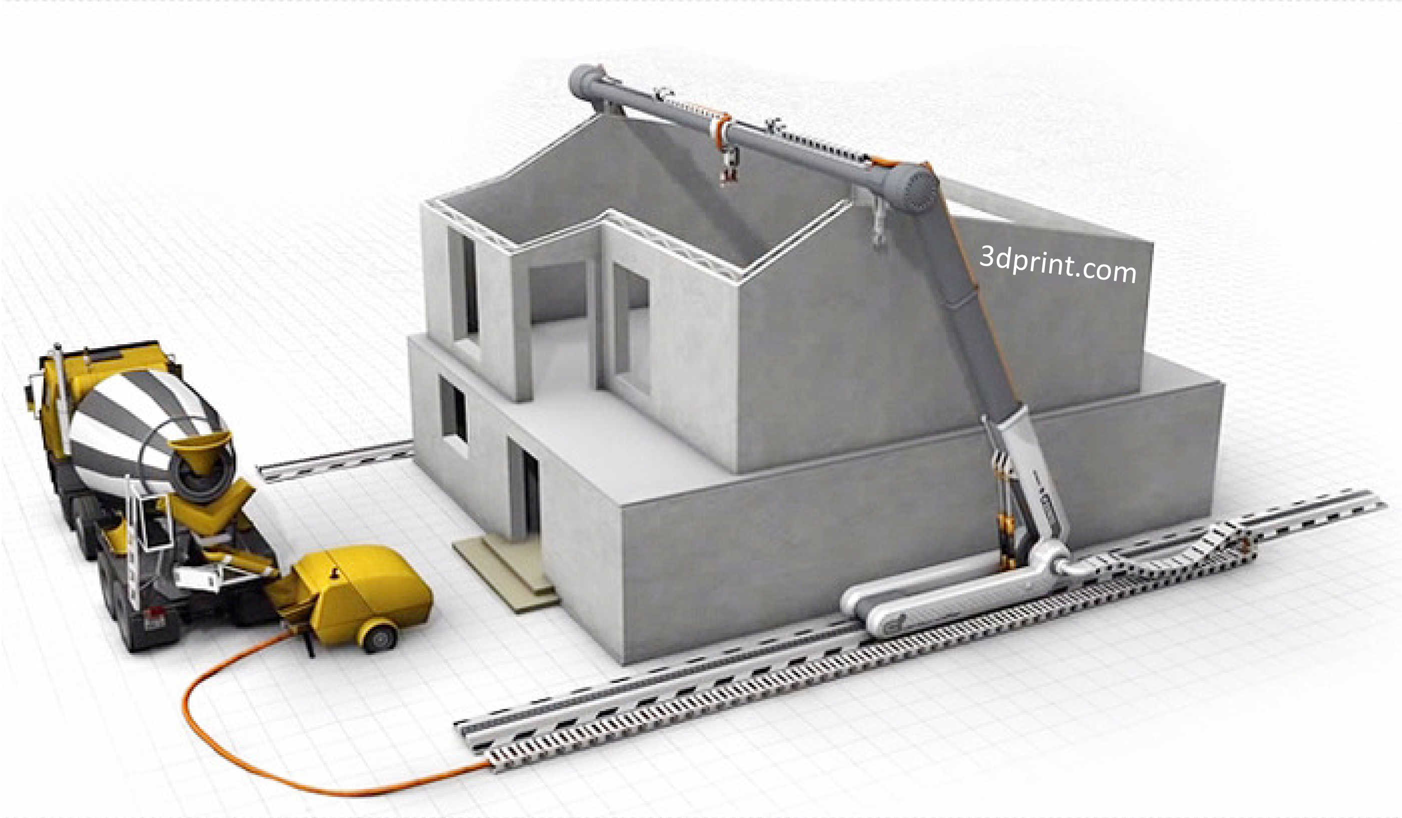
http://research.stlouisfed.org/fred2/series/CP/

Child Laborers in India



qz.com

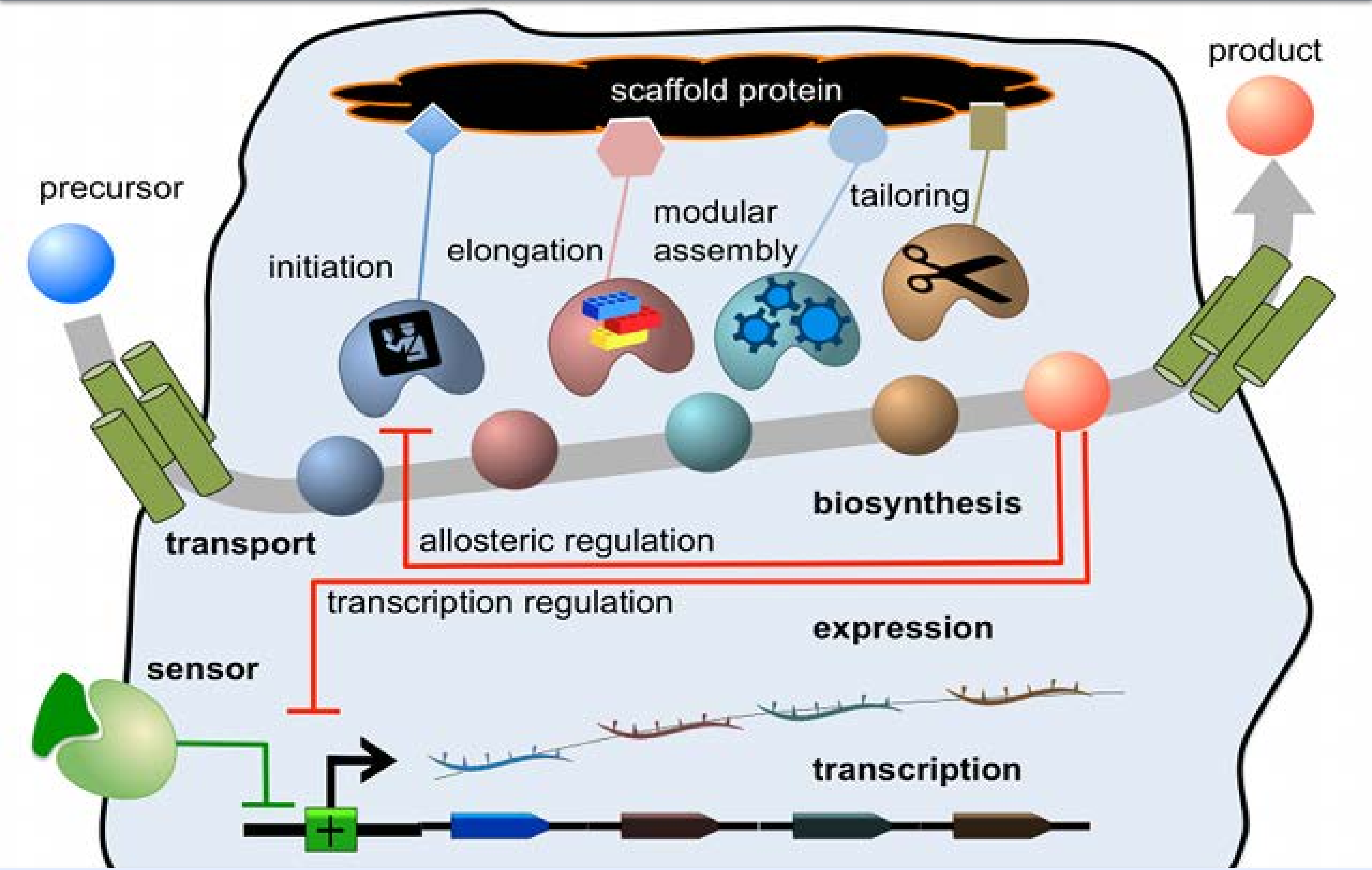
[Disrupt]()



Deploy

Manufacturing ● Can Robots Build Robots? Self-organize / Self-Assembly (SOSA) Factories?

Manufacturing ● Self-organize / Self-Assembly Factories ● Bio-inspired? Bio-mimicry?



Background - www.mhhe.com/biosci/genbio/raven6b/graphics/raven06b/howscientiststhink/17-lab.pdf
Allosteric Control - www.pasteur.fr/ip/resource/filecenter/document/01s-00004j-0eq/monod-changeux-jacob-1963.pdf

- Challenge ☑ migration path from PNGV to SDV
  ☑ **Autonomous Transportation (SDV)**

http://bit.ly/YESTERDAY-NEVER-DIES

http://bit.ly/TOMORROW-NEVER-DIES

SDV = Consumer Electronics = Automobile Manufacturers in Silicon Valley

FT

Industrial Internet Consortium founding member INTEL leading an array of partnerships in automotive IoS

- **BMW**: Intel technology is used in BMW's Navigation System Professional, part of BMW ConnectedDrive, to provide the processing performance needed to deliver a compelling experience to the driver and passengers, including a rich display screen interface and quicker response times when interacting with the applications.
- **Hyundai Motor Company**: The Driver Information System in the all-new 2015 Hyundai Genesis powered by Intel technology offers Best In Class in-vehicle high definition screen and improved response times whens interacting with the system.
- **Infiniti**: Infiniti selected Intel technology to power the company's Infiniti InTouch in-vehicle infotainment system to deliver a rich experience to the driver and passengers, such as high-end graphics on the touch-screen displays.
- **Kia Motors Corp**: Kia Motors Corporation's K9 luxury sedan will be powered by the Intel® Atom™ processor to feature dual-independent displays so that drivers and passengers can enjoy desired content anywhere in the car.
- **Ford**: Mobile Interior Imaging explores how interior-facing cameras could be integrated with sensor technology and data already generated within and around the vehicle to create a more personalized and seamless interaction between driver and vehicle.
- **Jaguar Land Rover**: Jaguar Land Rover will enhance its research and product development on future vehicle infotainment technologies through a new collaboration with Intel to explore and develop next-generation digital vehicle prototypes with in-vehicle experiences that connect car, device and cloud.
- **Toyota**: Intel and Toyota will focus research on developing a user interaction methodology including touch, gesture and voice technologies as well as information management for the driver.

http://static.squarespace.com/static/53864718e4b07a1635424cdd/t/544941efe4b04f35b9279aae/1414087166747/ADA%20-%20IoT%20Automotive.pdf

The average American automobile includes around 60 sensors covering aspects from driving to braking to climate control systems. For example, there are two types of speed sensors on some vehicles. One is a VSS (vehicle speed sensor), which provides input to the PCM (powertrain control module) for speedometer, transmission, cruise control, EGR (exhaust gas recirculation) strategy, etc.
The other is WSS (wheel speed sensor) and these inputs are used solely for the EBCM (electronic brake control module) for operation of the ABS (anti-lock brake system). Most if not all of a car's driving systems are accessible from its on-board diagnostics II (OBD II) port.

Here are just a few other well-known systems that have the potential for connecting via IoT:

- Road Condition Sensor
- Magnetic Sensor
- Vehicle Distance Sensor
- Forward Obstacle Sensor
- Blind Spot Monitoring Camera
- Drive Recorder
- Side Obstacle Sensor
- Air Pressure Sensor
- Airbag
- Road-To-Vehicle/Vehicle-to-Vehicle Communication System
- Rear View Camera
- Water Repelling Wind Shield
- Seatbelt Pretensioner
- Driver Monitoring Sensor
- Headup Display
- Steering Angle Sensor
- Electronic Control Throttle
- Electronic Control Brake
- Fire Detector Sensor
- Vehicle Speed, Acceleration Sensor
- Collision Detection Sensor
- Pedestrian Collision Injury Reduction Structure
- Electronic Control Steering
- Message Display System
- Hands-Free System
- Inside Door Lock/Unlock
- Rear Obstacle Sensor
- GPS Sensor

Software Defined Vehicles ● Connected Vehicle IoS Ecosystem

Autonomous driving functions will re-shape the economies of each of these silos and services. The extent and magnitude of the **AI roadmap** of the future will include a very broad spectrum.

Tech Mahindra

Internet of Systems Data - What is it good for?

Pervasive and Ubiquitous

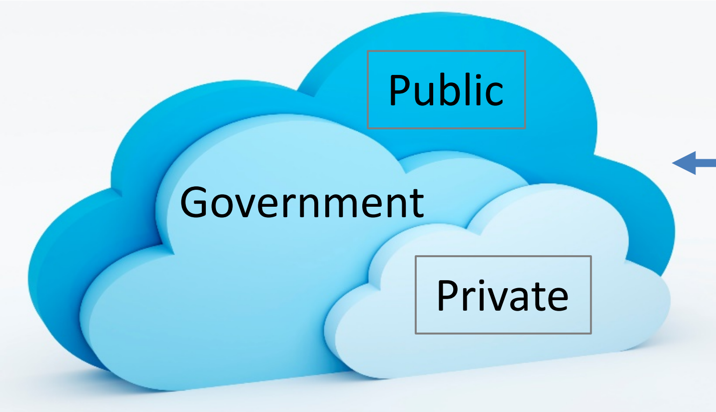
Ambient Intelligence

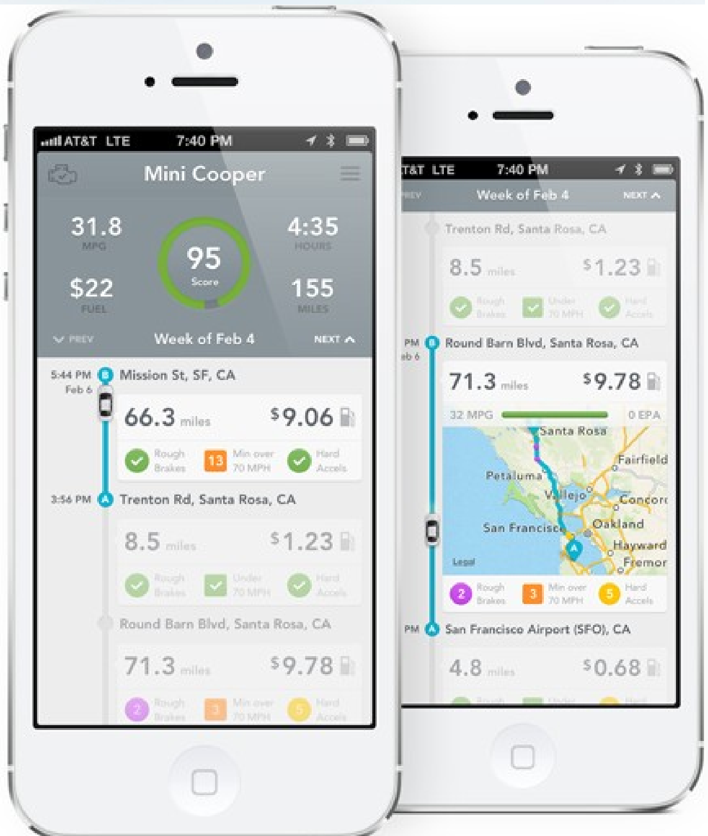
Autonomy

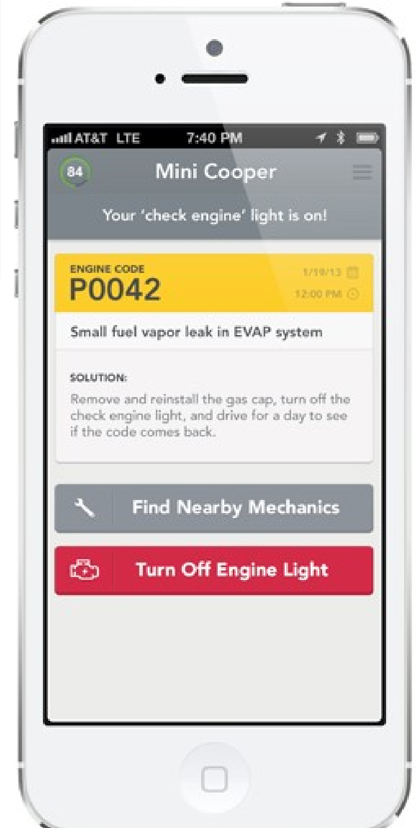
IoS, DaaS, IaaS, PaaS, SaaS, KaaS - Connected Car Composable Computing

http://bit.ly/Connected-Car-AUSTIN

http://bit.ly/Connected-Car-Sequel



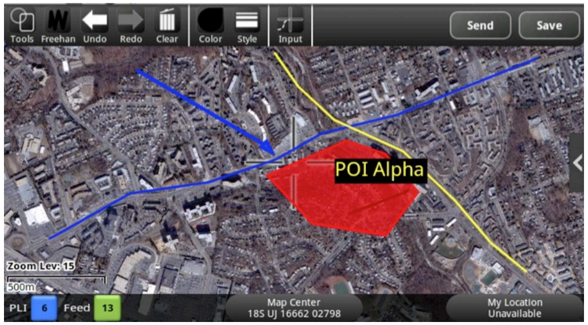




D = Data ▪ I = Infrastructure ▪ P = Platform ▪ S = Software ▪ K = Knowledge

Android Mobile Middleware Objects

Situational Awareness

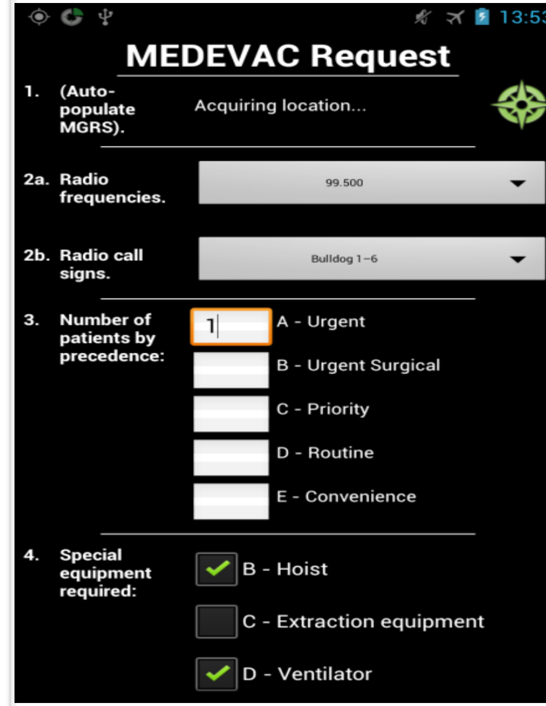


- Monitor/Track
- Mark spots on map
- Share maps with peers

Tactical Chat

- Send text messages
- Pictures, videos, audio
- Location tagged

Medevac Reports



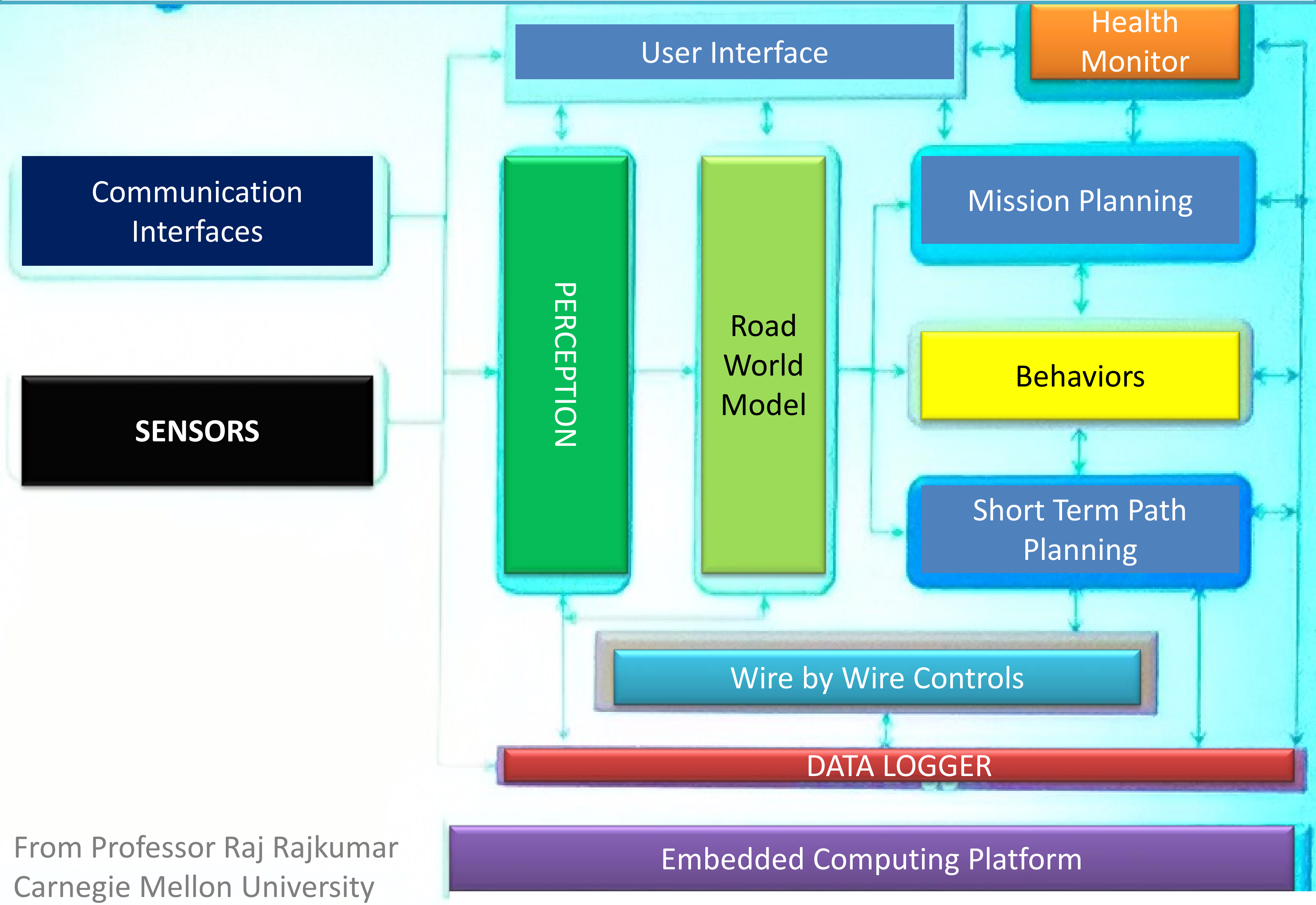
- Injury and location
- Real-time
- Reliable delivery

DARPA Transformative Apps – AMMO provides data persistence and communication-networking backbone (Dr Sandeep Neema, Institute for Software Integrated Systems, Vanderbilt University)

Monitor and Predict Physiological Status of Humans in Vehicles Transport Connects to Healthcare through Smart City Platform

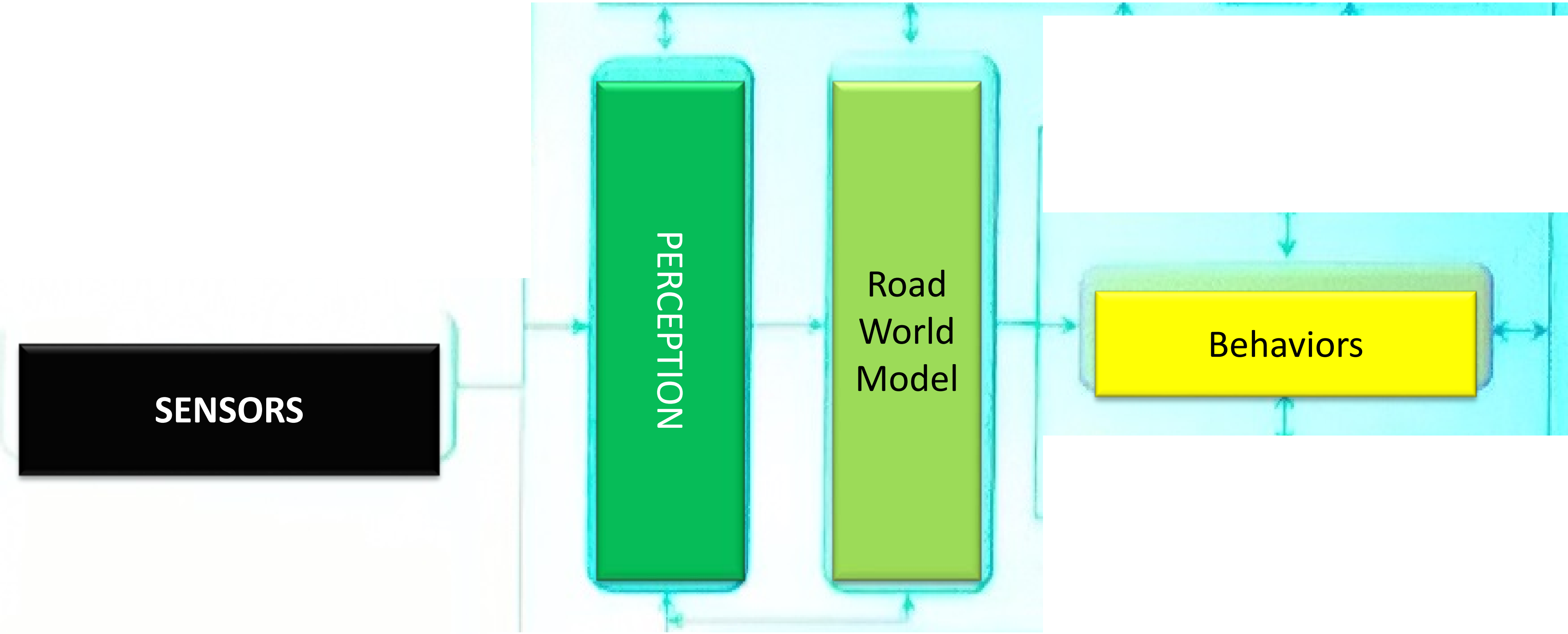
Plessey has been working on a heart-rate monitor that would be built into car seats

LOGICAL ARCHITECTURE FOR AUTONOMY by Professor Raj Rajkumar, Carnegie Mellon University



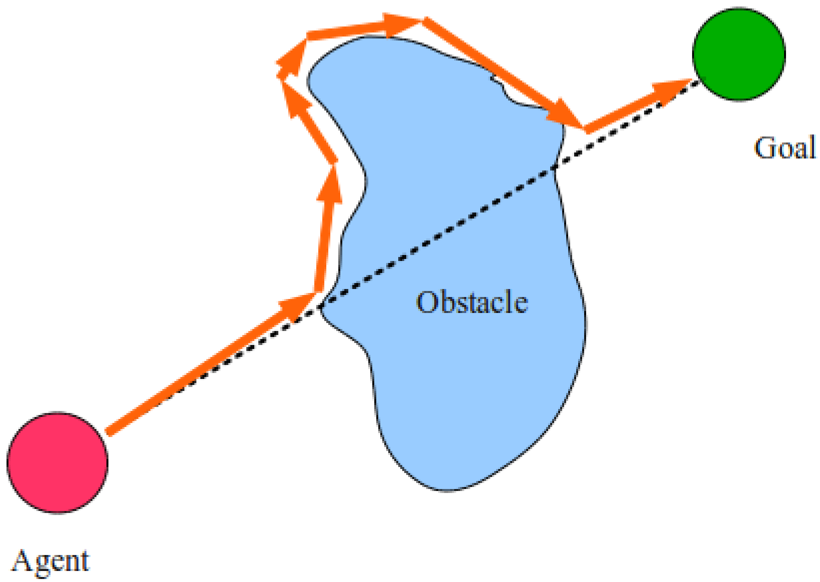
From Professor Raj Rajkumar
Carnegie Mellon University

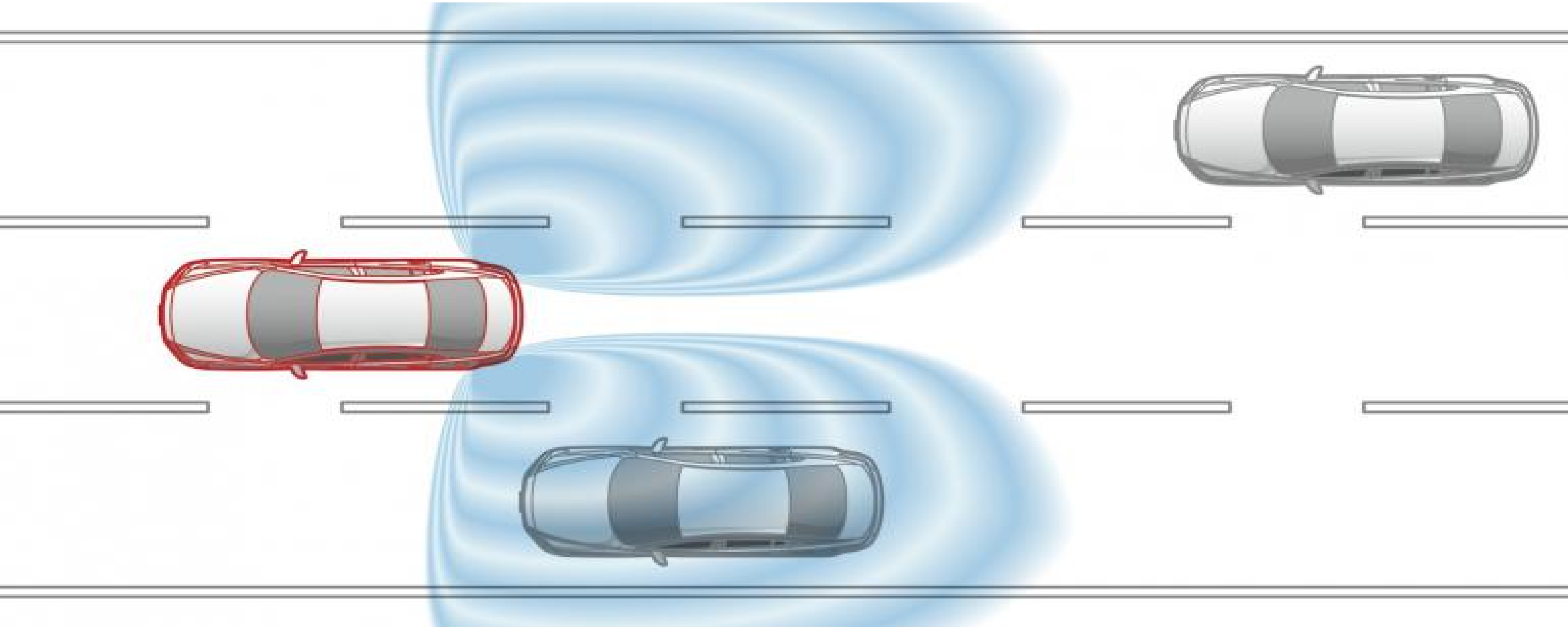
Data analysis problems and algorithmic issues for autonomous driving functions



From Professor Raj Rajkumar
Carnegie Mellon University

Ford's Intelligent Speed Limiter reads traffic signs, adjusts vehicle speed to comply with speed limits. Just launched in Europe, it's under consideration for Asian and North America.


Goal
Obstacle
Agent



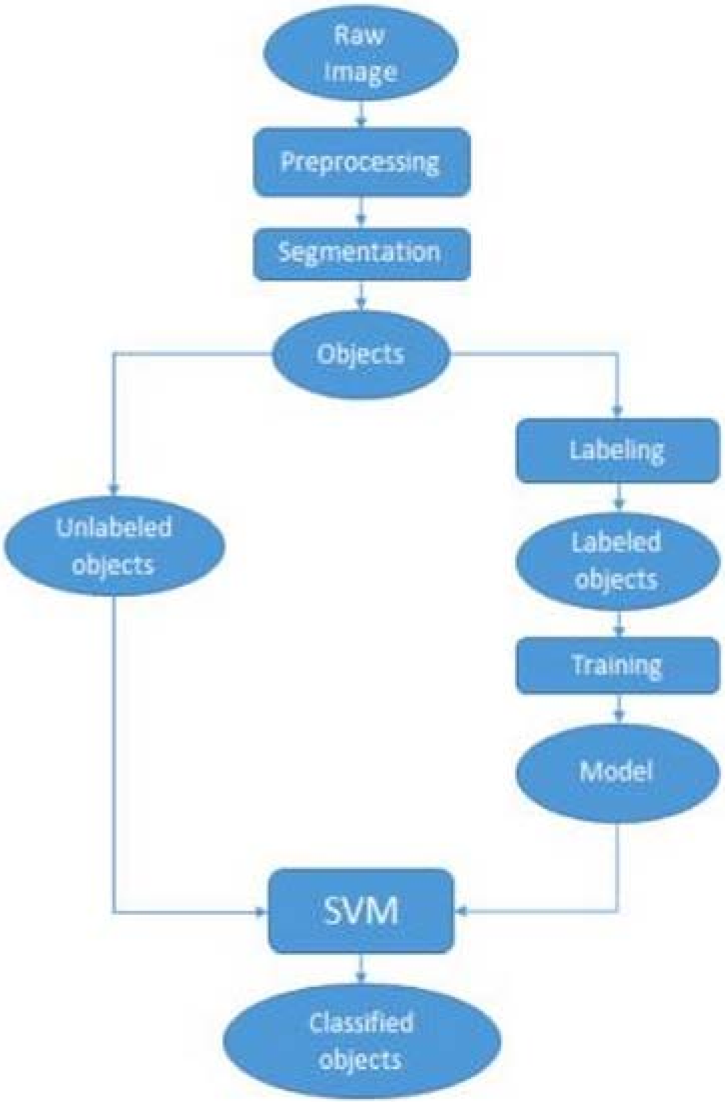
How does an autonomous vehicle understand the difference between an object without threat in a run time collision avoidance context?

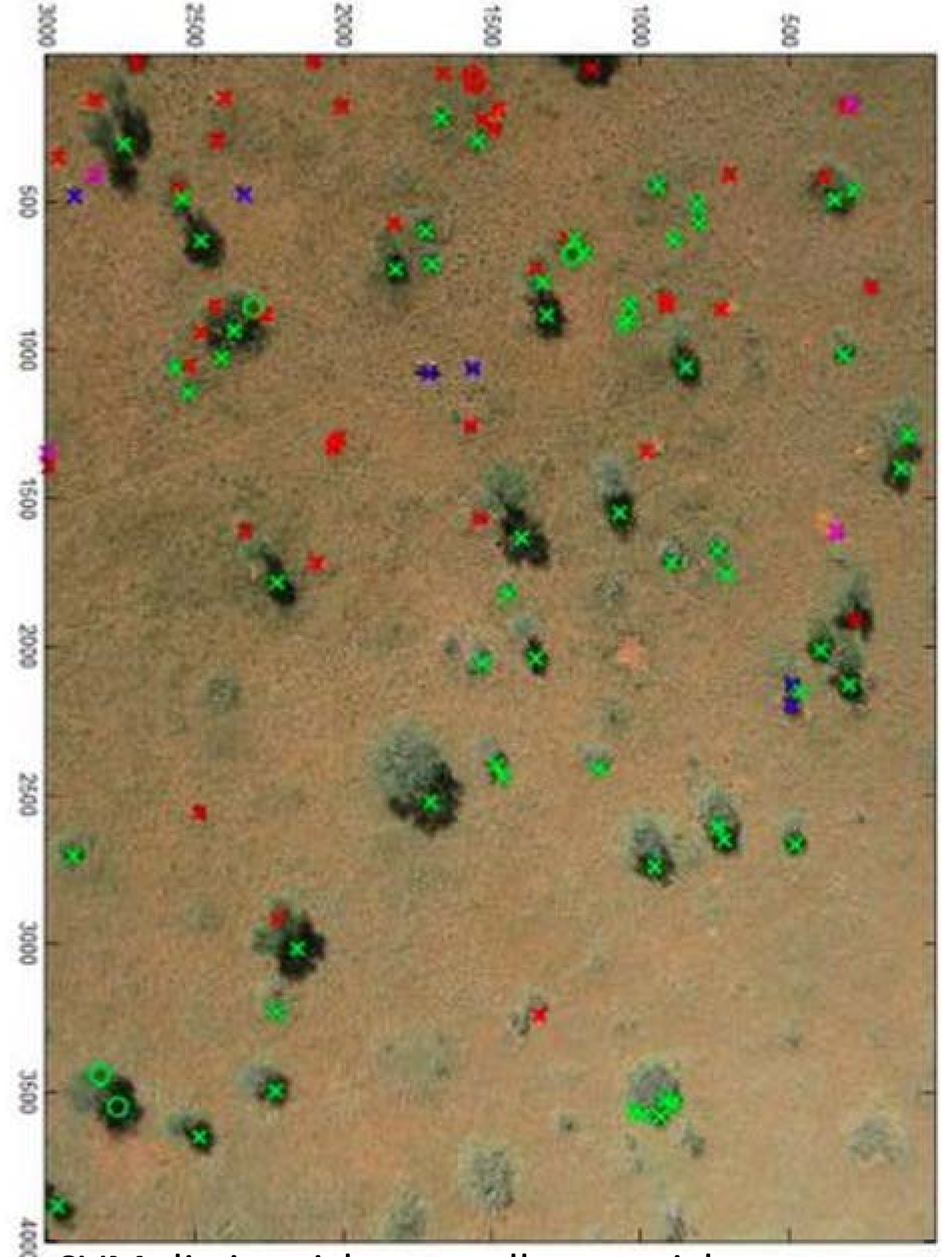
Without algorithmic solutions, even a harmless plastic bag in the air may cause an accident.

Oh I see a plastic bag

What is the "brain" of the autonomous vehicle thinking?

Connected Vehicle Tools Support Vector Machine



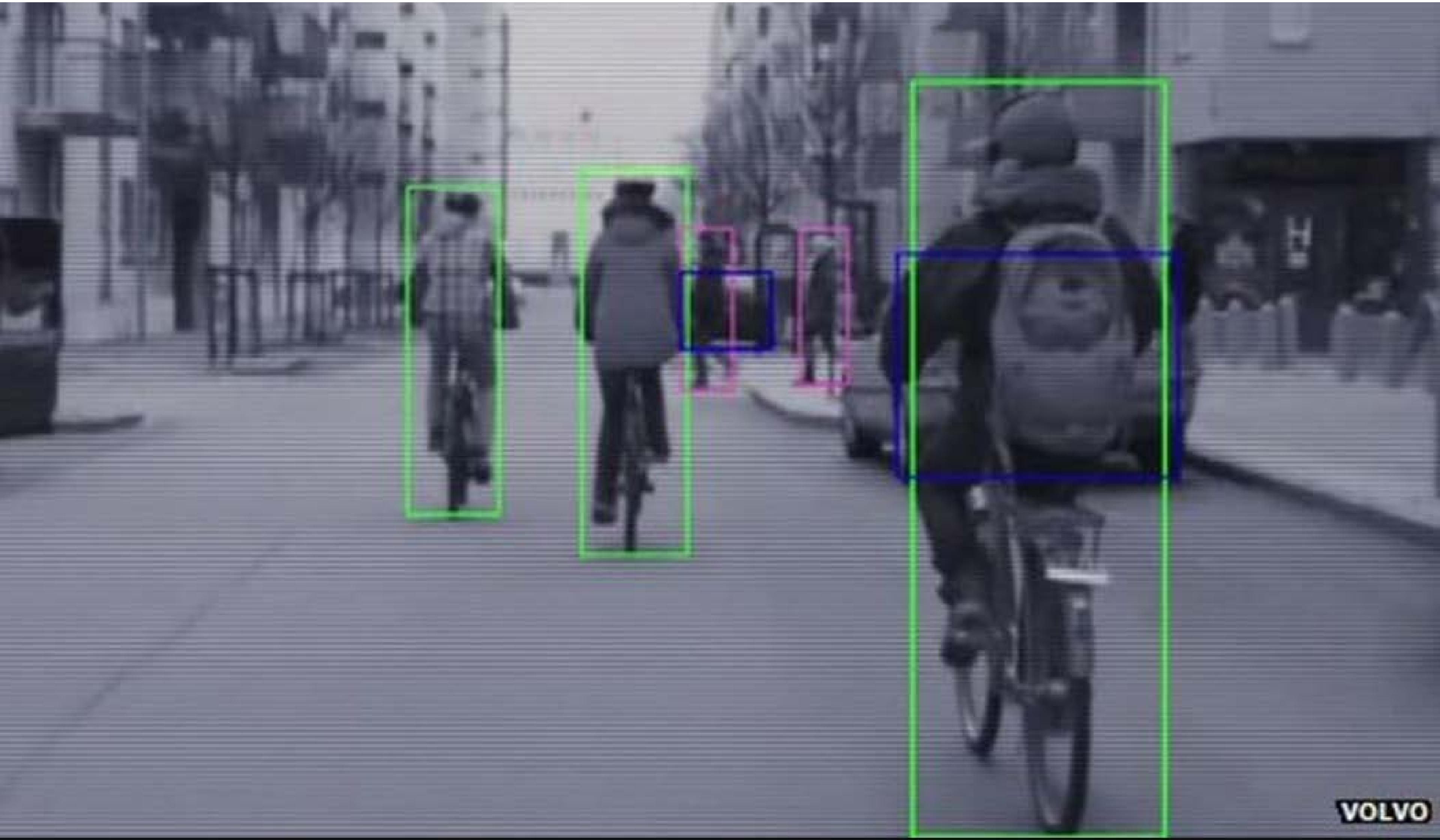


SVM distinguishes gazelles, ostrich, trees and ground in Namibia, Africa

www.epfl.ch ▪ Patrick Meier at www.qcri.com

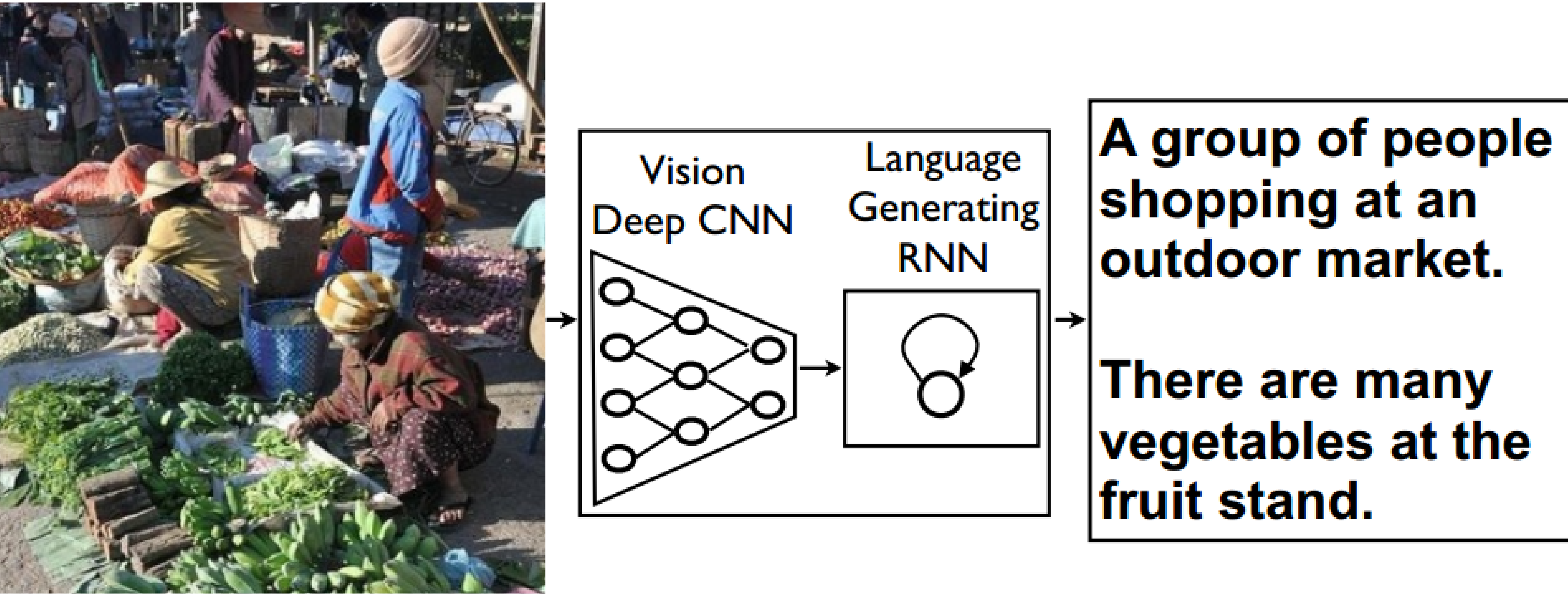
www.cs.toronto.edu/~hinton/csc2515/notes/lec10svm.ppt

SVM in ITS China



Volvo has fitted some of its cars with sensors and software that can tell cyclists apart from other objects

Neural Image Caption (NIC) Generator Translates images to natural language

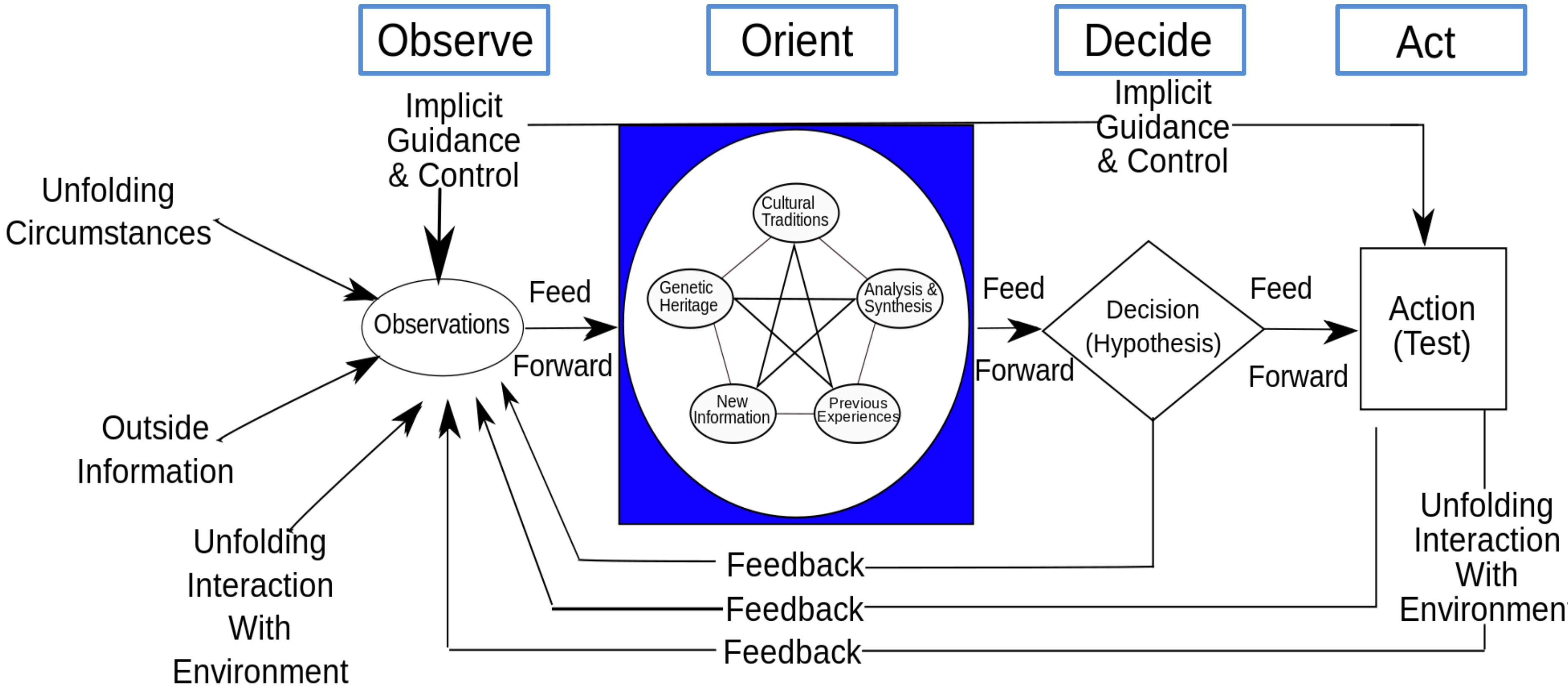


http://arxiv.org/pdf/1411.4555v1.pdf

To translate languages, Recurrent Neural Network (RNN) transforms a French sentence into a vector representation, and a second RNN uses that vector representation to generate a target sentence in German. Replace first RNN and input words with deep Convolutional Neural Network (CNN) trained to classify objects in images and add known classes of objects in semantic baffles with corresponding behavior (plastic bag versus wooden plank) with assigned probability of object in the image (environment). Feed CNN's rich encoding of the image into a RNN designed to produce phrases. We can then train the whole system directly on images and their captions, so it maximizes the likelihood that descriptions it produces best match the training descriptions for each image. The natural language spoken by human (inside vehicle) better trains the algorithms.

Author's idea is adapted from → http://googleresearch.blogspot.co.uk/2014/11/a-picture-is-worth-thousand-coherent.html

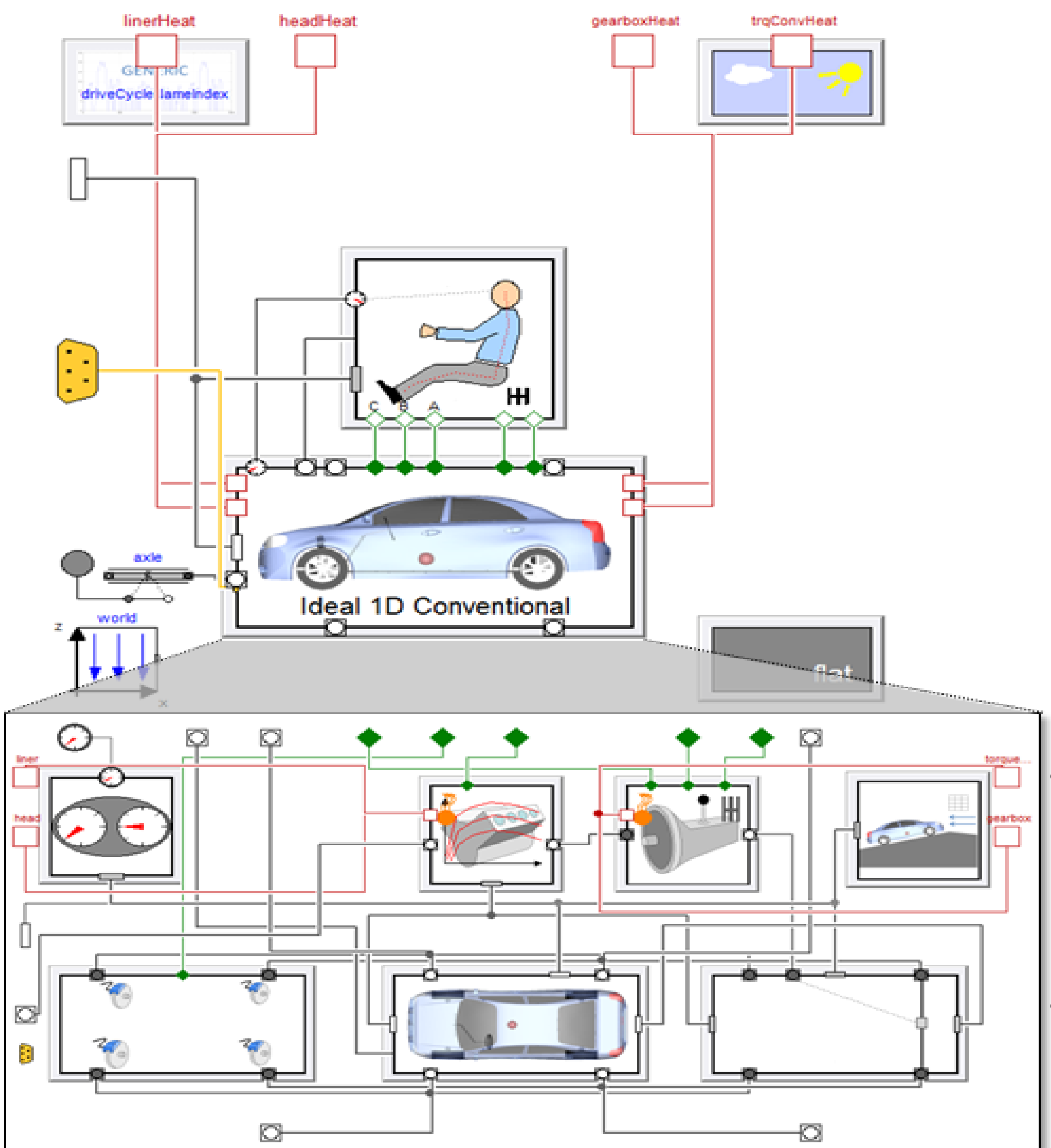
OODA Loop in Autonomous Driving Functions?



John Boyd

Temporal Decomposition of Complex Simulations

ECU based intruder dectection? Run-time condition monitoring?

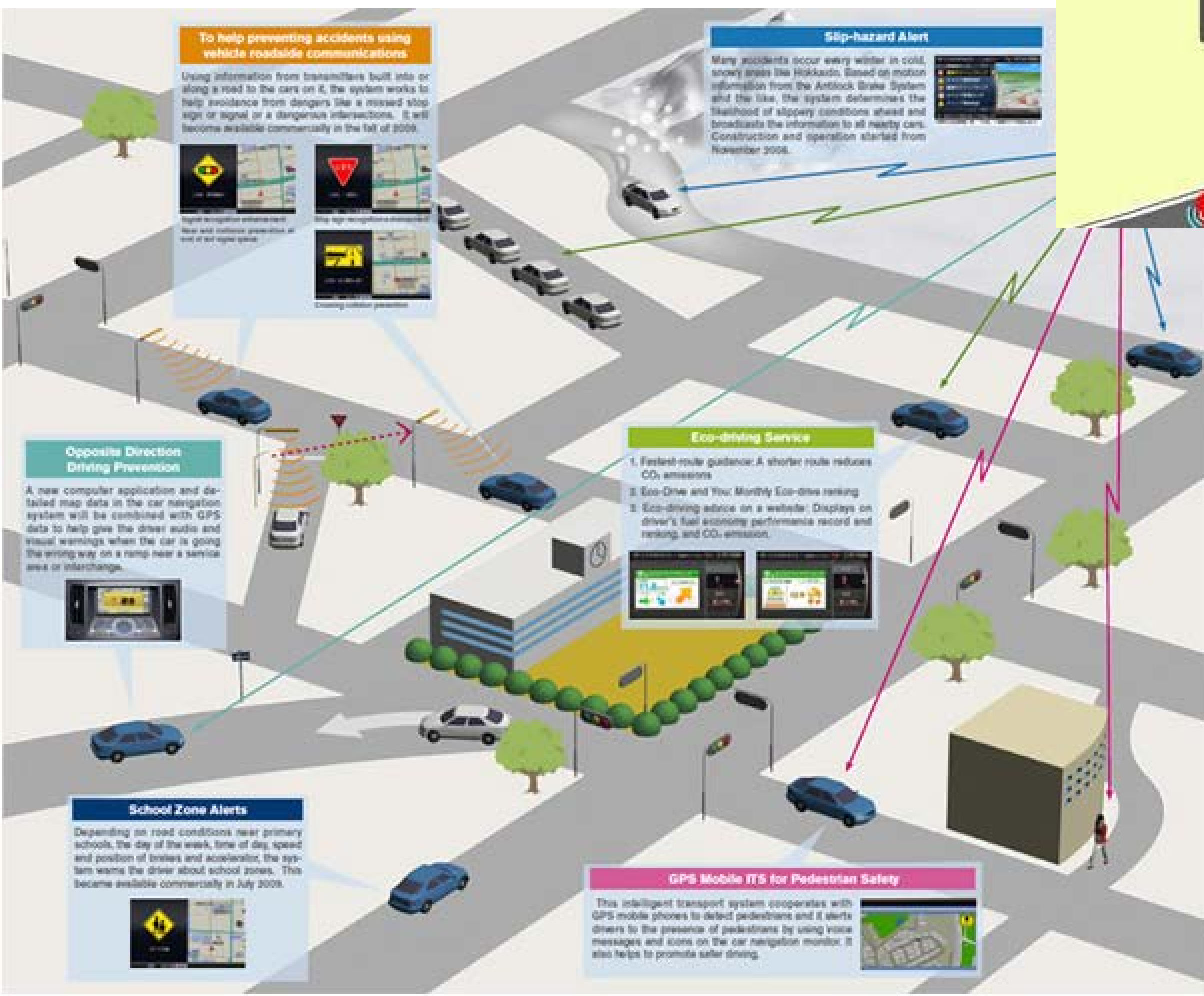


- Partition: Driver vehicle (Vehicle mechanics, Electrical and Driver) and Thermal Management (Fluid and Thermal parts of the model)

- Simulation with different processes and clock-rates but achieves correct behavior

Neema, H., J. Gohl, Z. Lattmann, J. Sztipanovits, G. Karsai, S. Neema, T. Bapty, J. Batteh, H. Tummescheit, and C. Sureshkumar, ***"Model-Based Integration Platform for FMI Co-Simulation and Heterogeneous Simulations of Cyber-Physical Systems"*** in Proceedings of the 10th International Modelica Conference, Lund University, Solvegatan 20A, SE-223 62 LUND, Modelica Association and Linkoping University Electronic Press, pp. 235-245, 03/2014.

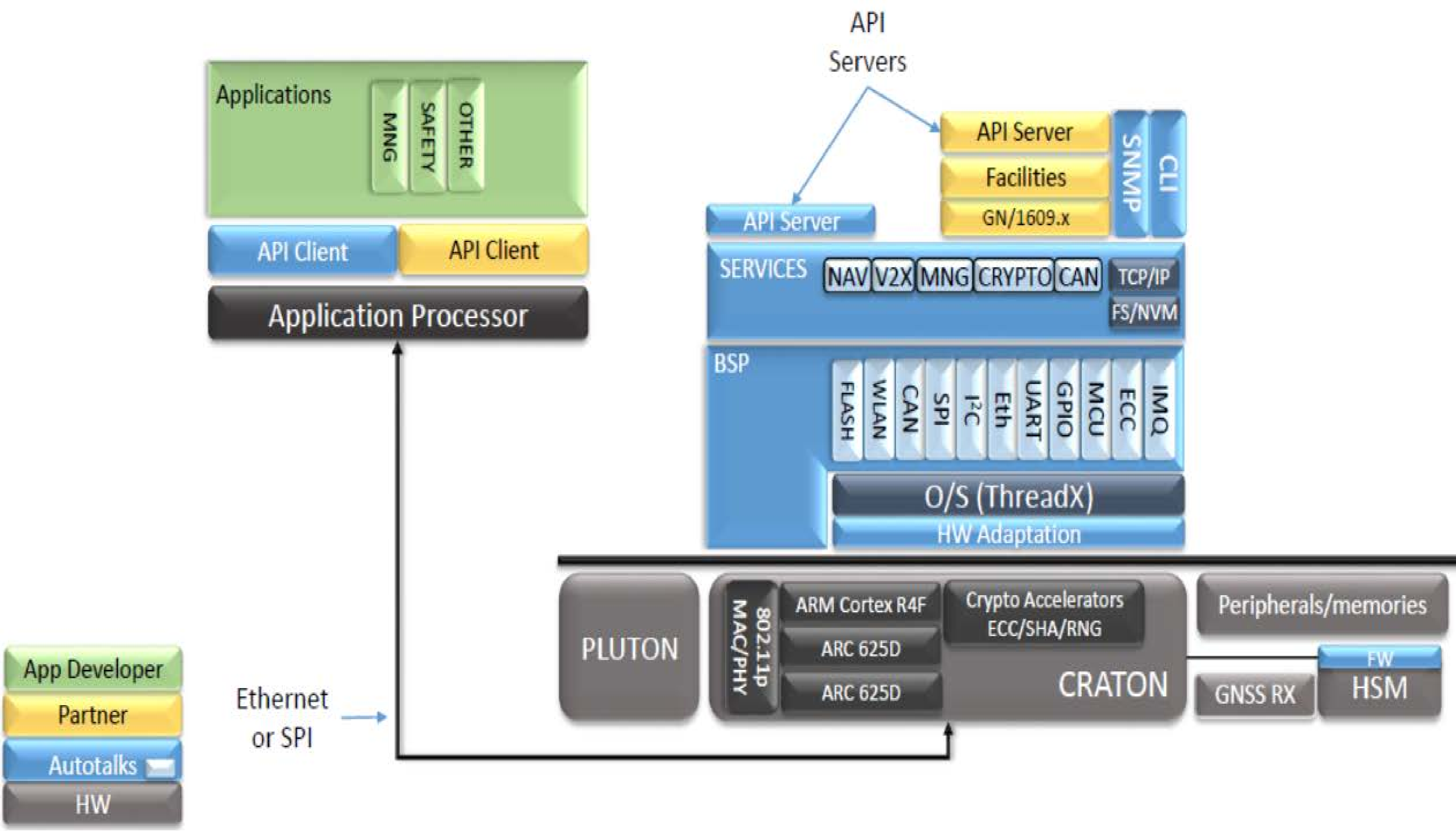
Connected Vehicles 101
Transportation of Data



Autonomy?

www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/its.html

How to Connect – Systems Integration



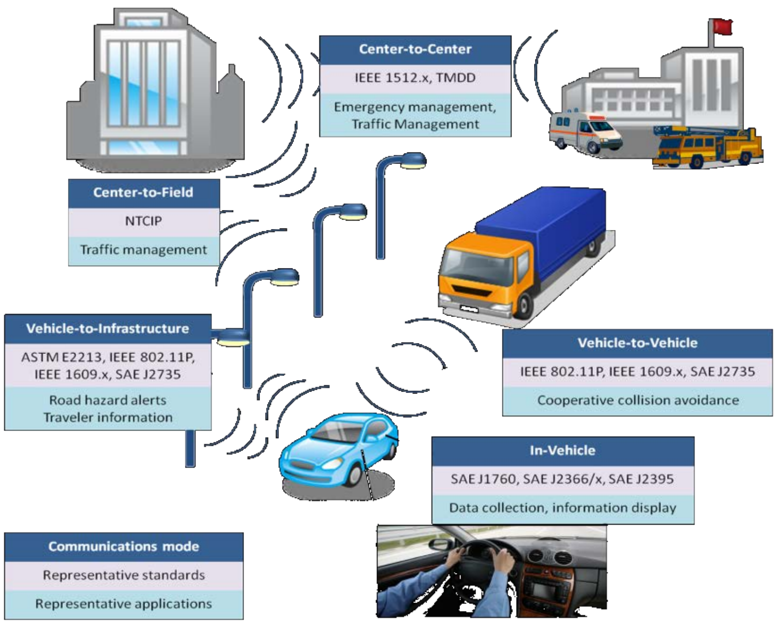
F6 Information Architecture

Abstraction applicable to connected vehicle pilot?

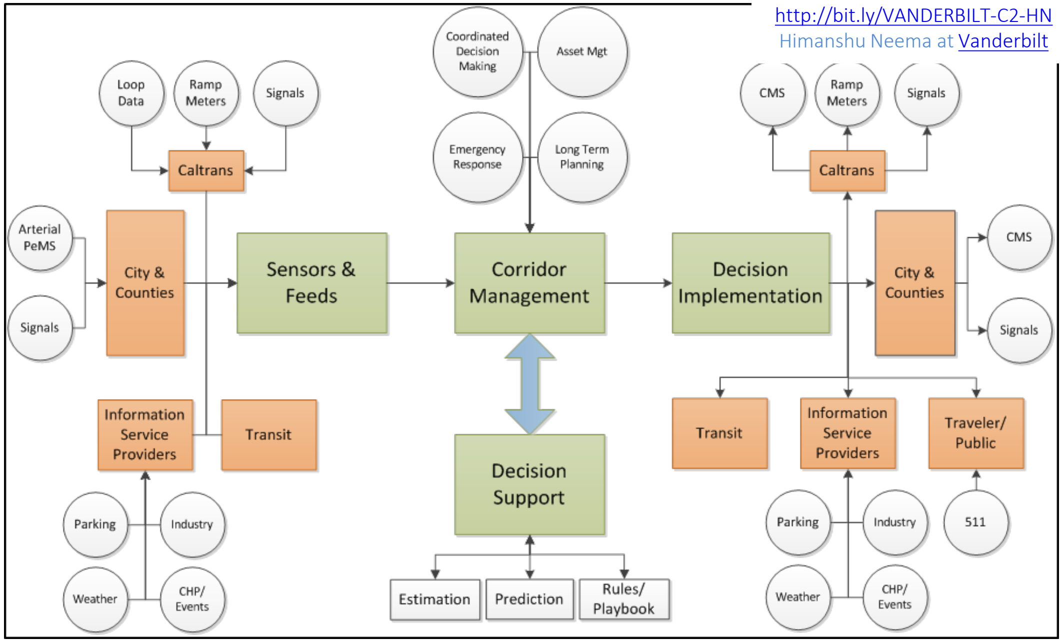
Challenge	Solution
Distributed system with network addressability	Essential architectural abstraction: interacting distributed components and actors F6OS platform → secure messaging Middleware → point-to-point and data-distribution communication patterns Component model → encapsulation and interfaces, scheduling, life-cycle Addressing →dictionary service
Dynamism	Dedicated software deployment service Dynamic reconfiguration upon faults Model-driven development toolchain and system integration process
Resource sharing	F6OS: Temporal/spatial partitioning, network bandwidth management, enforced resource limits Multi-use resources are encapsulated into actors
Fault tolerance	Multi-layer fault management architecture Replicated, fault tolerant platform actors Autonomous fail-over of actors/applications
Multi-level security	F6OS → secure transport with validated information flows, restricted OS calls for application actors, Mandatory Access Control on messages Formal model and proofs towards certifiability

GABOR KARSAI, Institute for Software Integrated Systems, Vanderbilt University

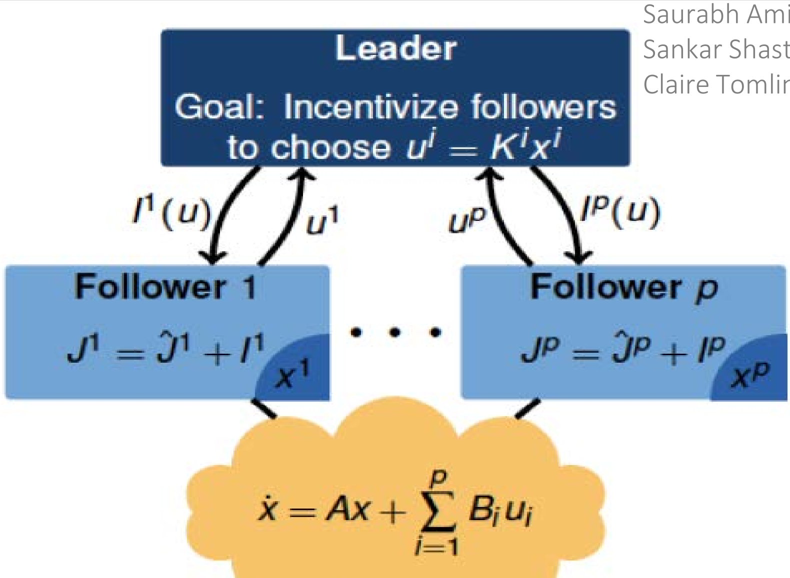
ITS Autonomy: Opportunistic cyber attacks?



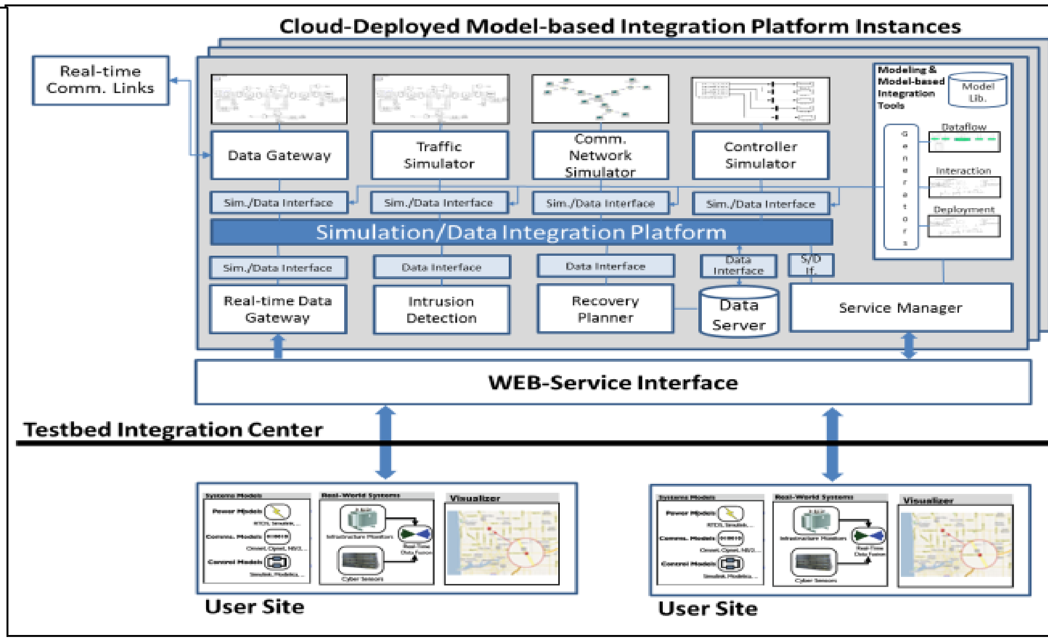
http://bit.ly/VANDERBILT-C2-HN
Himanshu Neema at Vanderbilt



Saurabh Amin
Sankar Shastry
Claire Tomlin



Game Theory in resilient control design - Stackelberg games



What level of autonomy ?

Observe → Orient → Decide → Act

Monitor → Diagnose → Plan → Execute

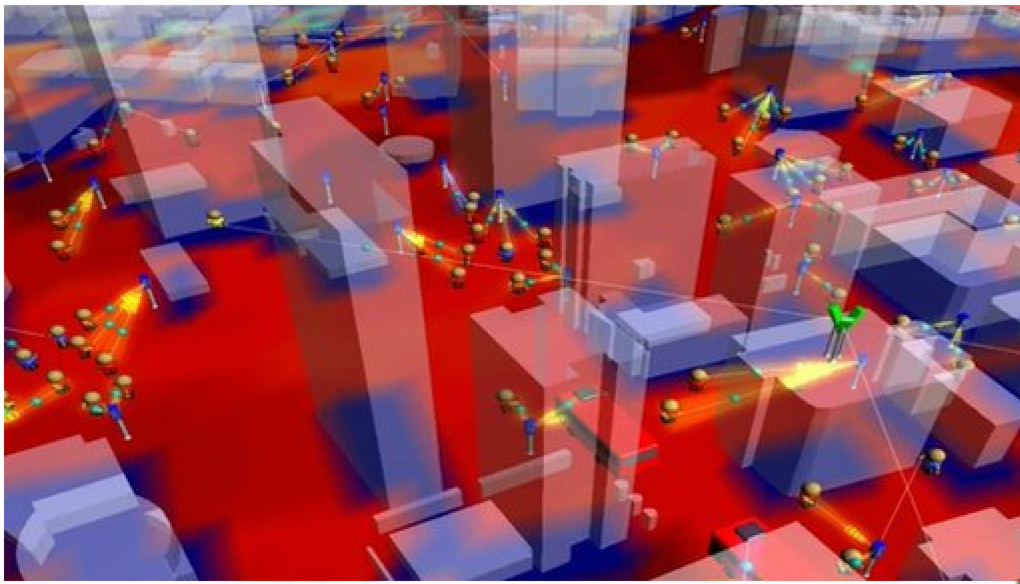
Perception / Situational Awareness → Analysis / Coordination → Decision Making → Capability

Sensory Processing → Perception / Working Memory → Decision Making → Response Selection

Monitoring & Detection → Situation Assessment → Response Planning → Response Implementation

Sensing / Perception → Analyzing / Planning / Decision Making → Acting / Executing → Communicating

Essential for Autonomy ?

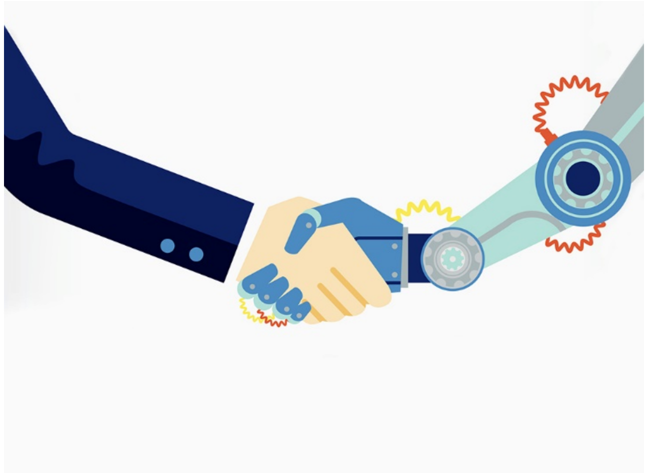


http://bit.ly/KATHLEEN-CAR-HACKED

http://bit.ly/KATHLEEN-FISHER-60-MINUTES

GOAL (For example, "Man on the Moon" was a goal set by JFK)

- Deployment of Semi-Autonomous Freight Transportation



SAFTI Semi-Autonomous Freight Transportation Initiative

Raj Rajkumar (CEO, Ottomatika) provides the brain and nervous system any automaker can use.

www.wired.com/2014/11/delphi-automated-driving-system/

ottomatika™ *Connected Automation*

Professor Raj Rajkumar, CMU

http://pjtec.info/a-system-that-any-automaker-can-use-to-build-self-driving-cars/

www.ctvnews.ca/sci-tech/dutch-approve-driverless-cars-for-public-large-scale-testing-1.2203969

Adapt “brain and nervous system” for cargo/commercial vehicles for large scale deployment ?

http://bit.ly/KATHLEEN-CAR-HACKED

Prof Raj Rajkumar (CMU) + House Transportation and Infrastructure Committee Chairman Rep Bill Shuster (R-PA) in DC on 06/24/14 [↓]

TRANSPORTATION ● http://bit.ly/DOT-DOT-DOT

www.wired.com/2015/03/delphis-self-driving-car-taking-cross-country-road-trip/

WIRED An Autonomous Car Is Going Cross-Country for the First Time

ALEX DAVIES GEAR 03.13.15 6:19 PM

AN AUTONOMOUS CAR IS GOING CROSS-COUNTRY FOR THE FIRST TIME

Delphi's self-driving technology, packed into an Audi SQ5, is headed across the country.

MARCH 22, 2015

This is an undertaking by select members of the Industrial Internet Consortium (IIC), a coalition of other corporations, various government agencies and guided by a group of academics in US.

SAFTI

Semi-Autonomous Freight Transportation Initiative

Broad Deployment Packages (BDP)

Dr Shoumen Datta

SAFTI - Semi-Autonomous Freight Transportation Initiative

- Goal – To Deploy Scenario in the Public Domain

  Freight truck transporting refrigerated cargo (containers with perishable grocery) arrives at an intermodal operation for shipment (by sea or air or rail or cross-dock from a to b)

  - *Driver disembarks prior to entering security perimeter*
  - *Truck shifts to autonomous mode and enters secure zone*
  - *Unloads / uploads cargo (informs supply chain partners)*
  - *Exits secure zone and arrives at a Hilton to pick up driver*
  - *Truck driver continues to warehouse / distribution center*

To reach this goal we must converge three broad areas

Broad Deployment Packages (BDP)

SAFTI - Semi-Autonomous Freight Transportation Initiative

- BDP1 – Semi Autonomous Vehicles with 'Brain'

- BDP2 – Connected Vehicle and Infrastructure

- BDP3 – Secure Transport of Data and Analytics

CONVERGENCE → SAFTI → SDV

SAFTI - Semi-Autonomous Freight Transportation Initiative

Decompose the “goal / scenario” to 3 very broad deployment packages (BDP)

- *The semi-autonomously operable fleet of light/heavy trucks (approx 1000-2000 physical units of SDV) invulnerable to cyber attacks.*
- *Operational infrastructure deployment in an environment where roads, traffic lights, bridges, tunnels, housing zones, pedestrian crossings are equipped to communicate (GIS, GPS, RF, DSRC) with autonomous objects as well as autonomous vehicles mixed with non-auto vehicles (Fedex ground hub). Transmission and analysis of data from users and operators (supply chain of goods, status of roads/bridges and cybersecurity)*
- *Intermodal port operator environment where these autonomous vehicles interact with humans and non-autonomous vehicles. Robotic handling of cargo containers (off-load, re-load) between ships to rail head and ground transportation (and air cargo link, if available). Transportation of data (sense and response) and monetization of pay per use analytics from users and operators (supply chain of goods, status of roads/bridges, security of goods in containers, micro-localization and highly granular identification of objects by products, containers, vehicles, distribution, logistics handling, DHS CBP compliant e-manifest and regulatory framework eg SOX409).*

Further decomposition of BDP

Let us break down each package to large units

SAFTI - Semi-Autonomous Freight Transportation Initiative

Broad deployment package - 1 (BDP1)

- *The semi-autonomously operable fleet of light or heavy trucks (1000-2000 SDV units) invulnerable to cyber attacks.*
  - *Calls for global partnership and globally interoperable standards*
  - *Pre-competitive standards based approach to vehicle "brain"*
  - *Semi-autonomous "brain" of SDV (robotic navigation) should/may be able to operate in Pittsburgh, Long Beach, Schiphol or Kaohsiung. In other words, traffic signal compliance in any country and collision avoidance in any geographic terrain under diverse range of weather.*
  - *Standard cybersecurity for run-time intruder detection and repulsion*
  - *Data flow/analytics about vehicle, environment and infrastructure*
  - *Network standards and compliance – worldwide interoperability*
  - *US team to collaborate with global partners and collaboration group*

SAFTI - Semi-Autonomous Freight Transportation Initiative

Broad deployment package - 1 (BDP1) was further sub-divided

– *Semi-autonomous vehicle production / test vehicle manufacturing sub-divided to BDP1.CCC (CAP) and BDP1.PPP (OTI)*

- *BDP1.CCC is a Closed Access Project (CAP, Green Room per IIC Policy)*
- *BDP1.PPP is an Open Technology Initiative (OTI, Slate Room)*
- *BDP1.CCC expects to produce an operating vehicle by 12/2016*
- *BDP1.PPP will focus on human-robot interactions that are likely to mimic the environment of the semi-autonomous vehicle on the road*

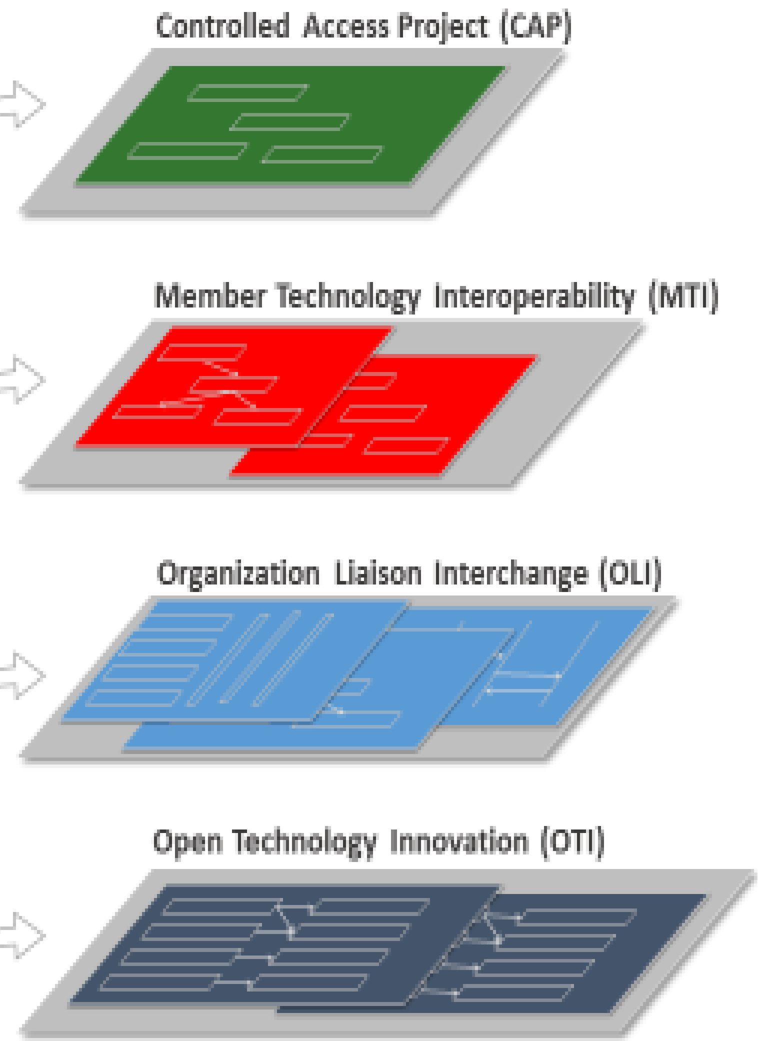
IIC Policy Framework

Controlled Access Project (CAP) – Green Room
Singular and Specified Project Managed
Written Restricted Access Policies and IPR Terms

Member Technology Interoperability (MTI) – Red Room
Consortium Members Restricted Access
Consortium Controlled and IPR Policies
Technology Interoperability Collaboration

Organization Liaison Interchange (OLI) – Blue Room
Multiparty SDO/SDI Interchange
MOU Defined Room and IPR Policies
Standards Interoperability Collaboration

Open Technology Innovation (OTI) – Slate Room
Public Collaboration for Shared Technology
No Controlled Access and IPR
Innovation Room for Developer Community



Jeff Fedders

This policy framework is applicable to the Industrial Internet Consortium (www.iiconsortium.org)

SAFTI - Semi-Autonomous Freight Transportation Initiative

Broad deployment package - 2 (BDP2)

– *Operational infrastructure deployment in an environment where roads, traffic lights, bridges, tunnels, housing zones, pedestrian crossings are equipped to communicate (GIS, GPS, RF, DSRC) with autonomous objects as well as autonomous vehicles mixed with non-autonomous vehicles (FedEx ground hub as an example). Transmission and analysis of data from users and operators (supply chain, status of roads/bridges, cyber-security)*

- *Communications protocols with interoperable standards and cybersecurity*
- *Physical infrastructure upgrades and equipment installation / monitoring*
- *Logistics operators as a part of the real-world deployment to provide access to non-autonomous fleet of trucks/lorries for data acquisition*
- *Data convergence from agencies dealing with traffic, weather, emergency*
- *Monetization incentives for contribution of data and pay per use analytics*
- *Deployment funded by each nation or country on their own soil but uses the semi-autonomous fleet of vehicles if developed as a global partnership*

SAFTI - Semi-Autonomous Freight Transportation Initiative

Broad deployment package – 3 (BDP3)

– *Intermodal port operator environment where these autonomous vehicles interact with humans and non-autonomous vehicles. Robotic handling of cargo containers (off-load, re-load) between ships to rail head and ground transportation (and air cargo). Data transmission and monetization of pay per use analytics from users and operators (supply chain of goods, status of roads/bridges, security of goods in containers, micro-localization and granular identification of objects by products, containers, vehicles, distribution, logistics handling, DHS CBP compliant e-manifest, regulatory framework eg SOX409 and other country specific regulations)*

- *Funded by each nation on their soil as a joint effort by an air/sea port operator + group lead with technological capability (US port operations + ISIS, Vanderbilt)*
- *Robotic handling, precision transfers and secure transport A to B to C (ship to rail)*
- *Highly granular data acquisition from operation for commercial visibility and transparency to enhance security as well as status of goods (perishable food)*
- *Data analytics & monetization model as the business driver for data exchange*

Approved for OTI

Temporary Summary

Semi-Autonomous Freight Transportation Initiative

SAFTI

The current goal of this initiative is
[1] to create a coalition of distinguished academia, global corporations, local standards organizations and government agencies
[2] to catalyze a highly credible global public-private partnership (PPP)
[3] to collectively work to deploy and integrate semi-autonomous freight vehicles (SDV) for intermodal cargo operations within the business ecosystem of freight transportation.

Project commences with construction/sourcing of ~1000 units based on standards or interoperable standards (old, new, to be designed) which will be tested for operational safety, cyber security and communications compatibility (SDV test bed environment).

Semi-autonomous vehicles (SDV) may be deployed by country specific PPP on public roads in different geographies (US, EU, APAC) to integrate with existing freight transportation operations. Pre-deployment of local infrastructure (global standards of communications, networks, data) for semi-autonomous vehicle integration.

This is an open technology innovation initiative. For details please explore "Grand Challenges" or IoS available from http://dspace.mit.edu/handle/1721.1/86935

Engagement with Software Defined Vehicles (SDV)

Semi-Autonomous Freight Transportation Initiative

SAFTI

Expertise and ability to contribute technical components and/or qualified human resources to work as a part of the team to execute various work units related to:

[a] robotic navigation / control as it pertains to software defined networked vehicles

[b] vehicle to infrastructure and vehicle to vehicle communication using dedicated short range communication (DSRC), ultra wideband UWB), cellular technologies, local and global positioning systems (basic building blocks are [i] road side units, RSU, each with GPS and DSRC gateways spaced no more than 1000M apart and [ii] vehicular units, VU, each with on board GPS and DSRC capability)

[c] SAE standards, IEEE 1609.3 (persistent 1μS alignment between V2R and V2V), ASTM E2213–03 for DSRC and IEEE 802.11P as a DSRC capable radio system or alternative communication systems (LTE) for software defined vehicles (SDV).

Schematics using US DoT CVRIA

We start the process of further decomposition using the US DoT mandated MS Visio-like tool referred to as the connected vehicle reference implementation architecture.

BDPs will be subjected to layer by layer decomposition in an attempt to create work packages based on the functionality that each layer and sub-layer may deliver in order to attain the goal described in BDP1, 2 and 3. The next few schematics are examples of the layered process. For more info visit www.cvria.net/html/resources/tools.html

This is the point where groups, companies and academics may dissect the components to a sufficiently granular level to determine if they can contribute to this challenge.

www.iteris.com/cvria/html/resources/cvriatraining.html

Evolution of CVRIA with Vulcan ?

Vulcan

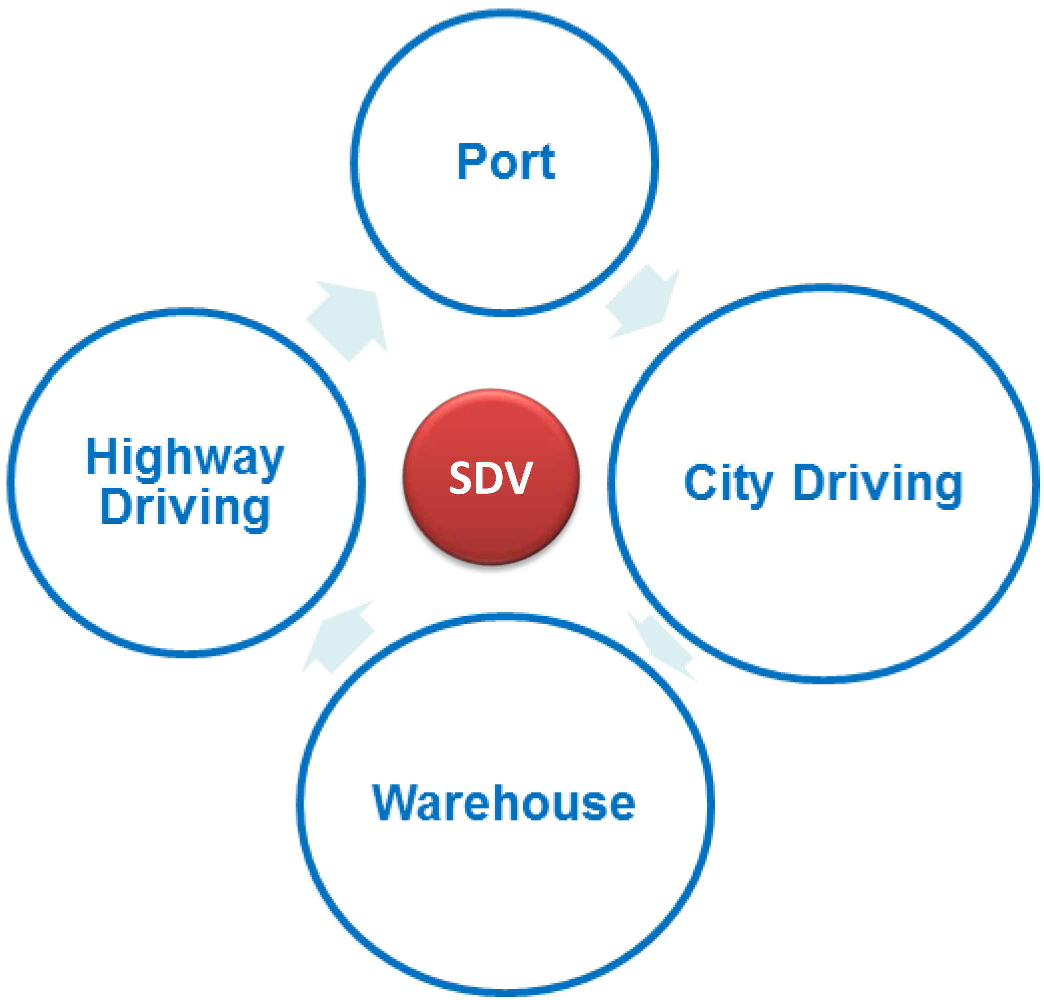
Framework

Applications

VehicleFORGE	PolicyForge	ISISForge	MAIhub
Custom analysis, visualization, collaboration, resources, and competitions	Custom modeling, analysis, visualization, and collaboration	Basic software forge, custom tools and tool integrations, testbed	Data archival/sharing, tool interchange, community metadata, collaborative workflows
Cyber-physical systems	**Medical infomatics**	**S/W development**	**Materials science**

SAFTI

Comprises of four operating scenarios for the light and/or heavy duty trucks and vocational vehicles. Each scenario requires certain capabilities to be designed into the project. They also point out where the project needs to make use of common interface definitions and services.



SAFTI SPECIFIC SCENARIOS FOR DEPLOYMENT OF SDV

Represents sections of a day-in-the-life of the semi-autonomous freight transportation vehicle

Four scenarios with key applications in each:

1. Operation near and within the FedEx (example) sorting hub (Pittsburgh, PA)

- Semi-Autonomous vehicle operation
- Freight and vehicle logistics management
- Vehicle maintenance management

2. Operation in the greater metropolitan area (Pittsburgh, PA)

- Eco-driving assist

3. Operation near and at the container port (eg CA, SC)

- Semi-Autonomous vehicle operation
- Freight and vehicle logistics management

4. Operation at an enforcement site on the Interstate Highway (eg: I-35 in Texas)

- Commercial vehicle enforcement

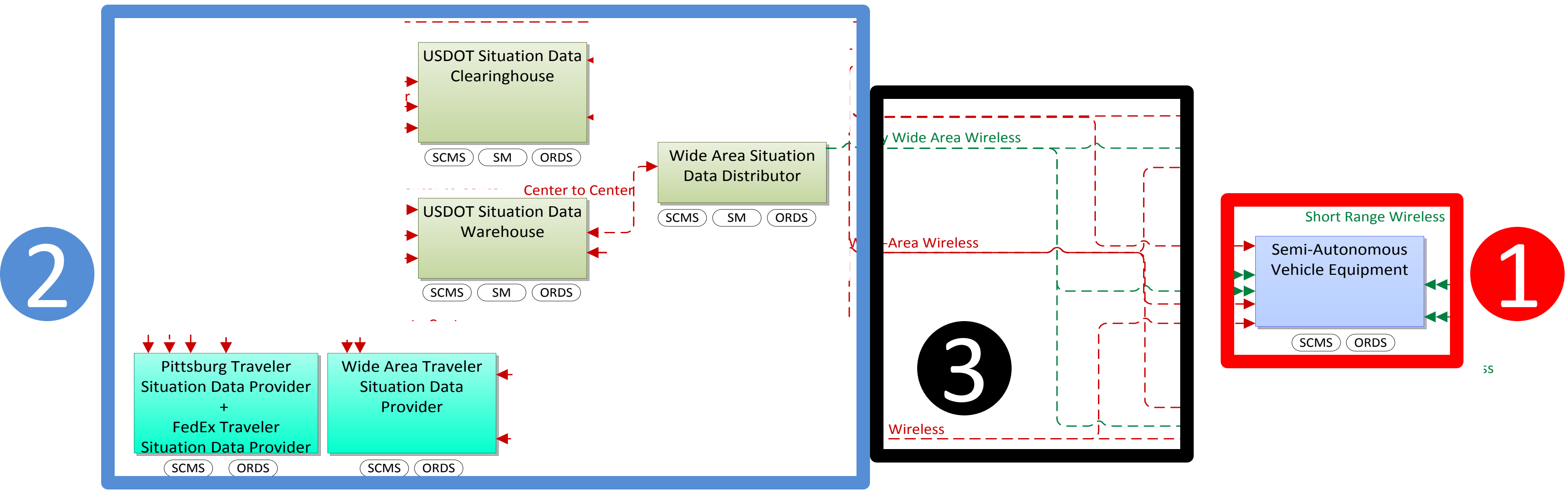
HOW SAFTI SPECIFIC SCENARIOS FIT IN THE SCHEMATICS BDP1.CCC (SDV), BDP2 (Infrastructure) and BDP3 (Data)

Can we create a secure "God Server" for this data? Question asked by Walton Fehr of US DoT at NIST on 2/12/2015

Data

Infrastructure

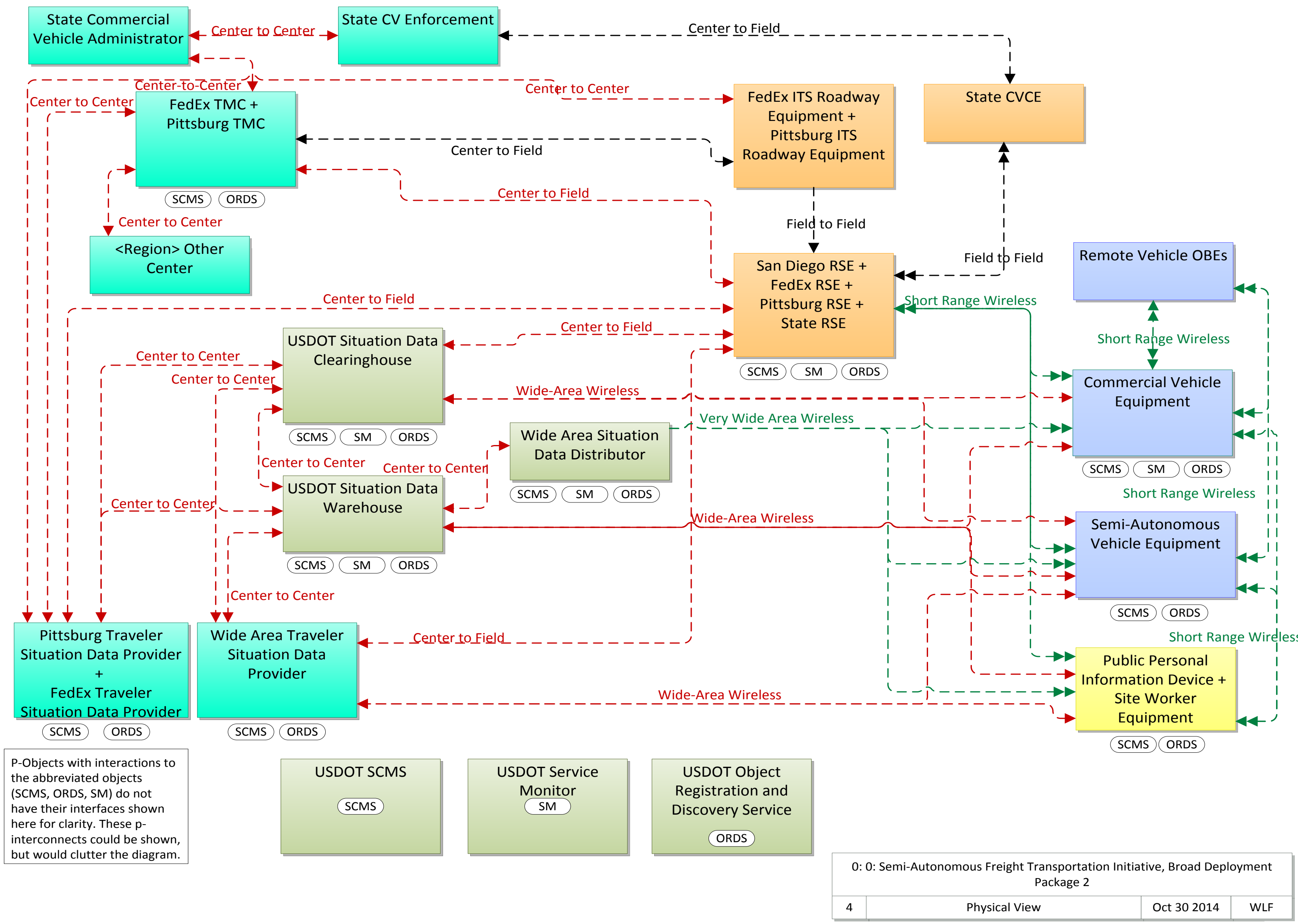
SDV



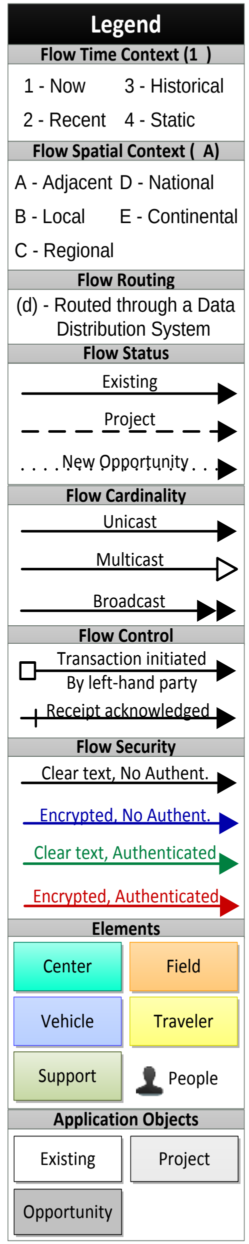
0: 0: Semi-Autonomous Freight Transportation Initiative, Broad Deployment Package			
4	Physical View	Oct 30 2014	WLF

SAFTI SPECIFIC SCENARIOS – Composite Physical Layer 0

CVRIA schematic shows the major objects to be deployed to accomplish the four scenarios.



LEGEND



Commercial Vehicle Equipment

Semi-Autonomous Vehicle Equipment

Two versions of vehicle onboard equipment (OBE) will be used in the project. Semi-Autonomous Vehicle Equipment will have all of the abilities of Commercial Vehicle Equipment plus what is need for self-driving.

Public Personal Information Device

Site Worker Equipment

Two versions of traveler equipment will be used on the project. General purpose personal information devices and special devices used by port and warehouse site workers.

FedEx RSE + Pittsburg RSE + San Diego RSE + State RSE

Roadside equipment (RSE) will be installed and operated by the various locations.

Center equipment will be used as needed in any scenarios.

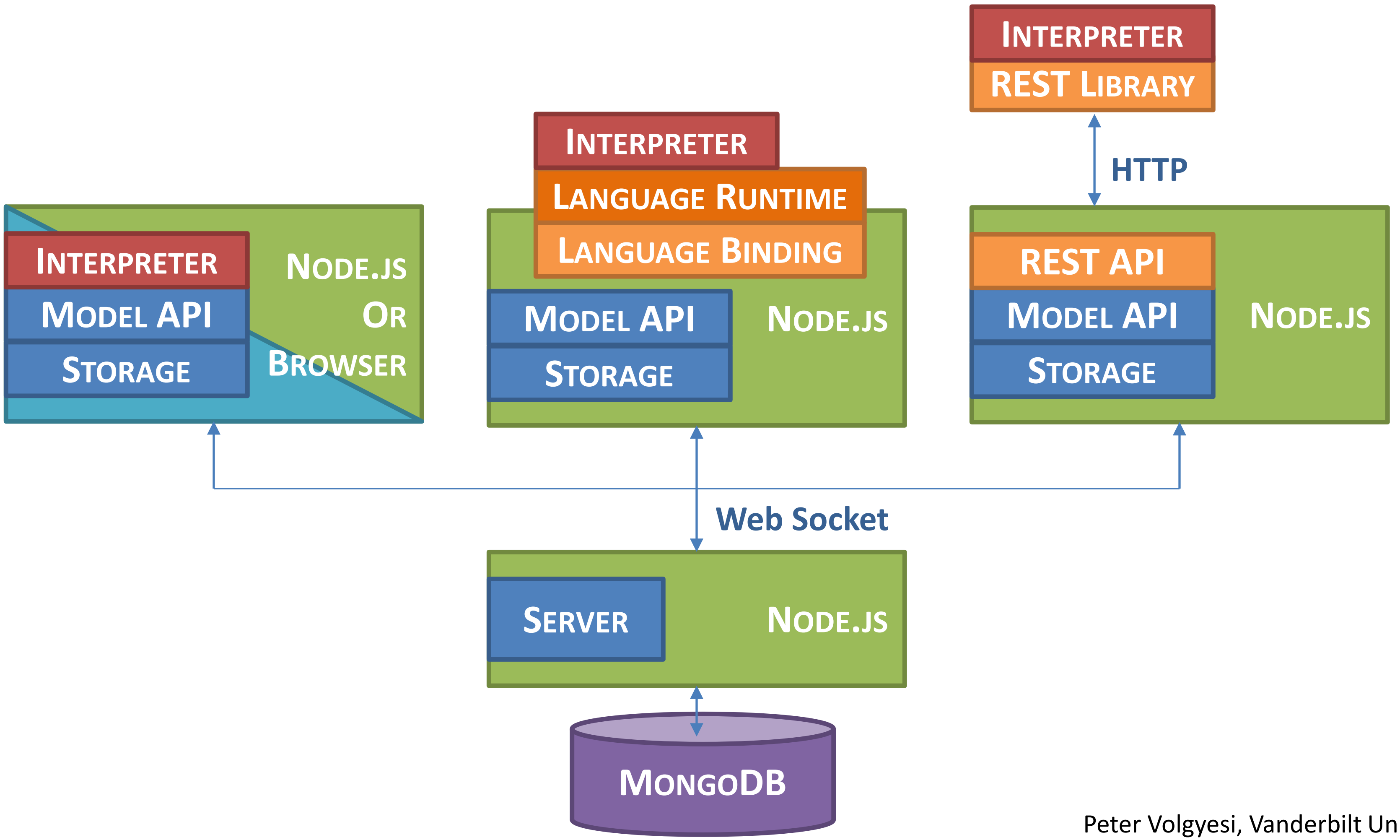
2: Layer 2 Legend			
1	Physical View	Oct 30 2014	WLF

Can WebGME help standardize CVRIA interfaces?

Implementation: ***JavaScript***
Deployable: server-side
client-side
in-browser

Python, Java, …
Deployable: server-side
client-side
Language and blocking "bridge"

Anything *with HTTP/REST lib*
Deployable: server-side
client-side
in-browser
Limited performance *and functions*

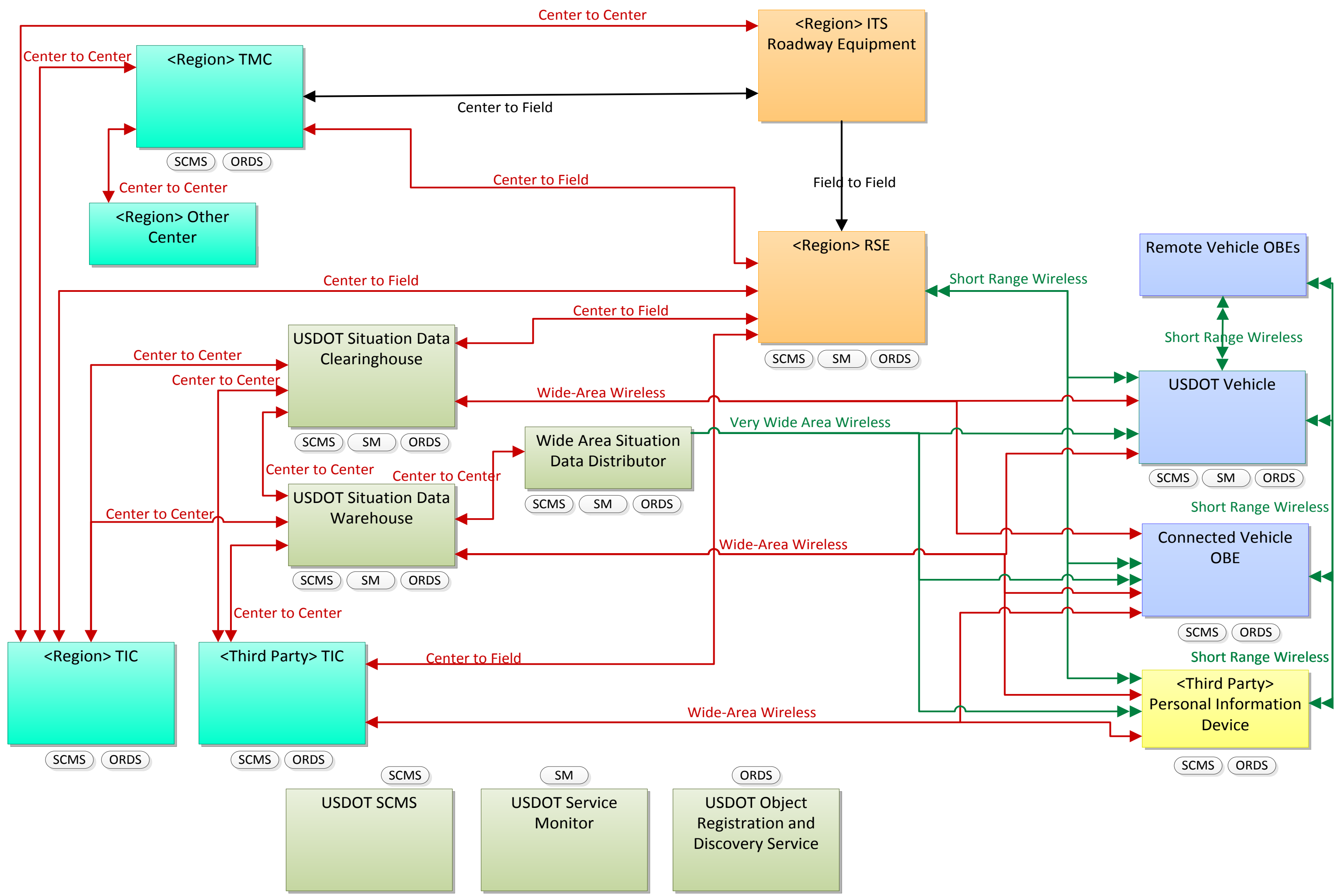


Peter Volgyesi, Vanderbilt University

Composite Physical Layer 0 - simplified for SAFTI scenario BDP2

Operational infrastructure deployment in an environment where roads, traffic lights, bridges, tunnels, housing zones, pedestrian crossings are equipped to communicate (GIS, GPS, RF, DSRC) with autonomous objects as well as autonomous vehicle operation with mixed vehicles (eg: Fedex Ground hub). The deployment will include the transmission and analysis of data from users and operators (supply chain, status of roads/bridges, cyber-security) using connected vehicle reference implementation architecture (www.standards.its.dot.gov/DevelopmentActivities/CVReference)

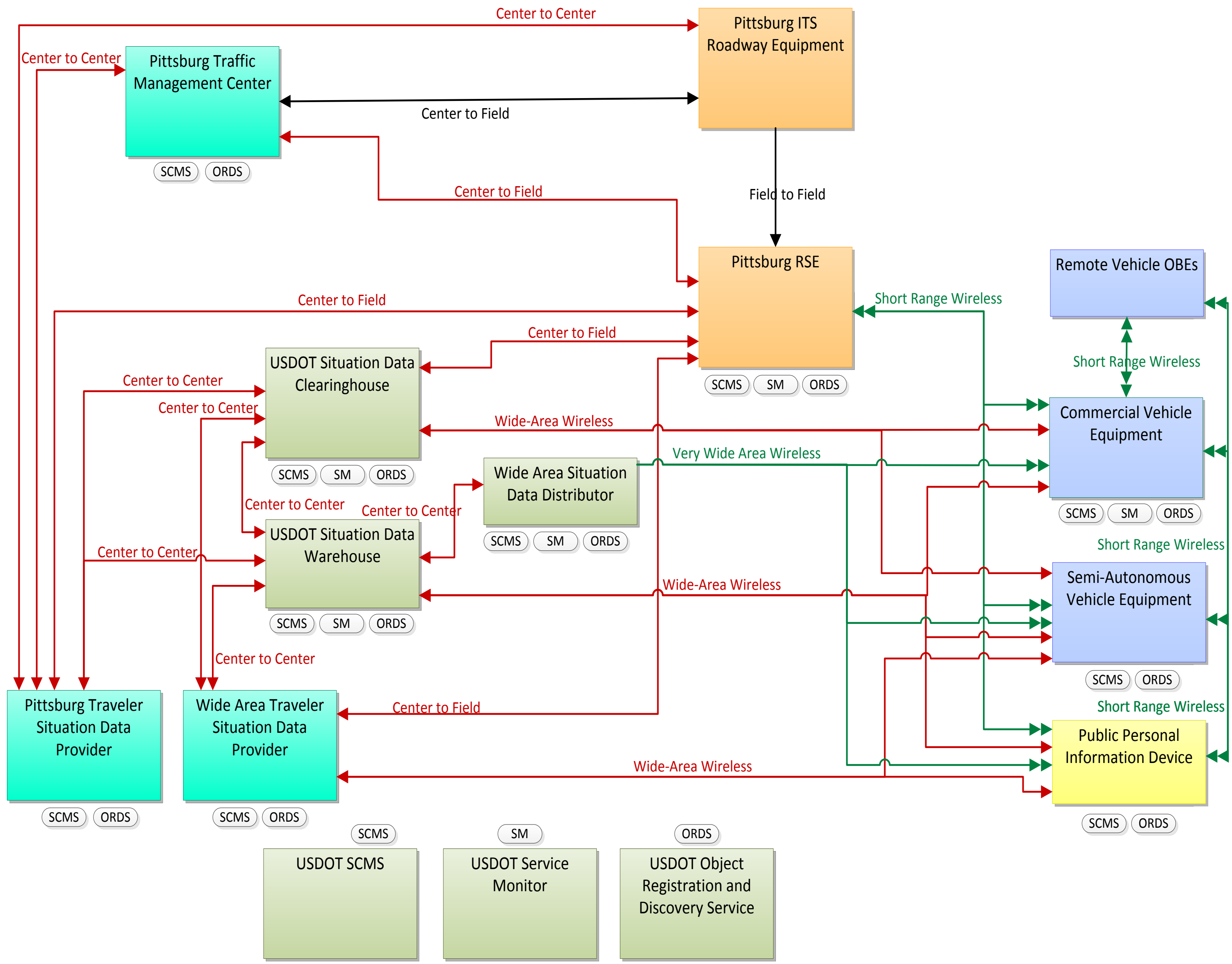
Physical View – Layer 0



0: Unified Implementation of the Connected Vehicle Reference Implementation Architecture – Regional Scale			
4	Physical View	Oct 24 2014	WLF

Approved for OTI

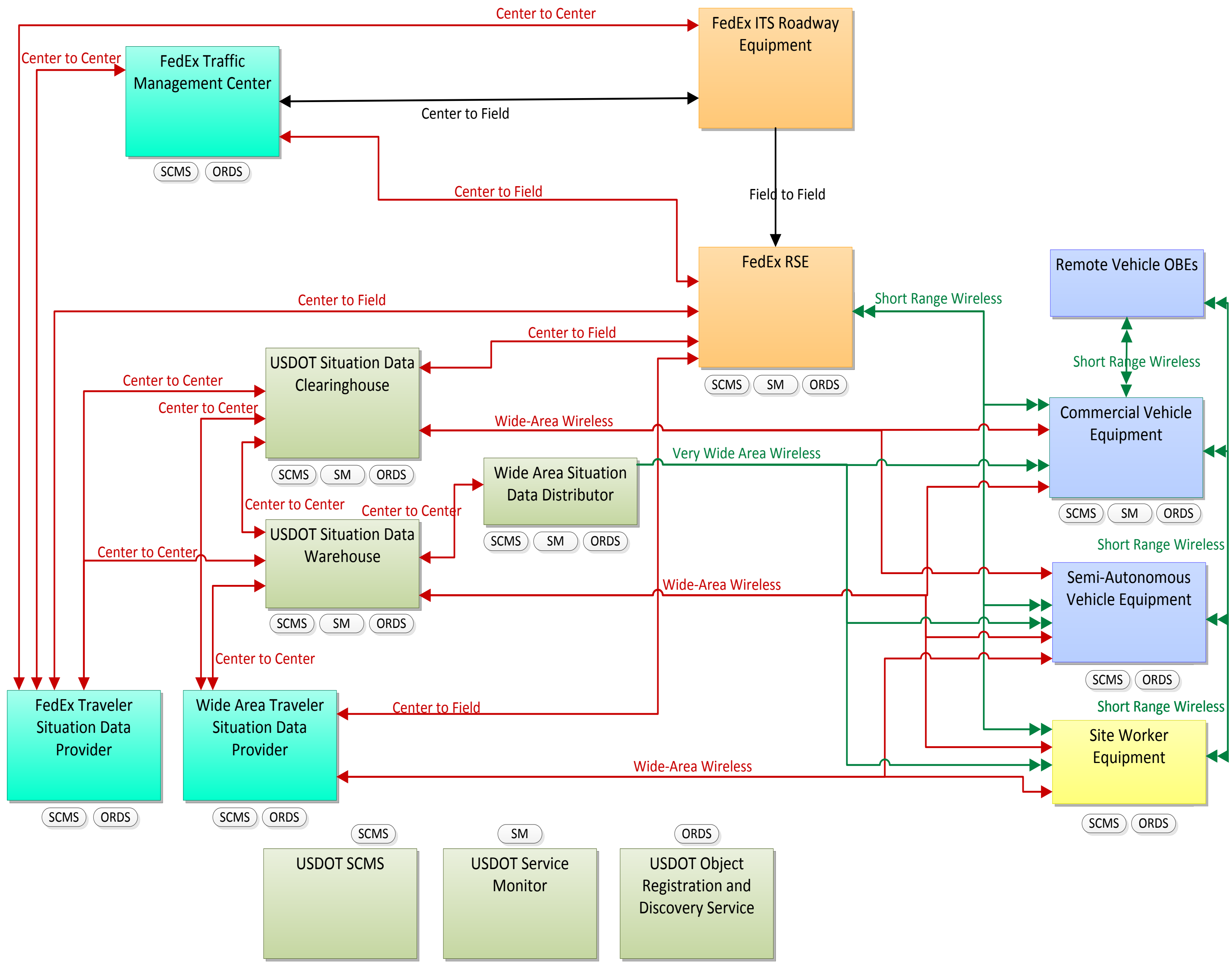
Specific versions of the Physical View - Layer 0 to be created for each of the operating environments of BDP2



Eg 1: Physical View - Layer 0 for Pittsburgh (BDP2)

0: Unified Implementation - Pittsburg Public Roadways			
4	Physical View	Oct 24 2014	WLF

Specific versions of the Physical View - Layer 0 to be created for each of the operating environments of BDP2



0: Unified Implementation - FedEx Private Roadways			
4	Physical View	Oct 24 2014	WLF

Eg 2: Physical View - Layer 0 for FedEx Terminal (BDP2)

3 general purpose information flows are associated with each Layer 0:

[1] Vehicle Situation Data originates from vehicles and mobile devices.

[2] Field Situation Data originates at field devices such as traffic signal controllers.

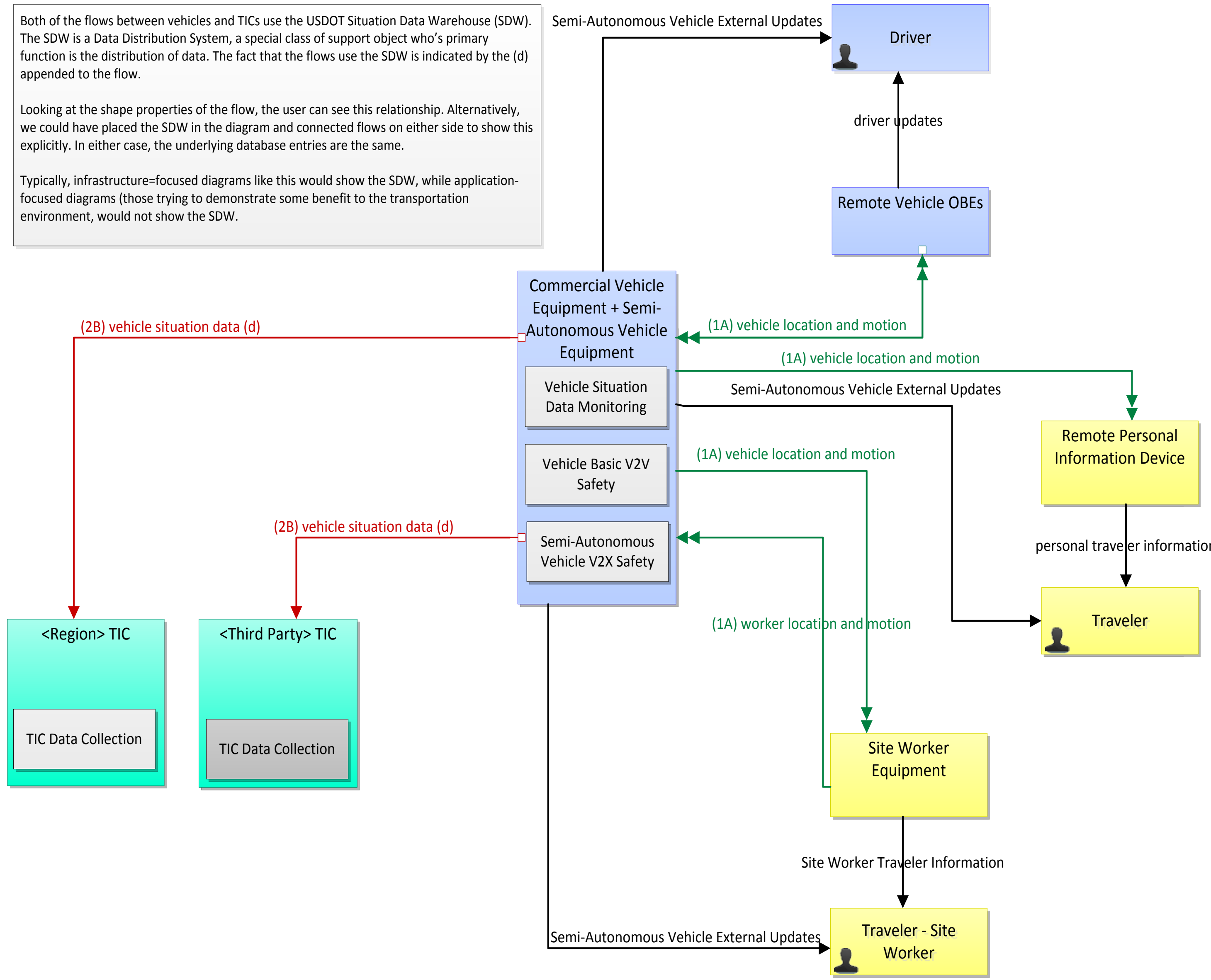
[3] Traveler Situation Data originates at centers and directed toward vehicles & mobile devices.

Information flow associated with Layer 0 – Vehicle Situation Data originates from vehicles and mobile devices.

Both of the flows between vehicles and TICs use the USDOT Situation Data Warehouse (SDW). The SDW is a Data Distribution System, a special class of support object who's primary function is the distribution of data. The fact that the flows use the SDW is indicated by the (d) appended to the flow.

Looking at the shape properties of the flow, the user can see this relationship. Alternatively, we could have placed the SDW in the diagram and connected flows on either side to show this explicitly. In either case, the underlying database entries are the same.

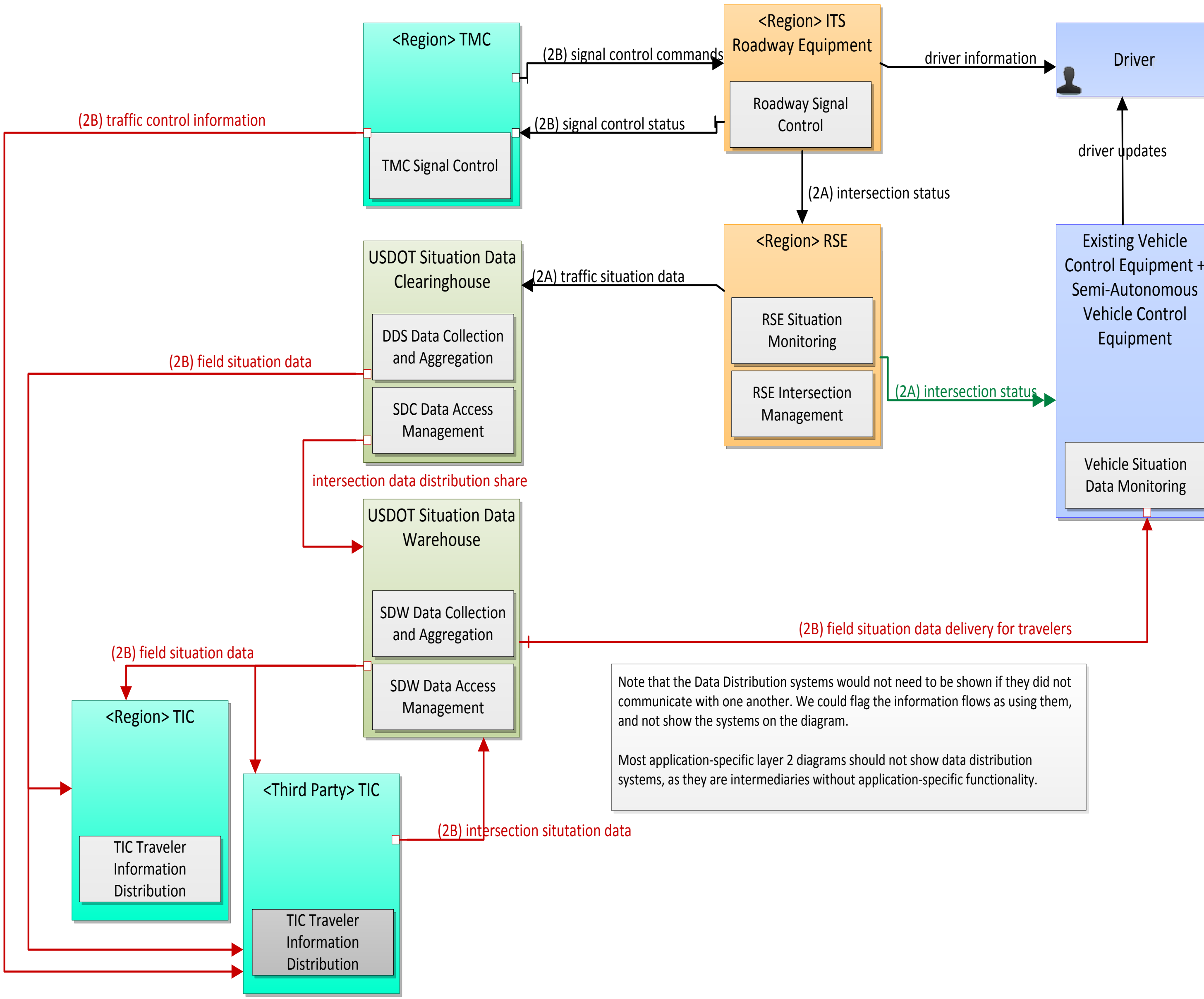
Typically, infrastructure=focused diagrams like this would show the SDW, while application-focused diagrams (those trying to demonstrate some benefit to the transportation environment, would not show the SDW.



Physical Layer 2
Vehicle Situation Data

2: Distribution - Vehicle Situation Data - FedEx Private Roadways			
4	Physical View	Oct 26 2014	WLF

Information flow associated with Layer 0 – Field Situation Data originates at field devices eg traffic signal controllers.



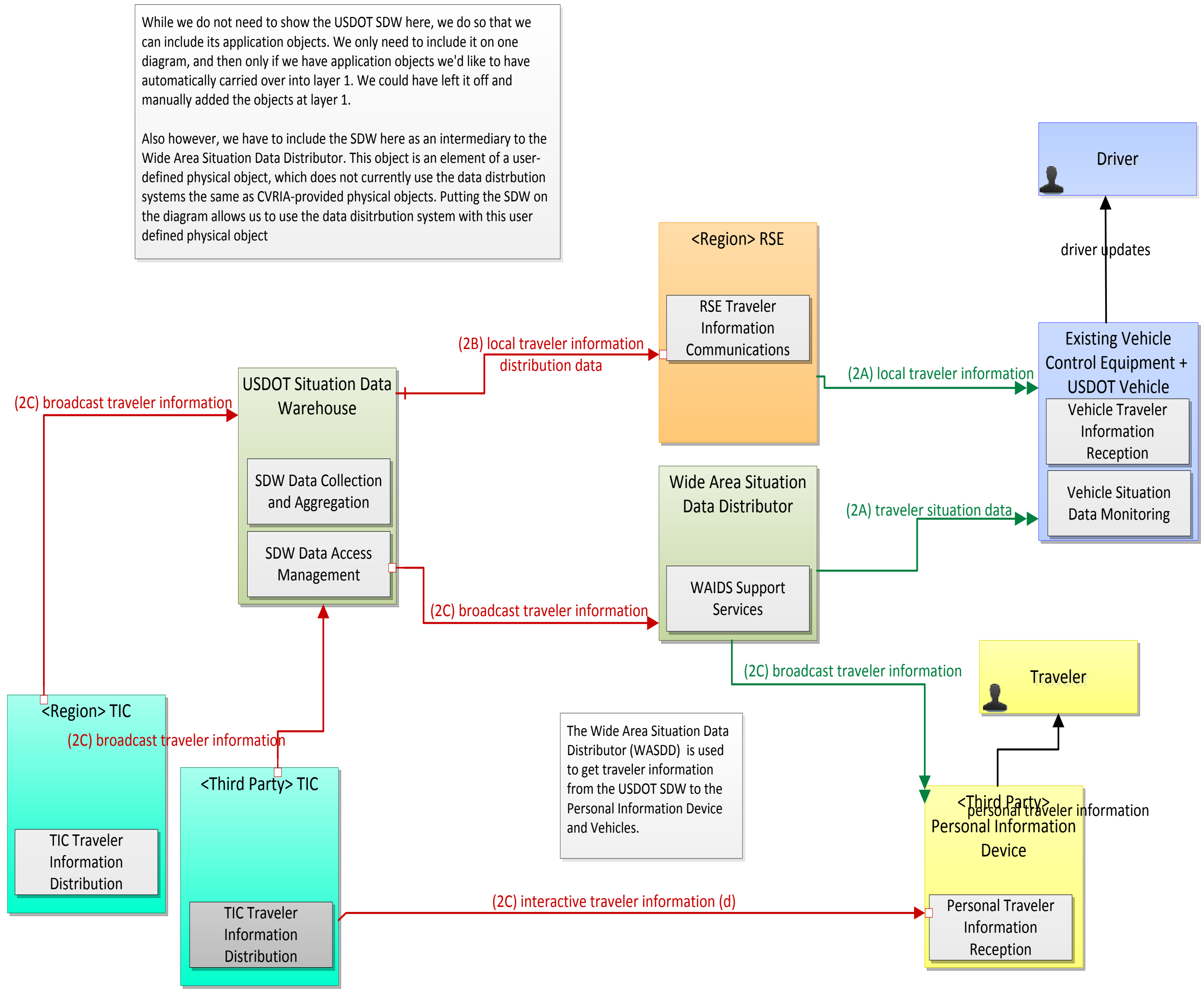
Note that the Data Distribution systems would not need to be shown if they did not communicate with one another. We could flag the information flows as using them, and not show the systems on the diagram.

Most application-specific layer 2 diagrams should not show data distribution systems, as they are intermediaries without application-specific functionality.

Physical Layer 2
Field Situation Data

2: Distribution - Field Situation Data - General Case			
3	Physical View	Oct 19 2014	NAT

Information flow associated with Layer 0 - Traveler Situation Data originates at centers & directed to vehicles, mobile devices.

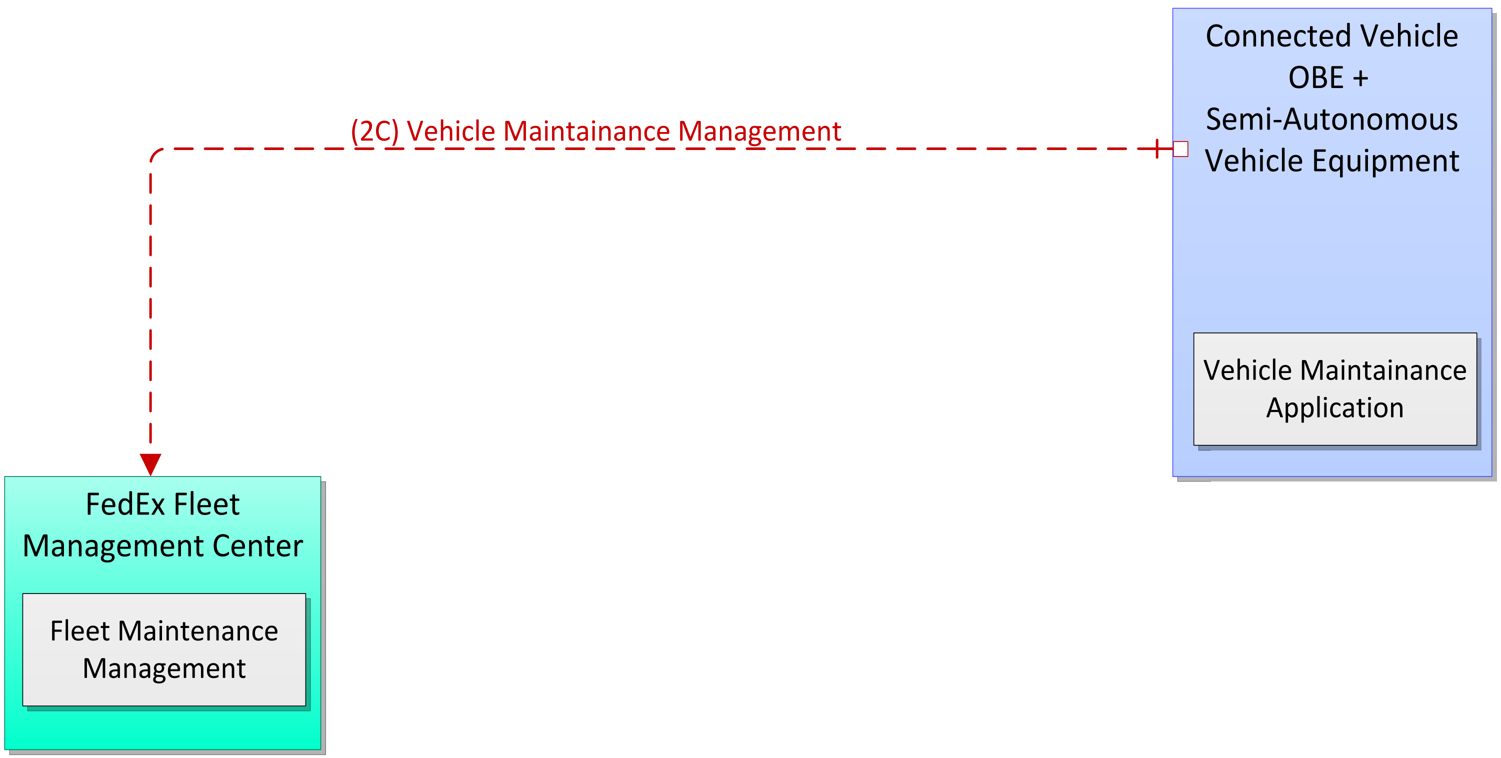


Physical Layer 2
Traveler Situation Data

2: Distribution – Traveler Situation Data – General Case			
3	Physical View	Oct 19 2014	NAT

Along with the general purpose information flows will be a number of peer-to-peer data exchange flows to support decision management, maintenance, enforcement and commercial activities related to goods on vehicle (supply chain, inventory, delivery)

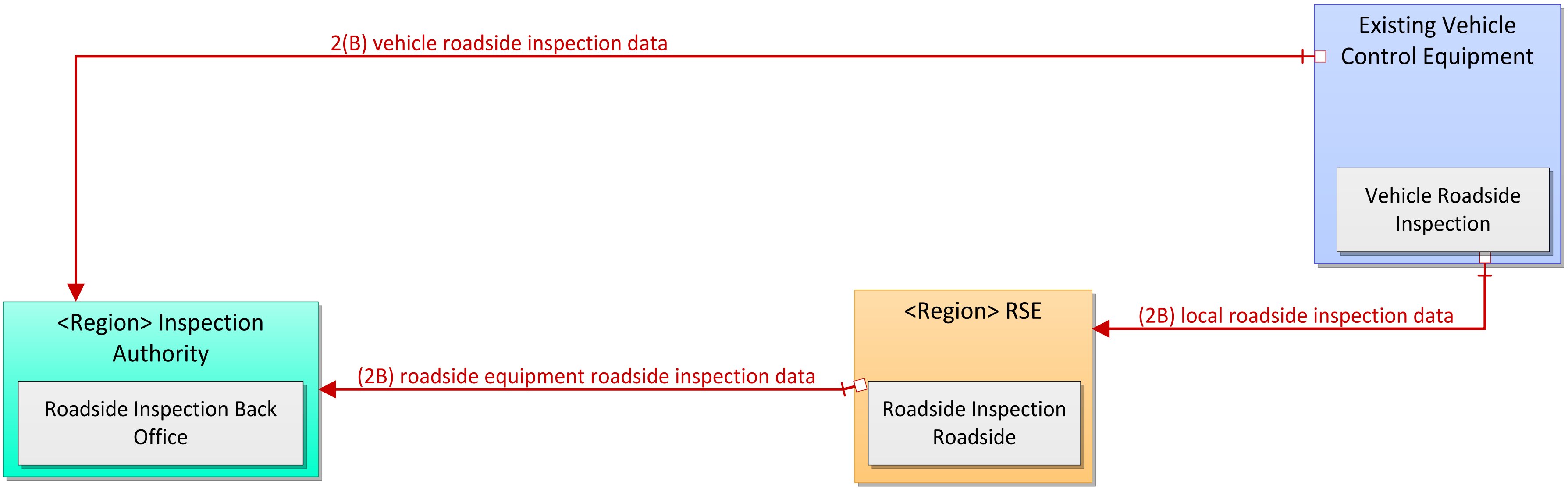
Management



2: Vehicle Maintainance Management			
4	Physical View	Oct 30 2014	WLF

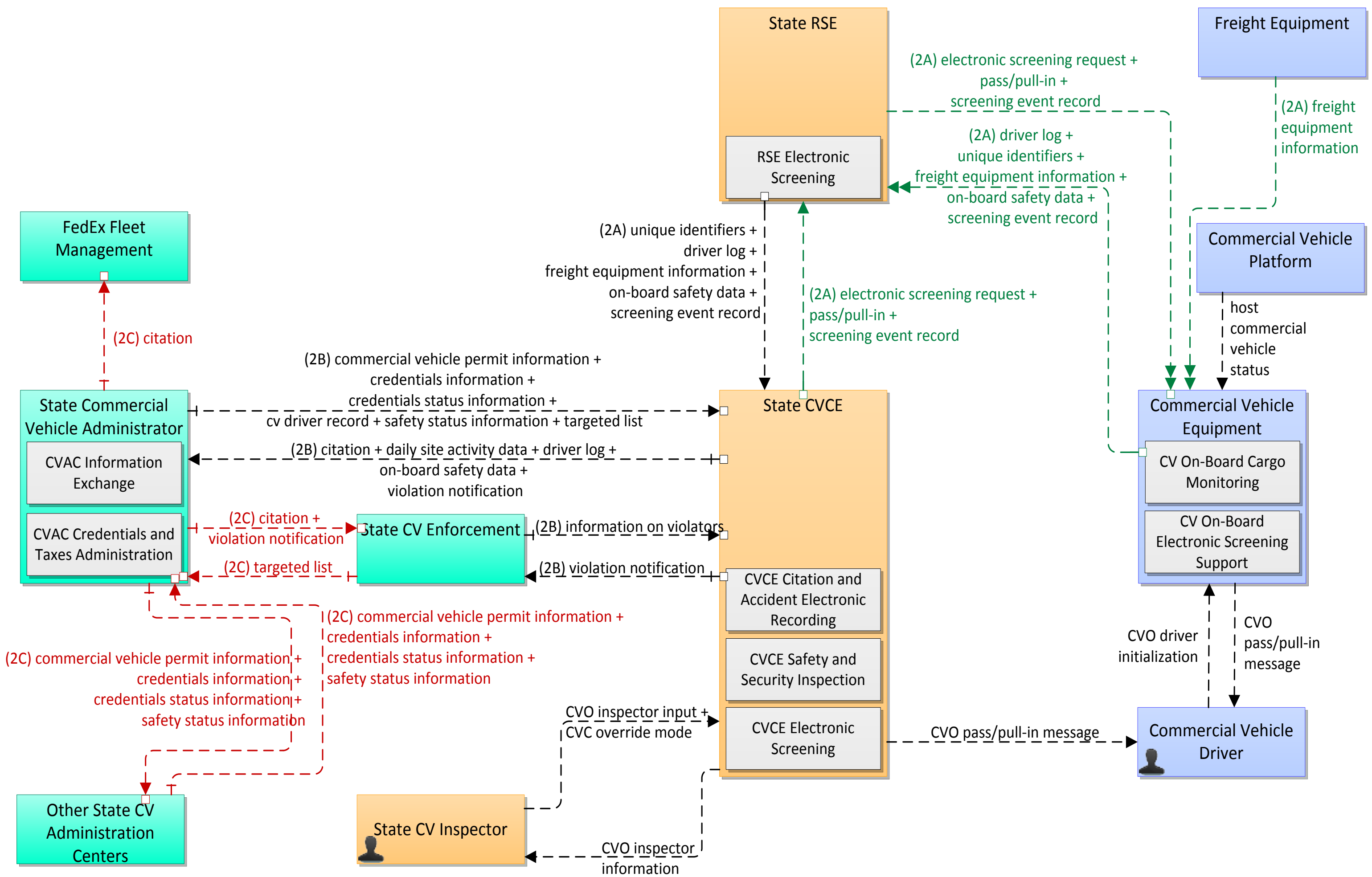
Along with the general purpose information flows will be a number of peer-to-peer data exchange flows to support decision management, maintenance, enforcement and commercial activities related to goods on vehicle (supply chain, inventory, delivery)

Maintenance



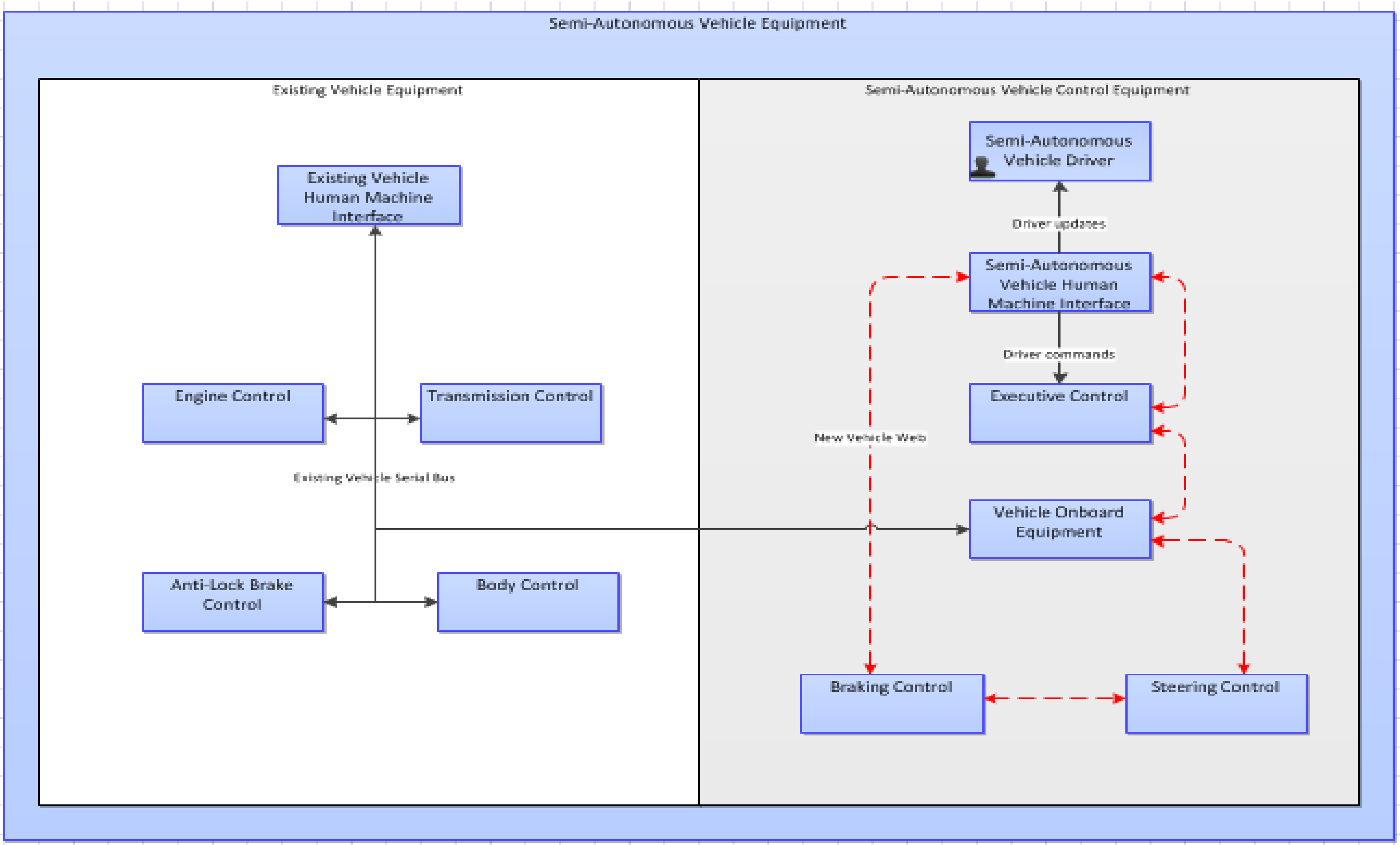
Along with the general purpose information flows will be a number of peer-to-peer data exchange flows to support decision management, maintenance, enforcement and commercial activities related to goods on vehicle (supply chain, inventory, delivery)

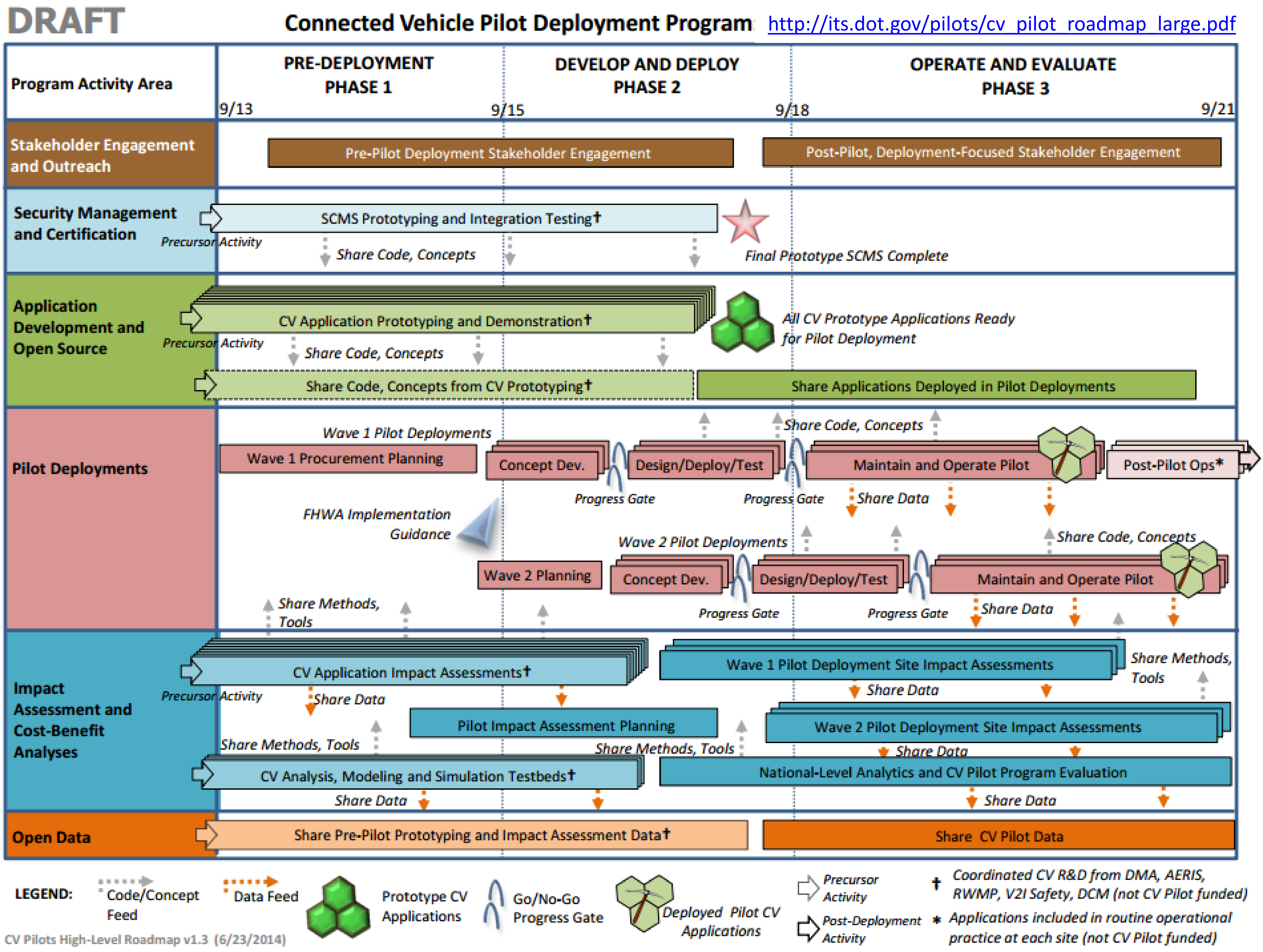
Enforcement



2: Smart Roadside Initiative (Electronic Clearance (Inspection Station)) (Copy 1)			
2	Based on CVRIA diagram r5	Oct 30 2014	WLF

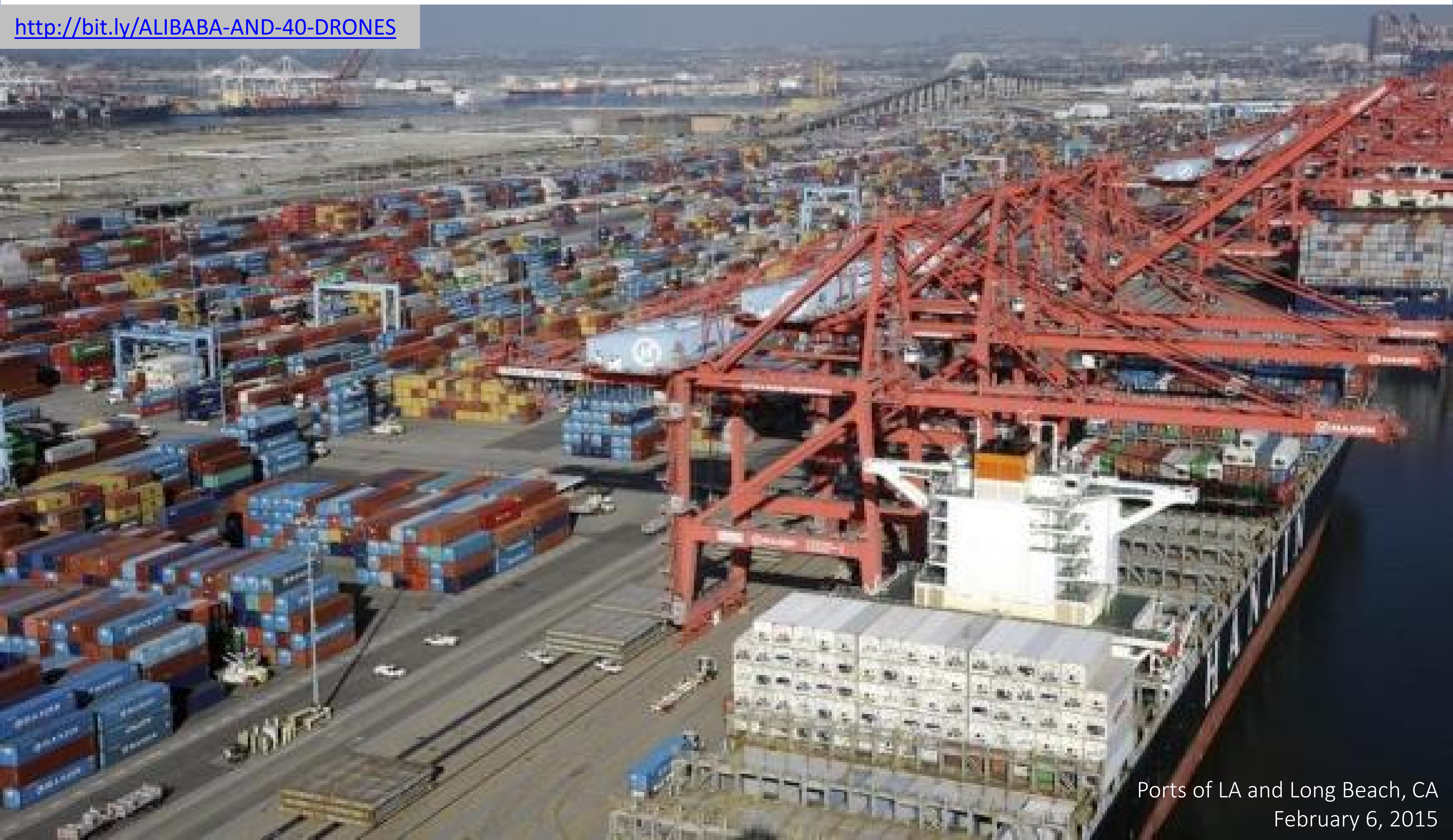
Several of the physical objects of BDP2 will be systems within systems (IoS). For example, within the semi-autonomous vehicle (physical object) will be the system that describes the semi-autonomous "brain" (BDP1) of the SDV (robotic navigation) which should/may function in Pittsburgh, Long Beach, Schiphol Airport, Port of Kaohsiung, Port of Oostende




DRAFT
Connected Vehicle Pilot Deployment Program http://its.dot.gov/pilots/cv_pilot_roadmap_large.pdf
Program Activity Area
PRE-DEPLOYMENT PHASE 1
DEVELOP AND DEPLOY PHASE 2
OPERATE AND EVALUATE PHASE 3
9/13
9/15
9/18
9/21
Stakeholder Engagement and Outreach
Pre-Pilot Deployment Stakeholder Engagement
Post-Pilot, Deployment-Focused Stakeholder Engagement
Security Management and Certification
SCMS Prototyping and Integration Testing†
Precursor Activity
Share Code, Concepts
Final Prototype SCMS Complete
Application Development and Open Source
CV Application Prototyping and Demonstration†
All CV Prototype Applications Ready for Pilot Deployment
Precursor Activity
Share Code, Concepts
Share Code, Concepts from CV Prototyping†
Share Applications Deployed in Pilot Deployments
Pilot Deployments
Share Code, Concepts
Wave 1 Pilot Deployments
Wave 1 Procurement Planning
Concept Dev.
Design/Deploy/Test
Maintain and Operate Pilot
Post-Pilot Ops*
Progress Gate
Progress Gate
Share Data
FHWA Implementation Guidance
Wave 2 Pilot Deployments
Share Code, Concepts
Wave 2 Planning
Concept Dev.
Design/Deploy/Test
Maintain and Operate Pilot
Progress Gate
Progress Gate
Share Data
Share Methods, Tools
Impact Assessment and Cost-Benefit Analyses
CV Application Impact Assessments†
Precursor Activity
Share Data
Wave 1 Pilot Deployment Site Impact Assessments
Share Methods, Tools
Share Data
Pilot Impact Assessment Planning
Wave 2 Pilot Deployment Site Impact Assessments
Share Methods, Tools
Share Methods, Tools
Share Data
CV Analysis, Modeling and Simulation Testbeds†
National-Level Analytics and CV Pilot Program Evaluation
Share Data
Share Data
Open Data
Share Pre-Pilot Prototyping and Impact Assessment Data†
Share CV Pilot Data
LEGEND:
Code/Concept Feed
Data Feed
Prototype CV Applications
Go/No-Go Progress Gate
Deployed Pilot CV Applications
Precursor Activity
Post-Deployment Activity
† Coordinated CV R&D from DMA, AERIS, RWMP, V2I Safety, DCM (not CV Pilot funded)
* Applications included in routine operational practice at each site (not CV Pilot funded)
CV Pilots High-Level Roadmap v1.3 (6/23/2014)

Why focus on freight ?

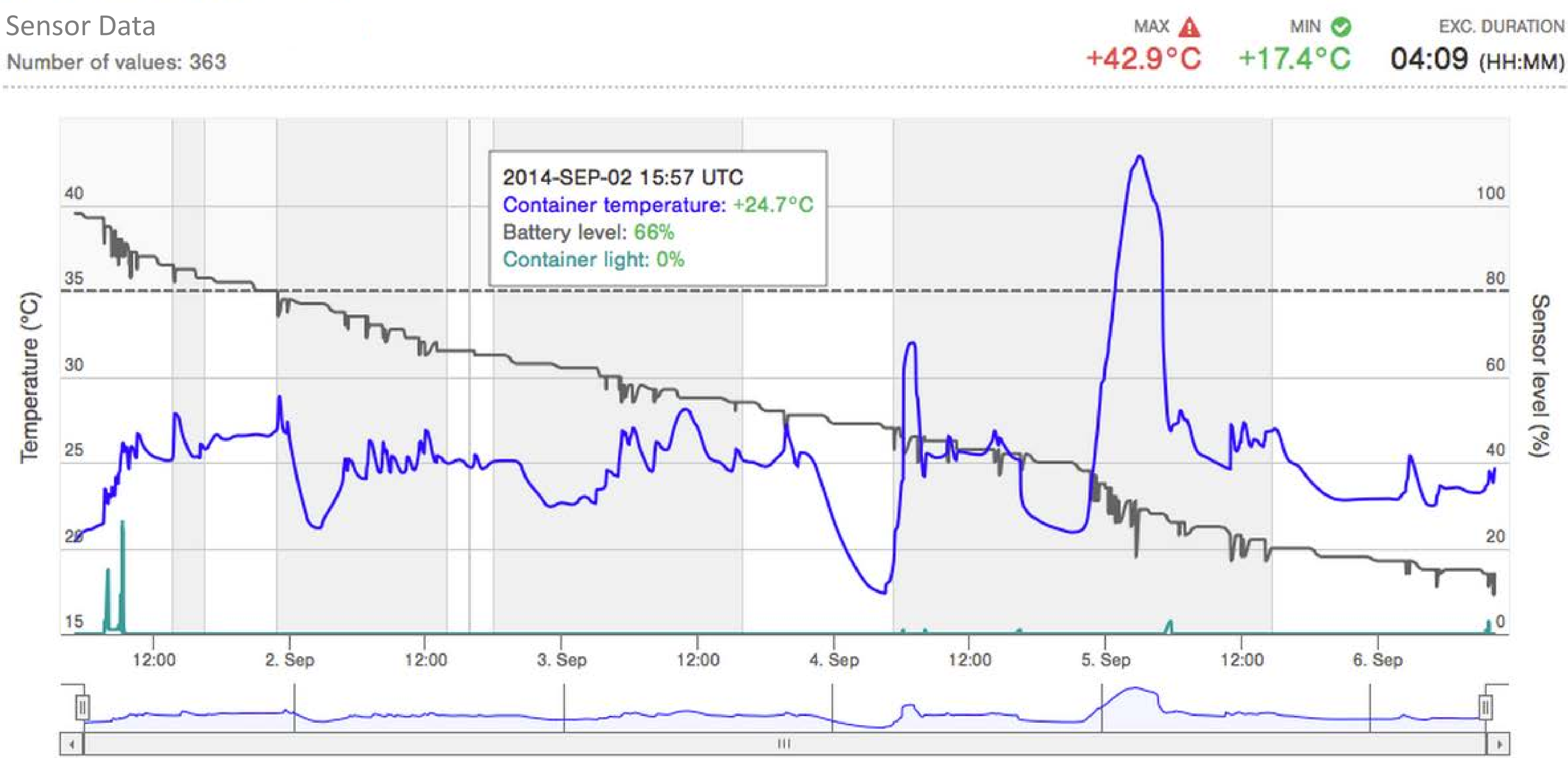
http://bit.ly/ALIBABA-AND-40-DRONES



Ports of LA and Long Beach, CA
February 6, 2015

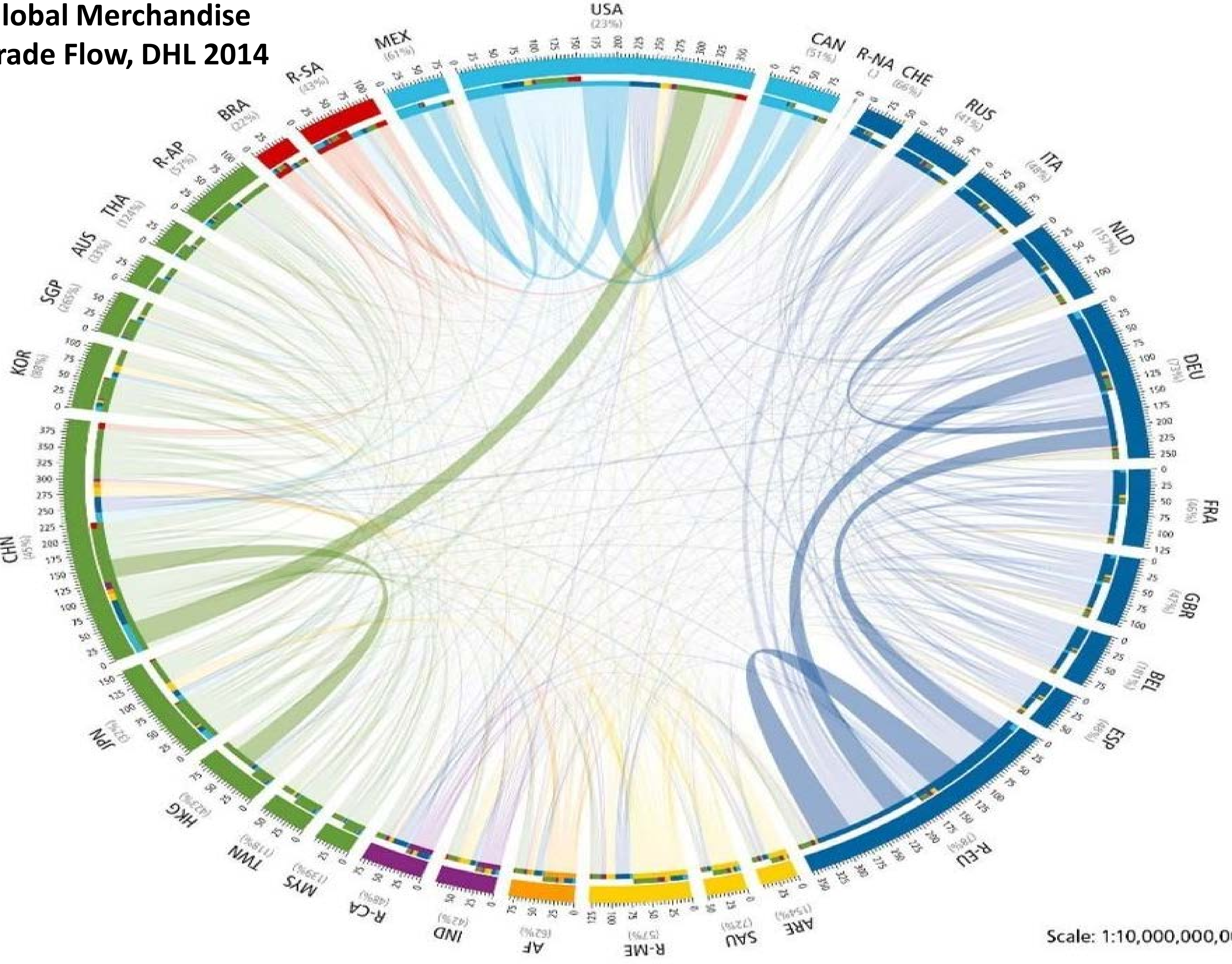
Why focus on freight ?

Refrigerated transport of perishable food items and bio-pharmaceuticals (vaccines) critical to life



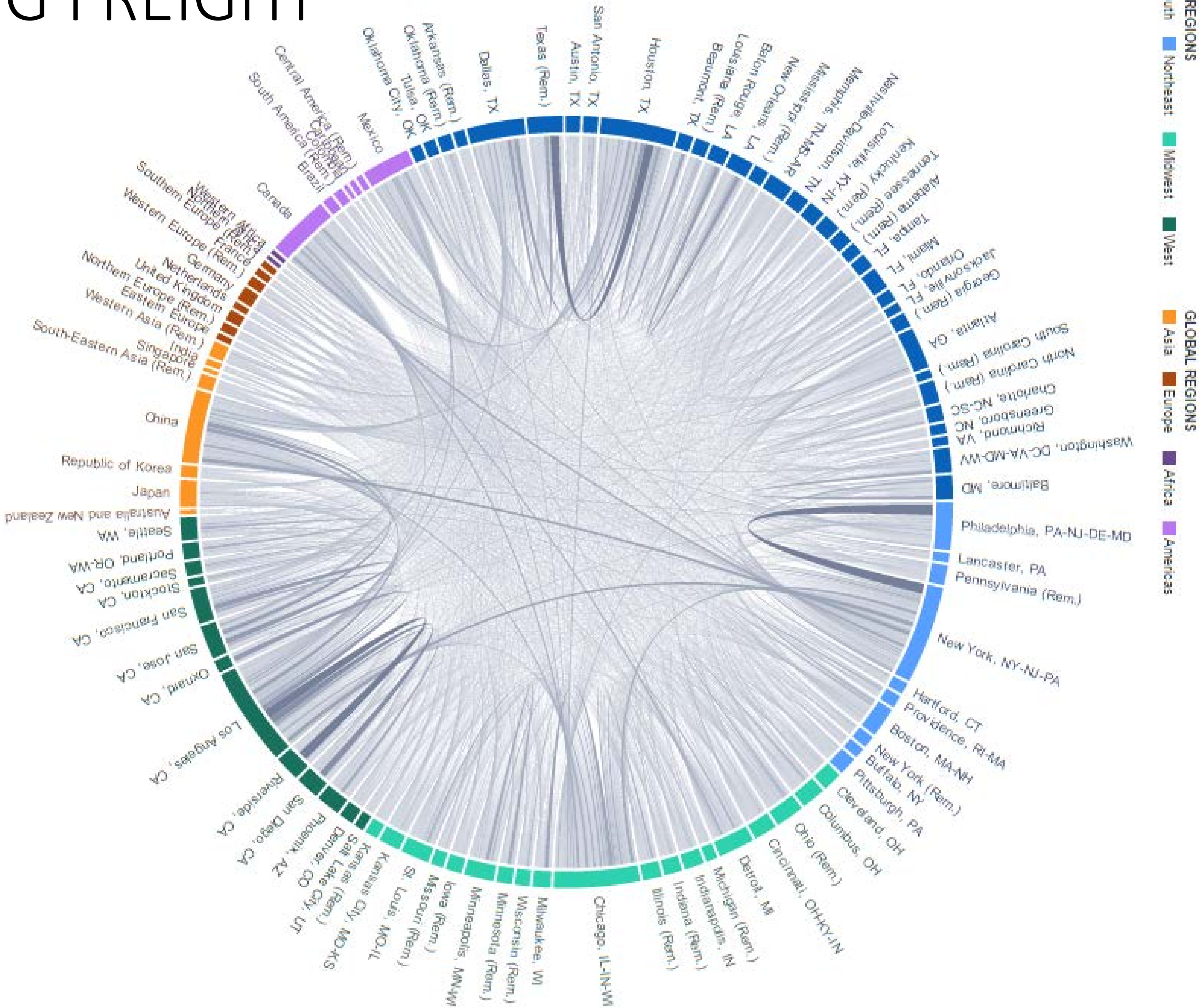
www.starbright.se/growth-in-refrigerated-transports/

Global Merchandise Trade Flow, DHL 2014



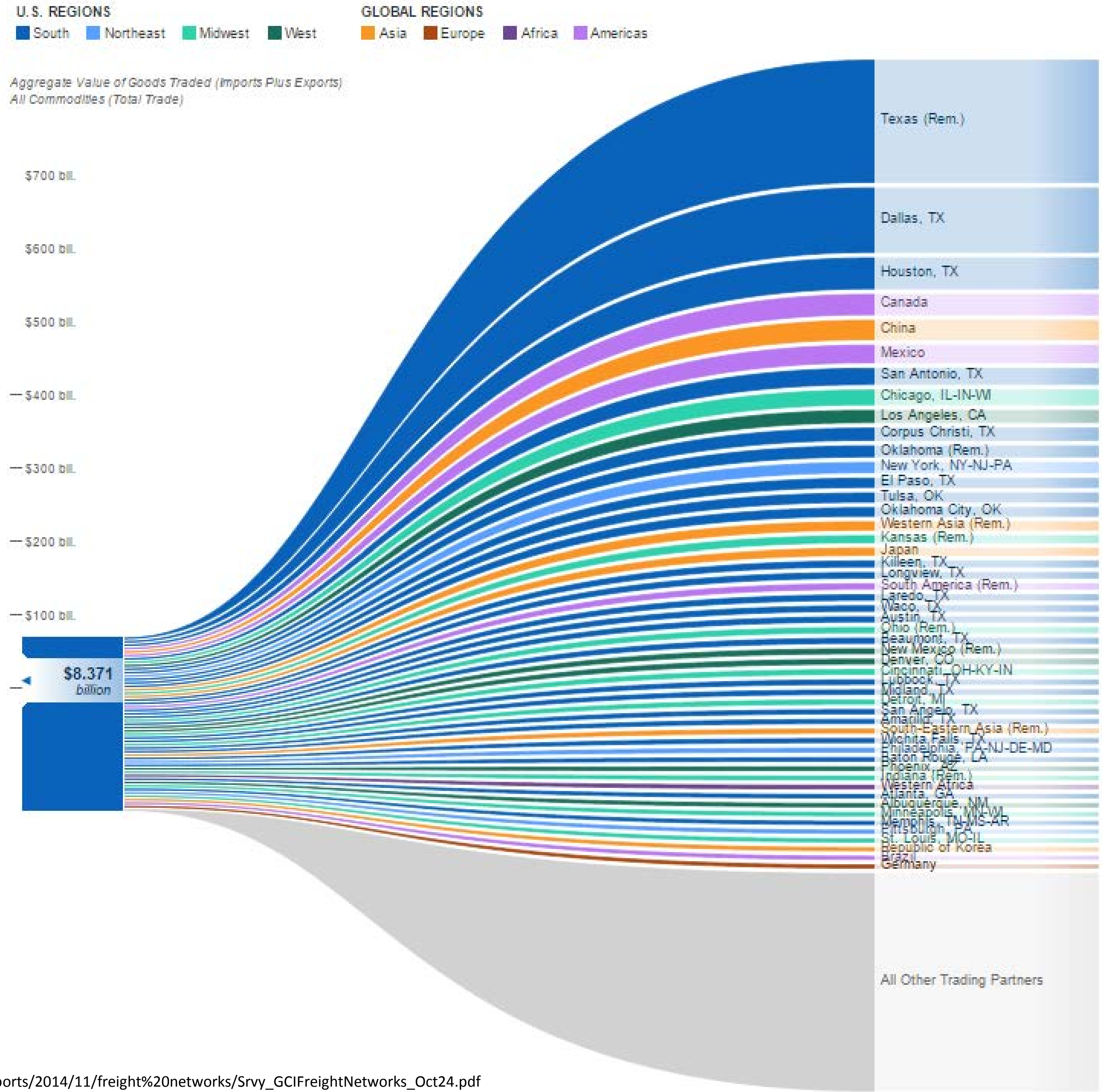
www.dhl.com/content/dam/Campaigns/gci2014/downloads/dhl_gci_2014_study_high.pdf

MAPPING FREIGHT



www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

Trade between Abilene, Texas & its partners



www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

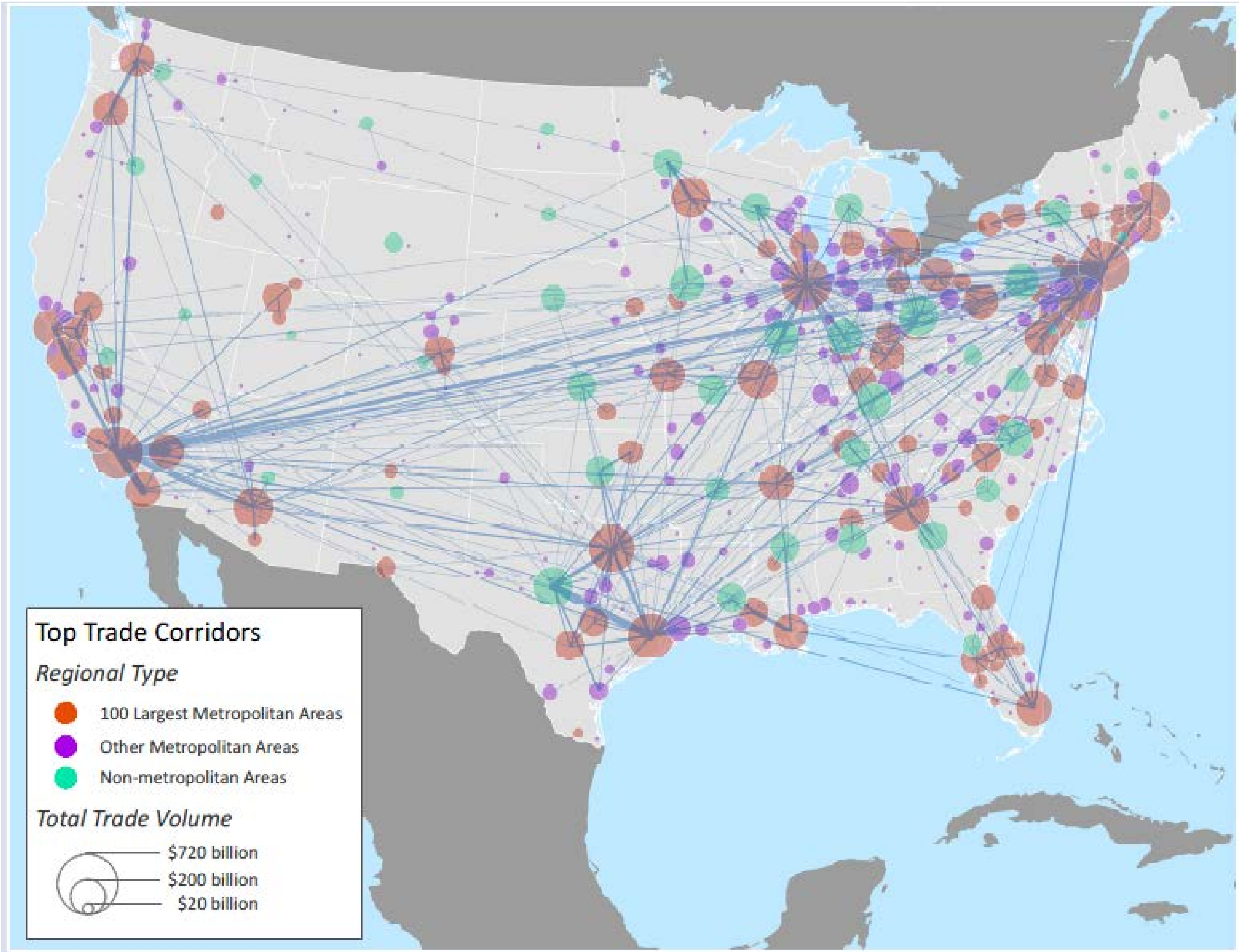
National Goods Trade ($20 trillion) exceeds GDP ($15 trillion)

		Destination				
		100 Metro Areas	Other Metro Areas	Non-Metro Areas	International	Total $ (millions)
Origin	100 Metro Areas	$6,345,676.8	$2,120,203.7	$1,755,438.9	$746,583.5	$10,967,902.9
	Other Metro Areas	$2,074,231.9	$824,166.1	$754,764.3	$258,508.2	$3,911,670.6
	Non-Metro Areas	$1,967,359.5	$865,213.4	$526,407.0	$240,862.9	$3,599,842.7
	International	$1,183,735.7	$363,097.0	$267,598.8	---	$1,814,431.4
	Total	*$11,571,003.9*	*$4,172,680.2*	*$3,304,208.9*	*$1,245,954.6*	*$20,293,847.6*

10% of US trade corridors move ~80% of all goods, the most valuable of which are concentrated in the country's 100 largest metropolitan areas. The national trade network—which includes the exchange of goods between different metropolitan areas, non-metropolitan areas, and foreign countries—moved $20.3 trillion worth of goods in 2010 (Brookings Institution, November 2014)

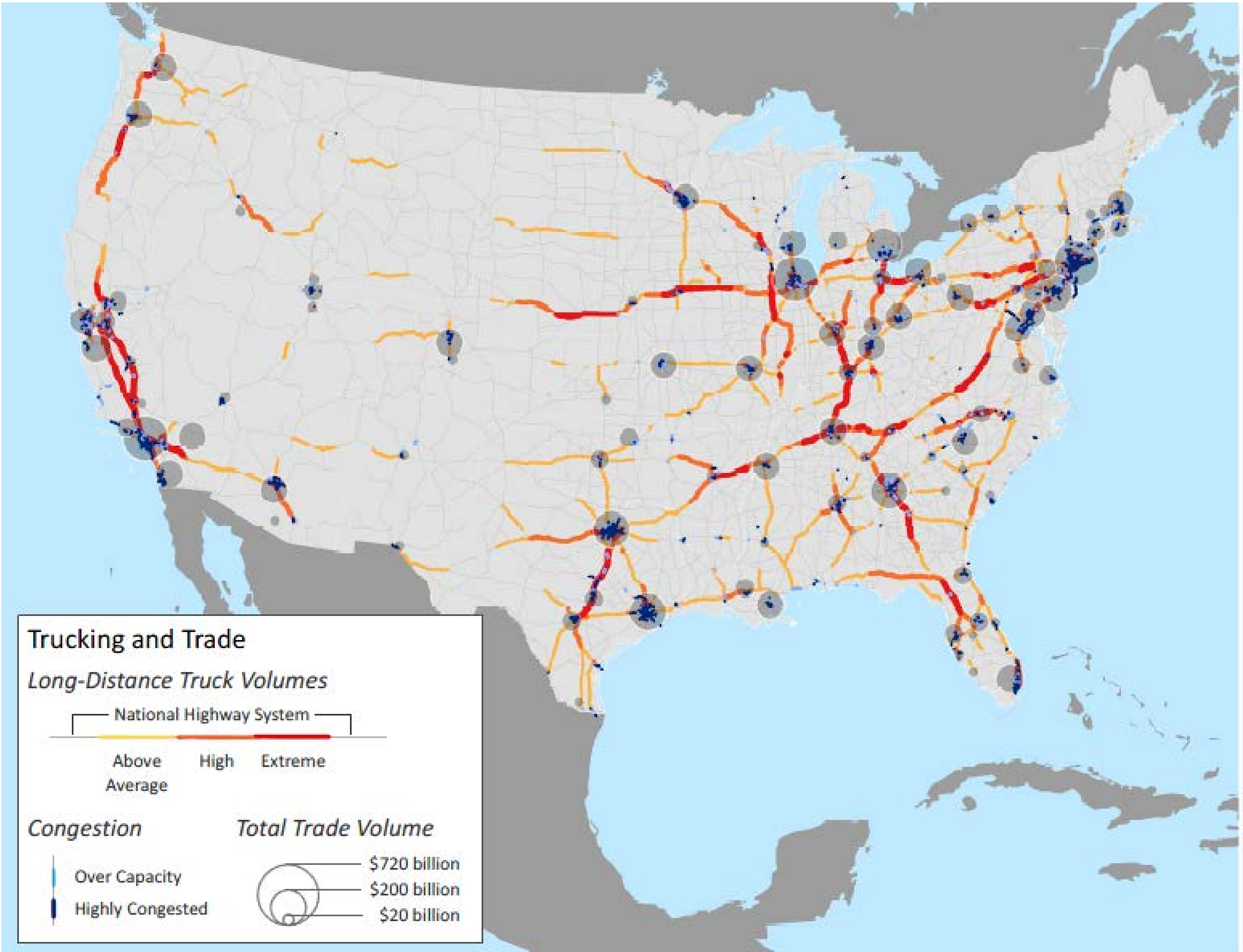
www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

Top 1% of corridors (888 corridors) traded goods worth $4.4 trillion (2010)



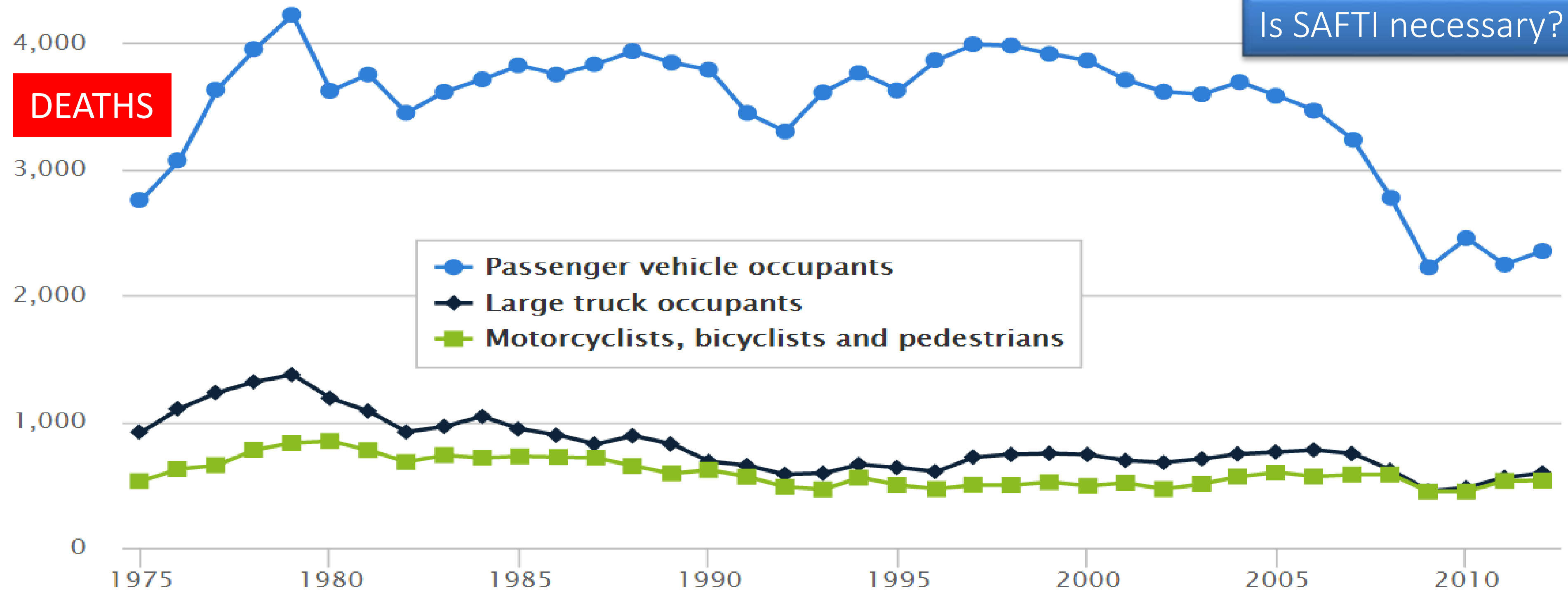
www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

Long Distance Truck Loads & Highway Congestion



www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

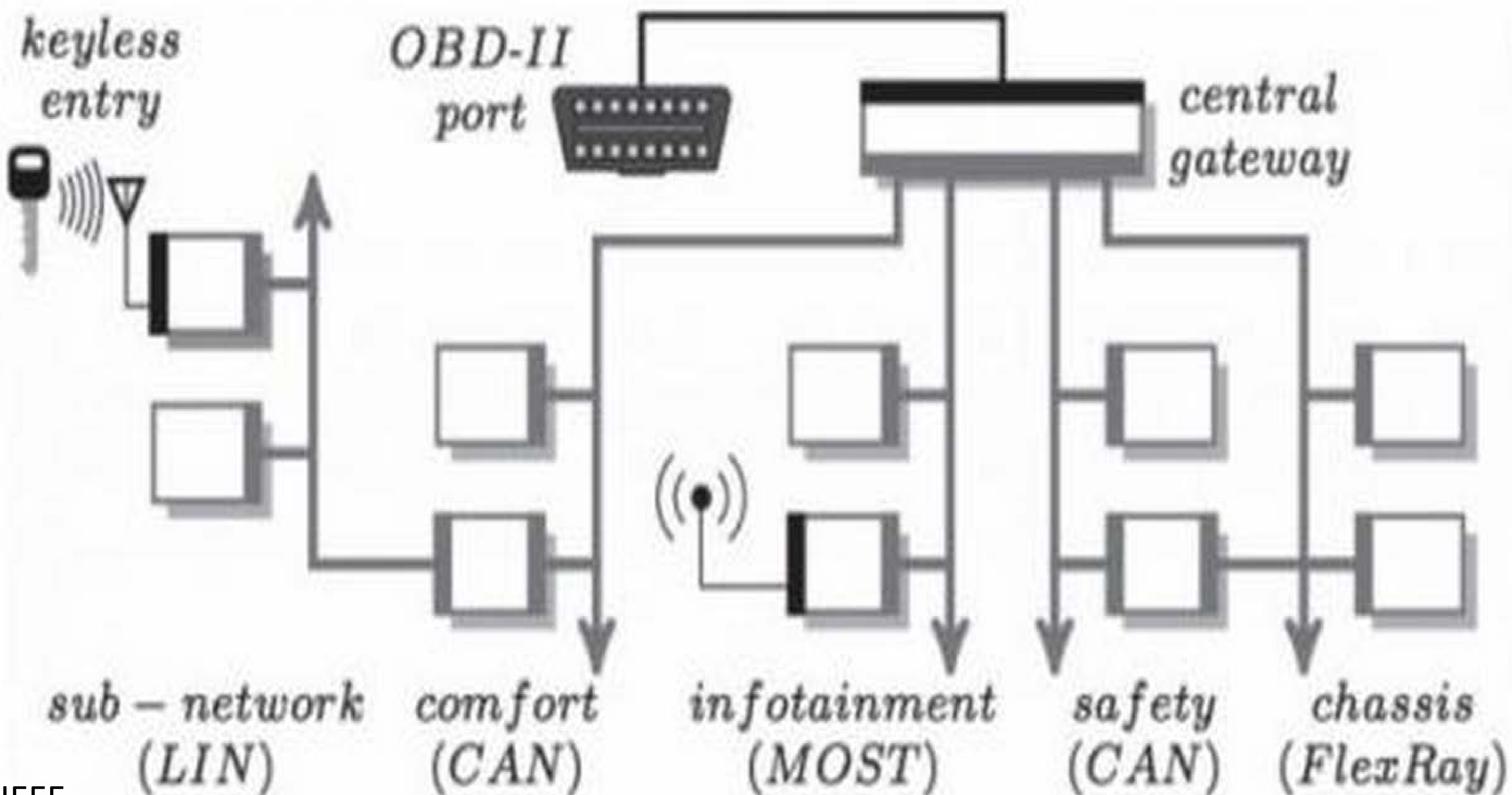
Is SAFTI necessary?



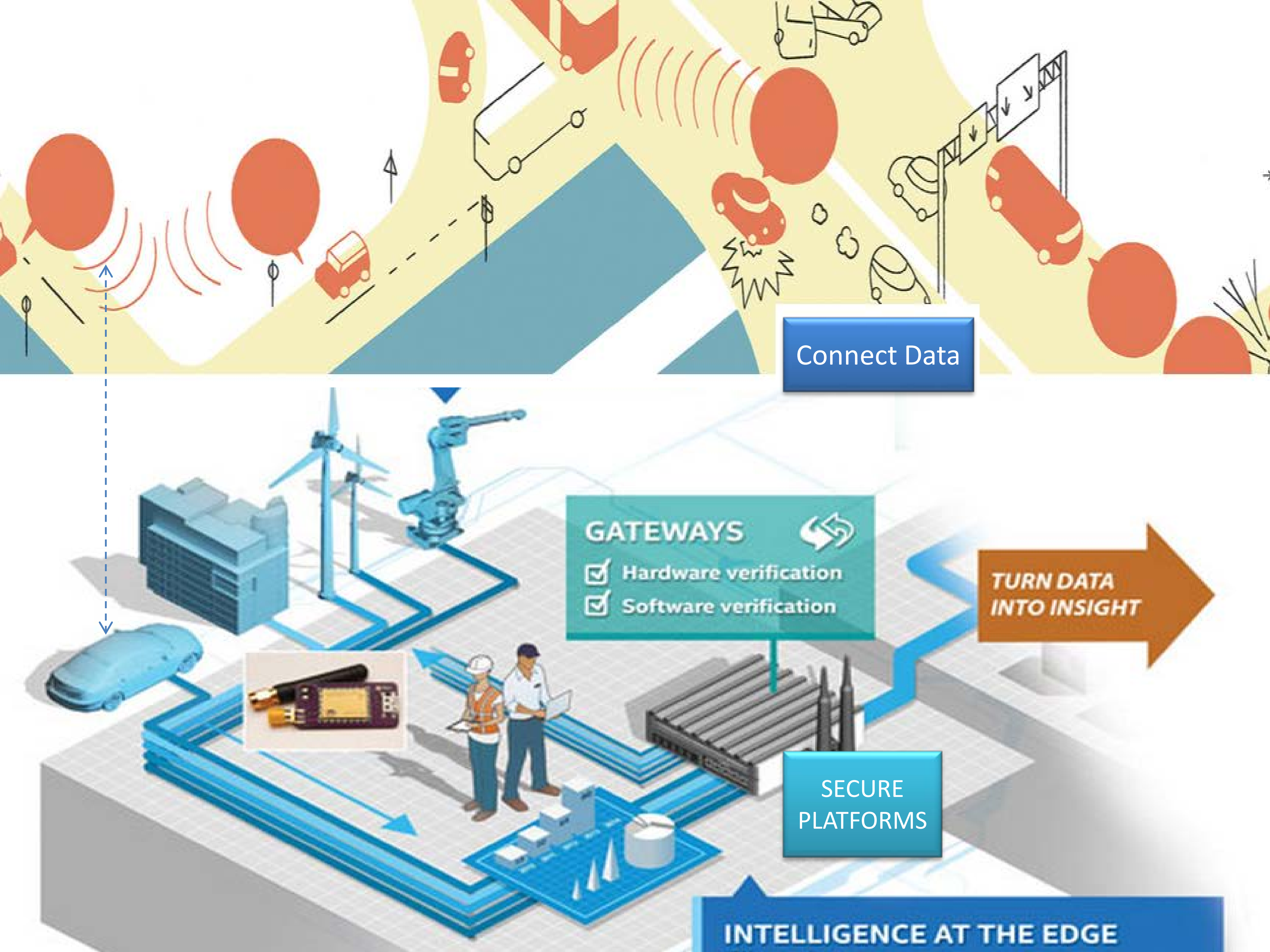
www.iihs.org/iihs/topics/t/large-trucks/fatalityfacts/large-trucks

SAFETY & SECURITY

in-vehicle network



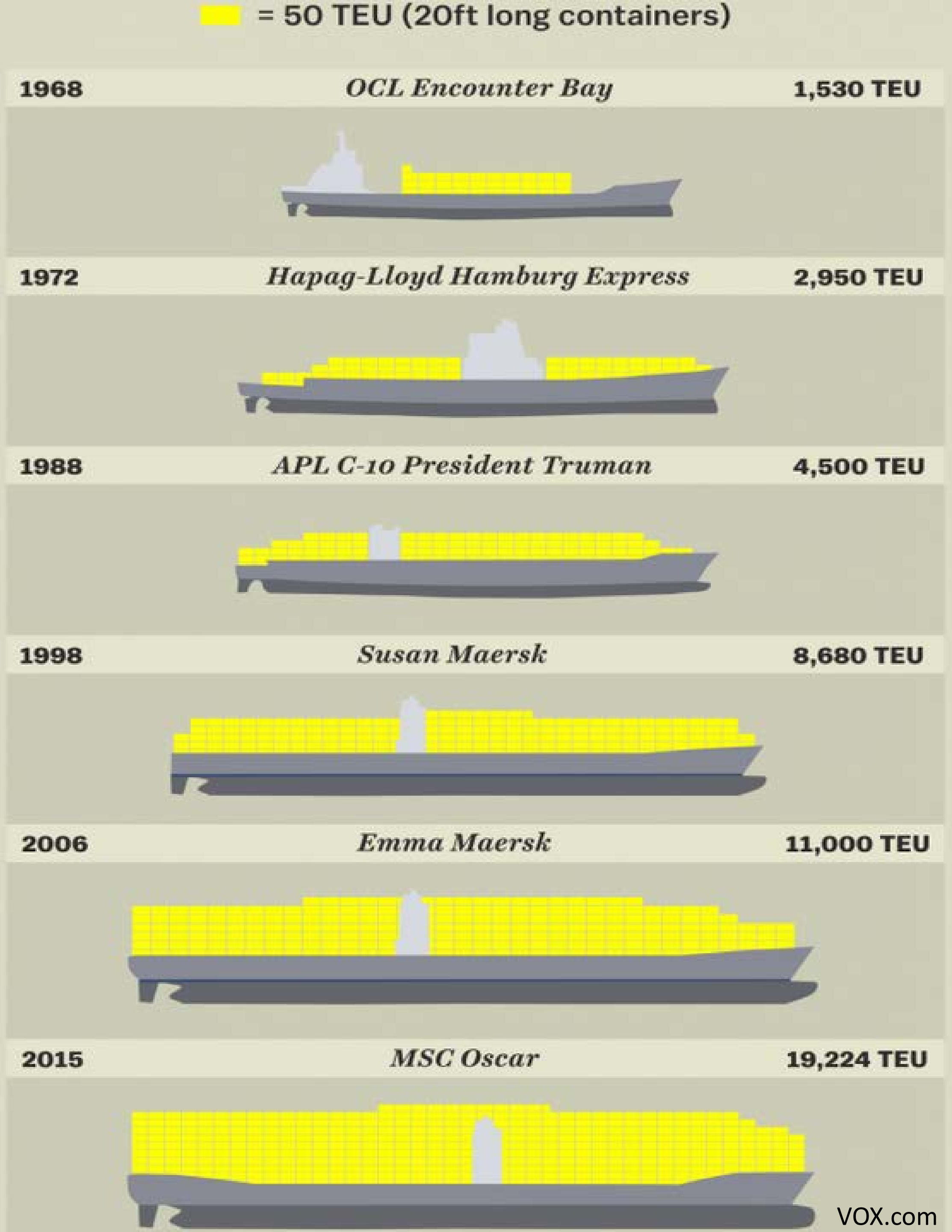
IEEE


Connect Data
GATEWAYS
Hardware verification
Software verification
TURN DATA
INTO INSIGHT
SECURE
PLATFORMS
INTELLIGENCE AT THE EDGE

SAFTI

Other Dimensions

- Resilience
- Data Deluge
- Precision Farming
- www.slideshare.net/iotdc/iot-dc-nov-18-2014
- www.slideshare.net/ctrutaustin/automated-vehicles-summit-final?related=1



Transportation Cybersecurity

LEO

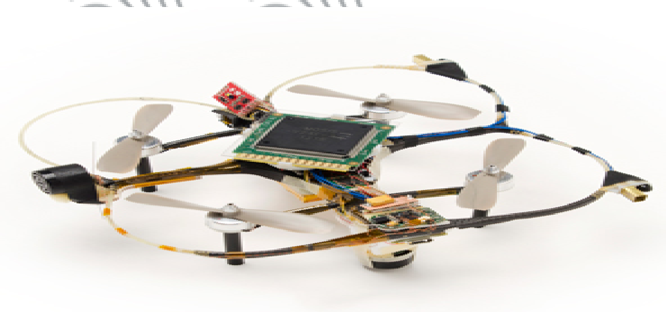
MEO

What happens if the network is disrupted?

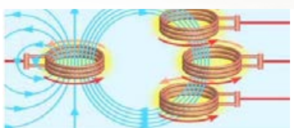
GEO

3

4



2



1

5

http://bit.ly/MICRO-DRONES-AFRL

http://bit.ly/ALIBABA-AND-40-DRONES

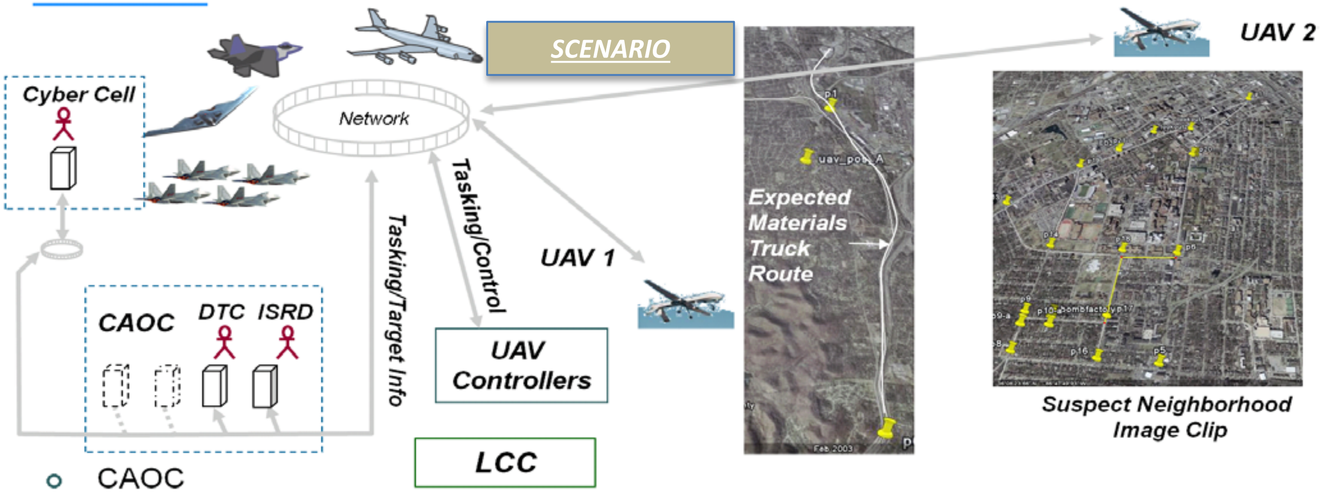
Truck installed Micro-Droneport

www.technologyreview.com/news/532176/a-brain-inspired-chip-takes-to-the-sky/

- [1] Drones on board using HACMS and fitted with UWB transceivers to create *ad hoc* radio network
- [2] Roof-top wireless electricity charging pad for droneport provided by WiTriCity
- [3] Drones transmit to LEO, MEO, NEO, HEO or GEO satellites in range
- [4] Satellite re-transmits to safe zones for communication / update
- [5] Responds with message and/or guidance to autonomous vehicle

UAV in security mission with USAF 8th Wing

Blue team:

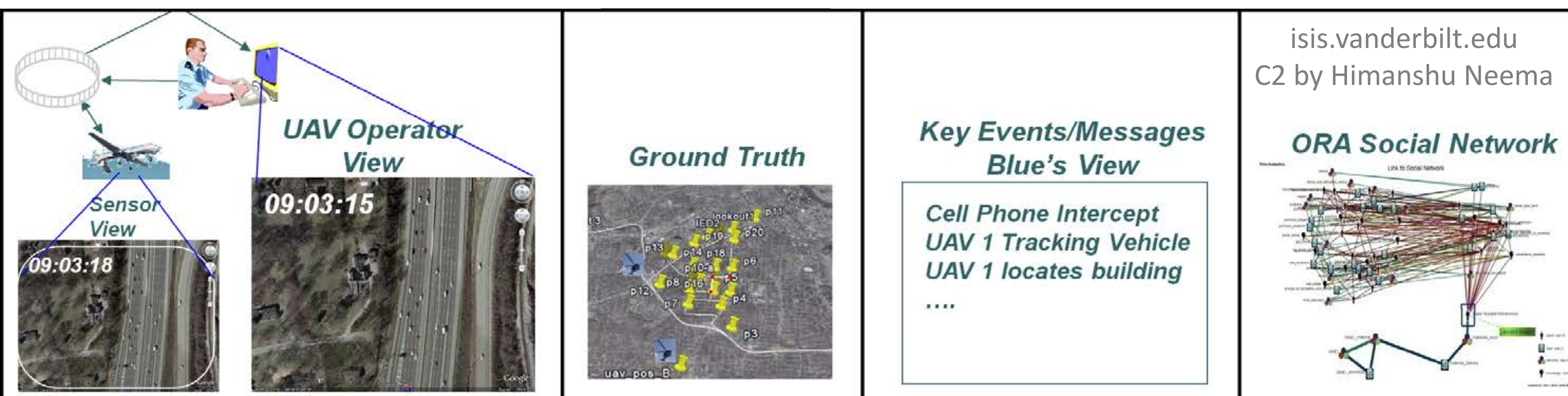


- CAOC
  - Commander
  - Dynamic Targeting Cell (DTC)
  - ISR Division (ISRD)
- Cyber Cell

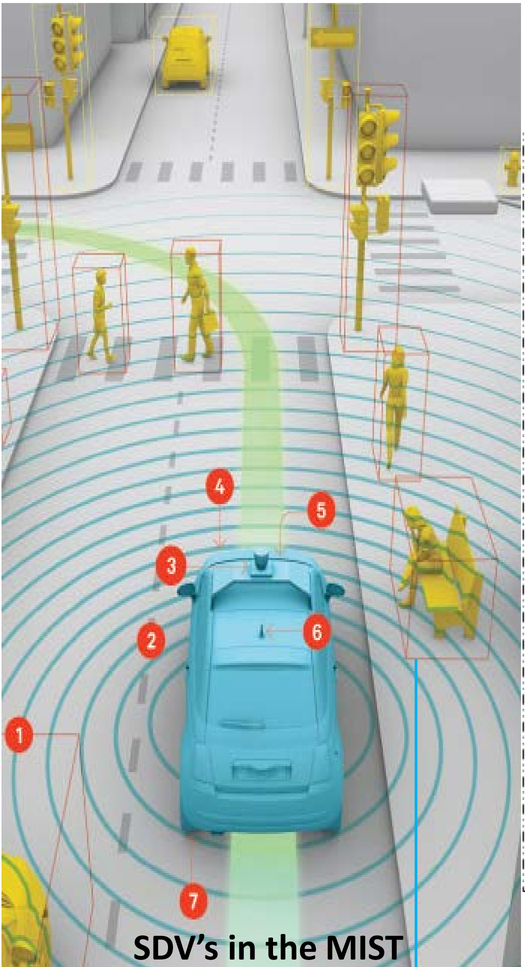
- **SIGINT**
- **UAV Operators/Controllers**
- **Land Component (LCC)**

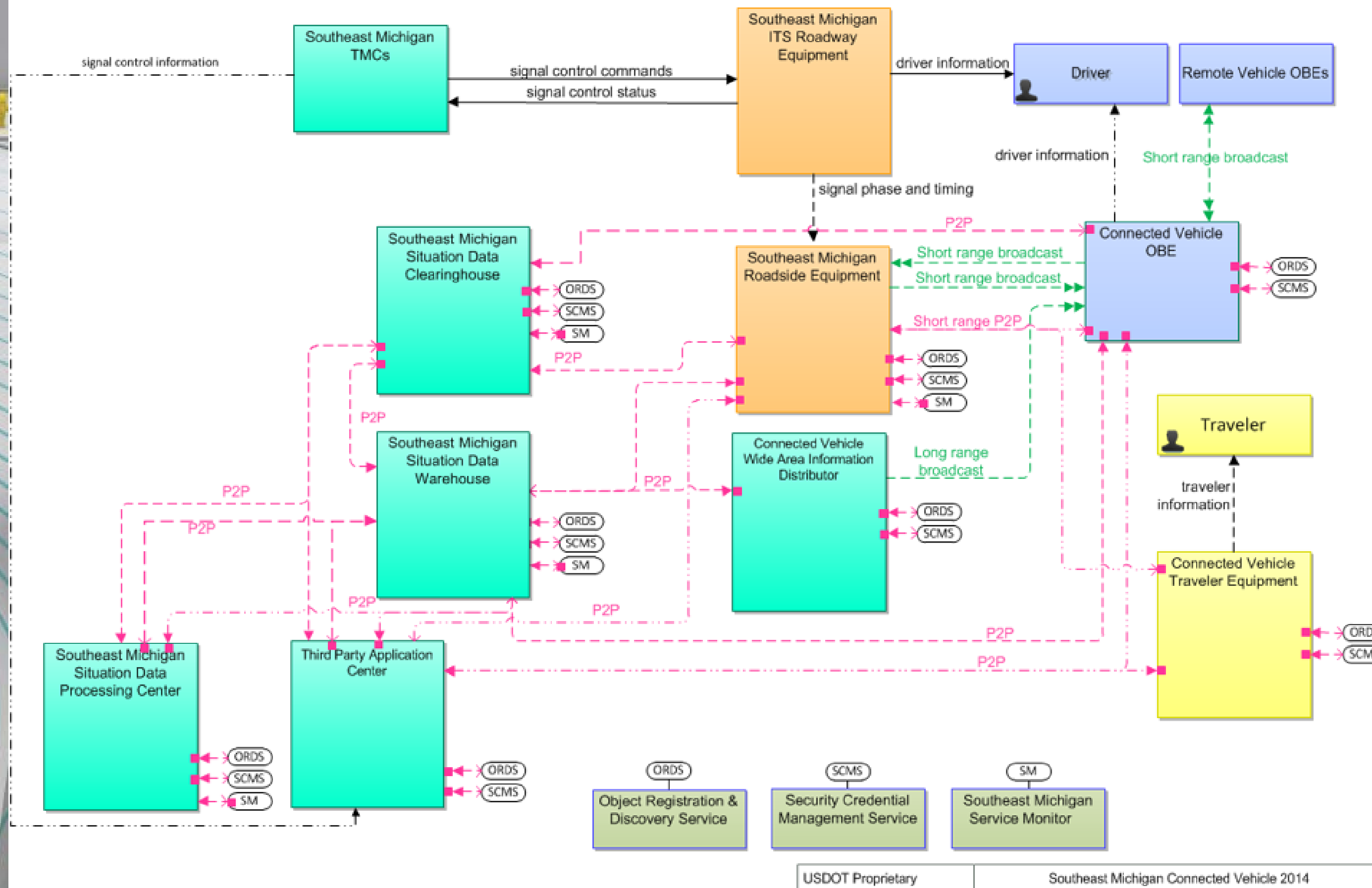
Red Team: Red Leader, WMD and VBIED trucks, truck drivers, Bomb factory

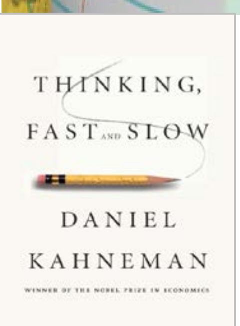
- Integration of loosely coupled models
- Track and trace time-critical targets
- Includes humans in decision support
- Resilience in face of cyber security threat
- Time-sensitive and reactive (adaptive) model
- Bi-directional action in urban environment



Hellabytes of data from deployment of software define networked vehicles (SDV)







Run-time Uncertainty Estimation?

Where is the data? Where are the sense and response run time analytical engines?

- Depends on bounded latency
- Cloud or Fog or Software Defined Vehicles in the Mist (*Gorillas in the Mist*)

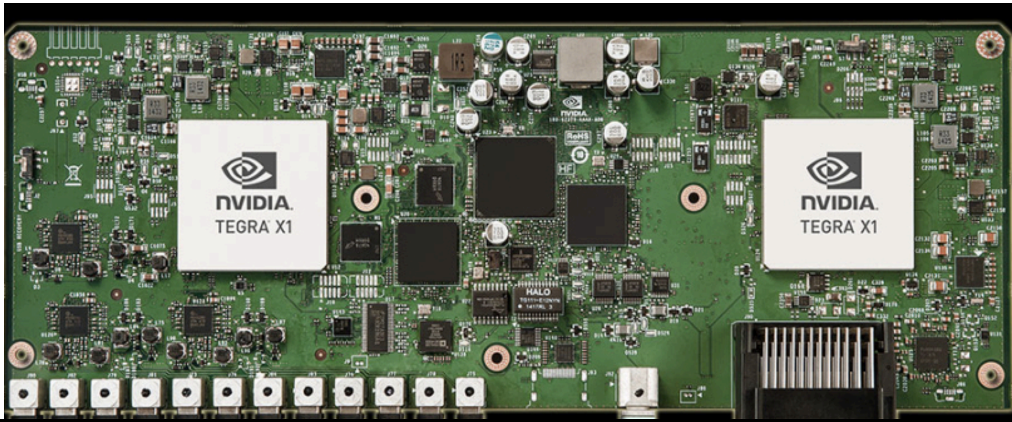
What is the Mist ? Ad hoc Composable Mobile Dynamic Grid Computing

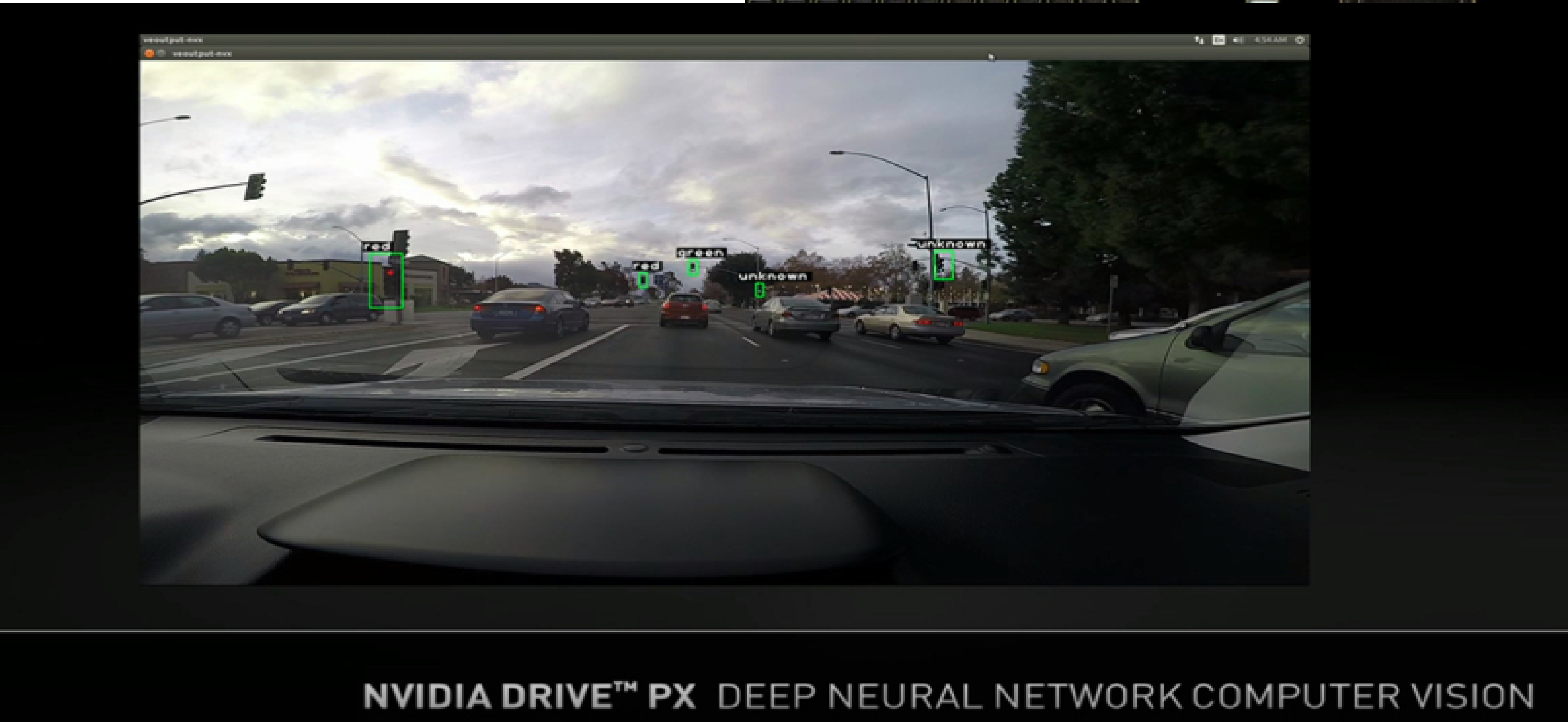
Access available computing power in near field vehicles for run time analytics (Mist)

Reuse concept of "grid computing to solve protein structure by using idle computers"

Globus Tool Kit by Steve Tuecke (do not confuse with marketing material by MS Cloud)

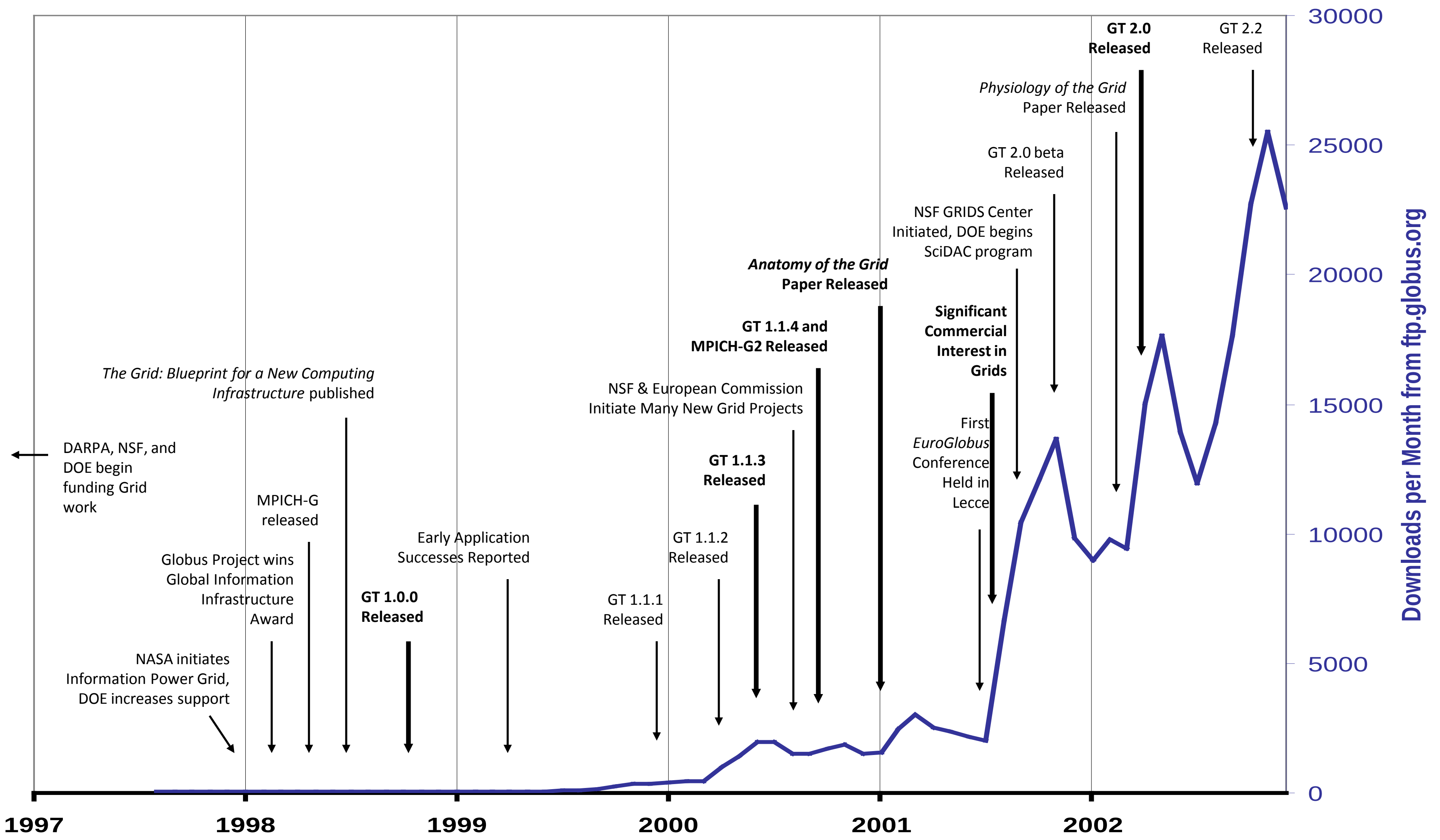
Tools for Composable Mobile Dynamic "Mist" Computing





Evolution of Grid Computing and Globus Toolkit

Composable Near Field Computing or “ Mist ”



Hellabytes of Data Per Second from Software Defined Vehicles

An example of collaboration of the cyber-physical systems is the collaboration of vehicles in proximity to avoid collisions. These vehicles communicate with each other in the cyber space dynamically forming an ad hoc communities to inform others the actions each of them is taking that may affect the communities of vehicles. Examples of such actions include applying a brake or changing lanes. They also interact, albeit indirectly, in the physical space by continuously sensing and measuring the movement and trajectory neighboring vehicles. The information gathered from both the cyber and the physical spaces is then synthesized to gain an understanding of the state and intent of the vehicles in proximity. From this understanding and based on prescribed objectives (e.g. to avoid collision, a physical effect), control decisions are continuously made to produce the desired physical effects in the vehicle in question, e.g. to slow down, stop, accelerate or change course, in order to avoid the undesired ones, such as collision between vehicles or between vehicles and other objects. [NIST CPS PWG ▪ Frameworks]

IoS (Cyberphysical Systems + Data) = Collision Avoidance

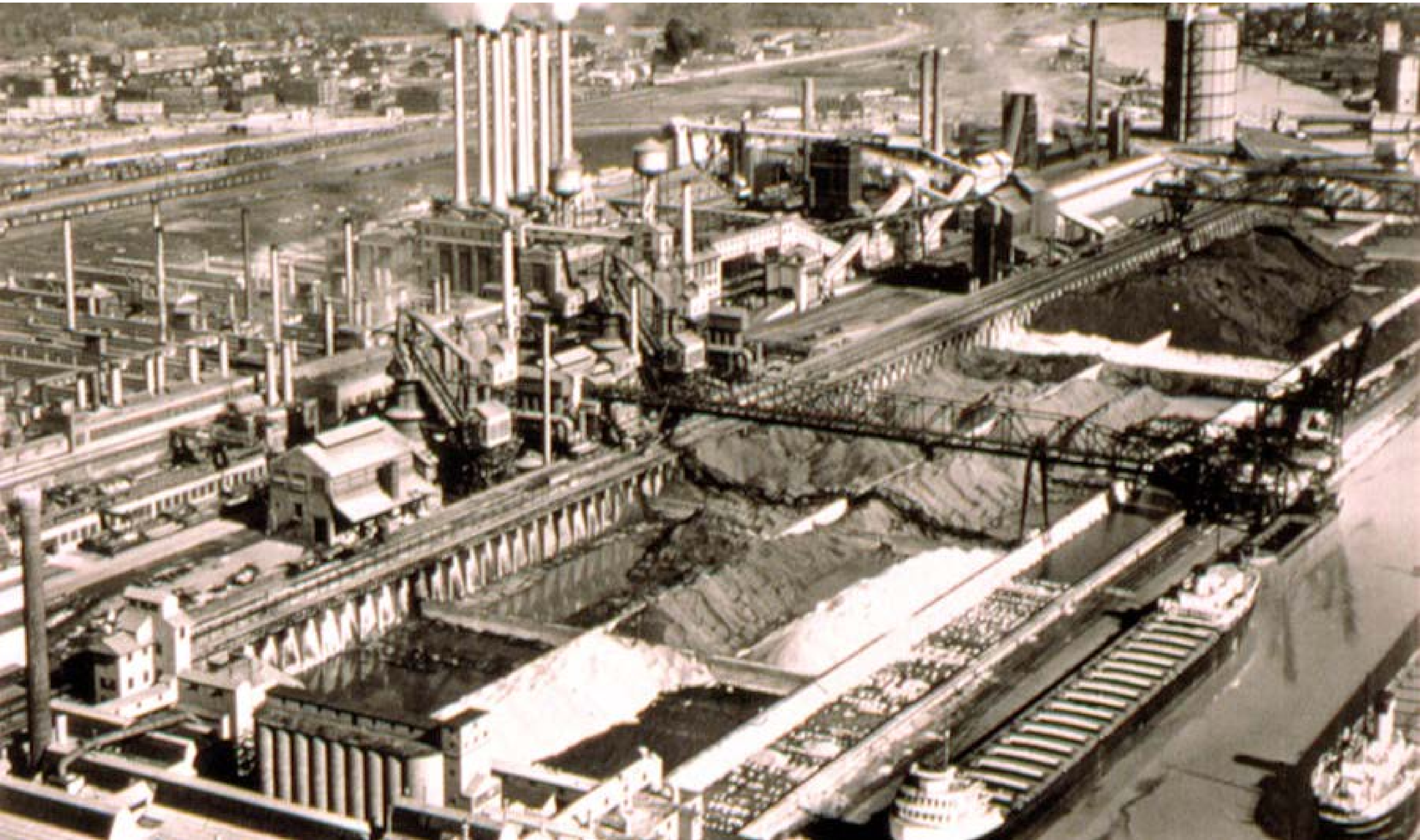
MIND THE GAP

IIC SAFTI proposal was modified to Intelligent Transport System (ITS) proposal and submitted to US DoT

OUTLINE OF THE INDUSTRIAL INTERNET CONSORTIIUM PROPOSAL TO DOT

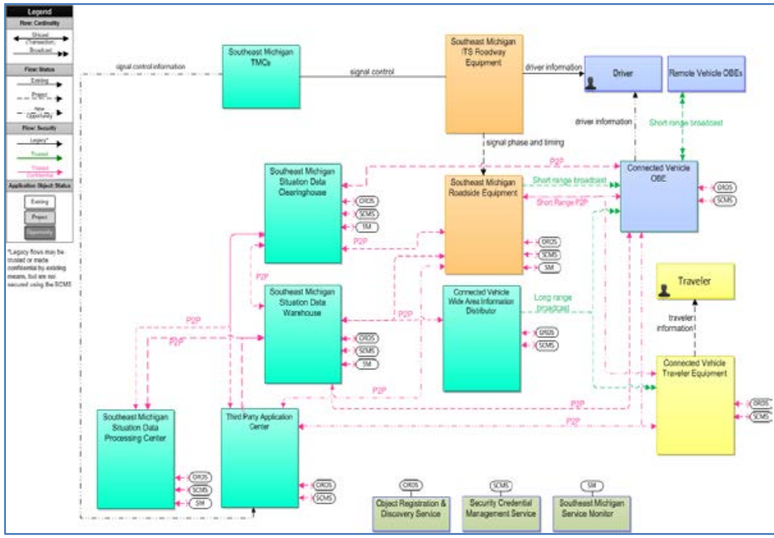
Submitted on March 27, 2015

The Transportation Grand Challenege coalition of IIC members and non-members who jointly submitted the proposal to DoT drew inspiration from the Ford Rouge River Plant (1928)



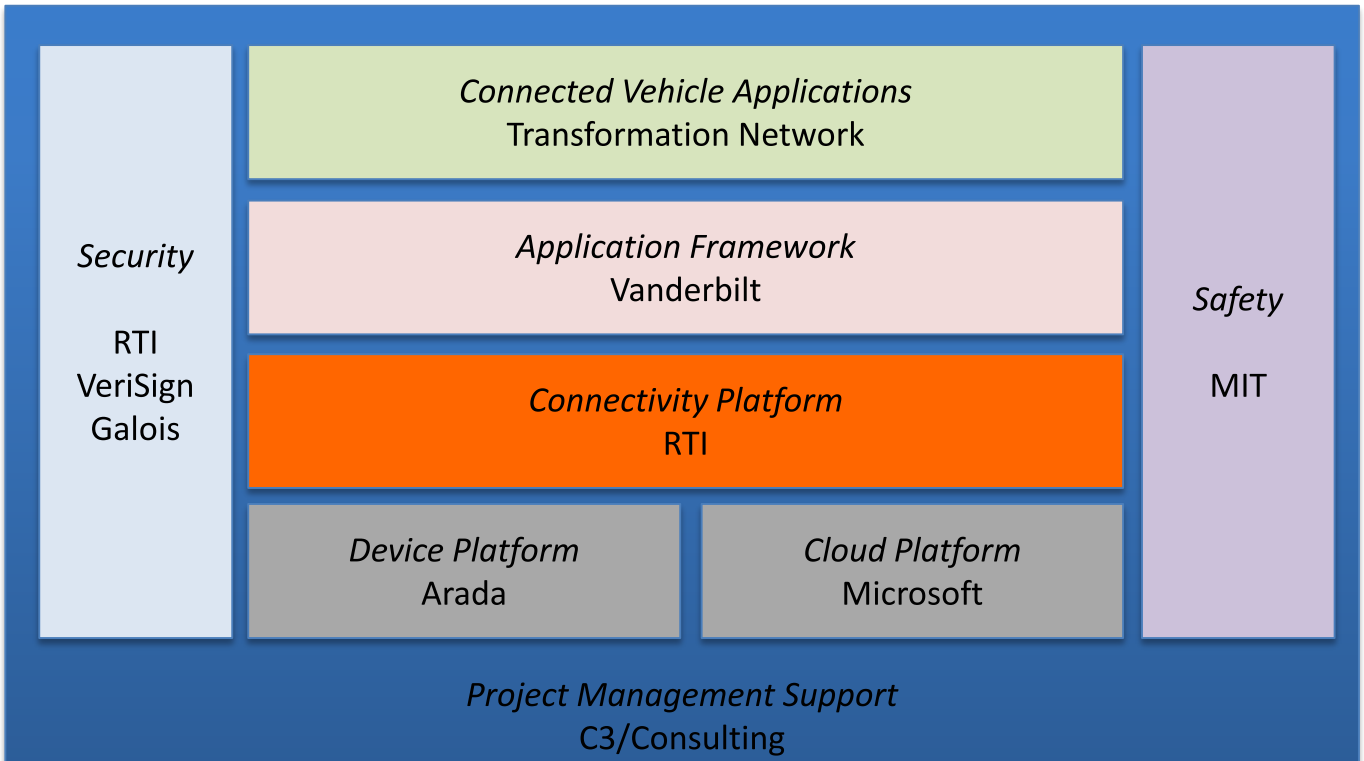
IIC Transportation Proposal Team

- IIC team proposes to develop a scalable, practical, usable next generation connected-vehicle infrastructure and demonstrate it in actual use in Owosso, MI
  - Software automation, scalable networking and security are key deliverables
- Team:
  - Vanderbilt University (tools) Prime Phase 1
  - RTI (middleware) Prime Phase 2
  - Arada (deployment) Prime Phase 3
  - Transformation Network (domain expert)
  - Microsoft (Azure cloud)
  - Verisign (certificate provisioning)
  - Galois (security arch review, testing)
  - Enterprise Web (provisioning)
  - MIT (traffic control, autonomy)
  - Tech Mahindra (operations)
  - NI (engineering software & roadside equipment)
  - Cyber Lightning (visualization)
  - Parstream (analytics)
  - SiriusXM (connectivity)

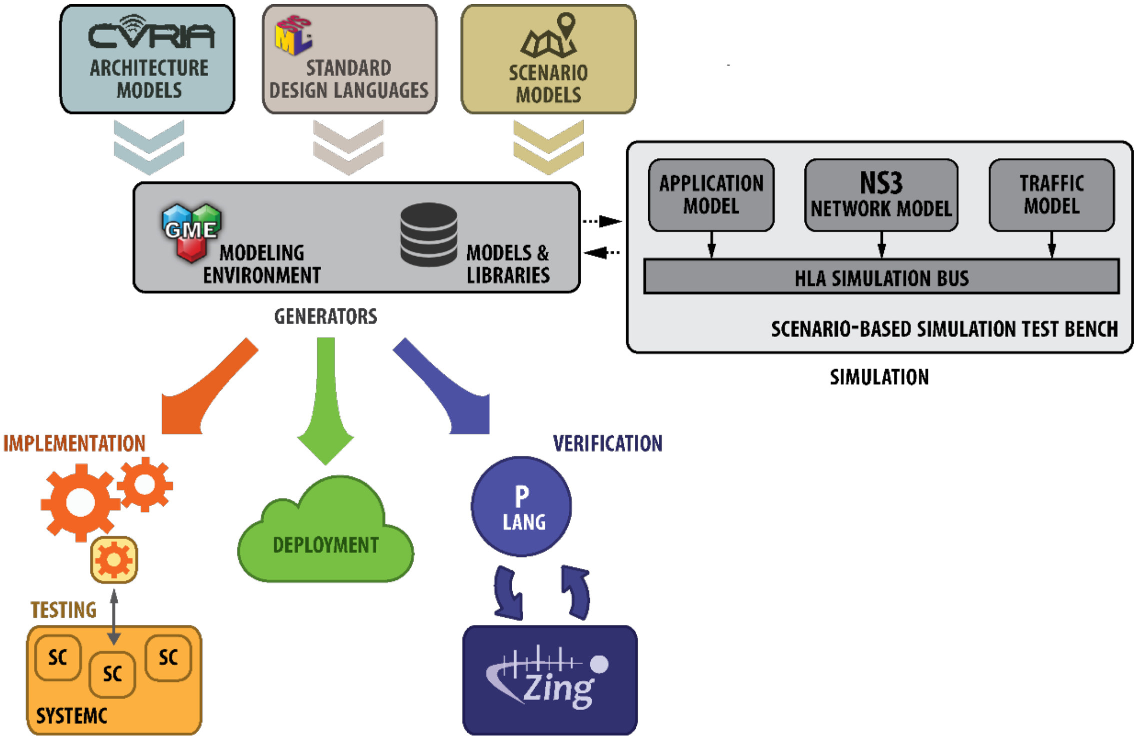


US DoT Connected Vehicle Reference Implementation Architecture (CVRIA)

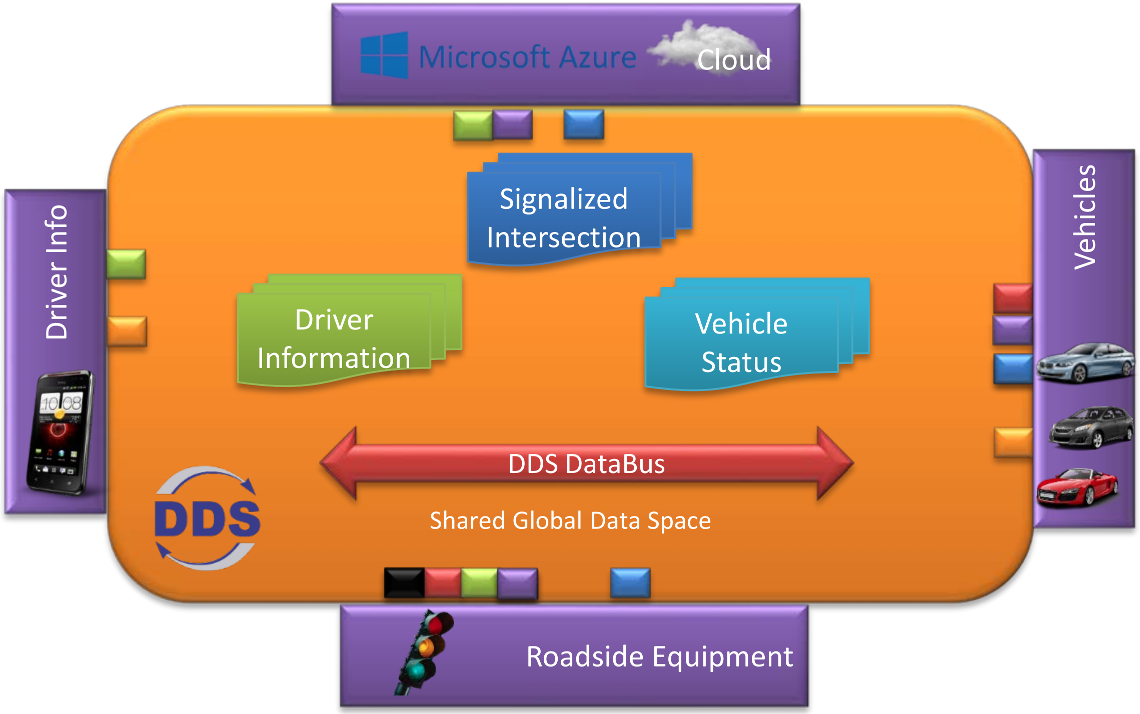
Team Structure by Architectural Emphasis



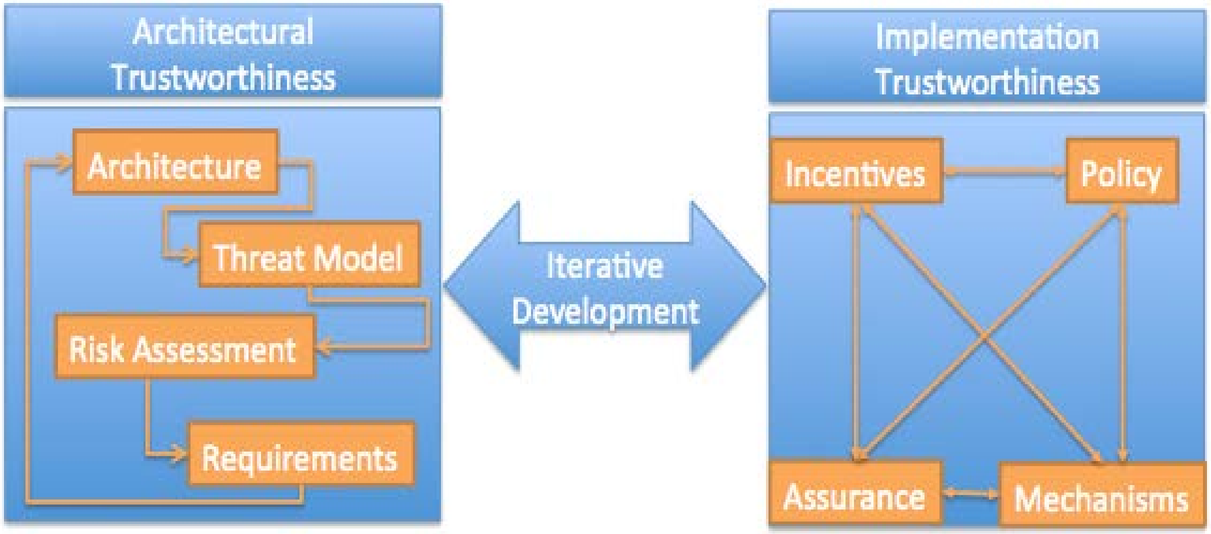
Domain-Specific Modeling Languages (DSML)



Standard Connectivity Platform



Security Analysis

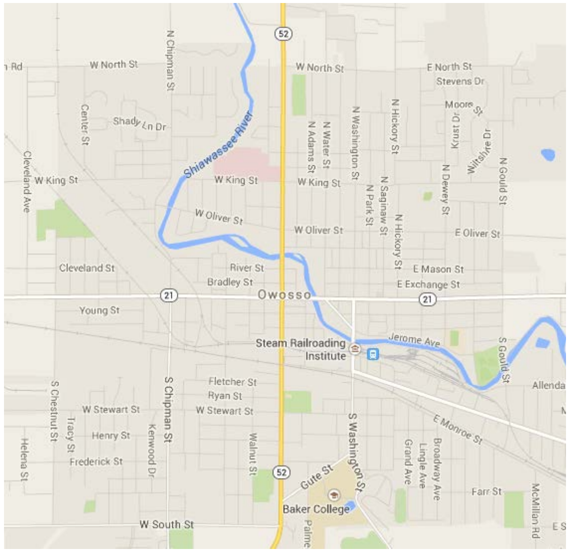


Deployment

DAVID ACTON

- Board Member and Chief Engineer of OnStar
- GM's global telematics and ITS planning and deployment
- Chief Electrical Engineer of Cadillac
- Director of Electrical Engineering for GM North America
- 2004 SAE Delco Electronics ITS Award for invention, design leadership, deployment, and operation.
- First deployment of 5.9GHz DSRC technology
- Founding member of the VII Working Group, which set the direction for V2X systems in the United States.

Deployment in Owosso, MI



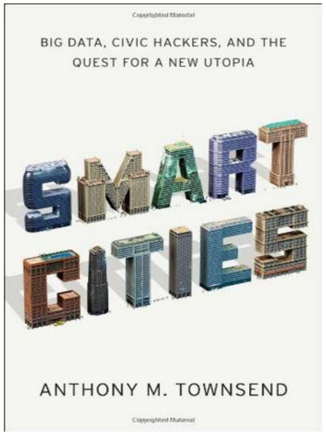
- Size: 4,000 vehicles
  - Big enough for proof of concept
  - Small enough to manage systems
- Citizens Involved
  - Populace, Mayor, City Council, Public Safety Officer, Traffic Engineer, County Road Commissioner & autonomous vehicle related program in public schools
- Adjacent to US DoT South East Michigan testbed

US DoT Proposal

Award Decision Aug-Sep 2015

- Vision, Mission and Opportunities

- Challenges
  - ☑ Autonomous Transportation
  - ☑ Smart Cities (water, energy, transport, health)
  - ☑ Healthcare
  - ☑ Data



Precision Farming - Converging IoS Ecosystems - Farm2Fork / Seed2Mouth

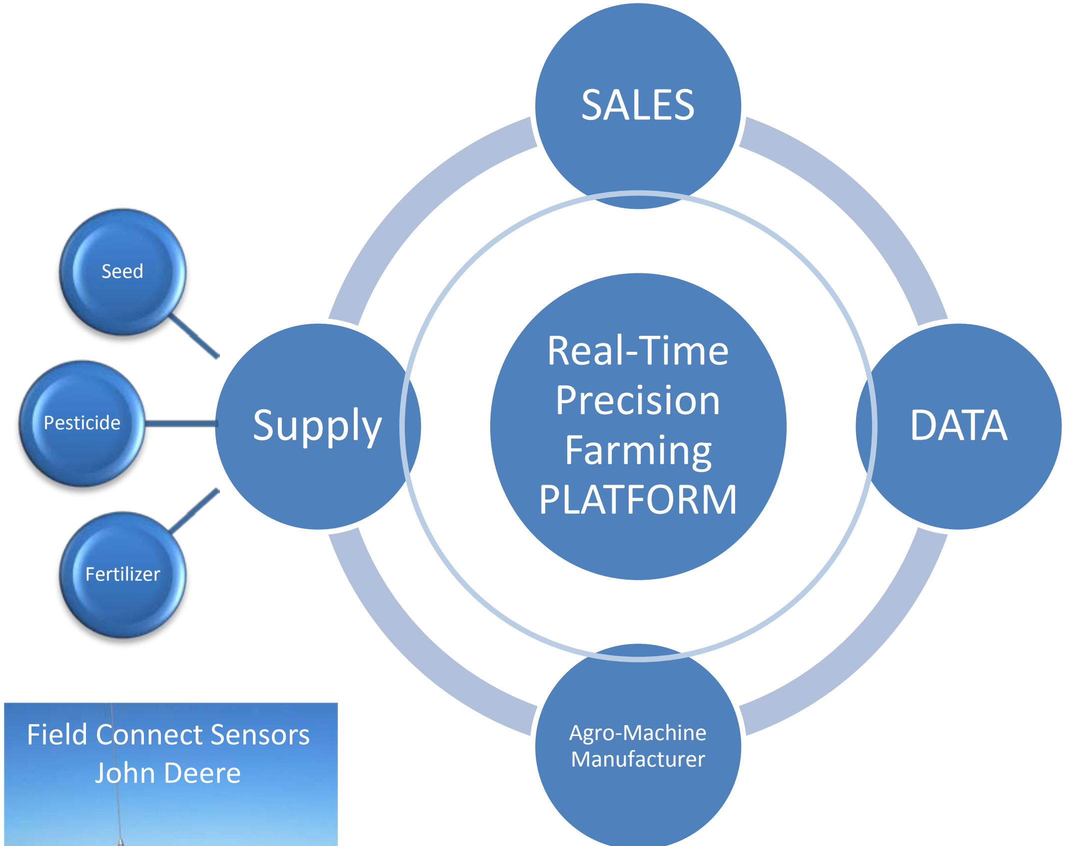
The potential convergence of Precision Farming ecosystem
- Seed to Mouth (S2M)
- Farm to Fork (F2F)

with other ecosystems, such as:
- Smart Cities
- Autonomous Transportation and operations management for trusted and secure supply chain network of partners.

Compliance with SOX-409 type regulations and DHS e-manifest are a part of this scenario. Additional links to energy and environmental systems are also obvious. Food safety, security, nutrition, availability and consumption are inextricably linked with global health, malnutrition, infant mortality and healthcare, in general.

Farming in California alone is a $50 billion industry

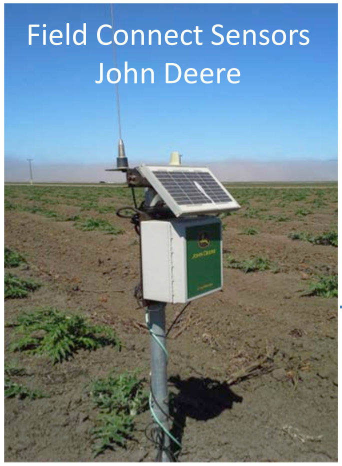
Retail Supply Chain – Sourcing / Distribution / Warehouse / Transportation
Track & Trace – Commodity Traders – Risk Management – Regulators (FDA)



-Measure, understand and apply
-Impact of data on quality & yield

-Weather data
-GPS micro-localization data
-Soil chemistry (GCMS) specifics
-Seed (sterile unless cultivated)
-Fertilizers (catalytic vs toxicity)
-Protection (pesticide, herbicide)
-Storage, shelf-life and waste
-Country of origin - goods supply

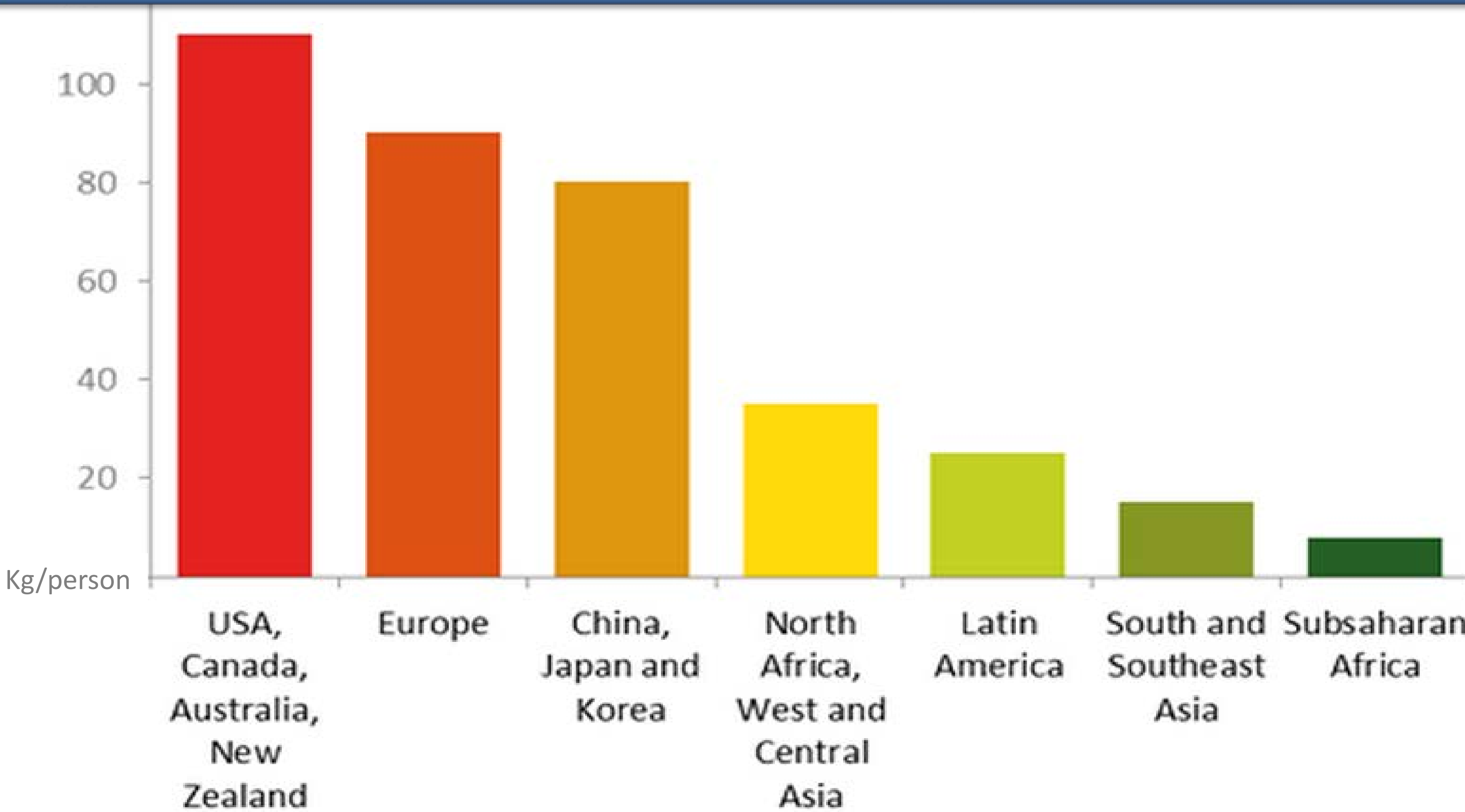
Leverage data to run long and short term simulations to plan for "what if" to optimize profit
- Weather patterns
- Demand uncertainty
- Export and import
- Tariff, cost, excise
- Regulatory policy



- Optimize MRO to improve asset uptime
- Mobile data collection and dissemination
  - soil sample / nutrient analysis (GCMS)
  - moisture monitors / field connect data
  - temperature / dielectric constant
  - color and chemistry of crops
  - growth rate / fertilizer distribution
  - weather micro-impact / acidity-alkalinity

NASA Soil Moisture Active Passive (SMAP)

FOOD WASTE PER PERSON

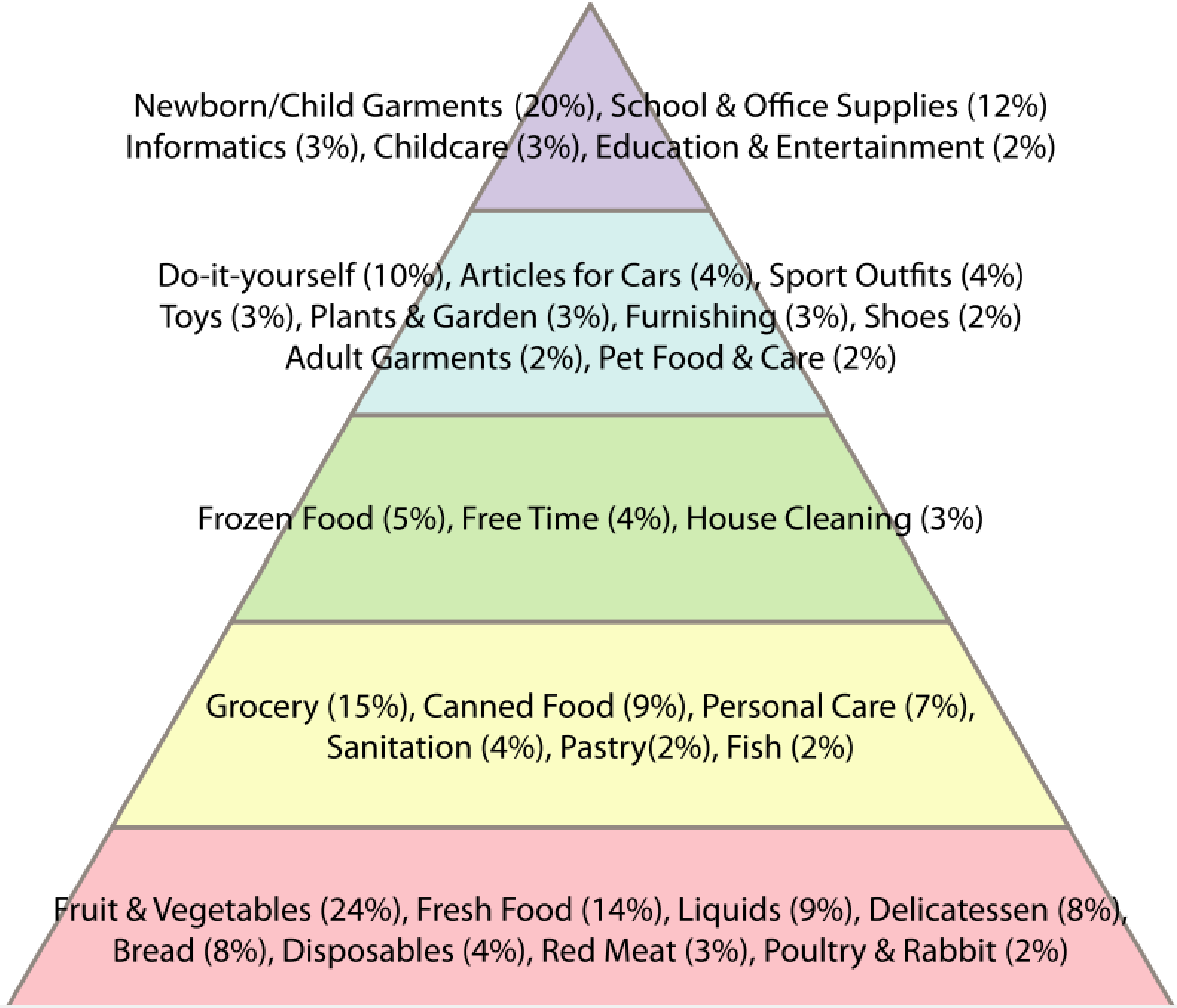


Note: Figures are consumer waste per capita based on data from 2007 in the FAO report 'Global Food Losses and Food Waste'. Globally consumer food waste amounts to roughly 350 Mt each year which equates to about 50 kg per person or 10% of total food supply.

Source: Gustavsson et al (2011), FAO

Shrink That Footprint

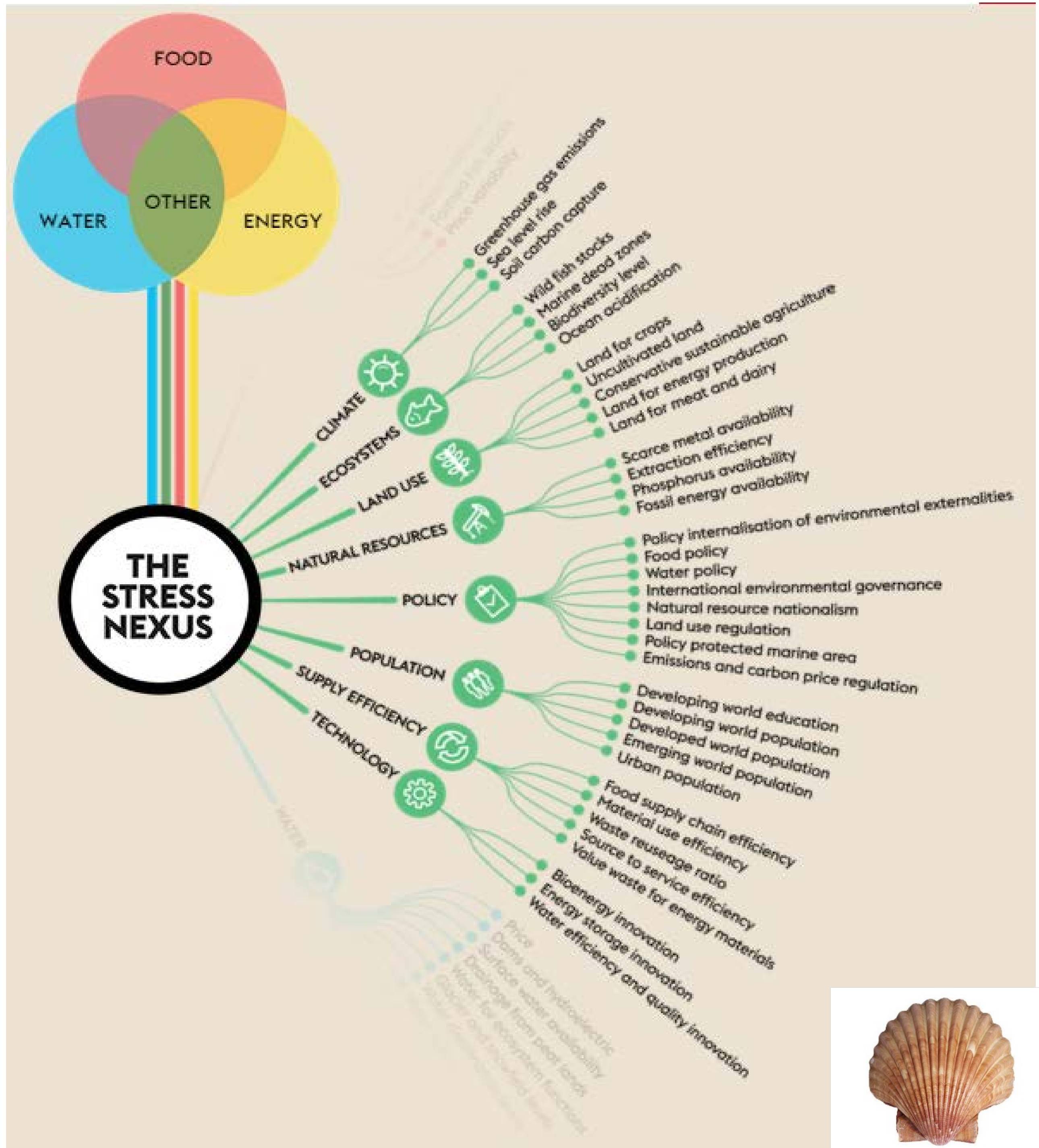
There is enough in this world for human need but never enough for human greed.



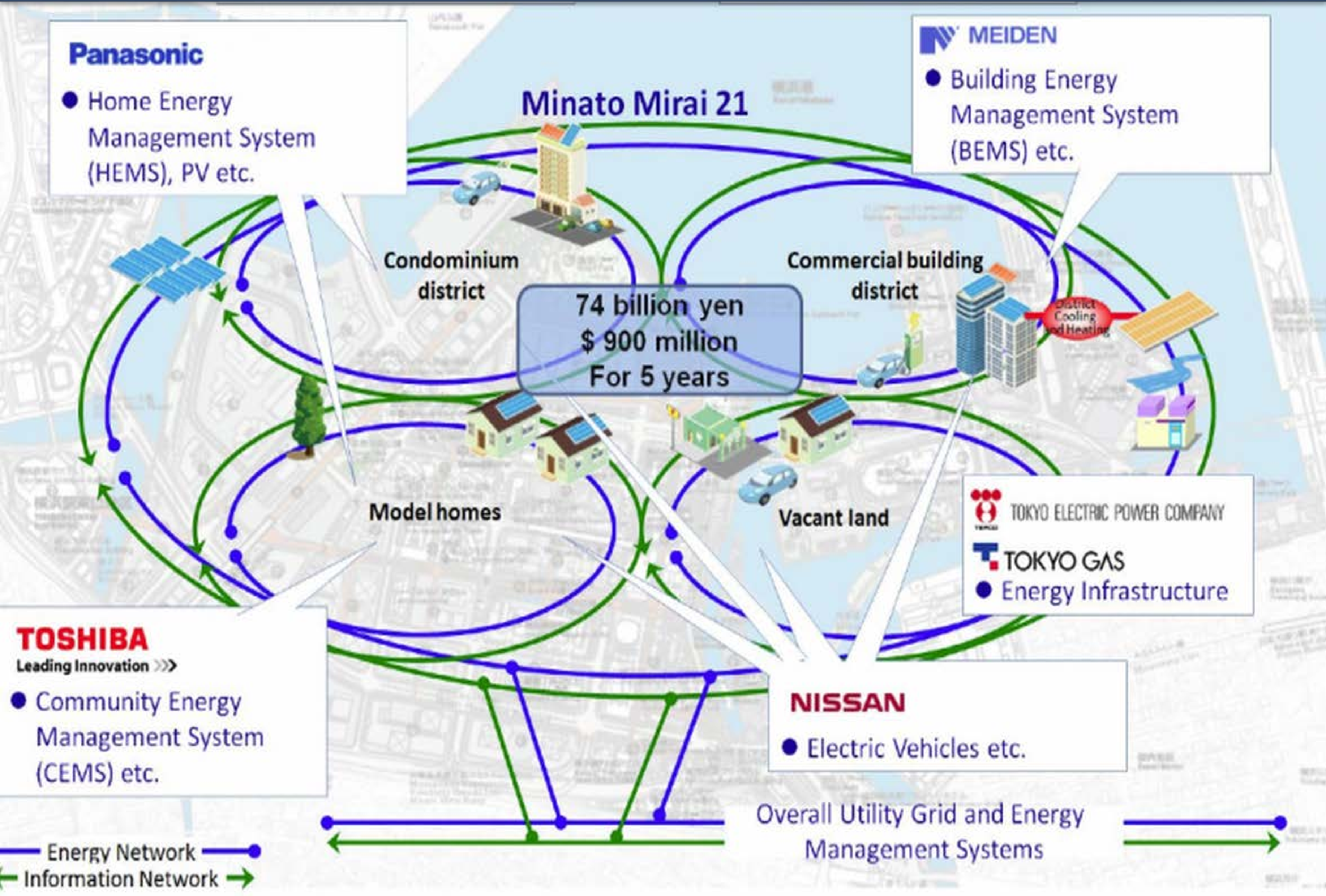
Pennacchioli et al (2014) The retail market as a complex system. EPJ Data Science 3:33

http://www.epjdatascience.com/content/pdf/s13688-014-0033-x.pdf

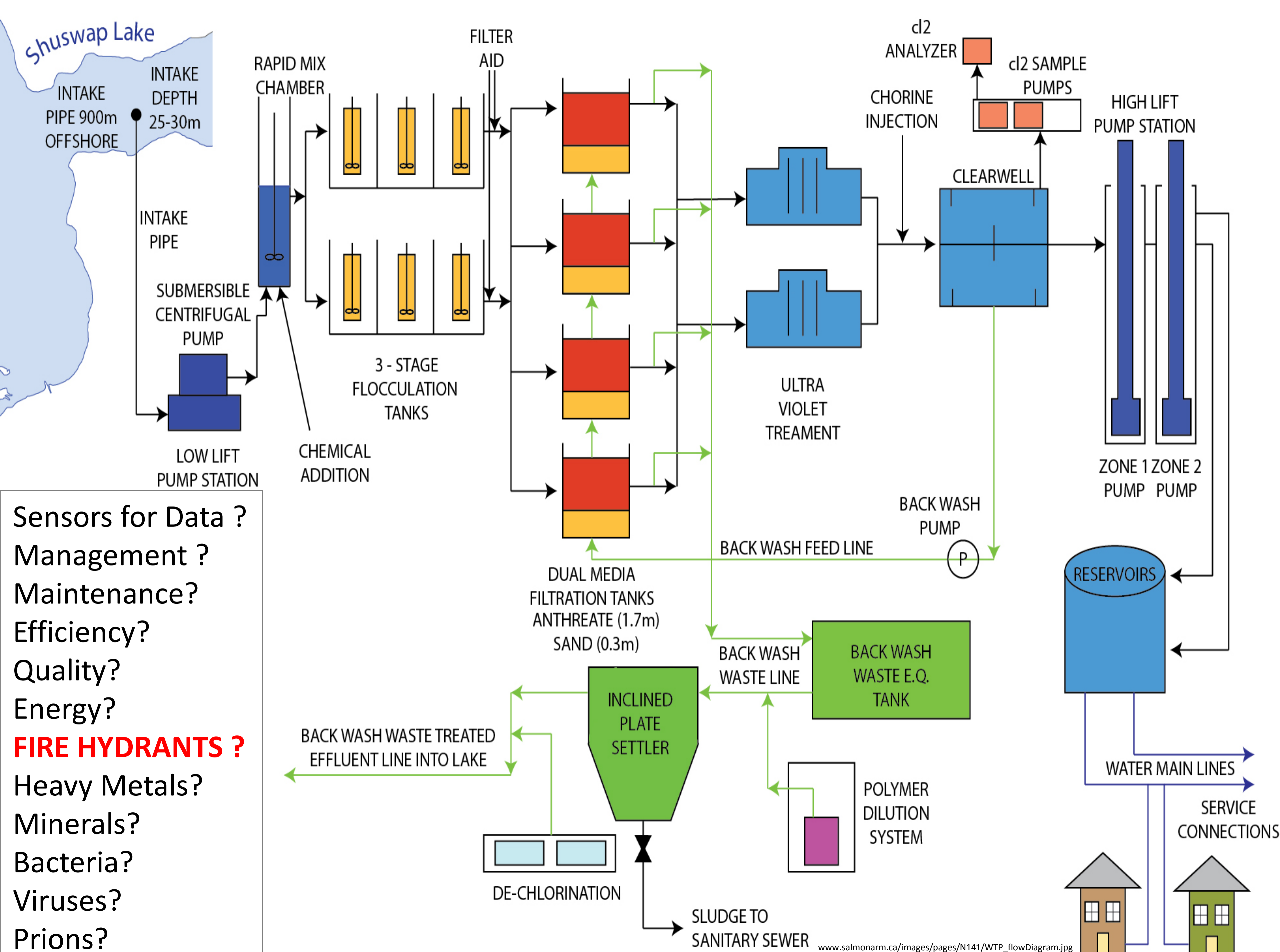
Global Stress Test



● Smart Cities ● Yokohama ● Santander ● Nice



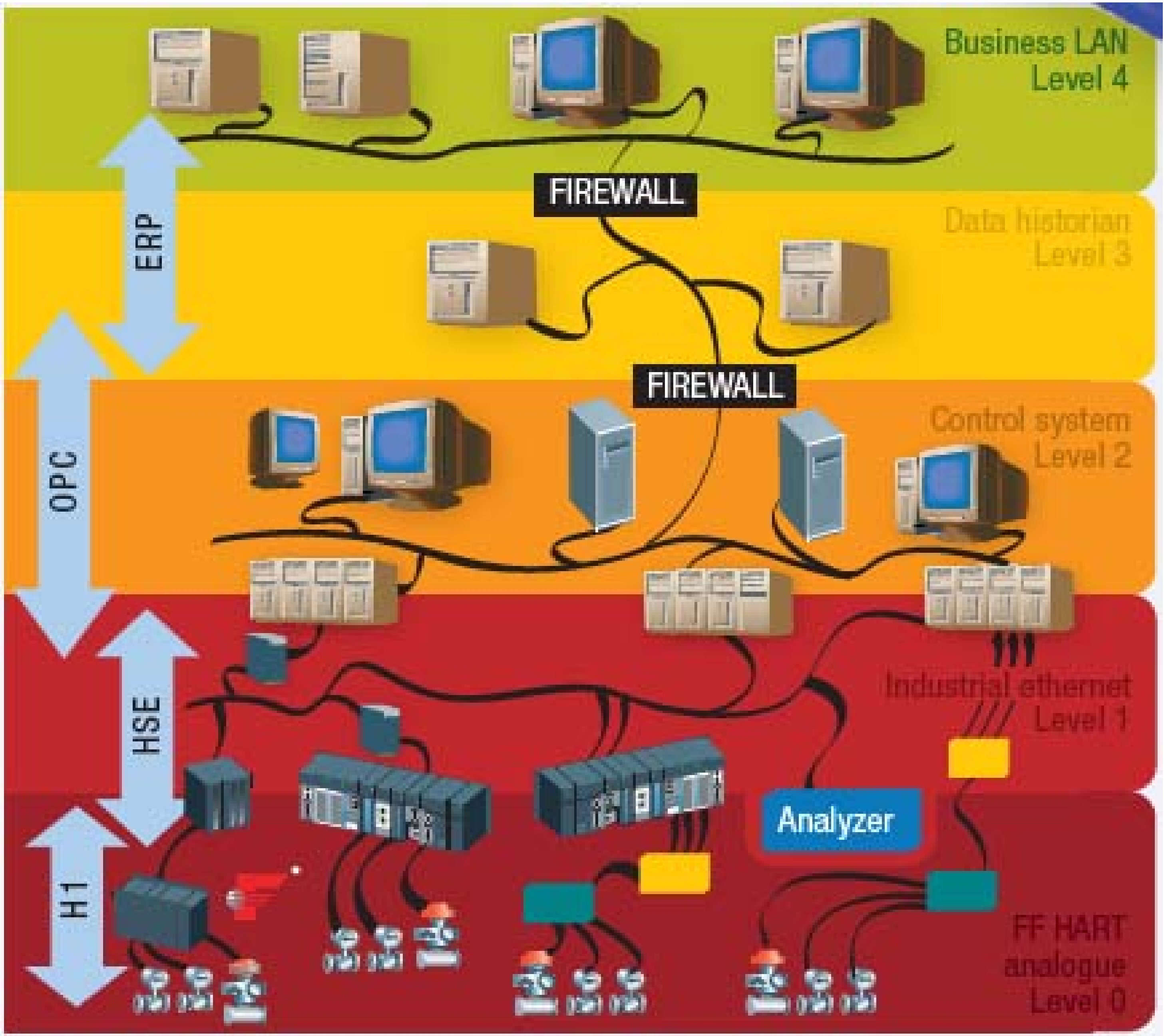
Reality Check ☑ Water



Sensors for Data ?
Management ?
Maintenance?
Efficiency?
Quality?
Energy?
FIRE HYDRANTS ?
Heavy Metals?
Minerals?
Bacteria?
Viruses?
Prions?

www.salmonarm.ca/images/pages/N141/WTP_flowDiagram.jpg

Water Systems Management (illustration based on chemical plant from NIST CPS PWG)



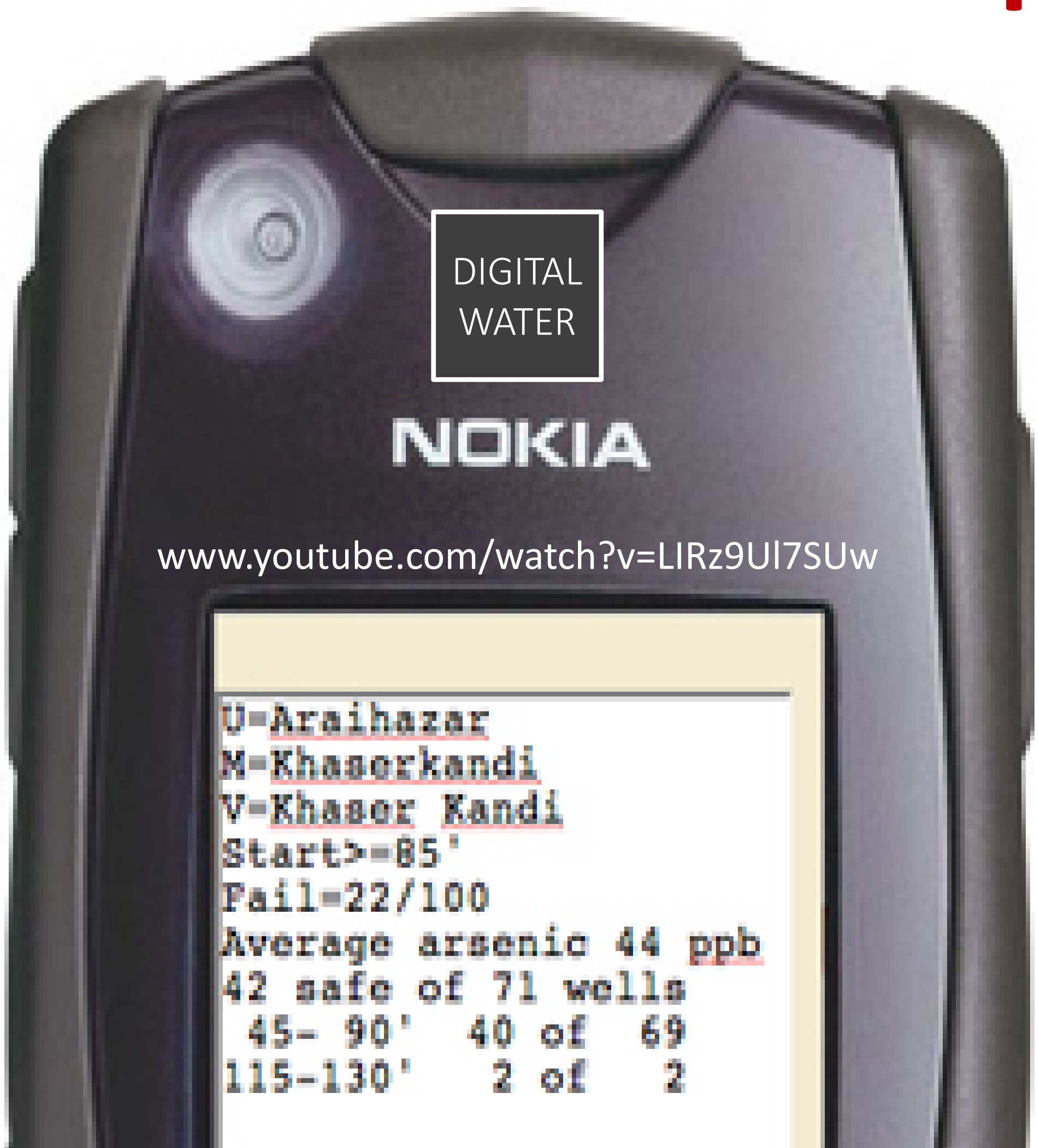
Internet of Systems

Sensors for Data ?
Management ?
Maintenance?
Efficiency?
Quality?
Energy?
FIRE HYDRANTS ?

Reality Check ☑ Arsenic in Water, Bangladesh

Internet of Systems

Socio-Economic Impact of IoS ?

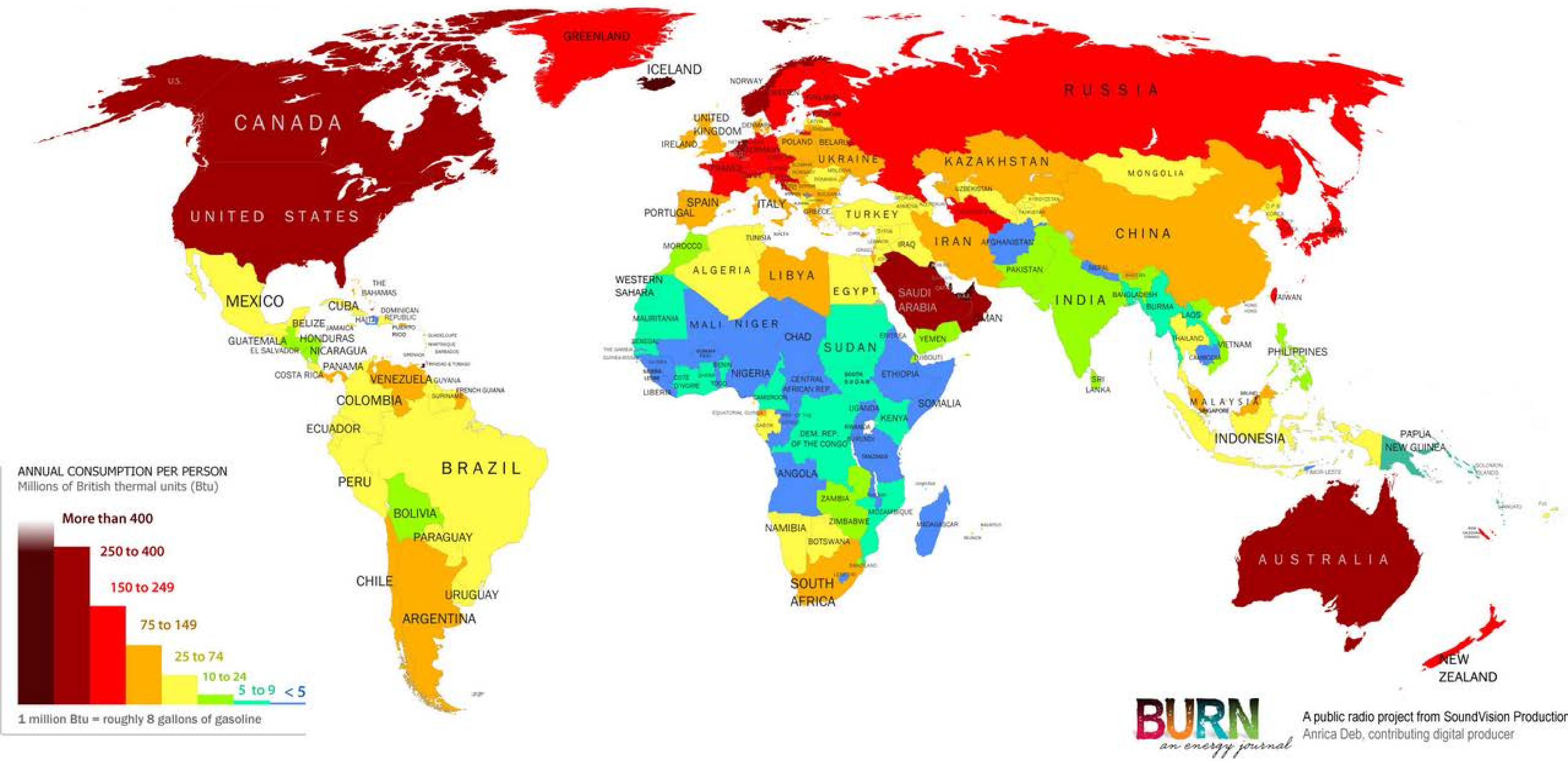


http://bit.ly/Water-Gate

This month, Melinda and I joined hundreds of scientists for a meeting in Seattle. The topic we discussed is something we're all passionate about: how to harness the advances of science in ways that benefit the poor.

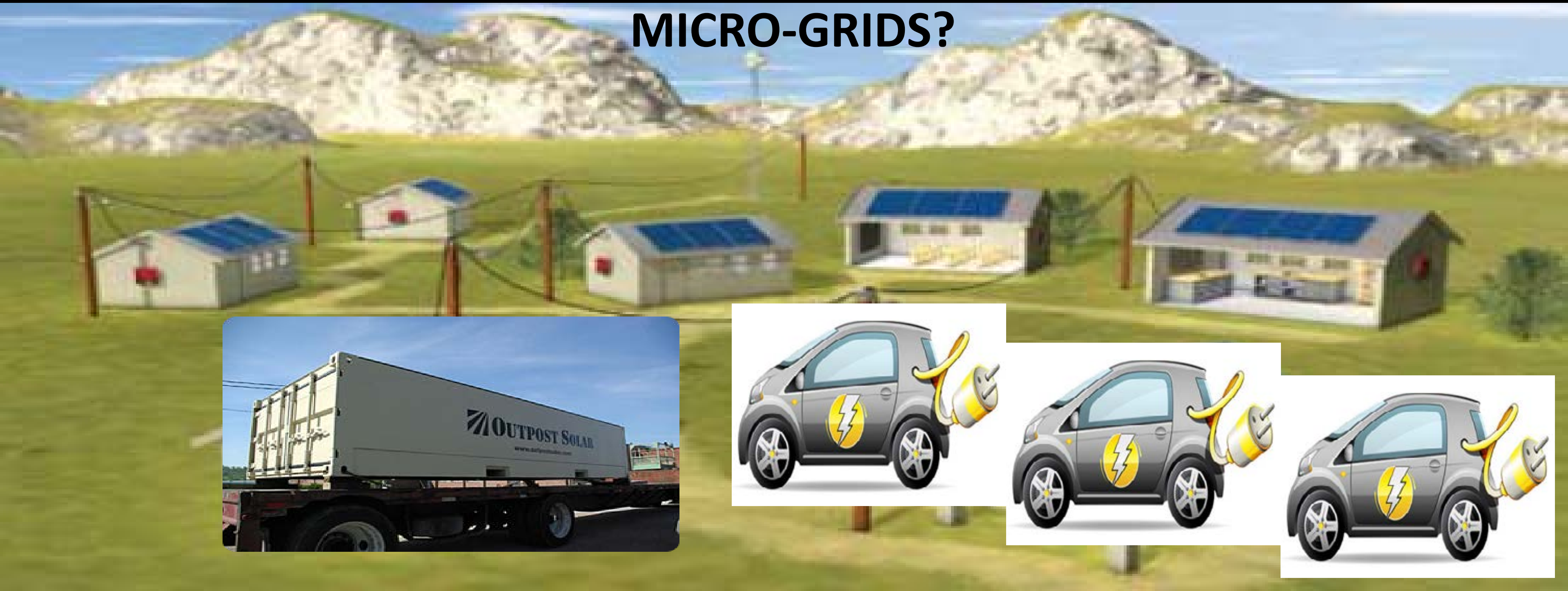
October 21, 2014 ● http://bit.ly/BILL-GATES

ENERGY CONSUMPTION BY COUNTRY (2010)

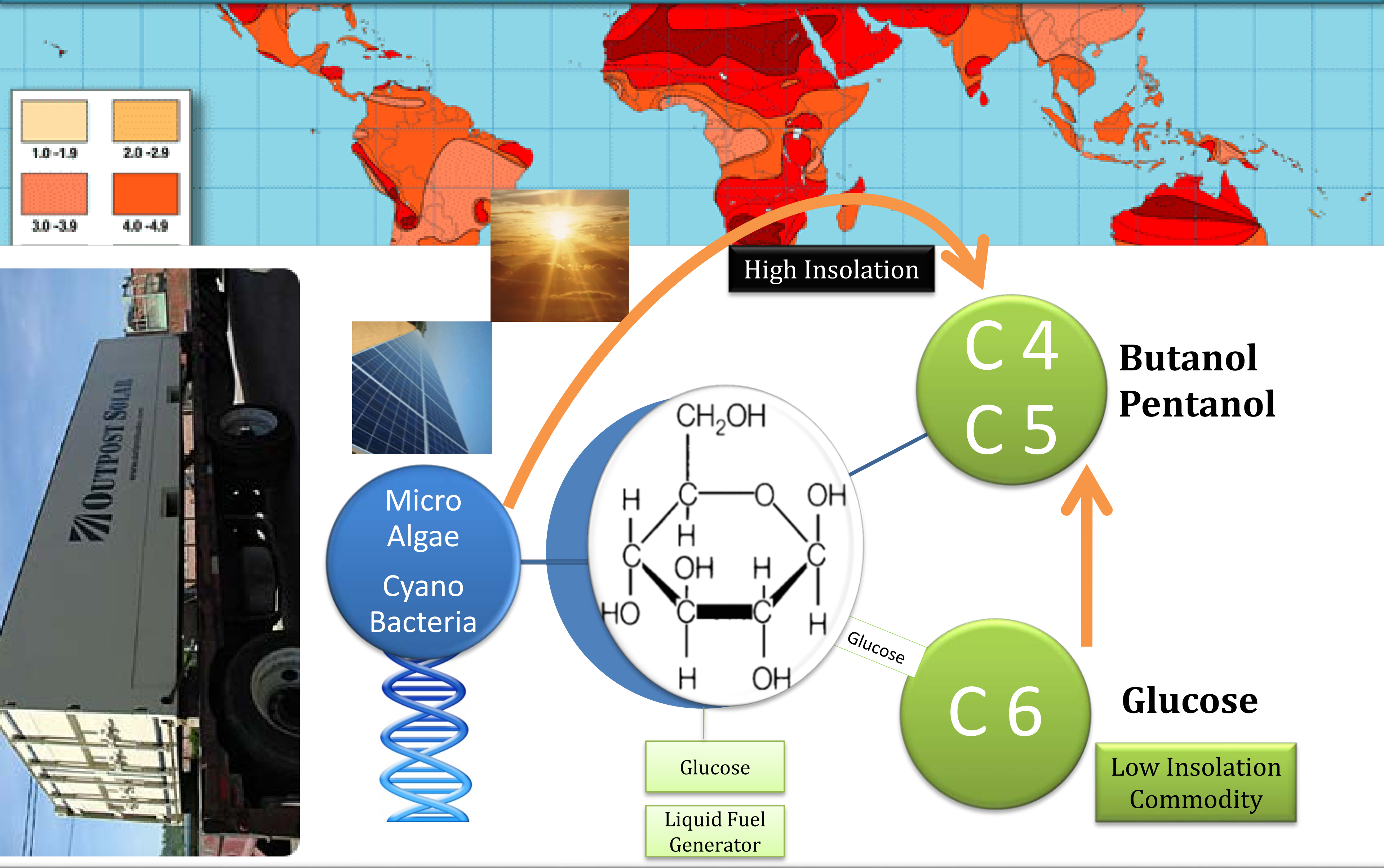


http://burnanenergyjournal.com/wp-content/uploads/2013/03/WorldMap_EnergyConsumptionPerCapita2010_v4_BargraphKey.jpg

MICRO-GRIDS?

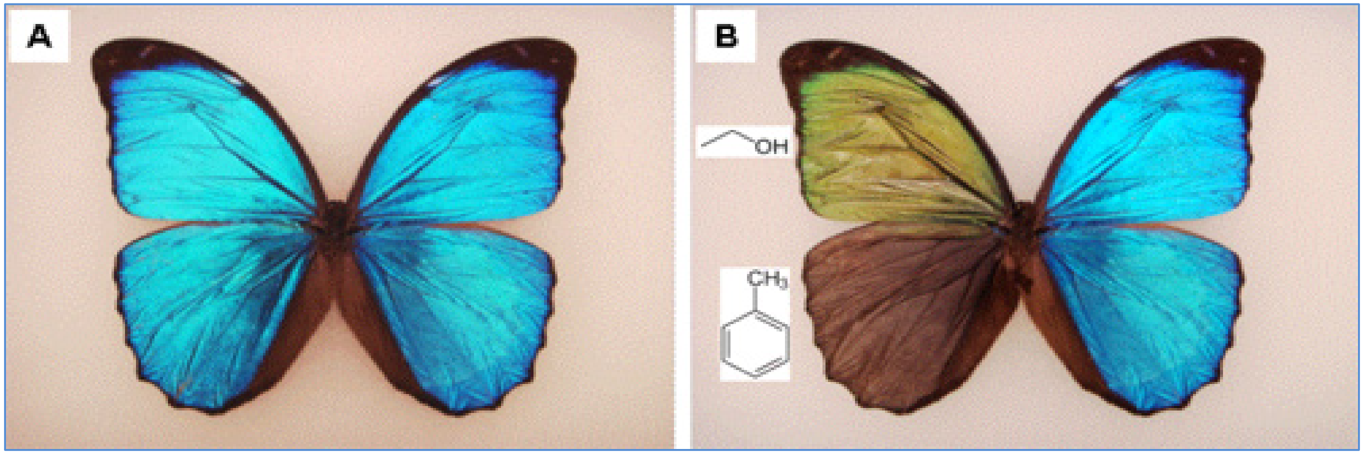


Renewables – Domestic Micro-Manufacturing Non-fossil Carbon-Neutral Liquid Fuel



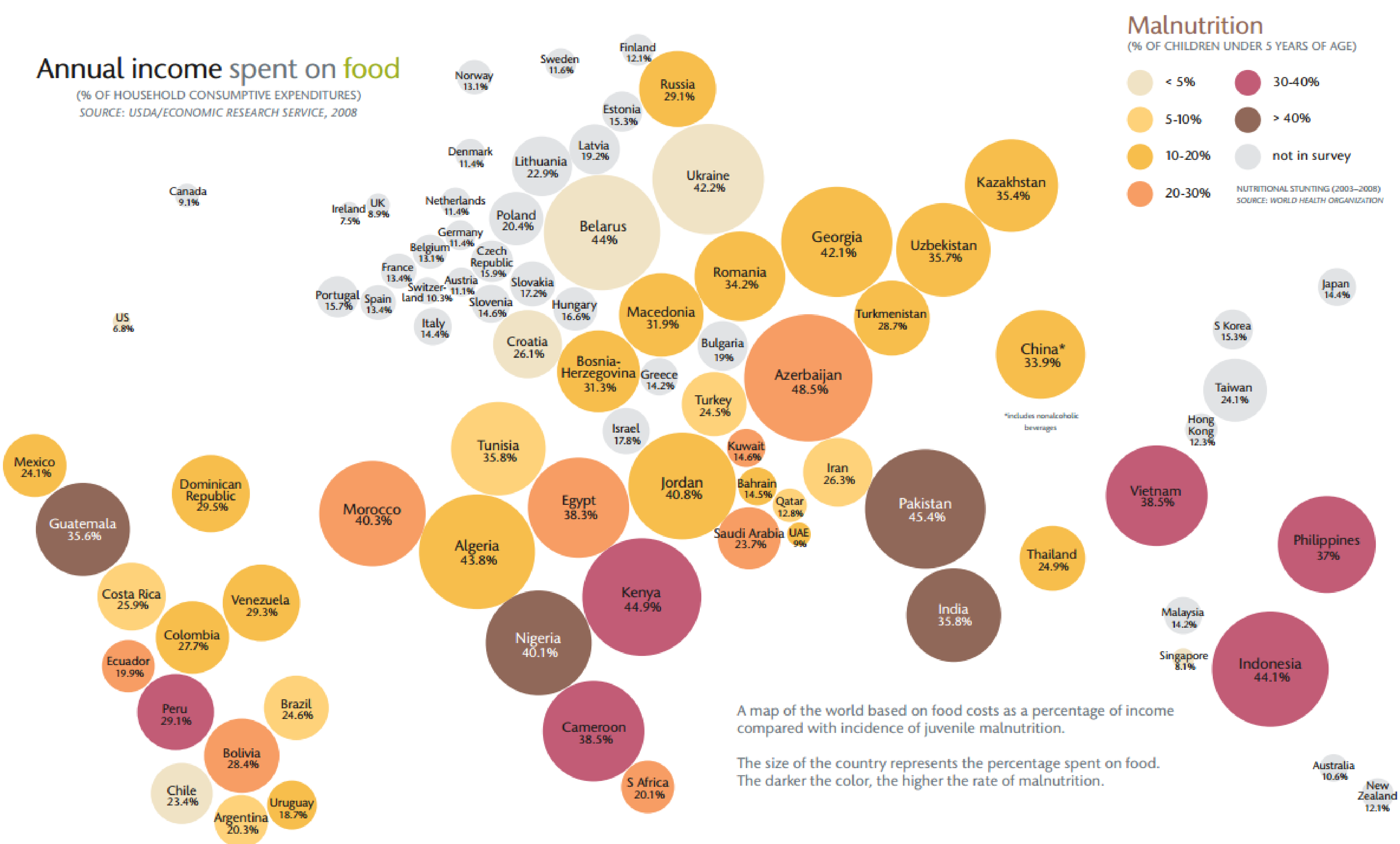
Bio-inspired energy draws from success of bio-mimetics

Swiss engineer George de Mestro invented Velcro after his dog came home covered with thistle burrs, Speedo learned from sharkskin to make faster swimsuits, and chemical companies designed self-cleaning paint after studying lotus leaves.



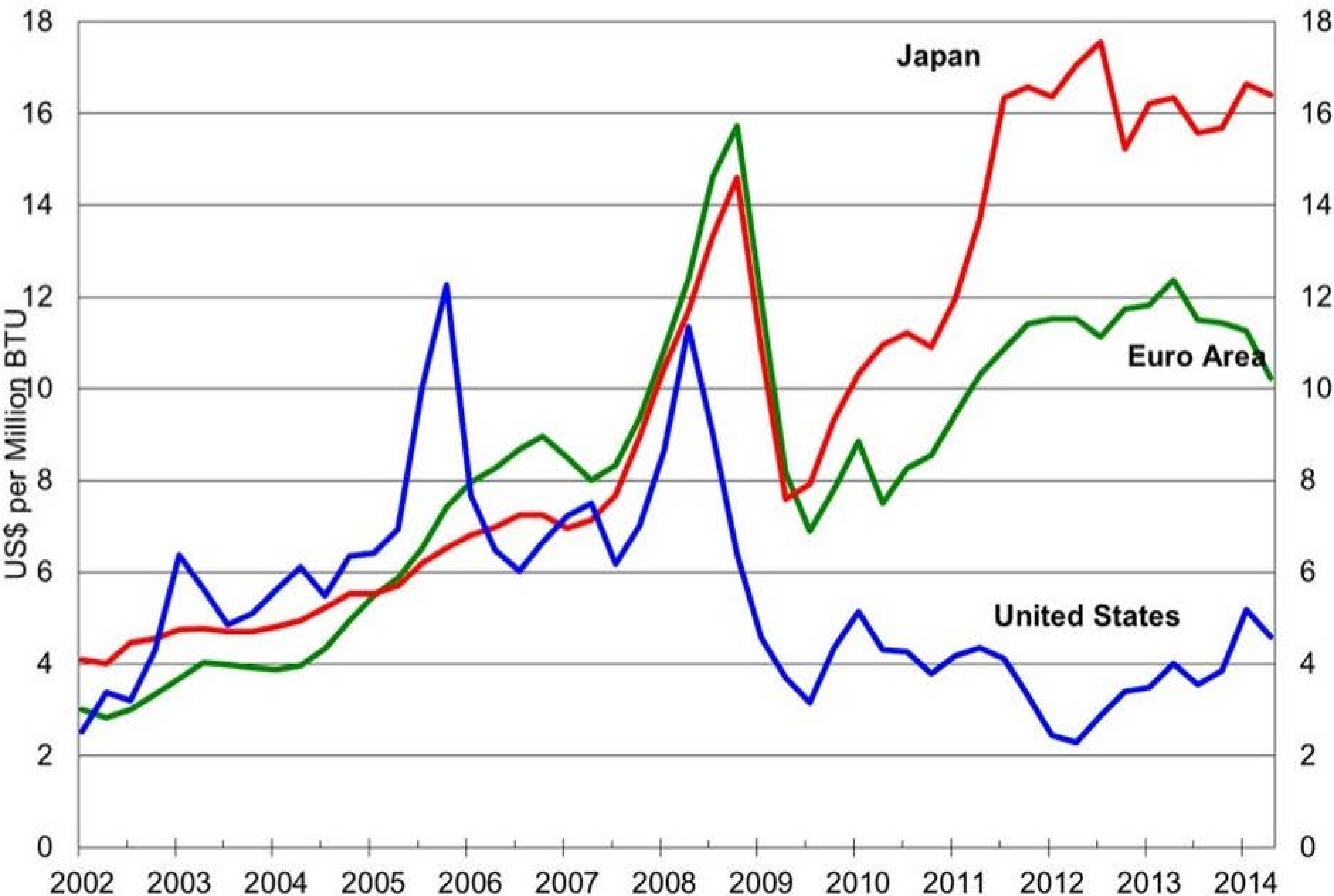
GE scientists have observed that *Morpho* wings change their color when they come into contact with heat, gases and chemicals. The normal iridescent blue color of butterfly wings (A) changes when exposed to ethanol (panel B top) or toluene (panel B bottom). Radislav Potyrailo's team at GE wants to use their findings to develop fast, ultra-sensitive thermal and chemical imaging sensors for applications in night vision goggles, super-sensitive surveillance cameras, handheld or wearable medical diagnostic devices. ☑ www.gereports.com/post/80985289914/like-a-butterfly-out-of-hell-the-next-wave-of

Reality Check ☑ Food v Fuel debate is ignored by corn ethanol producers



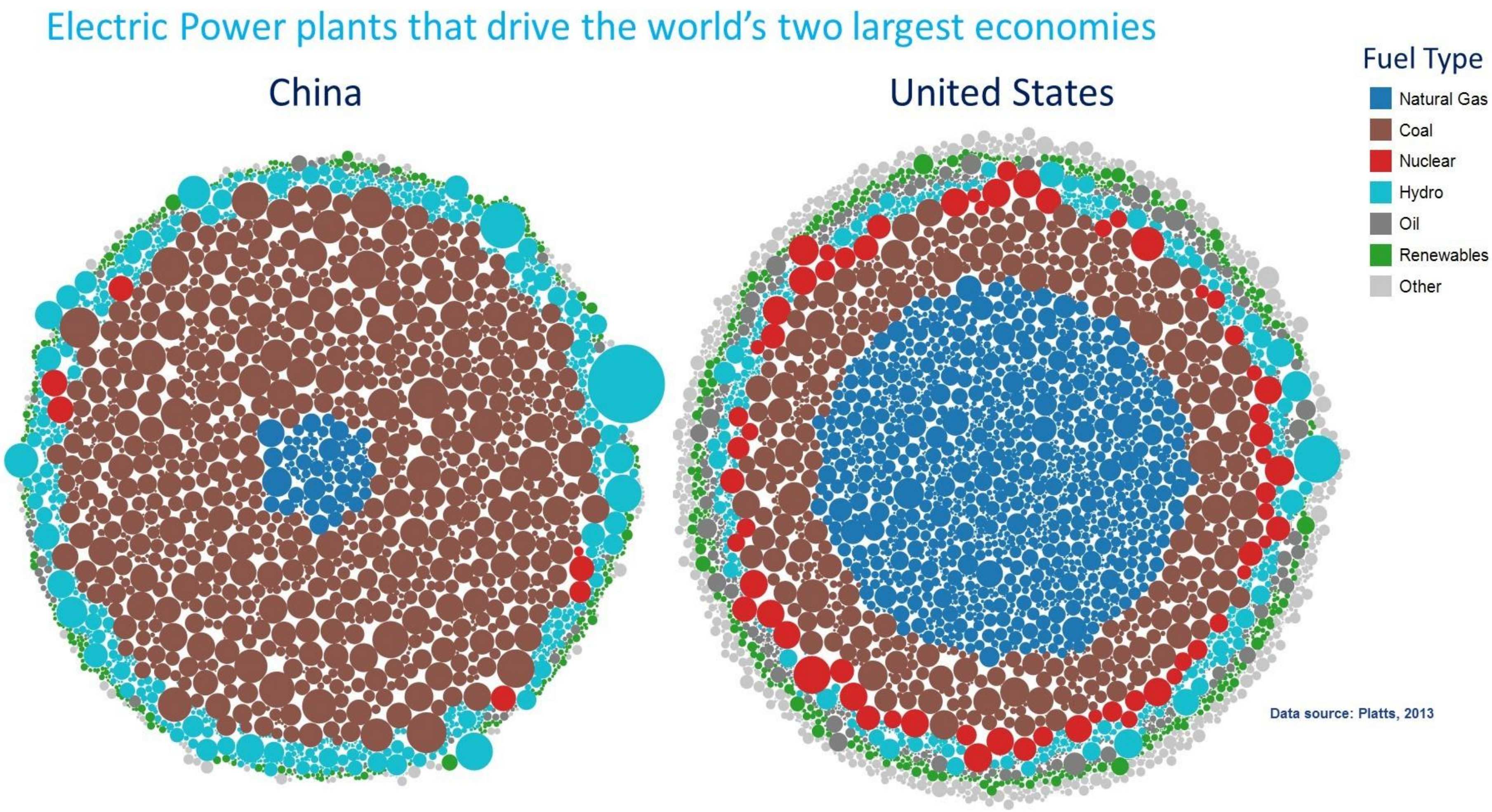
www.ers.usda.gov/

Reality Check ☑ Natural Gas Prices by Region (USD per million BTU)



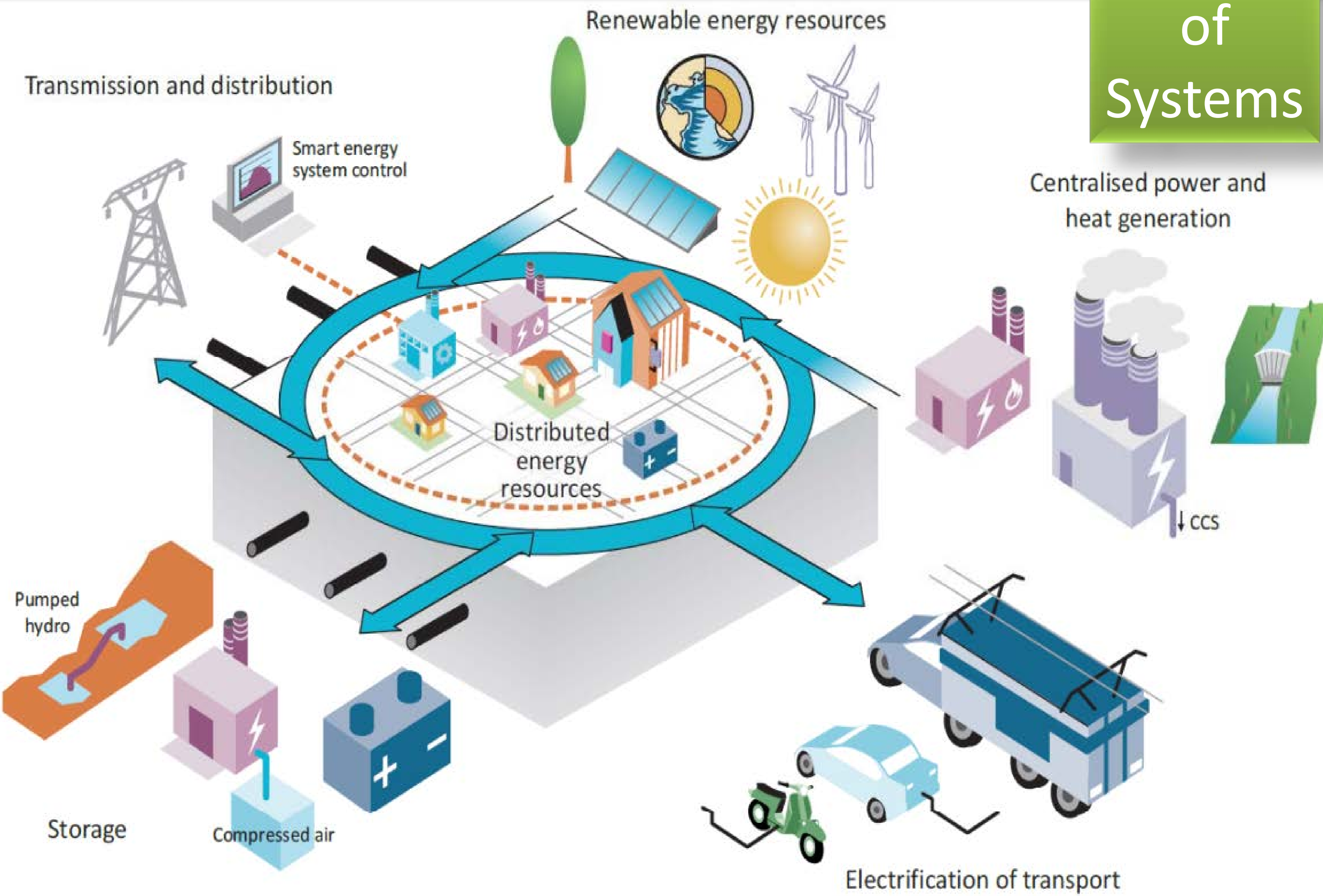
The World Bank

Reality Check ☑ G2 favors the GHG producers – Coal and Gas, naturally

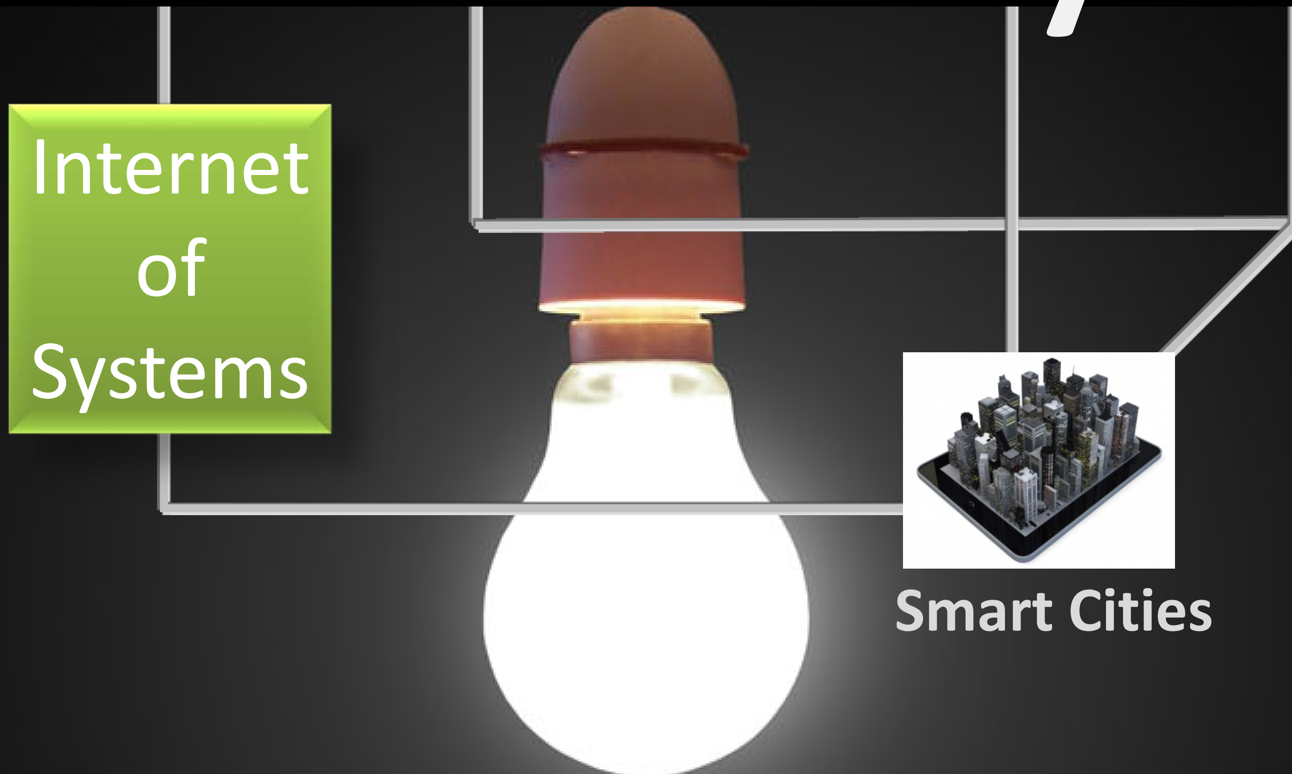


IoS - keeping the dream alive

Internet of Systems



Grand Unifying



Challenge

I invented nothing new. I simply assembled into a car the discoveries of other men behind whom were centuries of work ▪ HENRY FORD

GLOBAL SMART CITIES – GRAND UNIFYING IoS PLATFORMS ?

Smart energy and electricity micro-grid network

Smart transportation and traffic management

Smart water and waste water treatment

Smart maintenance and infrastructure

Smart data and connectivity

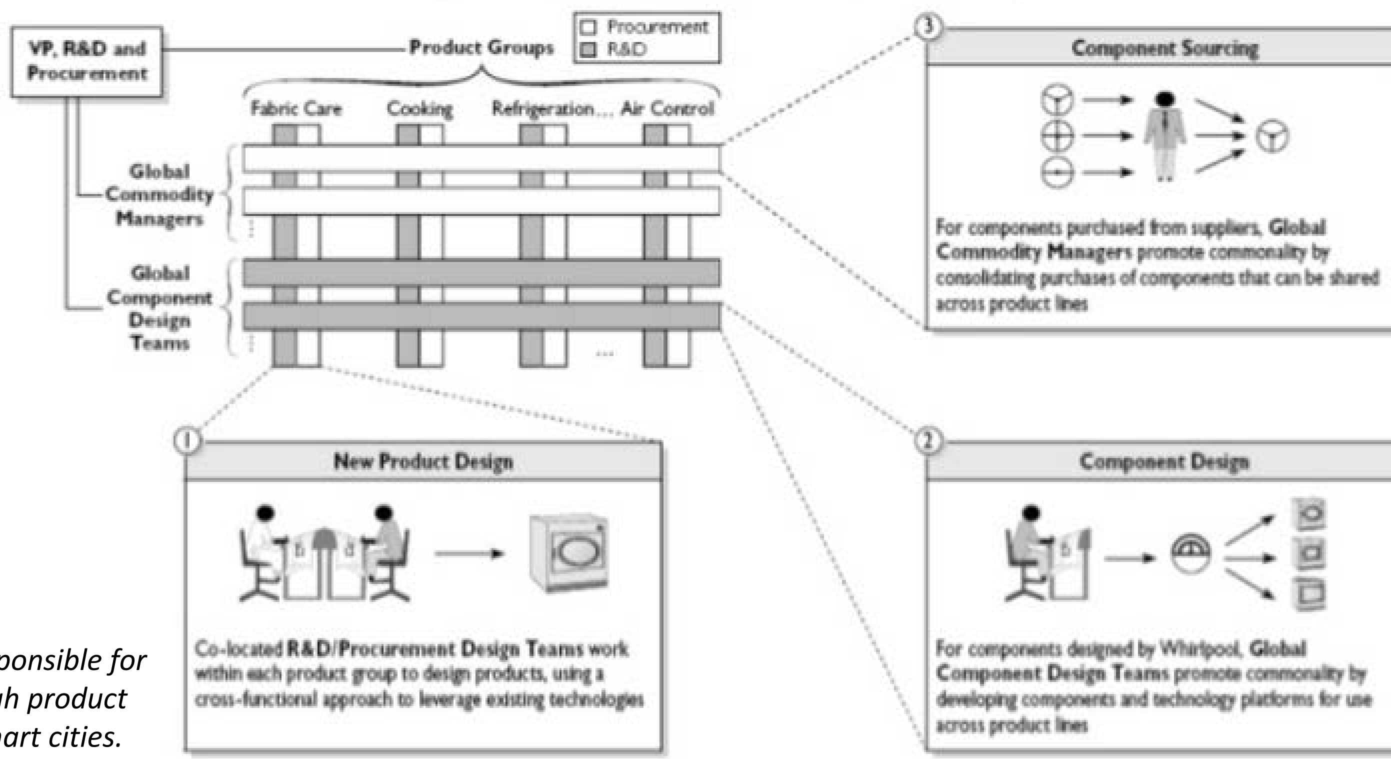
Smart waste management

Smart healthcare

Smart parking

Smart homes

[Smart drone]()



How groups within Whirlpool are responsible for optimizing commonality gains through product development stages – a lesson for smart cities.

NIST GLOBAL CITIES CHALLENGE

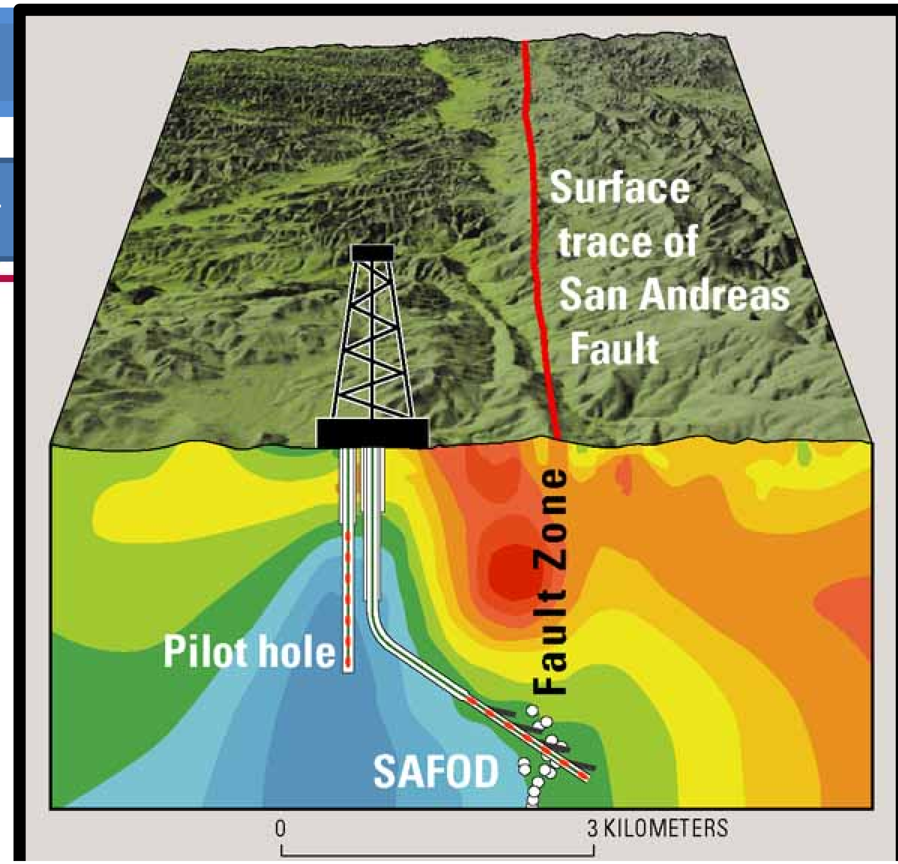
http://bit.ly/GLOBAL-SIM-CITIES

Seismic and Infrastructure Monitoring

Buildings

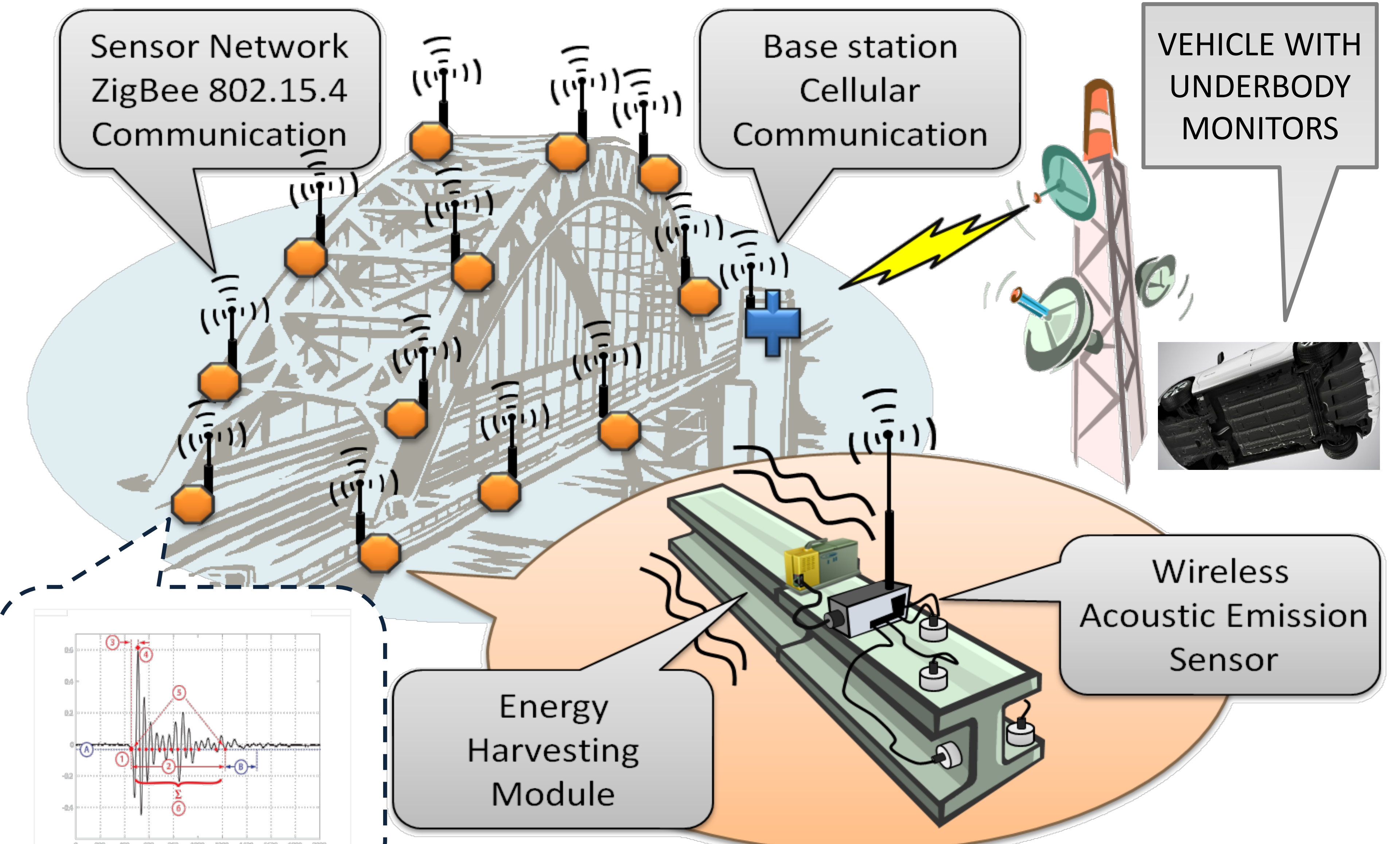
Bridges and Roads

Water/Sewer



DATA COLLECTION FROM INFRASTRUCTURE – BRIDGES & OTHER MAJOR CRITICAL STRUCTURES

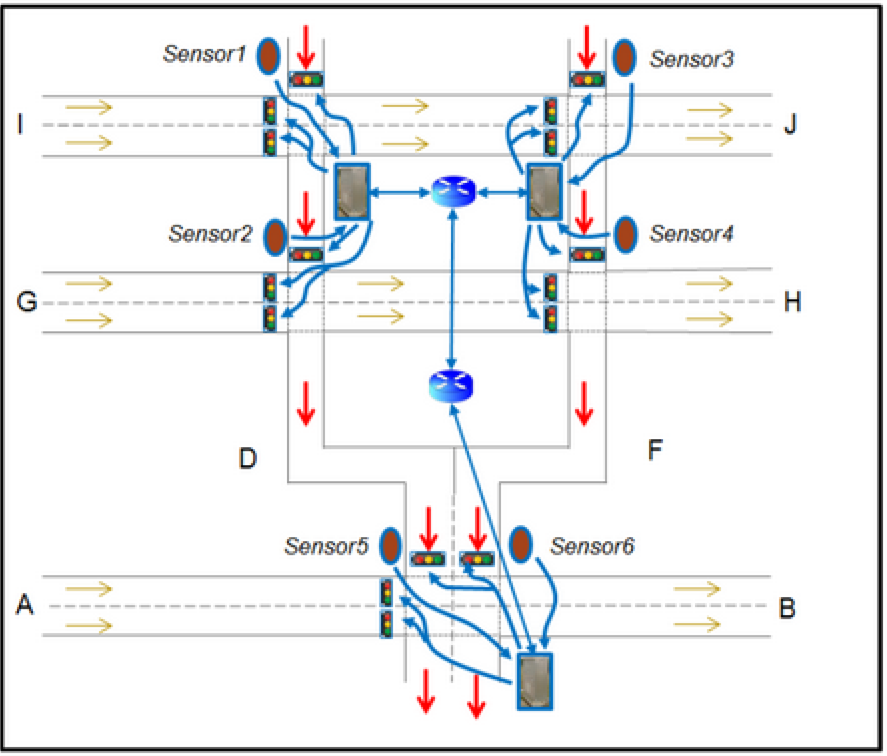
Autonomous vibration (accel-erometers), stress (strain gauges) & cracks (AE sensors) monitoring supported by vibration-based energy harvester



Peter Volgyesi, Vanderbilt University

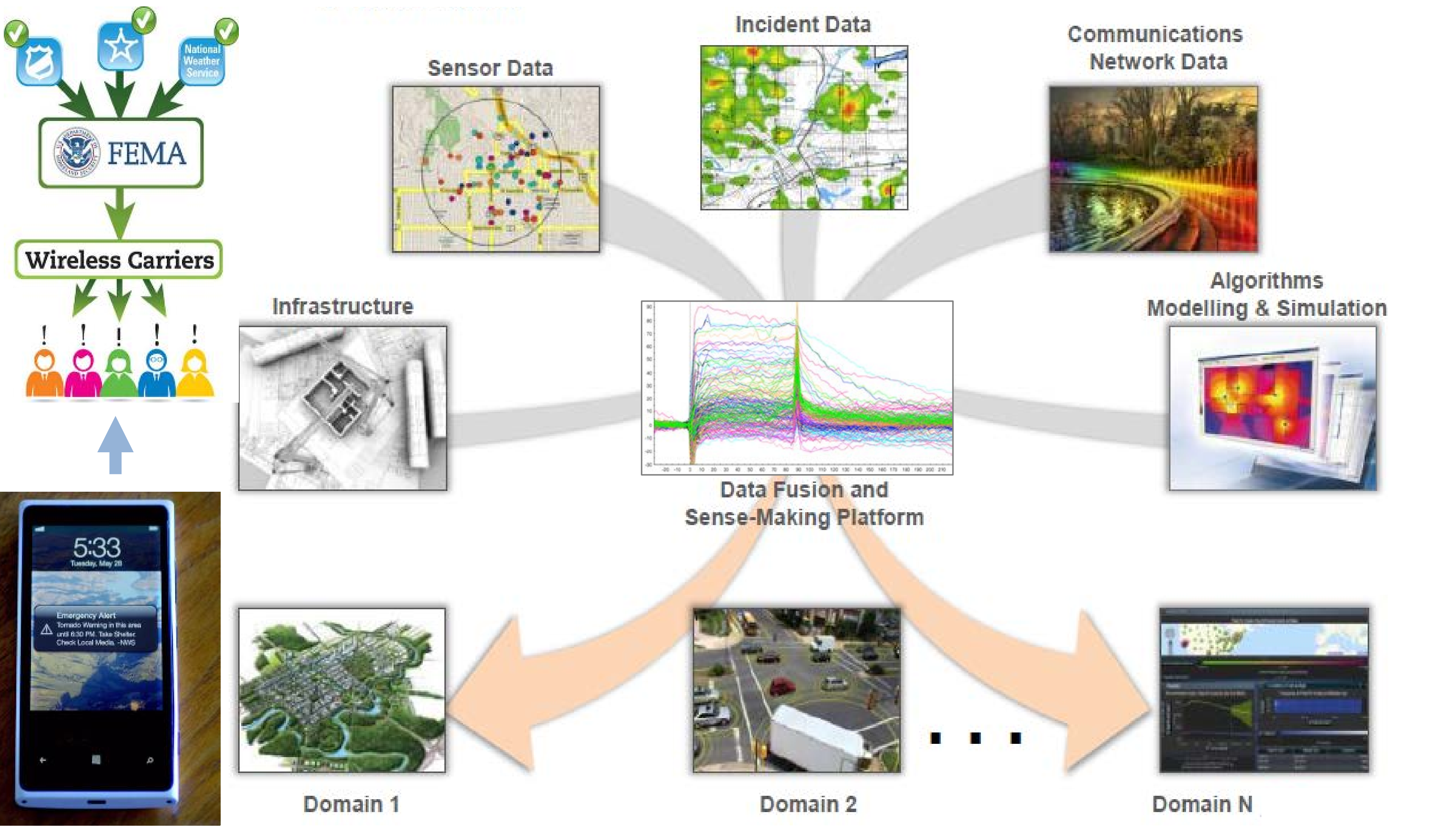
sites.google.com/site/marmoteplatform/

CONNECT DATA and ANALYTICS for EMERGENCY VEHICLE TRAFFIC



- Emergency vehicles need to get through (North-South)
- Significant traffic across (East-West)
- Each intersection is controlled by traffic lights
- Sensors are deployed on vertical streets
- Arbitrary number of controllers can be added, assigning them to sensors and lights and providing control algorithm.
- Arbitrary attacks can be inserted between controllers and their inputs/outputs.
- Simulation ends: last emergency vehicle reaches destination.
- Metrics: emergency vehicle latency vs. overall road occupancy

DATA and ANALYTICS for EMERGENCY & RESILIENCY MANAGEMENT



Data, Message, Alert Dashboard for Communities & City Managers

SINGAPORE

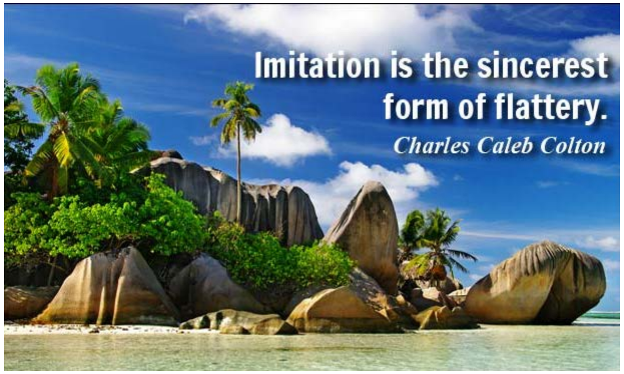
What Singapore thinks today,
the world may think tomorrow.

Smart Nation

It may take decades to emulate and mimic what Singapore is thinking and implementing today to catalyze harmonization of platforms.

• Paradox to Paradigms to Platforms to Populations

Let us learn how to build smart cities from

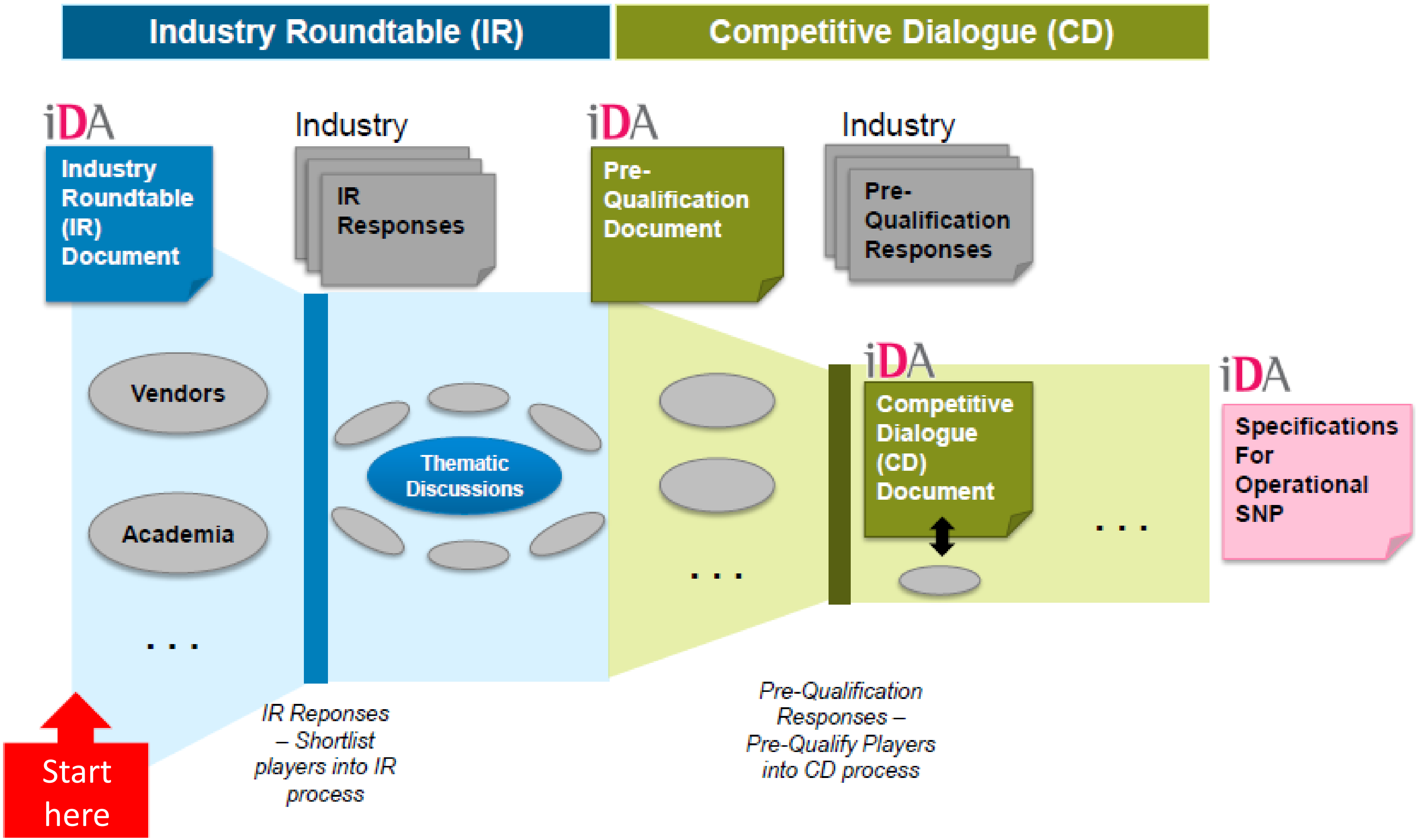


Smart Nation Singapore

The next 26 charts are copied from the briefing by Mr Steve Leonard, Executive Deputy Chairman, IDA delivered to the industry on 10 October 2014, Singapore

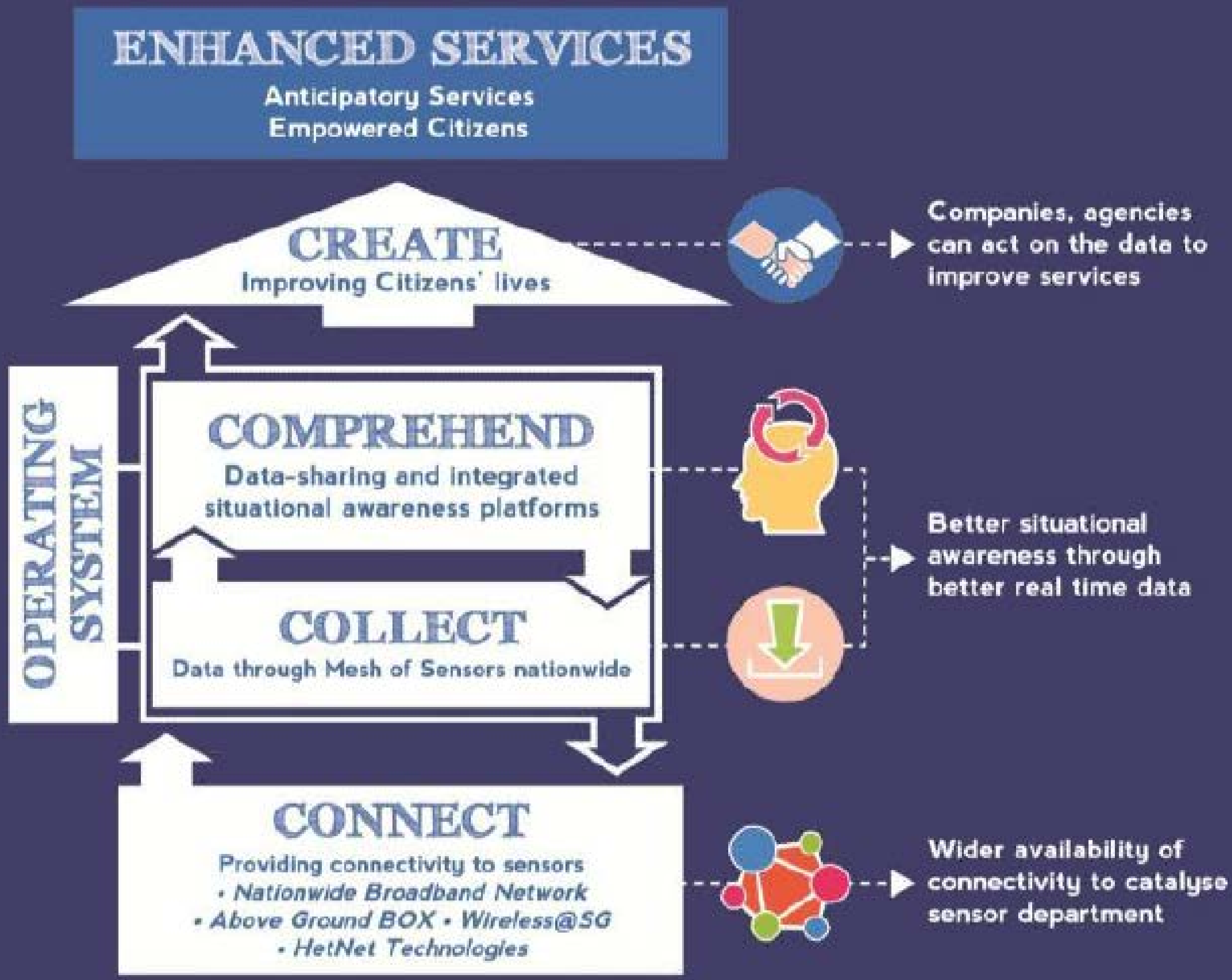
Smart Nation Platform

Overview of Process



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

SMART NATION PLATFORM



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

CITIZEN CENTRIC SERVICE DELIVERY


Enjoyable user experience


Make meaningful choices


Empowered to participate and co-create


One Public Service

IDA-logo.png

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

PLATFORM COMPONENTS

COMMUNICATIONS to establish resilient wired and wireless connectivity to sensors

---

SENSORS AND PROBES to sense, capture and register environmental information

---

SMART NATION OPERATING SYSTEM to process, fuse and share data with agencies

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

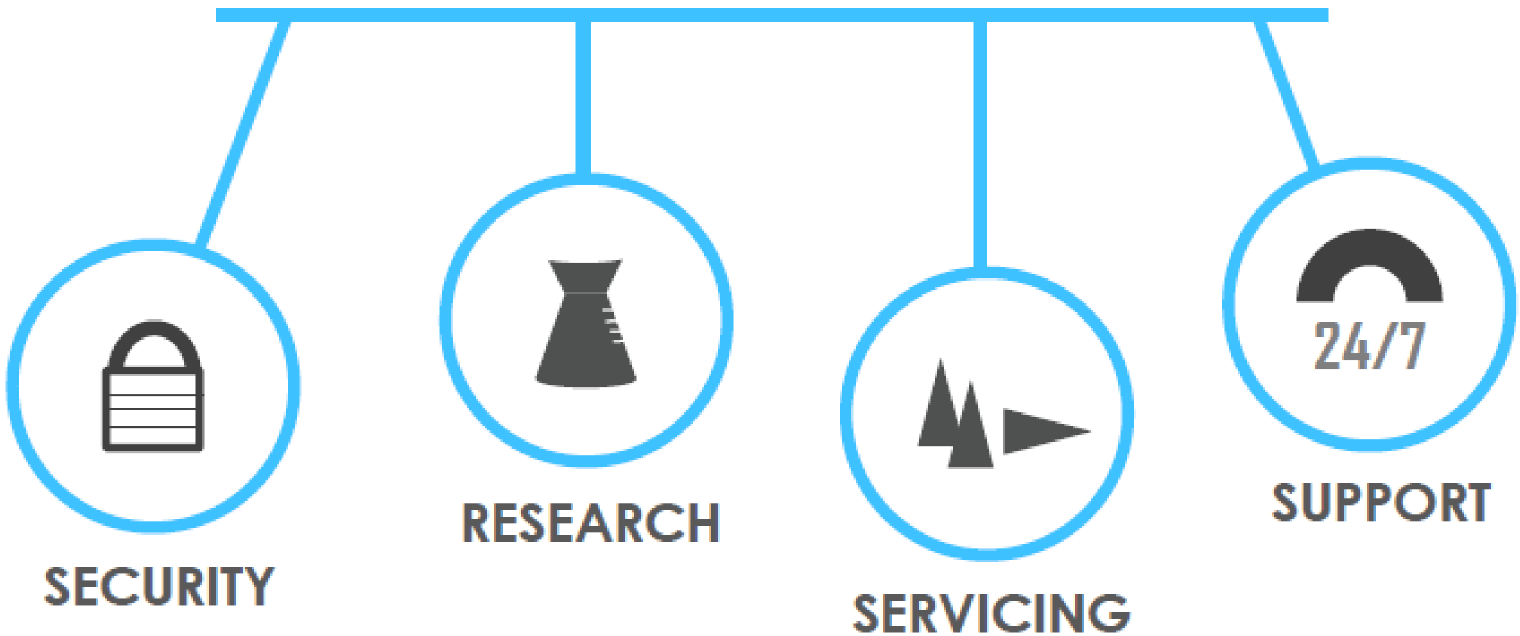
iDA SINGAPORE

SUPPORTING INFRASTRUCTURE

COMMUNICATIONS

SENSORS AND PROBES

SMART NATION OPERATING SYSTEM

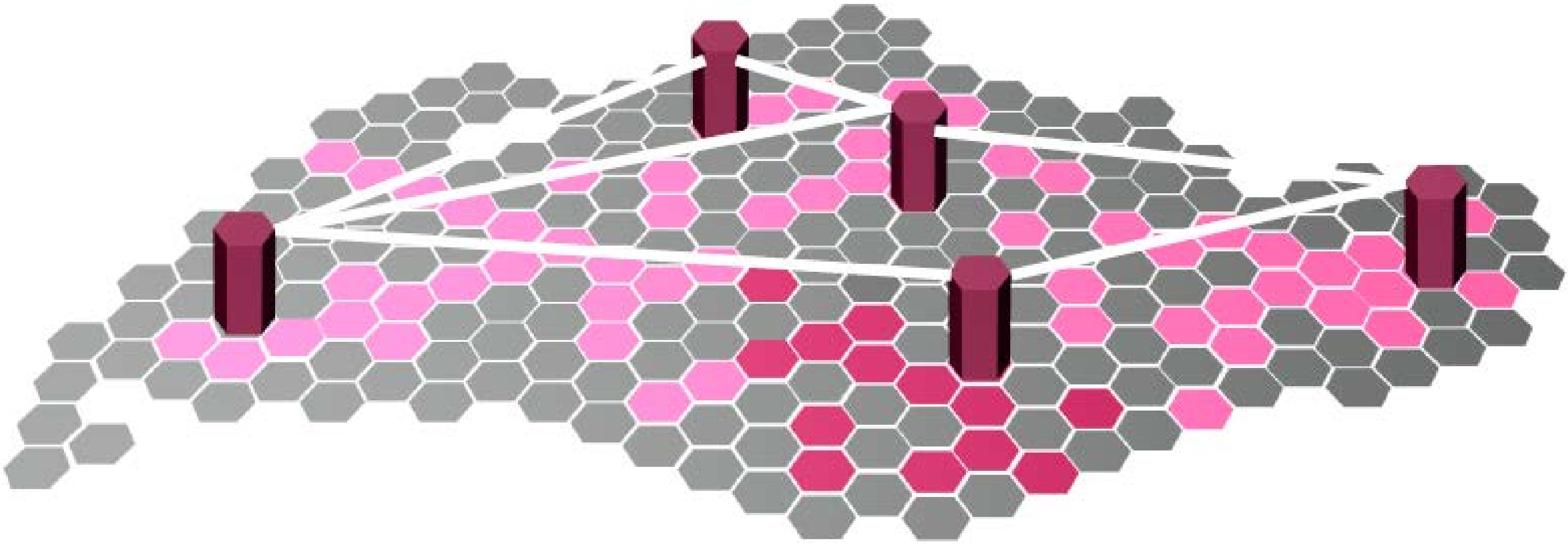


© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

iDA SINGAPORE

NATIONWIDE DEPLOYMENT



Delivering **RESILIENT** and **TRUSTED** sensor connectivity nationwide to catalyse sensor rollouts and enable data-driven decision making and **ANTICIPATORY SERVICES**

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

iDA SINGAPORE

AN INTEGRATED SMART NATION

IMPROVED INFORMATION DISSEMINATION

OPTIMIZED TRANSPORT

ENHANCED RESOURCE MANAGEMENT

TIMELY MUNICIPAL SERVICE DELIVERY

Smart Nation Vision

Urban Mobility | Environment | District Management | Healthcare

Logistics | Manufacturing | Energy & Sustainability | Retail & Advertising

Smart Nation Platform

Smart Nation Operating System (SN-OS)

Communications & Sensor Network

Supporting Ecosystem

Build Industry

Develop IP

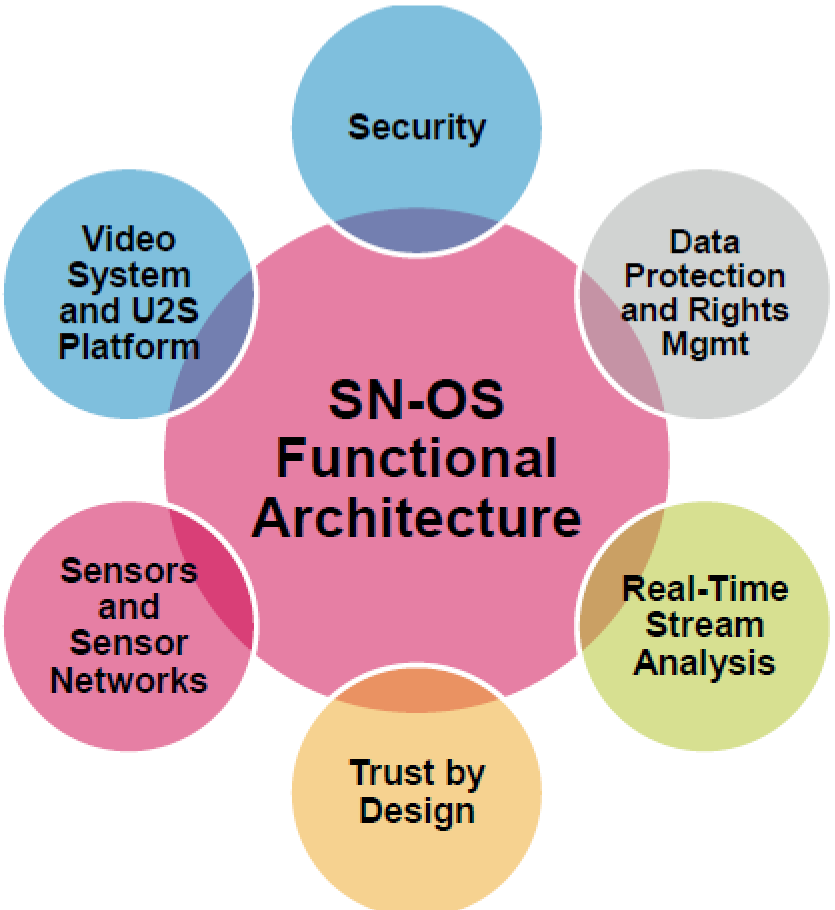
Build Manpower

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

iDA SINGAPORE

Smart Nation – Operating Systems



Internet of Systems

www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

a Communications & Sensor Network

Smart Nation Platform

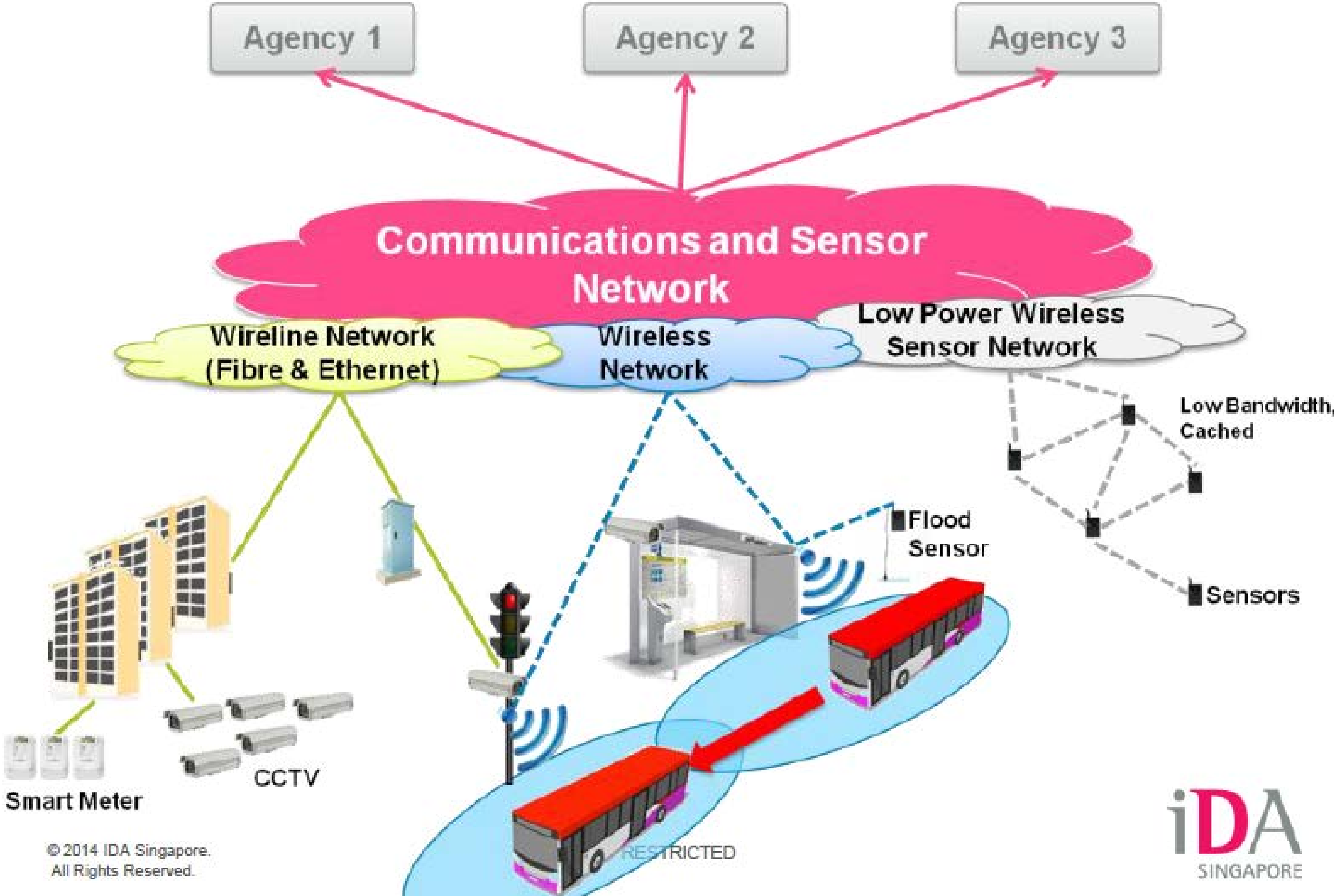
Smart Nation Operating System (SN-OS)

Communications & Sensor Network

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

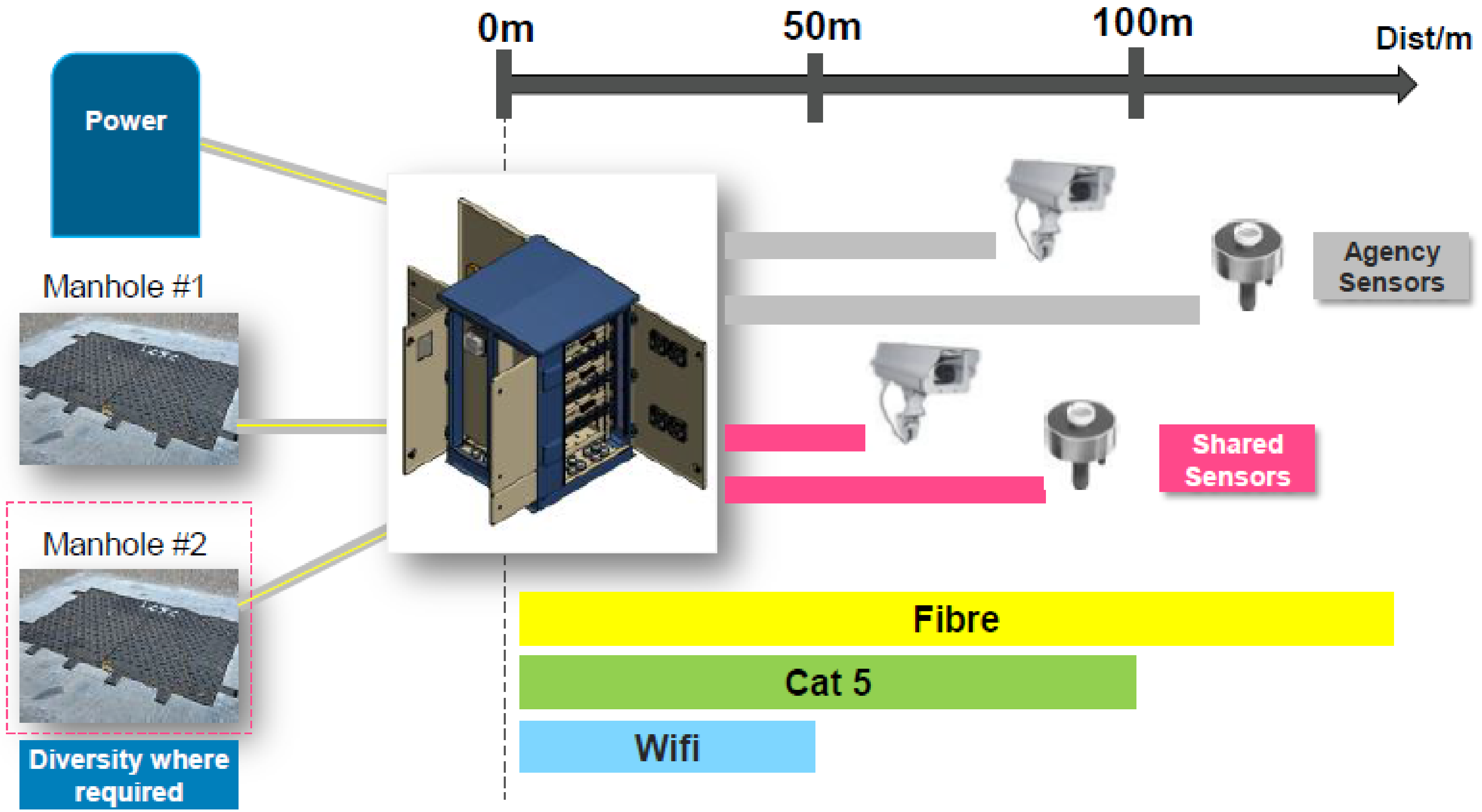
A "plug-n-play", trusted and resilient network infrastructure for deploying sensors



© 2014 IDA Singapore.
All Rights Reserved.
RESTRICTED

iDA SINGAPORE

Aggregation Gateway (AG) Box provides connectivity and power



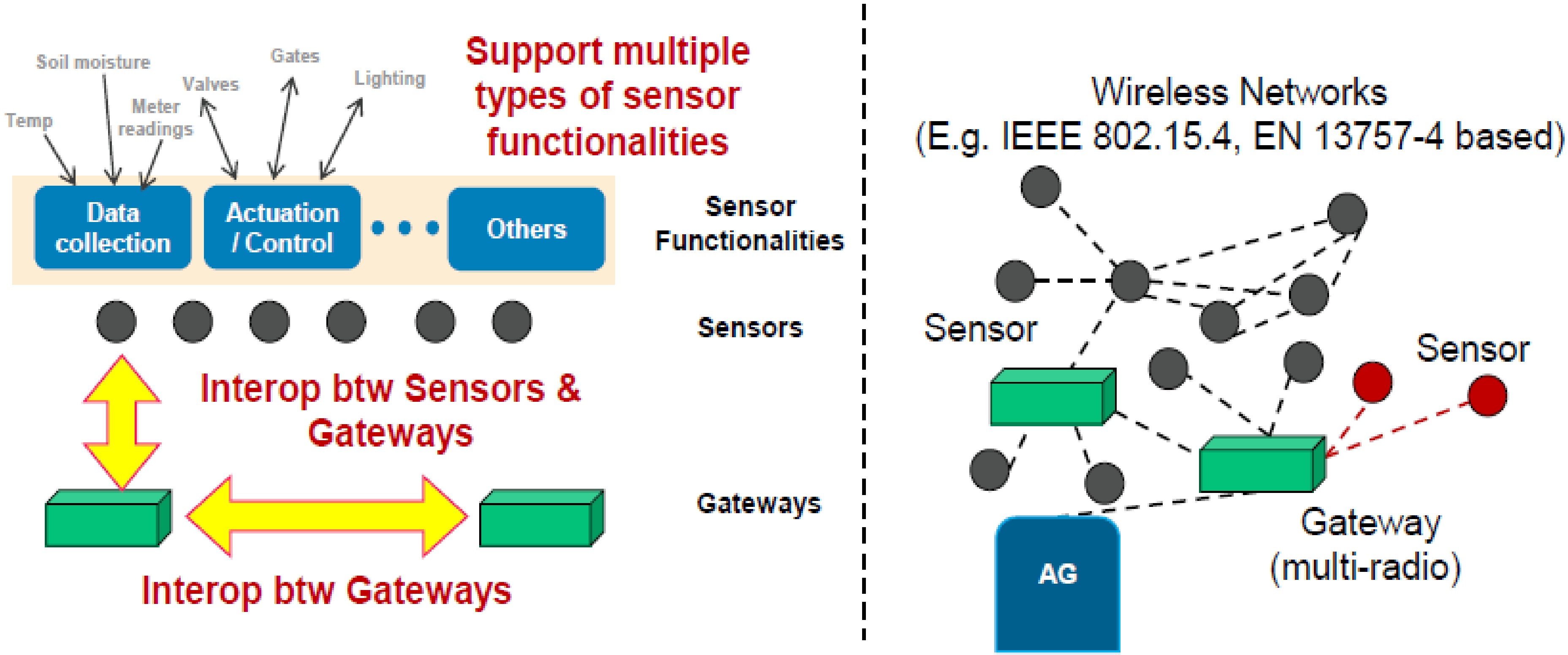
- Providing heterogeneous and resilient connectivity and power
- Ownership of trenches and physical infrastructure to support sensor rollout
- Set of shared sensors to support common needs

© 2014 IDA Singapore.
All Rights Reserved.

RESTRICTED

iDA SINGAPORE

Wireless Sensor Network



- **Low power**
  - Support battery-powered sensors
- **Security**
  - Multi-tier security
  - End-to-end channel & data security
- **Dynamic topology**
  - Self-healing
  - Self-configuring
- **Scalable Management**
  - Device management
  - Network management

© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

Deployment of Shared Sensors

Hotspot Cleanliness

Crowdedness and Flow of People Traffic

Water Level Detection

Earthquake Monitoring

Example: Possible data that can be derived from CCTV feeds

© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

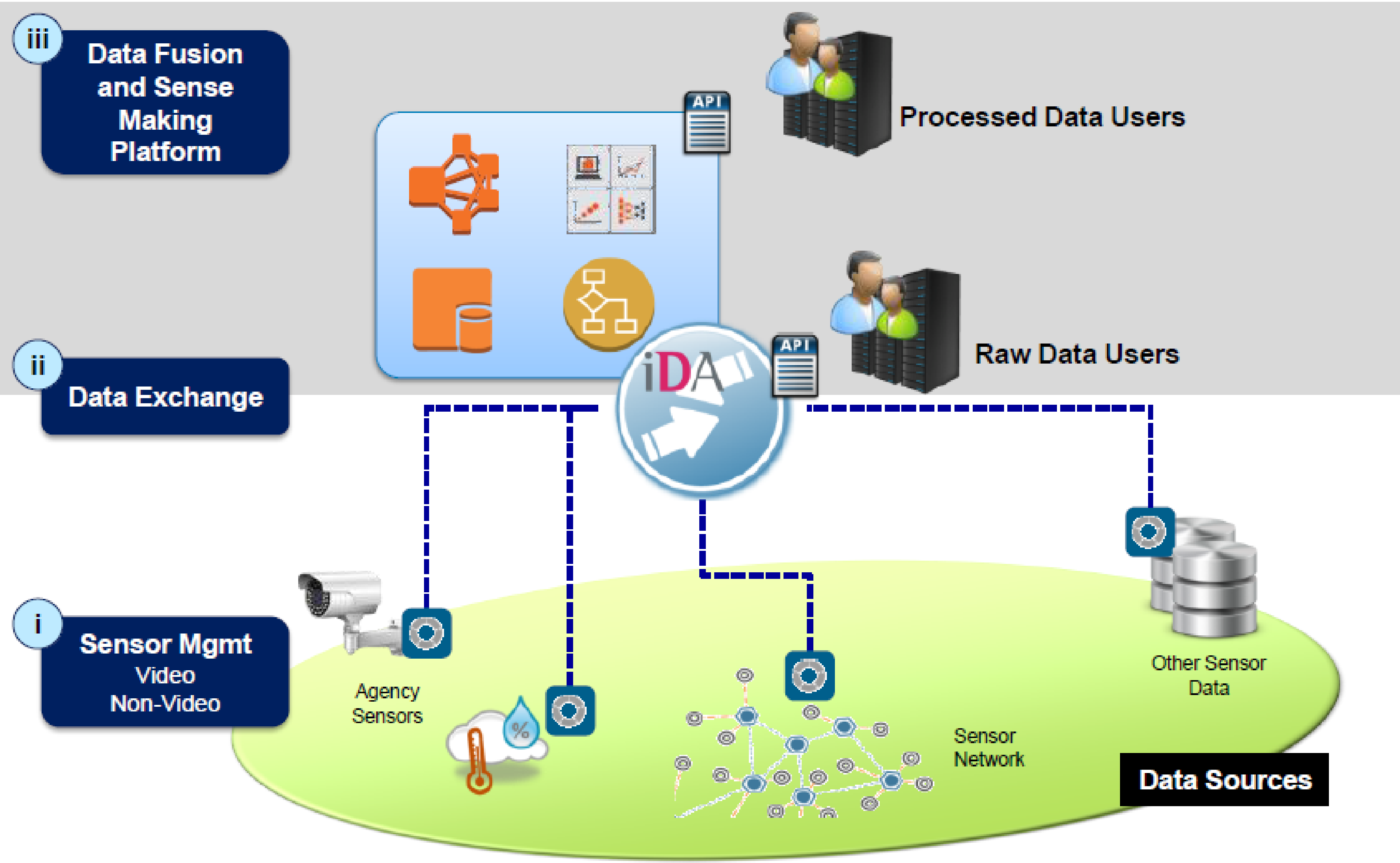
Indicative Initial Deployment of AG Boxes

http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

b Smart Nation Operating System (SN-OS)

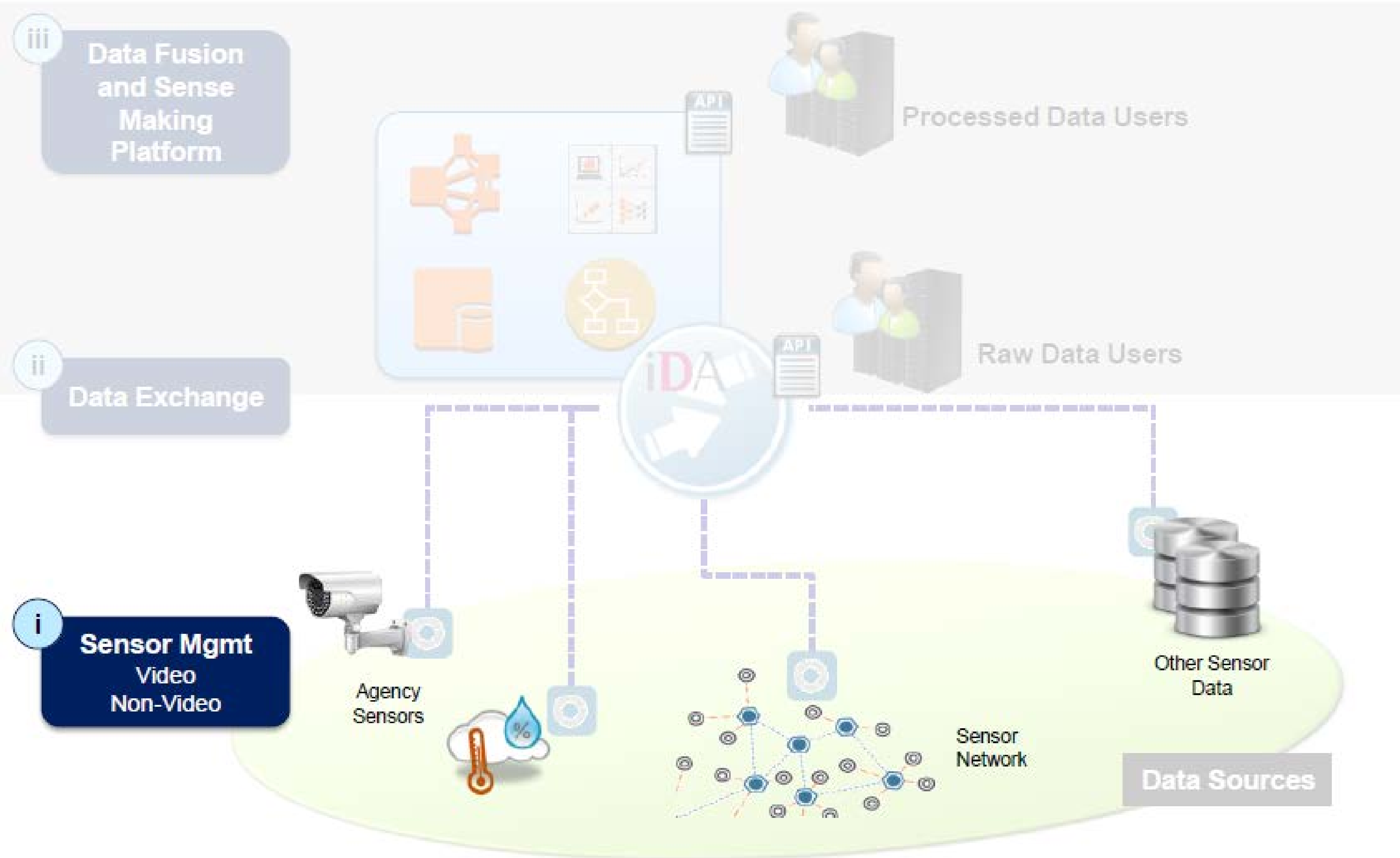
© 2014 IDA Singapore.
All Rights Reserved.

Smart Nation Operating System (SN-OS)



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

(i) Sensor Management



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

(i) Sensor Management Functionalities

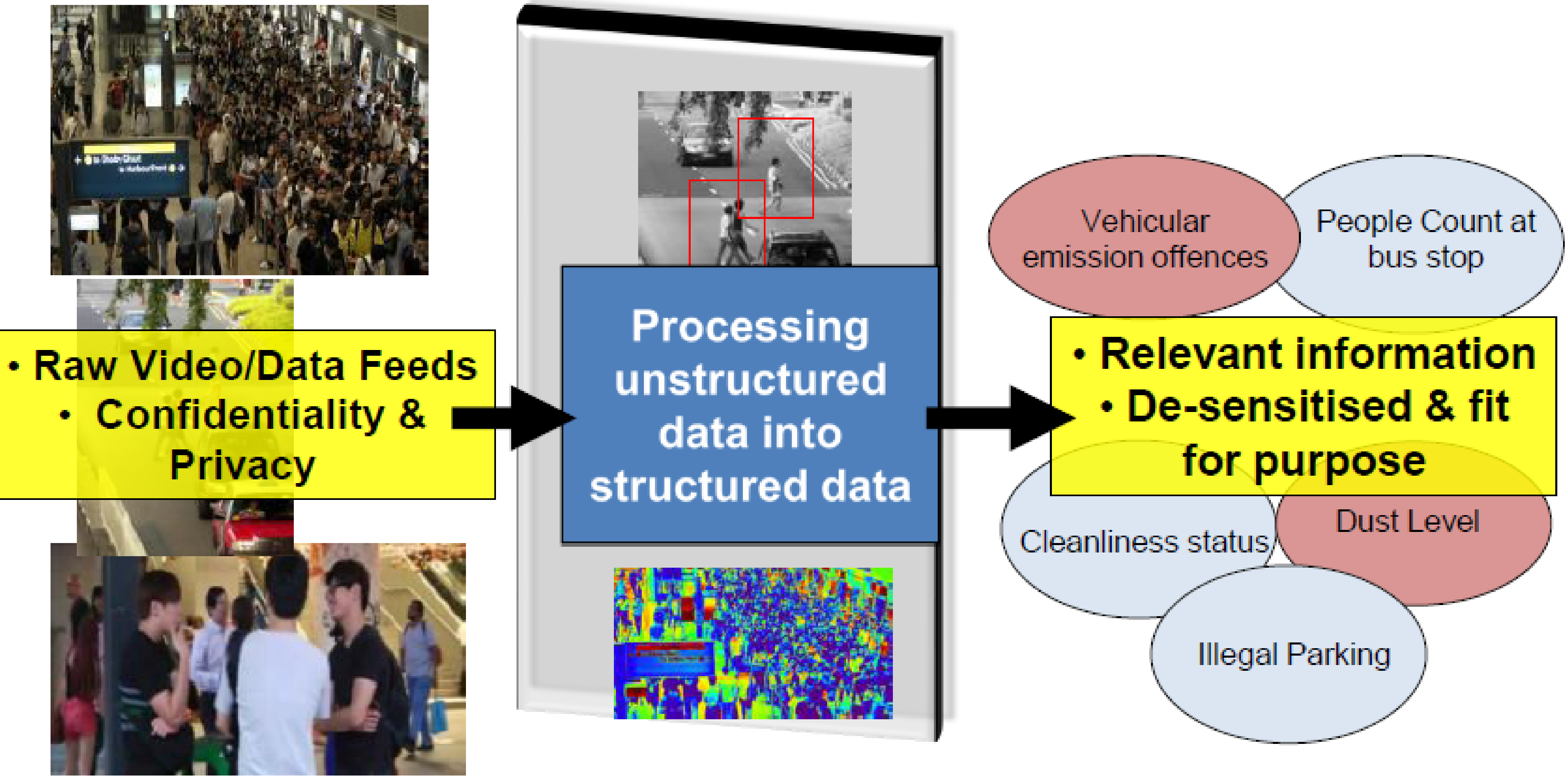
Monitoring	Remote Configuration	Application Mgmt/Device Drivers
• Battery voltage and state of charge • Node/gateway status • Sensor network performance: load, latency	• Activation, de-activation of sensors • Sensing mode or period update rate • Sensor-specific configuration	• List of sensors to be implemented • OTA support of new sensors

© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

Unstructured to Structured (U2S) Platform

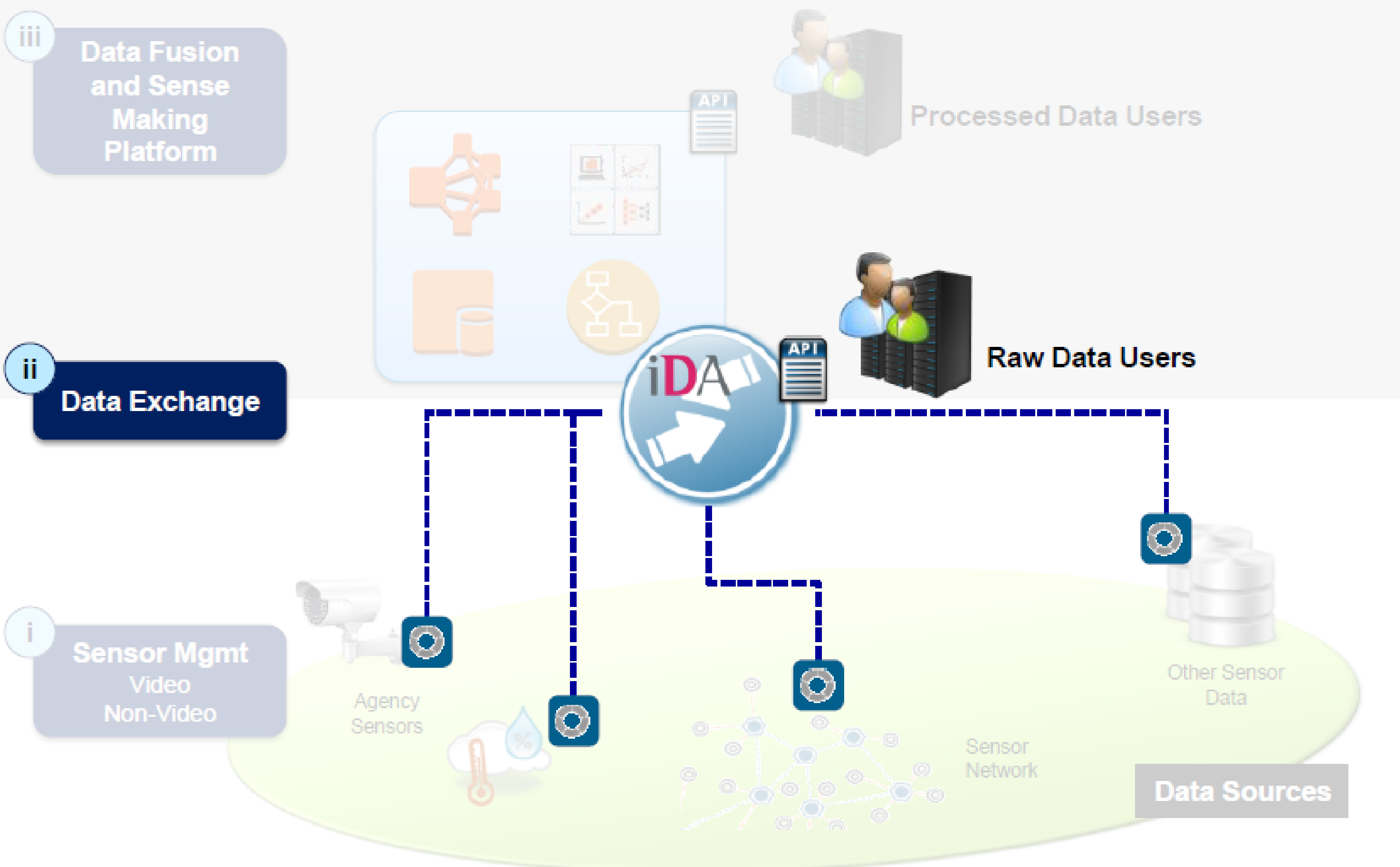
Conversion of Unstructured Streams into Data



(1) Obfuscate sensitive sensor data

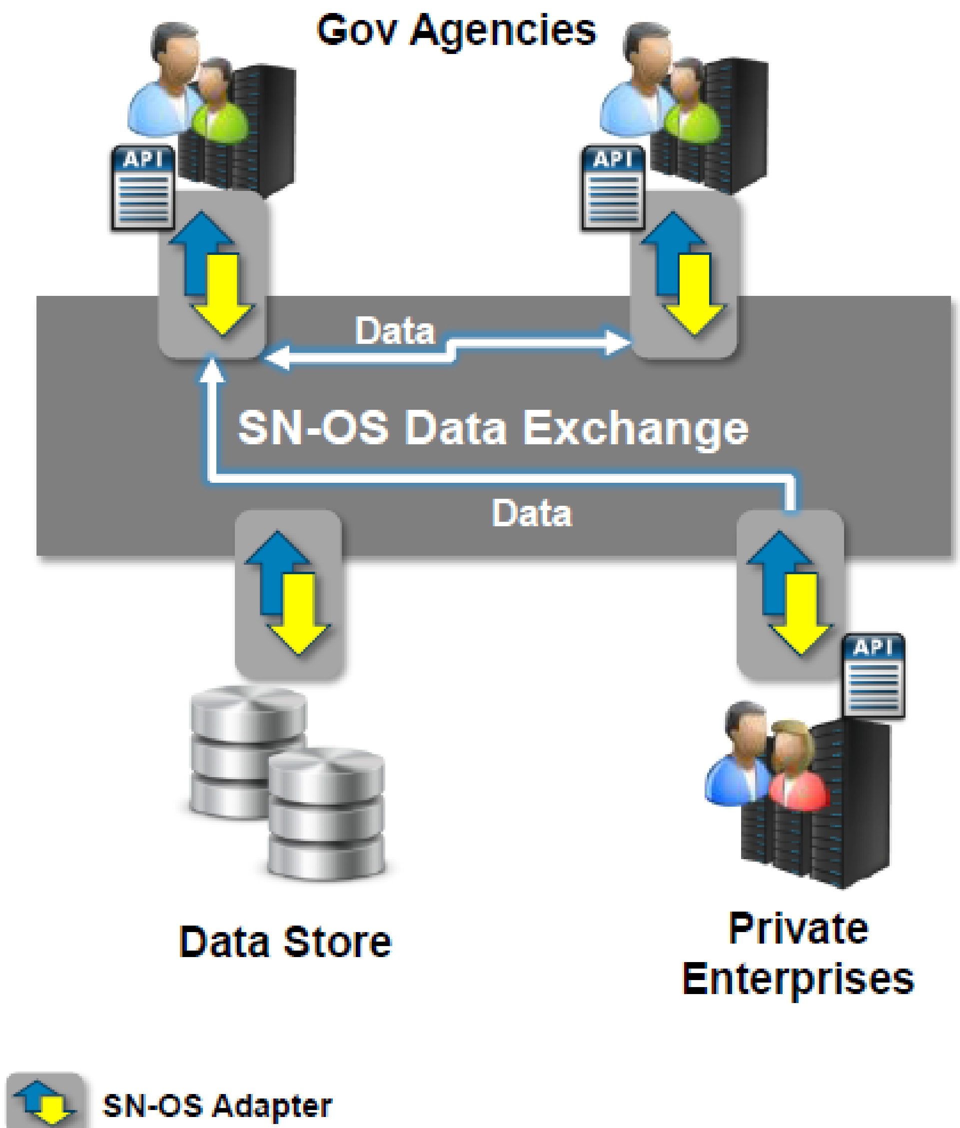
(2) Produce only relevant information for Agencies

(ii) Data Exchange



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

(ii) Data Exchange to Facilitate Data Sharing



An **unified platform** to facilitate **reliable, secure, timely discovery & sharing** of human and machine-centric sensor data between government agencies (**WOG**) and between **Private Enterprises-WOG**

Open Standards & Protocols

Security & Trust

Modular

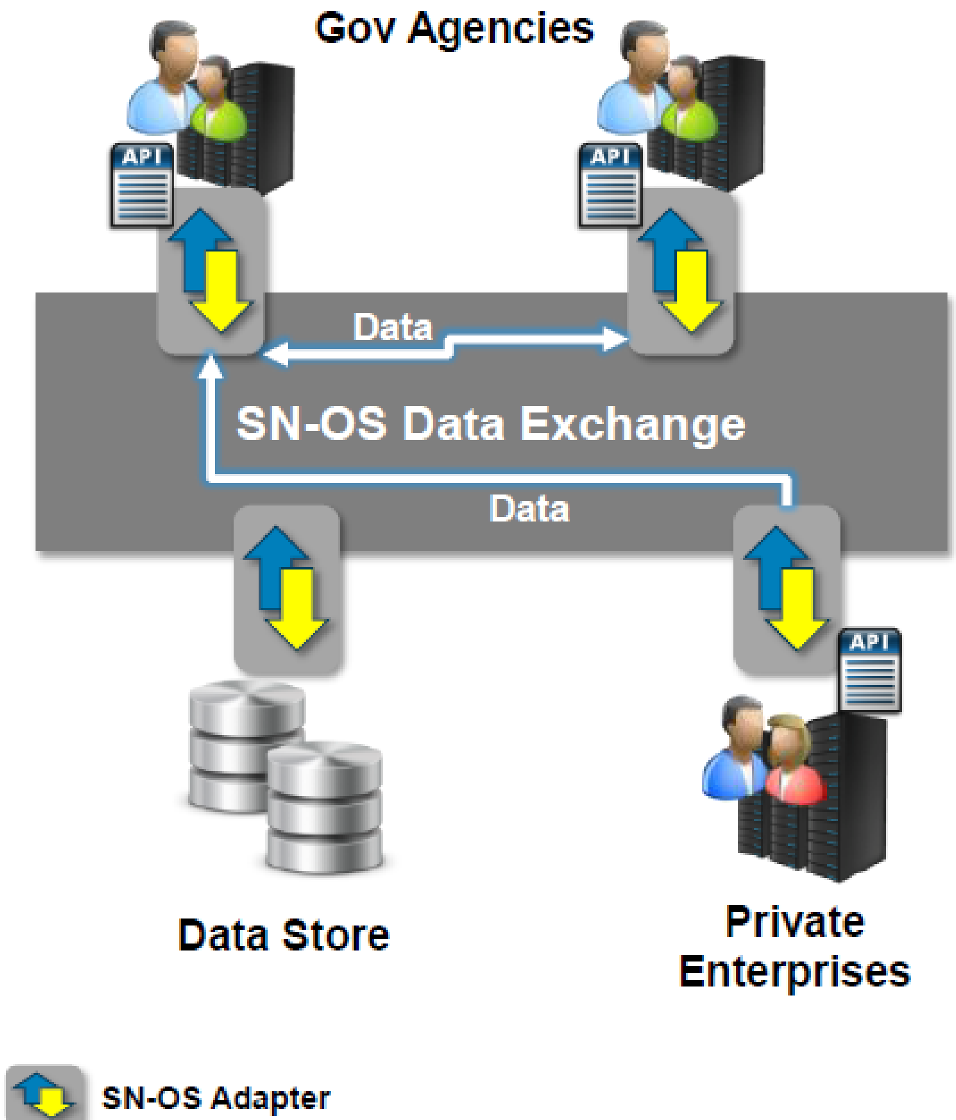
Data Security & Policies

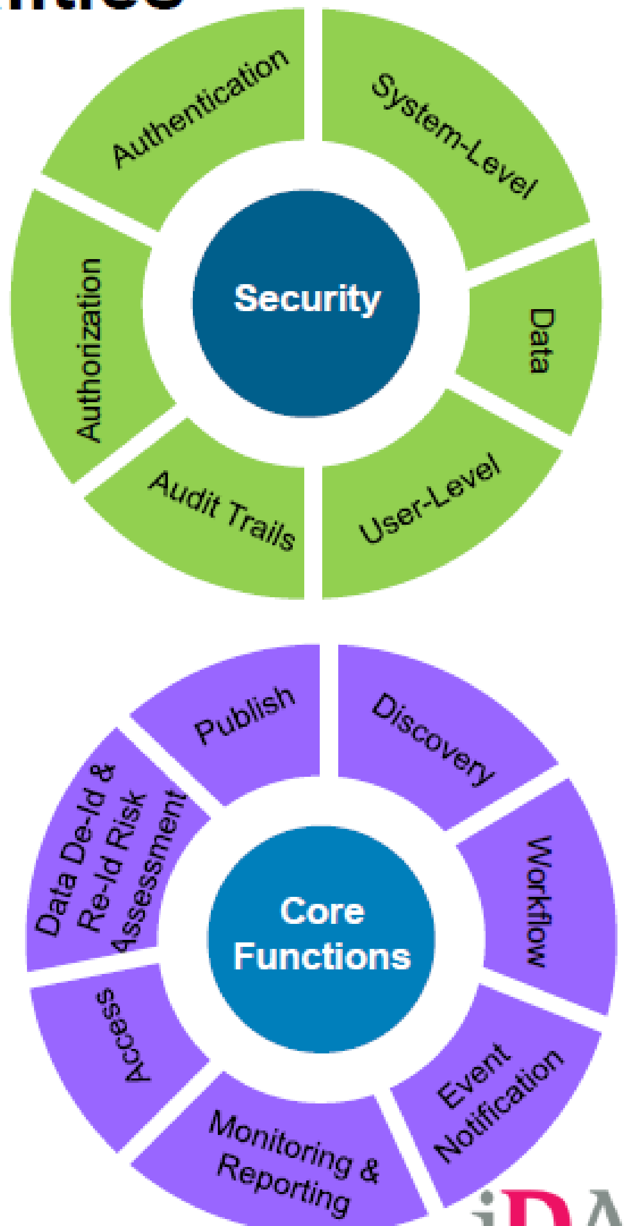
Federated Design

© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

(ii) Data Exchange Functionalities

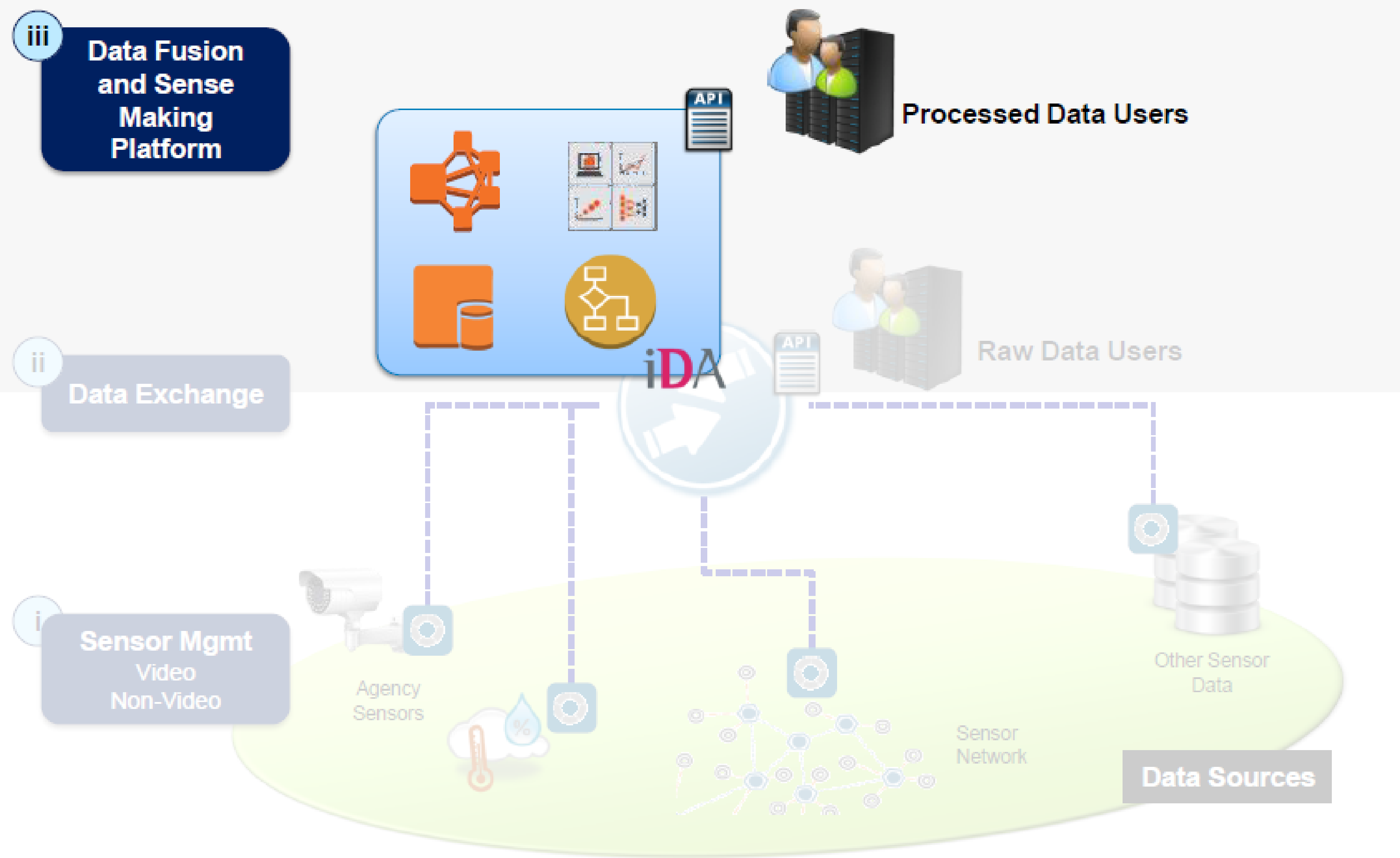




© 2014 IDA Singapore.
All Rights Reserved.

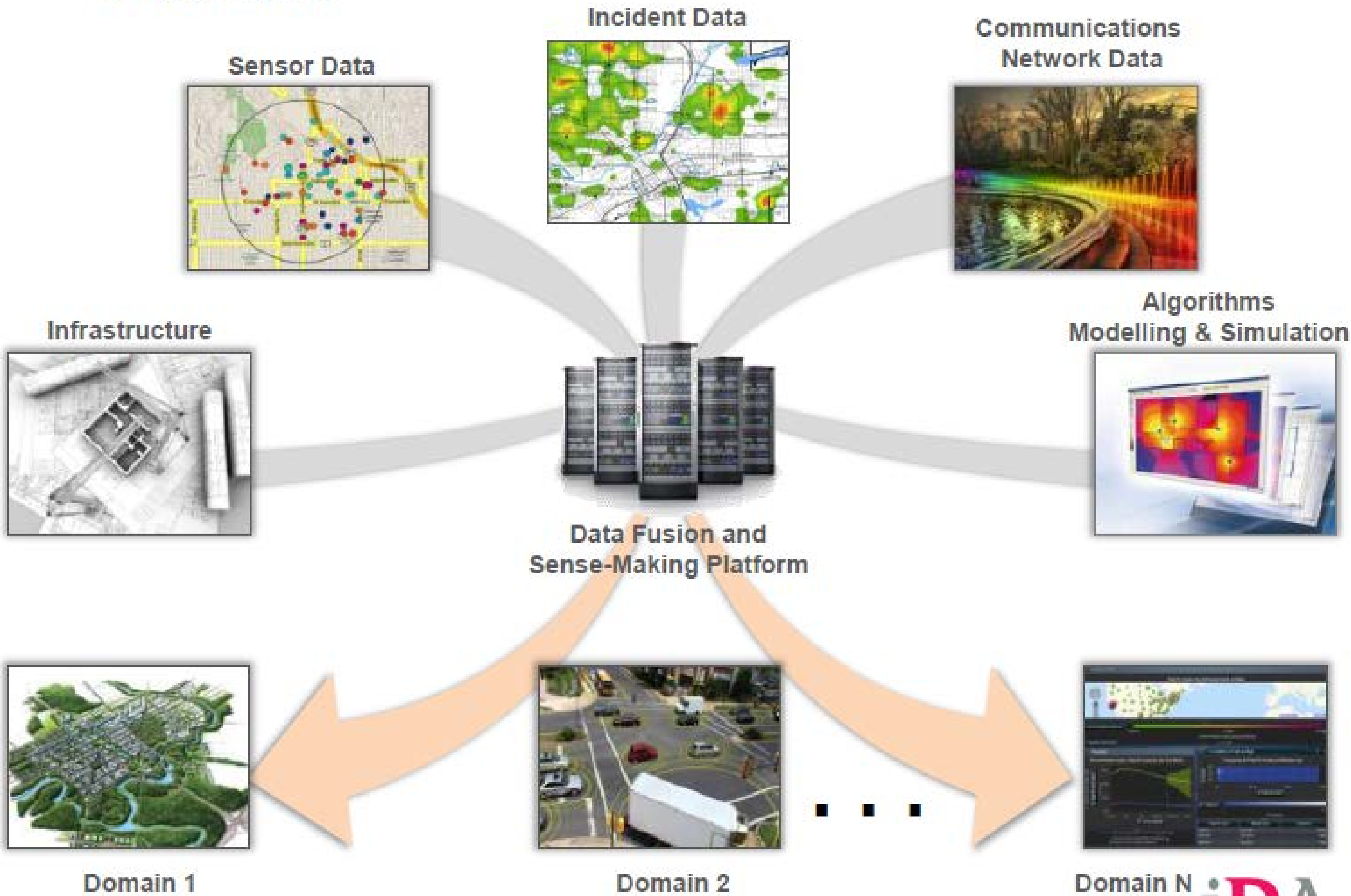
iDA SINGAPORE

(iii) Integrated Data Fusion and Sense Making Platform



http://www.ida.gov.sg/~/media/Files/Collaboration%20Initiatives/Collaborations/2014/1010_SNP_IR/SNPBriefingSlides.pdf

(iii) Integrated Data Fusion and Sense Making Platform

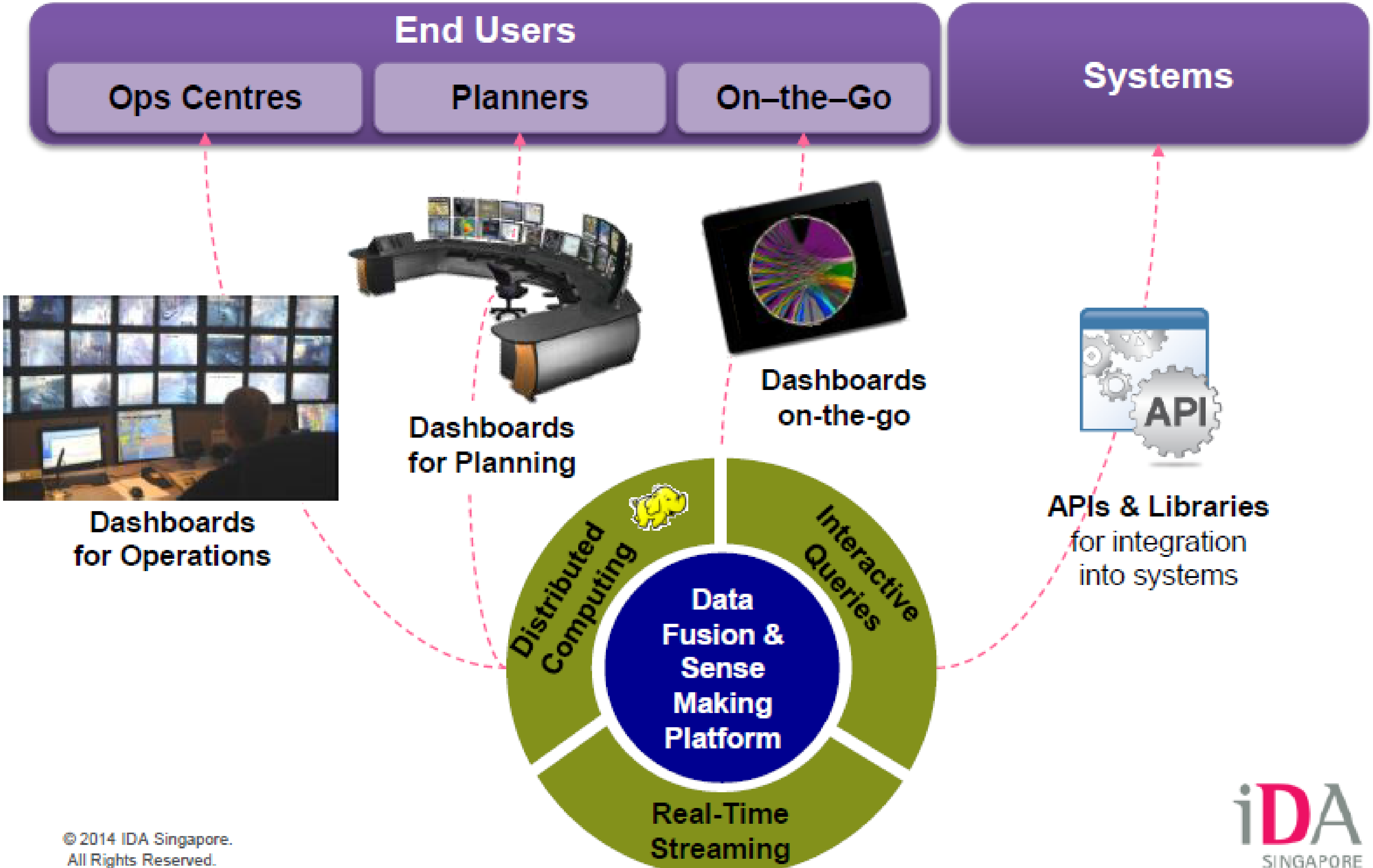


© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

(iii) Integrated Data Fusion and Sense Making Platform

Delivery of Data Products



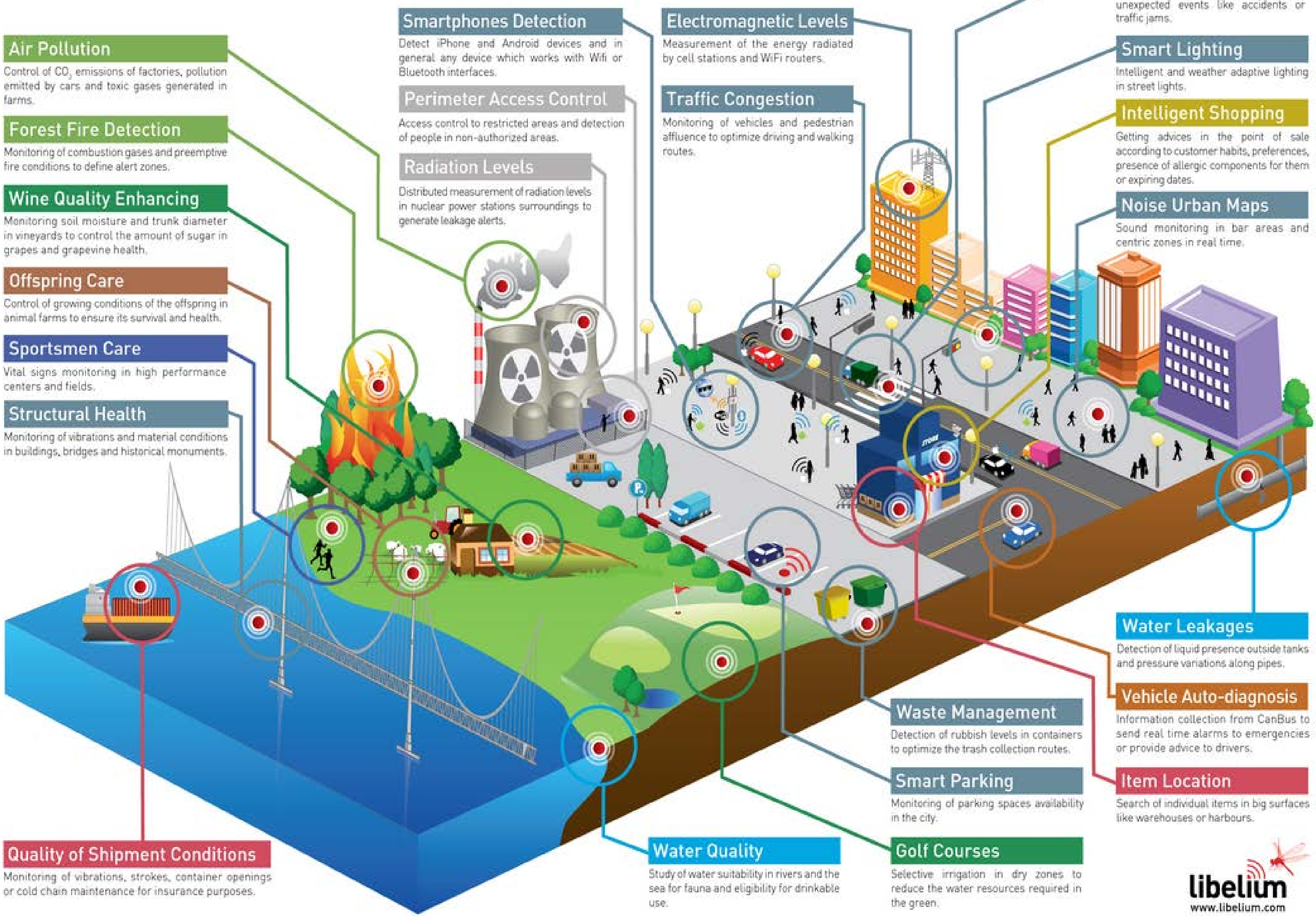
© 2014 IDA Singapore.
All Rights Reserved.

iDA SINGAPORE

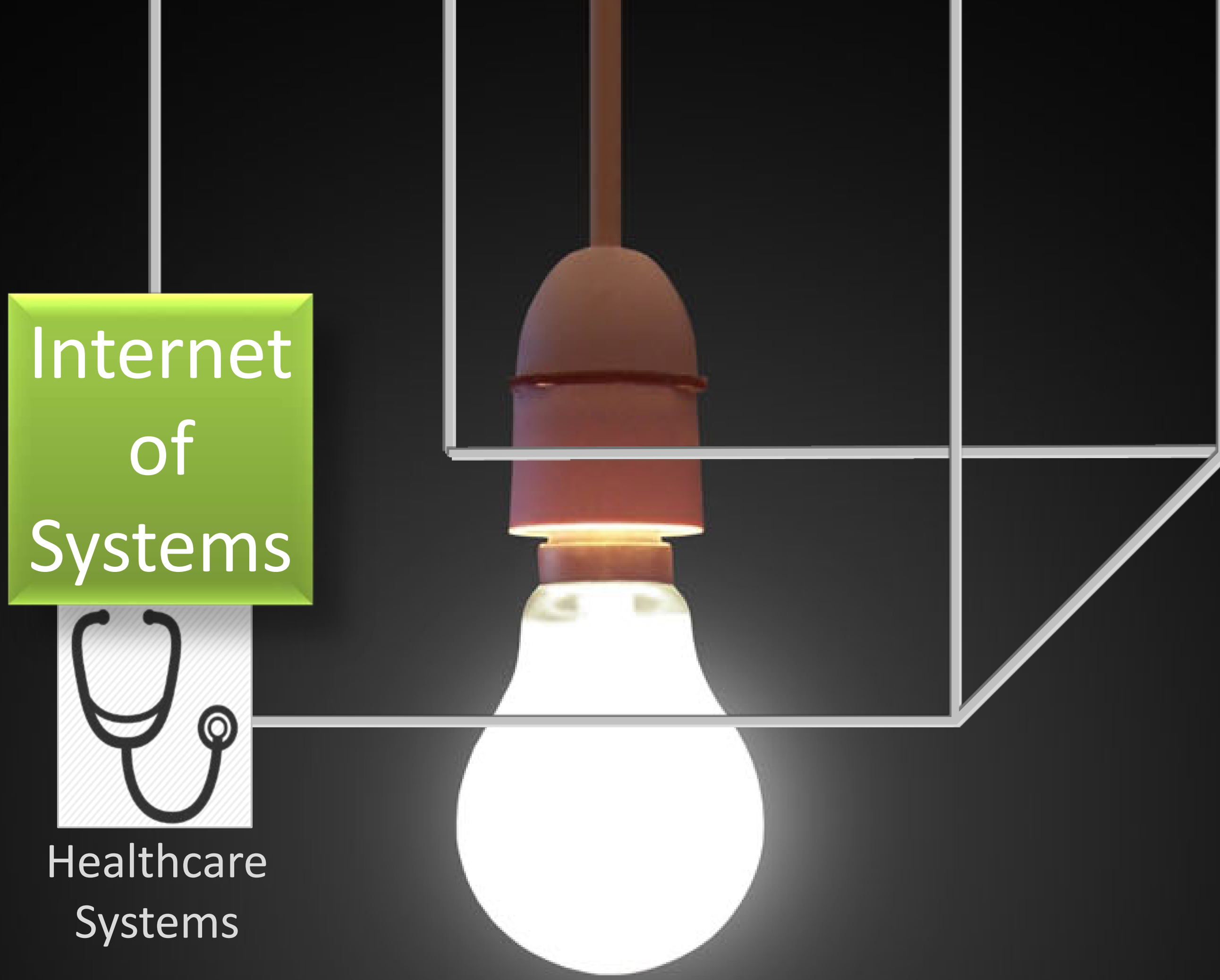
What was most remarkable in the Smart Nation Singapore briefing ?

No hype about "Big Data" or IoT

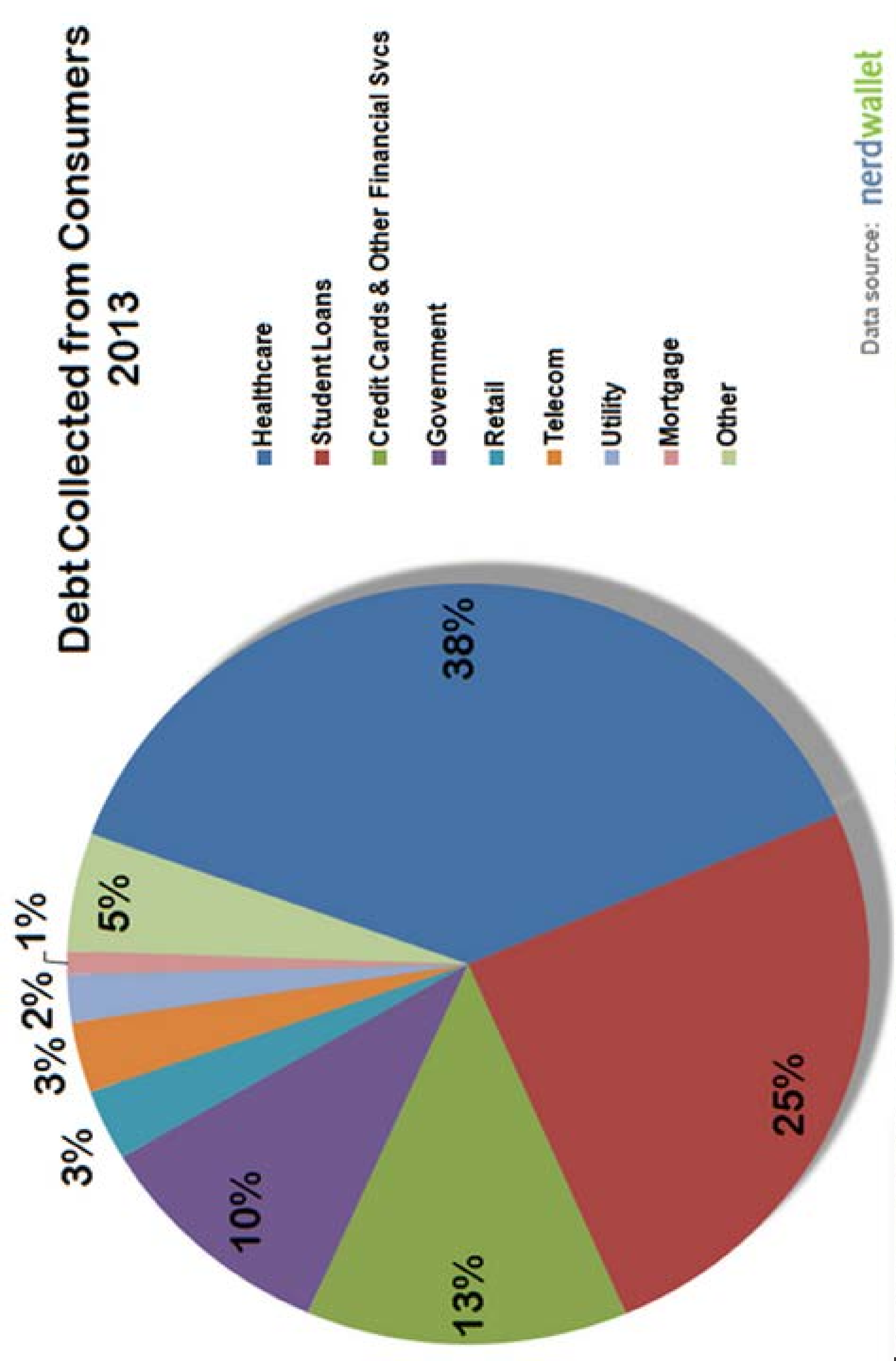
IoS → Smart Nations → Smart World → → Smarter Planet



☑ Healthcare



Grand Challenges



Statement

CEDARS-SINAI

US$ 292,643.73

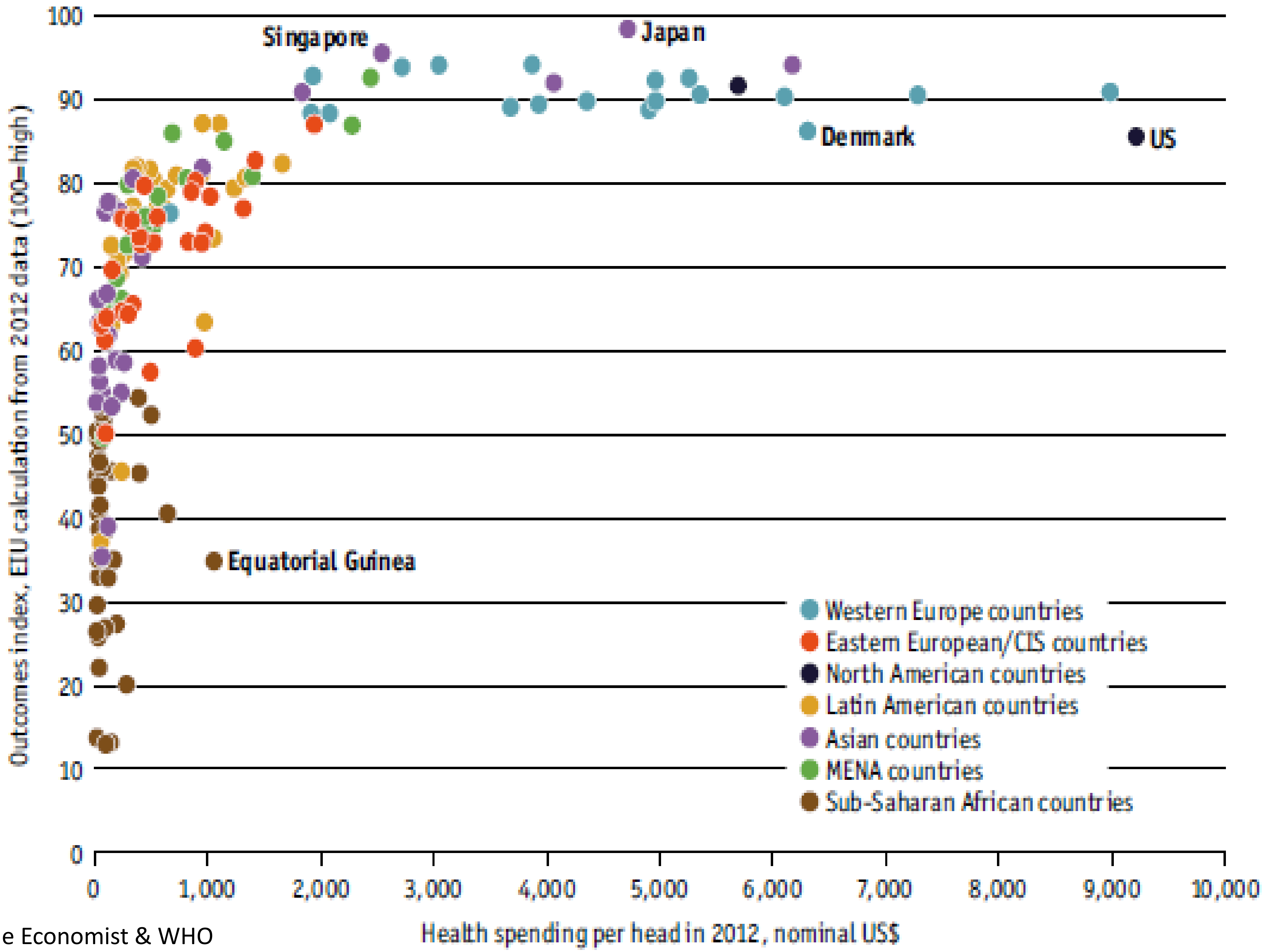
Account Number:
Patient Name:
Service Date: November 25, 2013

Primary Insurance: UNITED HEALTHCARE
Secondary Insurance: No Insurance on file

Description	Pre-discount charges billed to insurance
Pre-discount Charges*	**$292,643.73**
Summary of Charges	
ROOM & BOARD - SEMI-PRIVATE T*	$72,624.00
PHARMACY - GENERAL CLASSIFICA*	$11,152.32
MEDICAL/SURGICAL SUPPLIES AND*	$11,115.53
LABORATORY - GENERAL CLASSIFI*	$5,358.41
RADIOLOGY - DIAGNOSTIC - GENE*	$8,294.16
CT SCAN - GENERAL CLASSIFICAT*	$14,481.65
OPERATING ROOM SERVICES - GEN*	$65,333.50
ANESTHESIA - GENERAL CLASSIFI*	$31,049.61
PHYSICAL THERAPY - GENERAL CL*	$1,139.25
OCCUPATIONAL THERAPY - GENERA*	$762.90
MAGNETIC RESONANCE TECHNOLOGY*	$36,089.15
RECOVERY ROOM - GENERAL CLASS*	$19,604.18
EKG/ECG (ELECTROCARDIOGRAM) -*	$816.29
OTHER DIAGNOSTIC SERVICES - G*	$14,822.78
Hospital Discount to Patient*	$-171,196.61
Insurance Payments Received	$0.00
Patient Payments Received	$0.00
Actual Discounted Charges Pending with Insurance*	$121,447.12

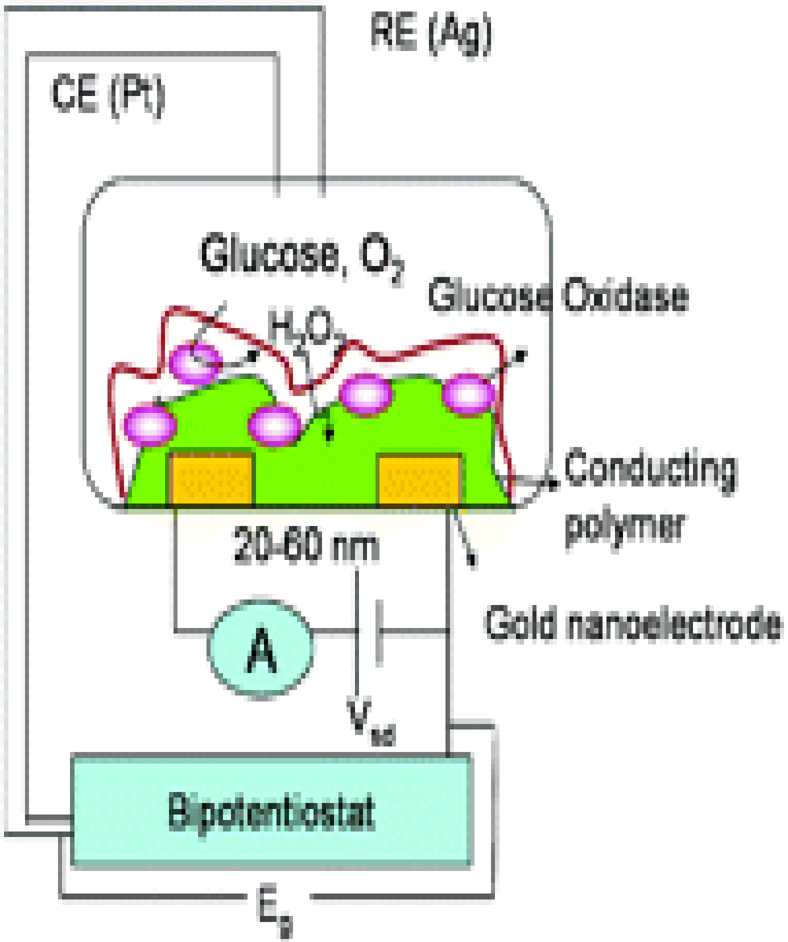
The Medical Center provides discounts for services covered by most insurance plans, and r uninsured patients. Please note: there may be additional charges that have not yet been osted.

Outcome vs Spending



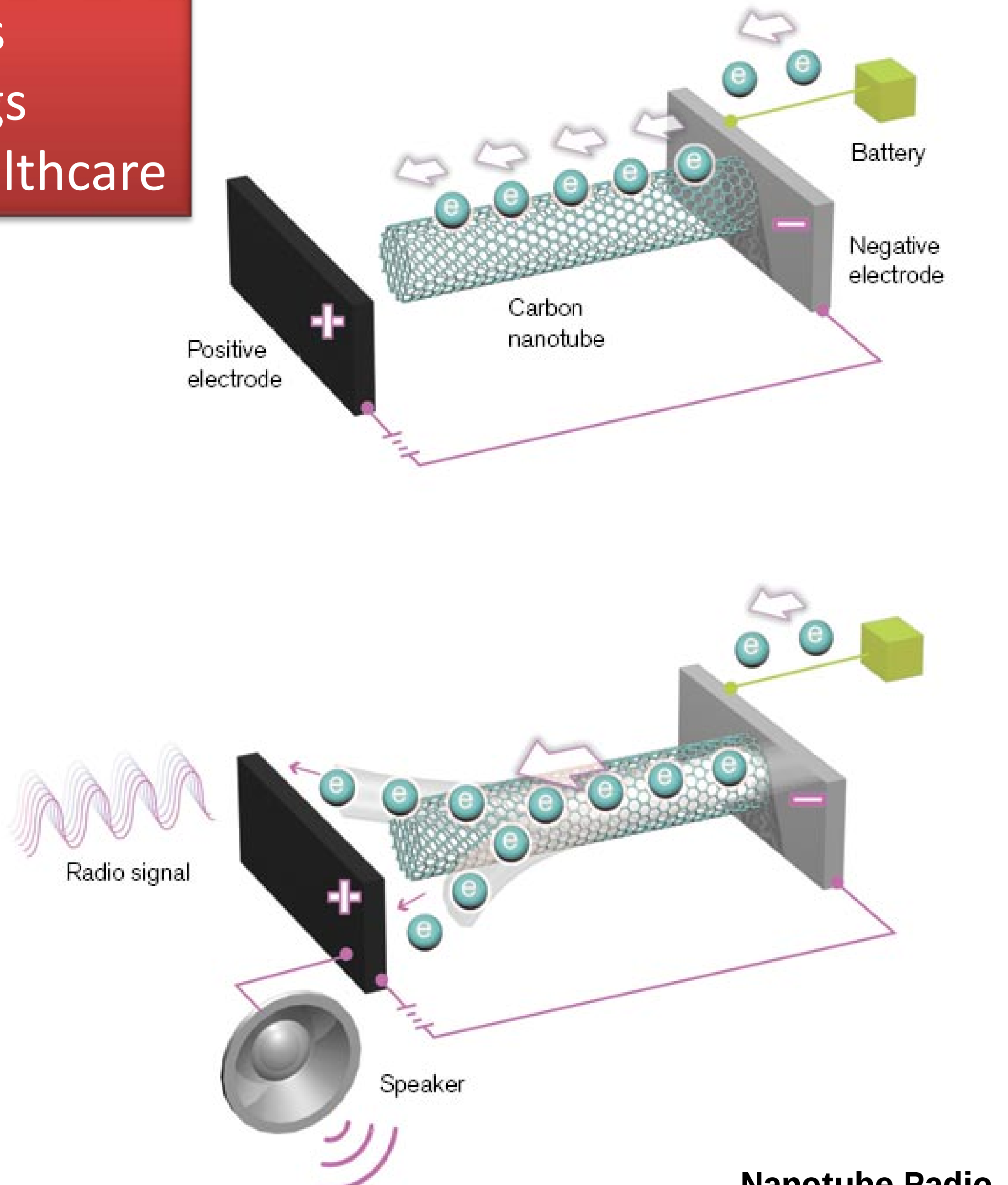
The Economist & WHO

The Management of Diabetes
The Medical Internet of Things
The Industrial Internet of Healthcare



Blood Glucose Nano-sensor

NanoLetters (2004) 4 1785-1788

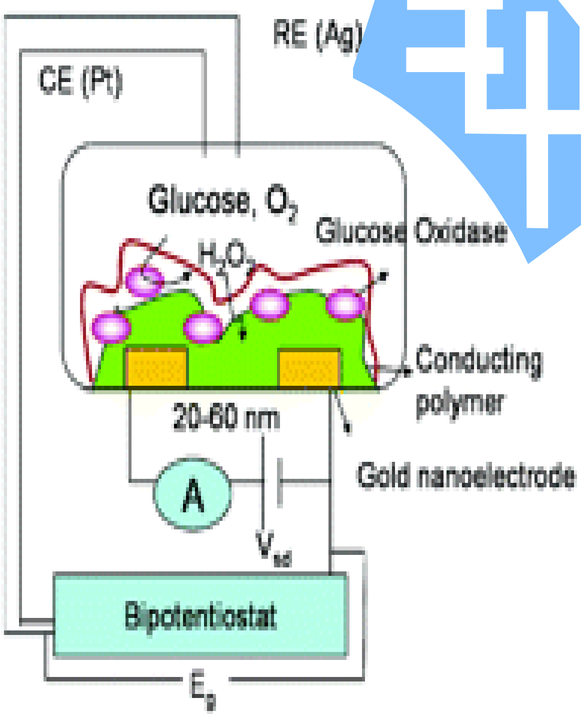


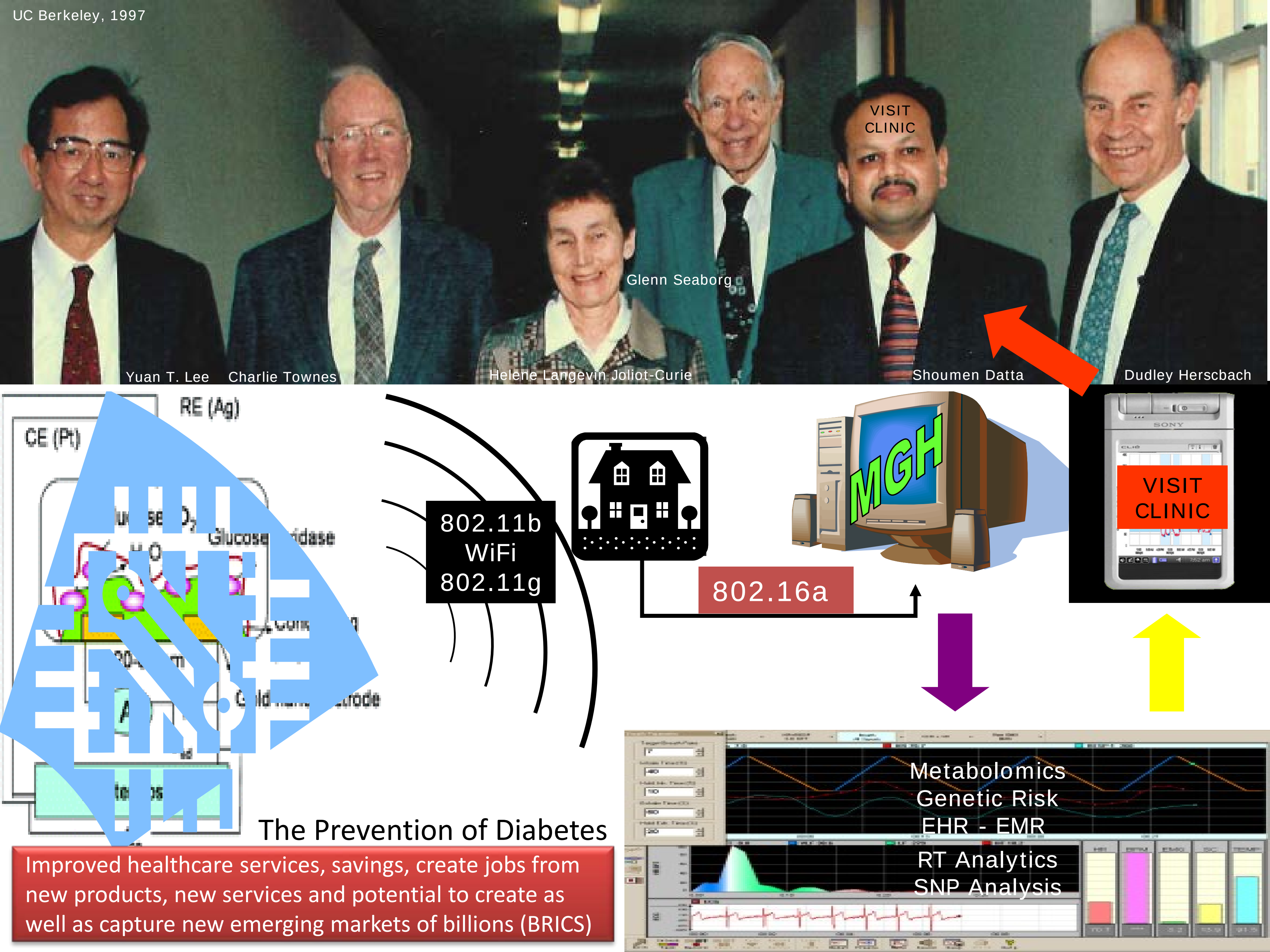
Nanotube Radio

NanoLetters (2007) 7 3508-3511

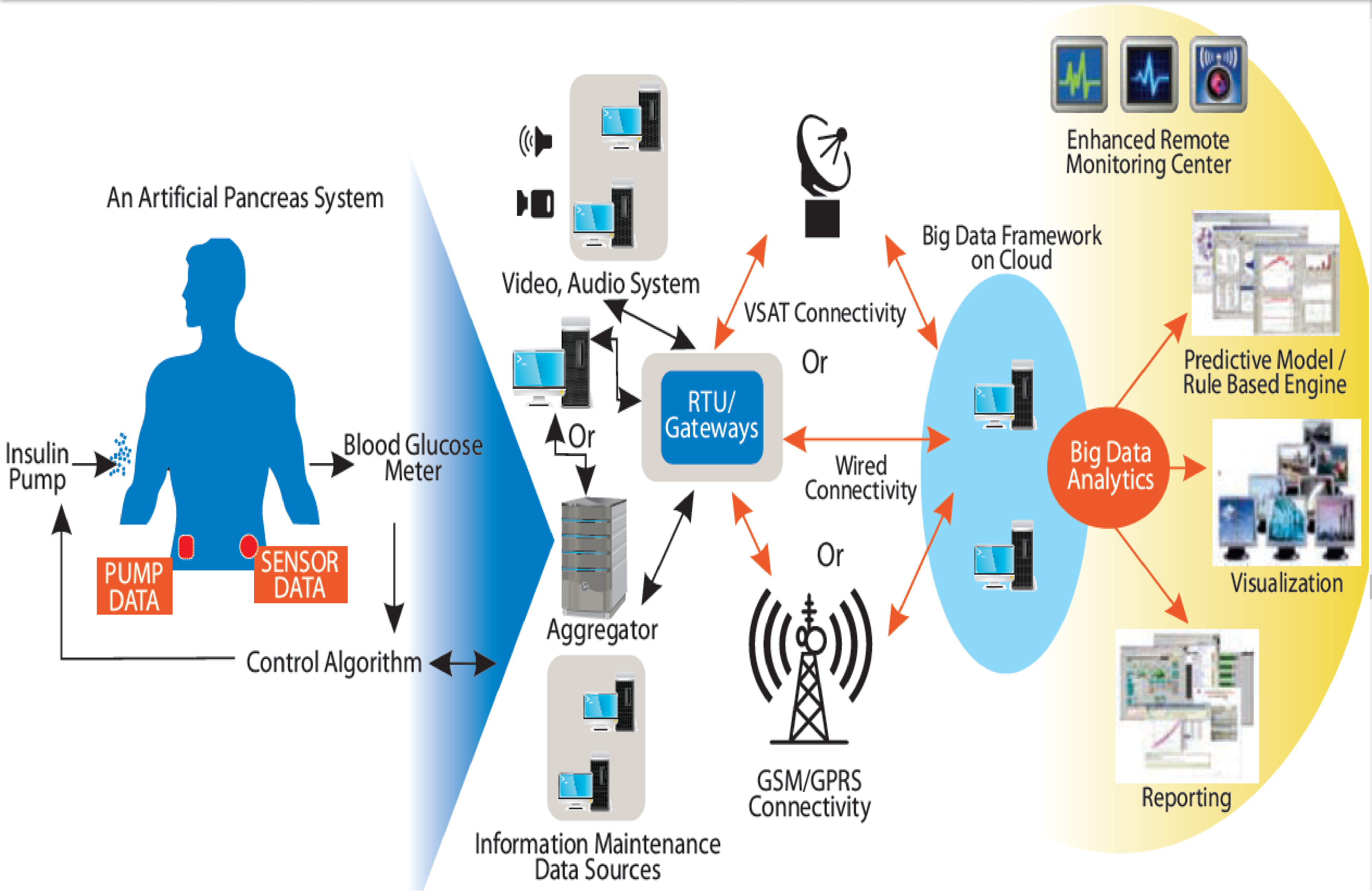
- Remote Heath Monitoring

May I implant a glucose nano-sensor nano-radio chip on your shoulder? You are fat. You could become diabetic.




UC Berkeley, 1997
VISIT
CLINIC
Glenn Seaborg
Yuan T. Lee
Charlie Townes
Helene Langevin Joliot-Curie
Shoumen Datta
Dudley Herschbach
RE (Ag)
CE (Pt)
802.11b
WiFi
802.11g
802.16a
MGH
SONY
VISIT
CLINIC
Metabolomics
Genetic Risk
EHR - EMR
RT Analytics
SNP Analysis
The Prevention of Diabetes
Improved healthcare services, savings, create jobs from new products, new services and potential to create as well as capture new emerging markets of billions (BRICS)

IoS Diabetes Management • Artificial Pancreas Device Systems



www.tcs.com/SiteCollectionDocuments/White%20Papers/Personalized-Artificial-Pancreas-Device-Systems_1014-1.pdf

Pay-Per-Pee Home Health – IoS Wireless Toilet Bowl Connected to Health Informatics

Weigh-scale, BMI, FOBT, urine analysis, sugar, ketone body analysis, blood pressure monitor, pulse oximeter, networked to phone via WiFi and/or Bluetooth with biometrics and face recognition for secure communication with physician and hospital or clinic, globally.

Walgreens Specials - $1.99 for 24-pack Diet Coke • $1.99 for Bone Density • $1.99 Mammogram

PDEXA SCAN
BONE MINERAL
DENSITY PROFILE

Value Network Ecosystem Testbed

Walgreens – Retail Healthcare
GE – Equipment
Cisco – IPv6 Routers
AT&T – Data Transmission
Intel – MIPS
IBM – Data Analytics
Samsung – Diagnostic Apps
Walmart – Grocery Supply Chain

CVS IoS Special - $0.99 for 1-quart Milk • $1.99 for Bone Density • $2.99 Mammogram

PDEXA SCAN
BONE MINERAL
DENSITY PROFILE

PDEXA SCAN in every drug store, petrol pump, grocery

Osteoporosis

EU → 28 million in 2010 to 34 million in 2025 (increase of 23%)

US → 44 million (represents 55% of people aged 50+)

Brazil → 10 million (1 in every 17)

India → 36 million (2013)

China → 70 million (50+). Cost of treatment USD1.5 billion in 2006. Estimated US$12.5 billion in 2020 and US$265 billion in 2050.

In 2008, Indonesia had 34 DXA machines, half of them in Jakarta (population 237 million) which translates to 0.001 machine per 10,000 population. The equivalent recommended number for Europe is 0.11 (per 10,000)

http://bit.ly/BONE-HEALTH

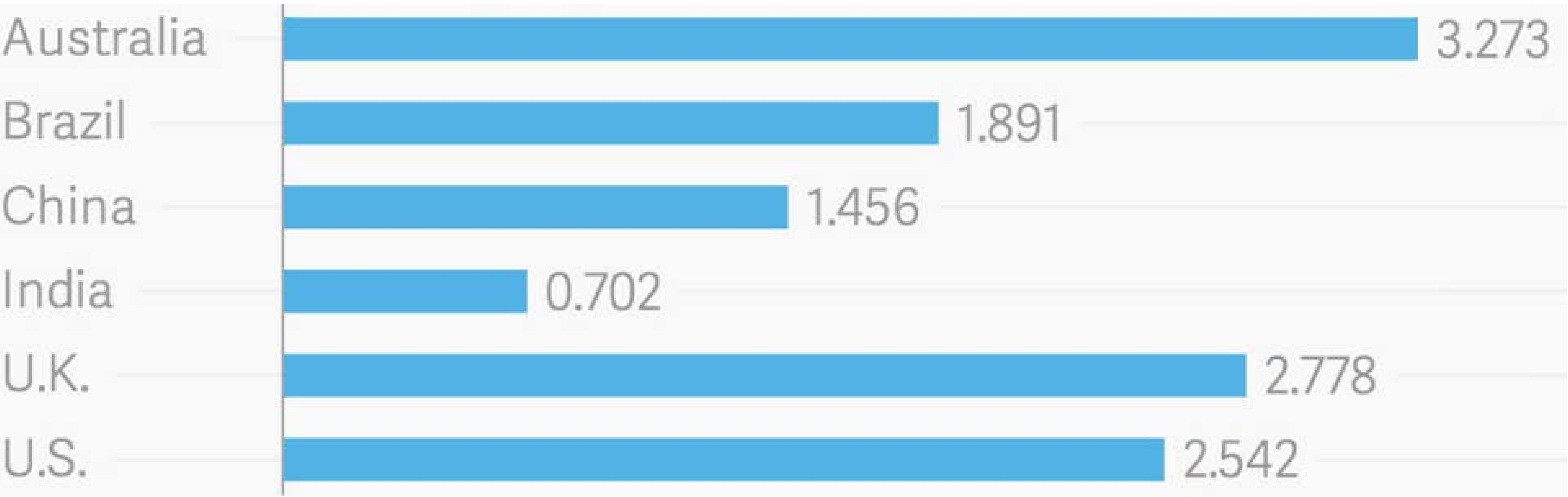
Health data without de-identification

CONNECT

GROCERY STORE
PURCHASE LOG

Integrated system detects fall in bone density and correlates with reduced purchase of milk. Prevention for osteoporosis starts early. Avoids trauma and/or morbidity from broken bones. Connected healthcare data.

Density of Doctors per 1000 people (WHO, 2011)



Population of India	1,252,000,000
Number of doctors in India	750,000
Number of new cervical cancer patients in India	70,000
Number of new gynecological cancer specialist each year in India	1

http://qz.com/269394#2/why-you-have-to-share-a-doctor-with-1424-other-people/

Fast Forward → Penny Per Person Per Use Per Day

$1 - Bone density

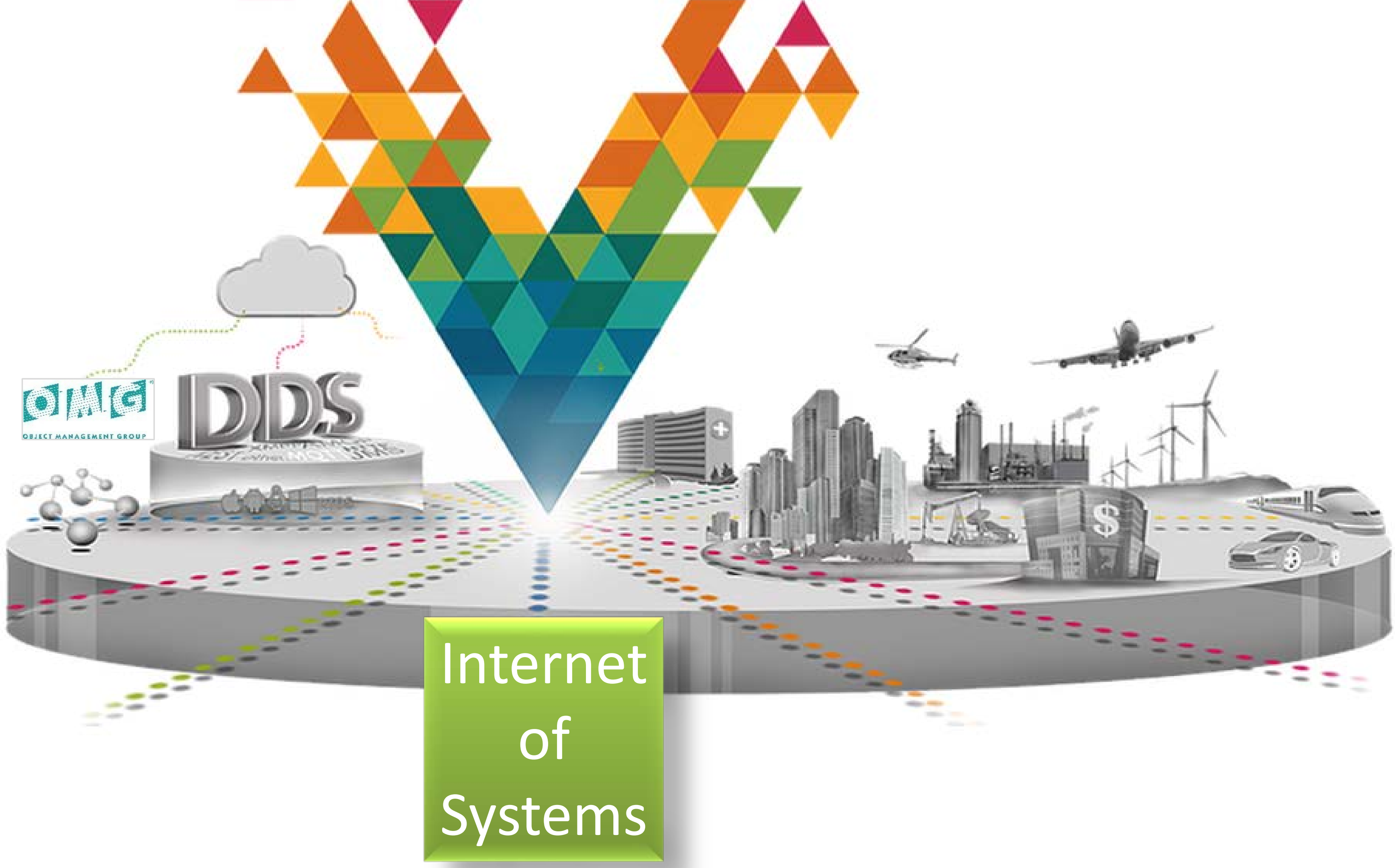
$1 - Mammogram

at the corner of Happy and Healthy in every zip code in India, China, Indonesia

data transmitted to specialists and reports sent to individuals, doctor and clinic

The micro-revenue earnings potential with 10% penetration for population of 3+ billion & aging!

Macro-economics
of
micro-revenue



Grand Platforms

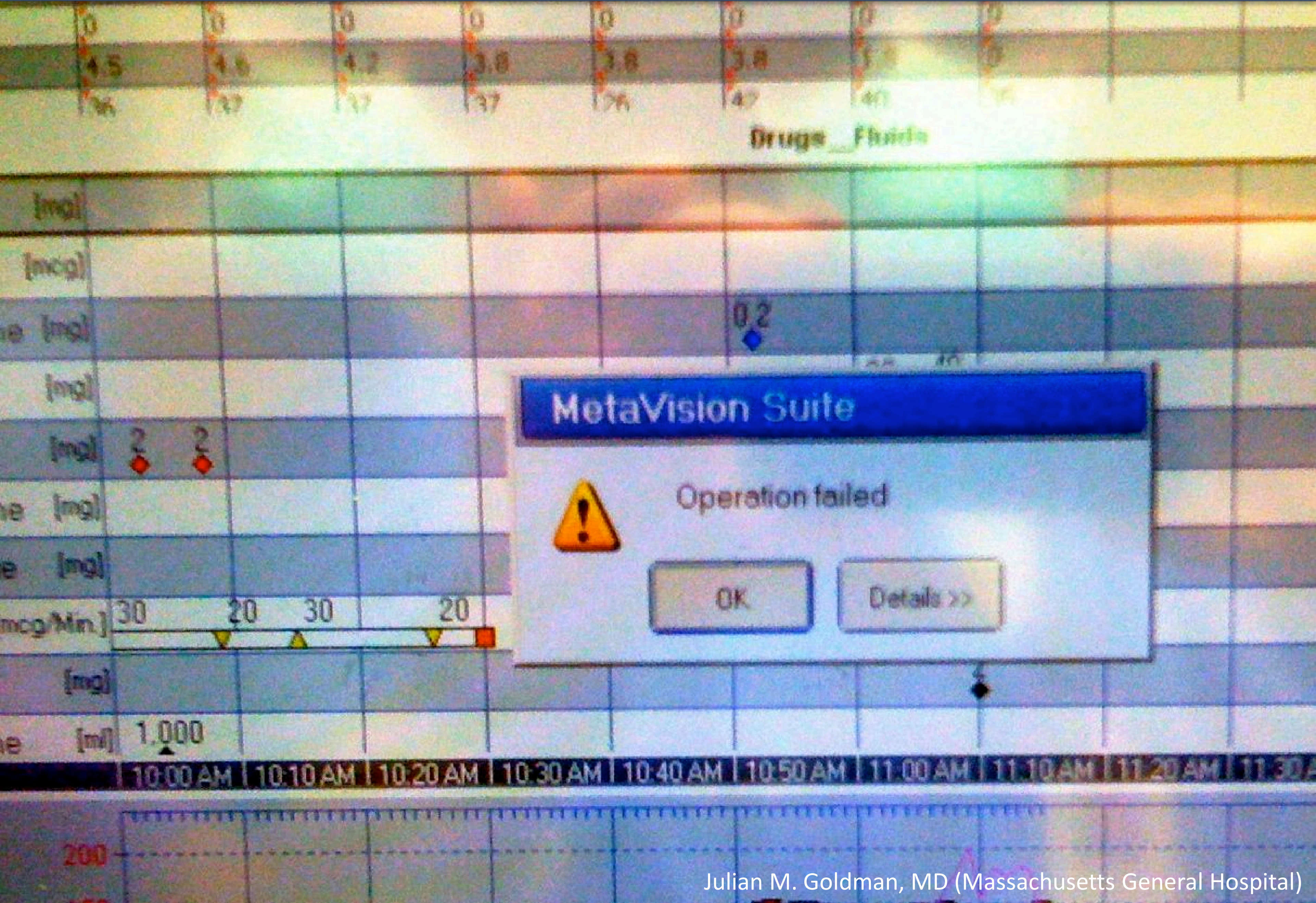
How Many Die From Medical Mistakes in U.S. Hospitals?

www.propublica.org/article/how-many-die-from-medical-mistakes-in-us-hospitals

- 1999 – IOM published “To Err Is Human” up to 98,000 die each year because of mistakes.
- 2010 – OIG US HHS: bad hospital care caused 180,000 deaths in Medicare in a given year.
- 2013 – Journal of Patient Safety: between 210,000 and 440,000 patients suffer some type of ***preventable*** harm that contributes to their death.
- That would make medical errors the third-leading cause of death in the US, behind heart disease, which is the first and cancer, which is second.

http://journals.lww.com/journalpatientsafety/Fulltext/2013/09000/A_New,_Evidence_based_Estimate_of_Patient_Harms.2.aspx

Screen capture from intra-operative EMR during surgery



Julian M. Goldman, MD (Massachusetts General Hospital)

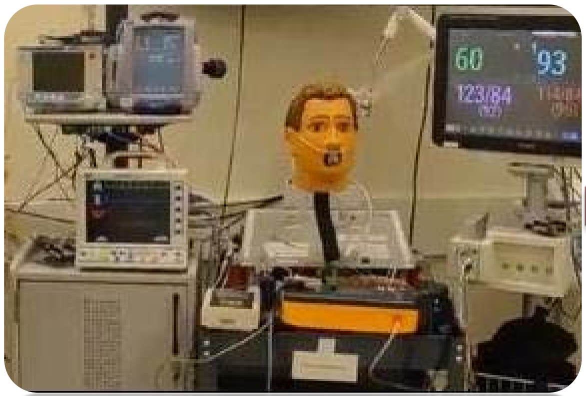
Autonomous Control of Morphine Infusion Pump – Medical Device Integration

Infusion Pump

Capnometer

Patient Simulator
Ventilator

Intelligent Monitor



Vital Signs Monitor

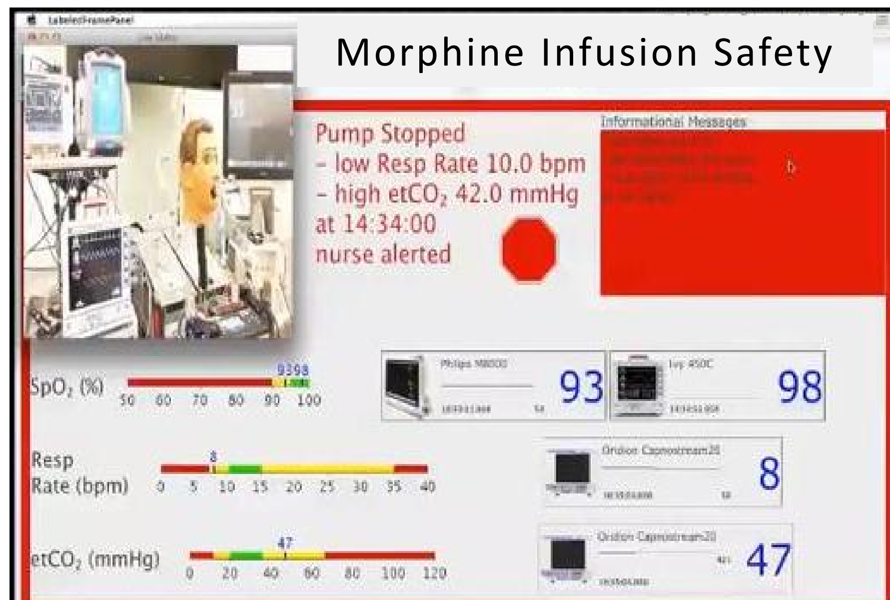
Simulator connected to vital signs monitor

Fluke ProSim 8 connected to intelligent monitor

Approx 6,875 serious preventable PCA-related adverse events pa.
Annual Economic impact $15-145M ($13,803 per injured patient)

- ↓ O_2 Saturation
- ↓ Respiratory Rate
- ↑ end-tidal CO_2

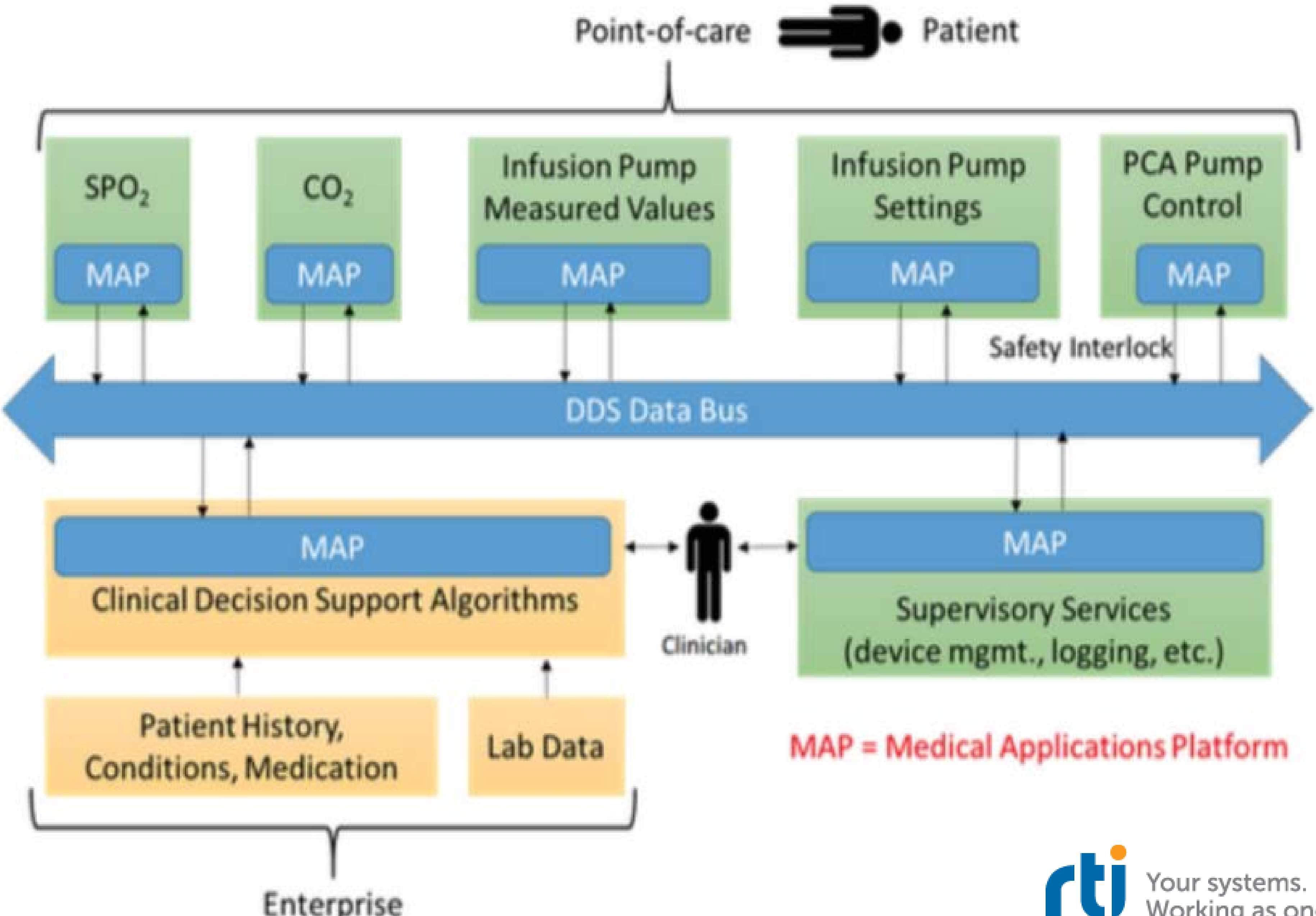
Connected Data
Collective Analysis
Automated Response



Patient Controlled Analgesia Safety Application

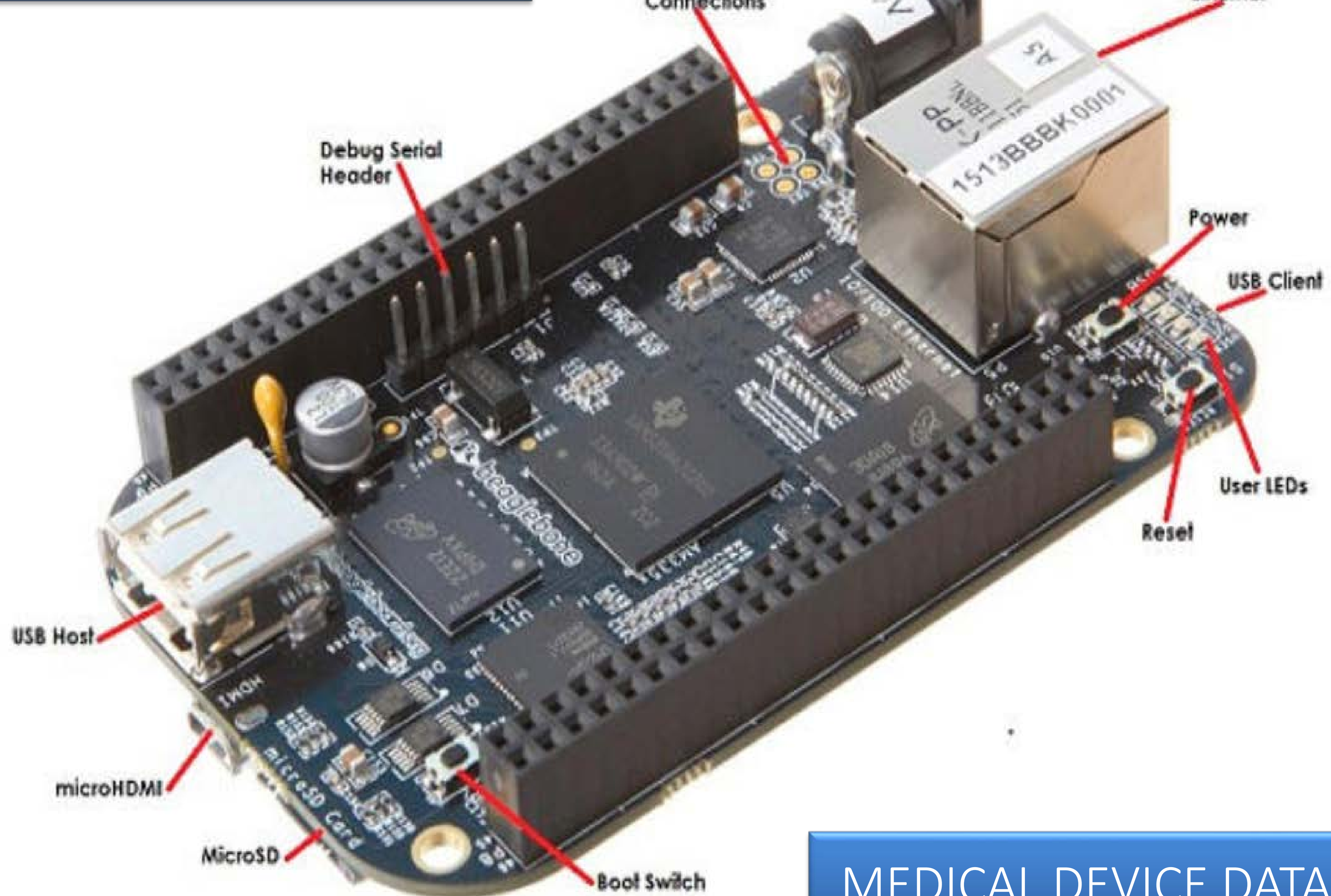
Julian Goldman MD (MDPnP.org and Partners.org)
Massachusetts General Hospital, Harvard Medical School
Harvard – MIT Center for Integrative Medicine and Information Technology

Autonomous Control of Morphine Infusion Pump – Medical Device Data Integration



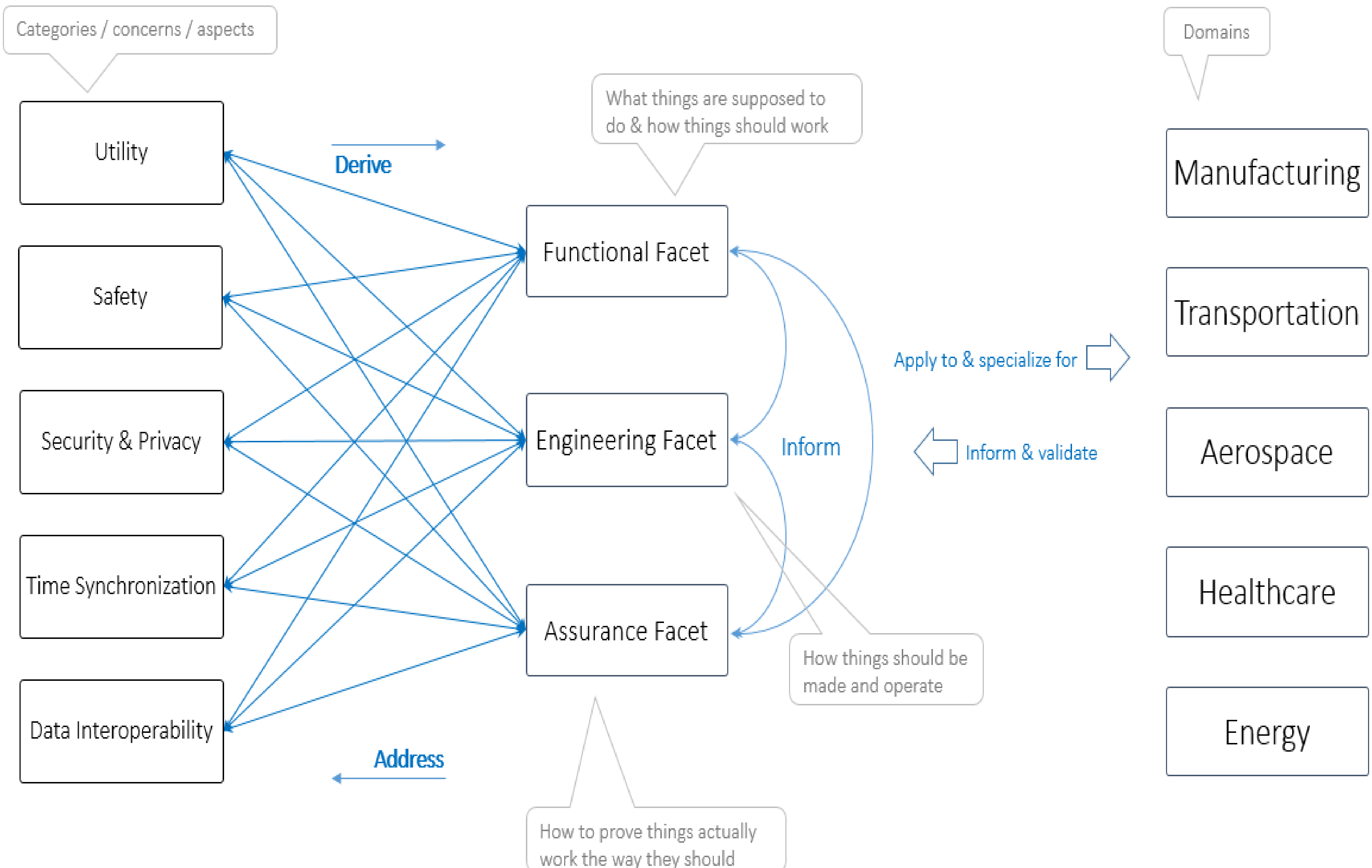
rti Your systems. Working as one.

BAND-AID



MEDICAL DEVICE DATA

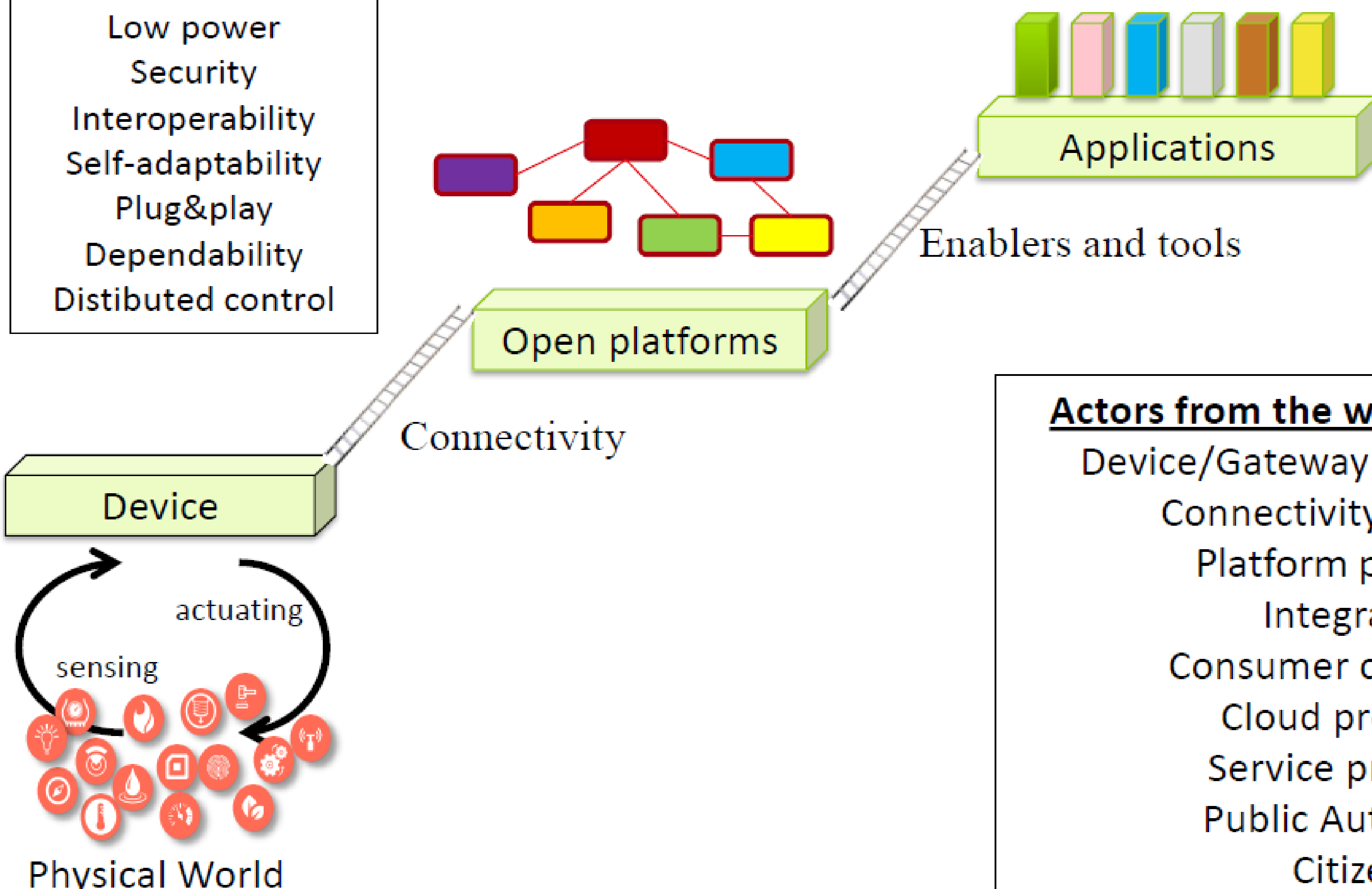
Apply Analytical Rigor of CPS to Healthcare



General Abstraction ● Connectivity, Open Platforms and Broad Spectrum of Applications

Technical challenges

Heterogeneity
Integration
Low power
Security
Interoperability
Self-adaptability
Plug&play
Dependability
Distibuted control



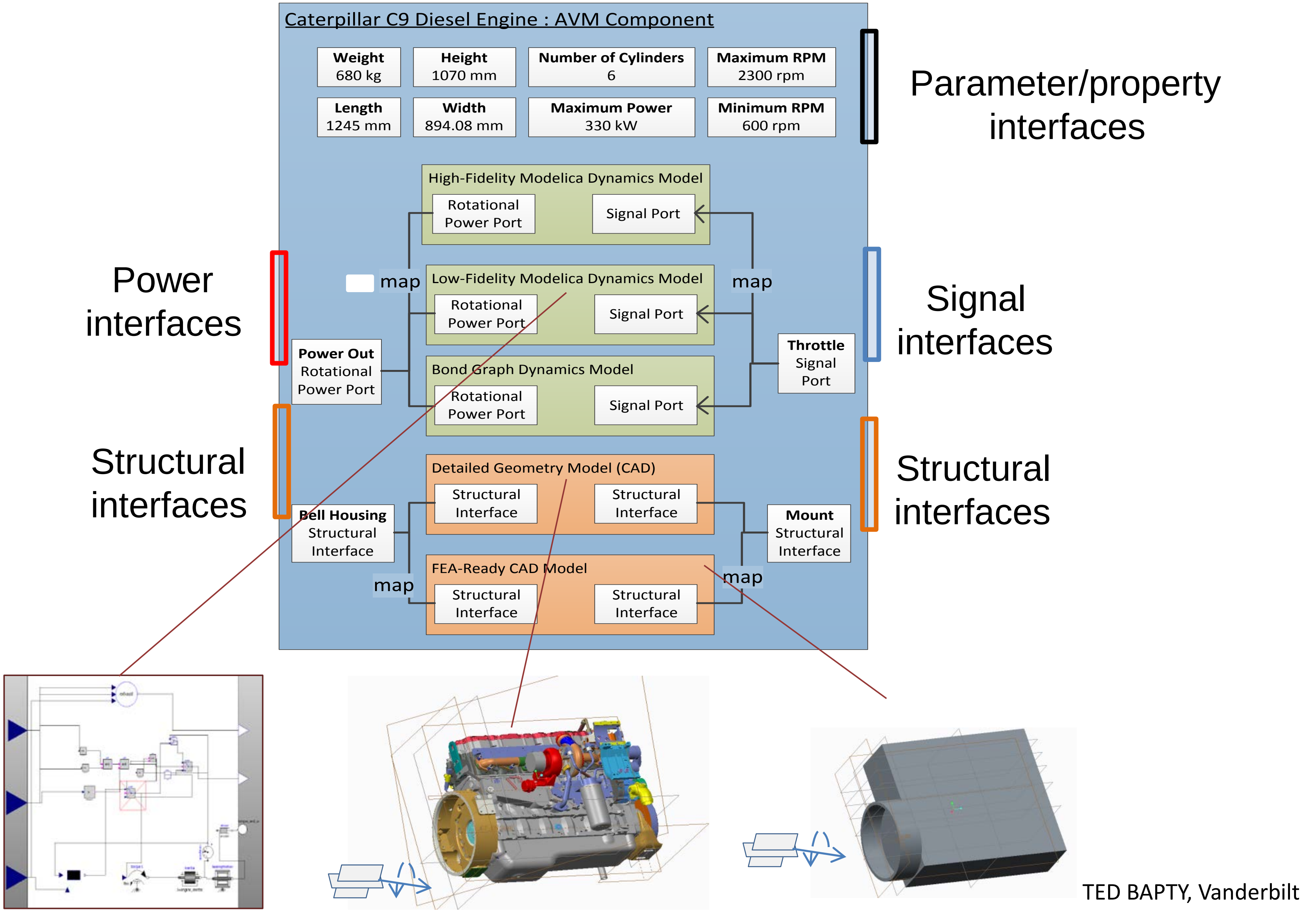
Actors from the whole value chain

Device/Gateway manufacturers
Connectivity providers
Platform providers
Integrators
Consumer companies
Cloud providers
Service providers
Public Authorities
Citizens

www.cea.fr

AVM Component Model

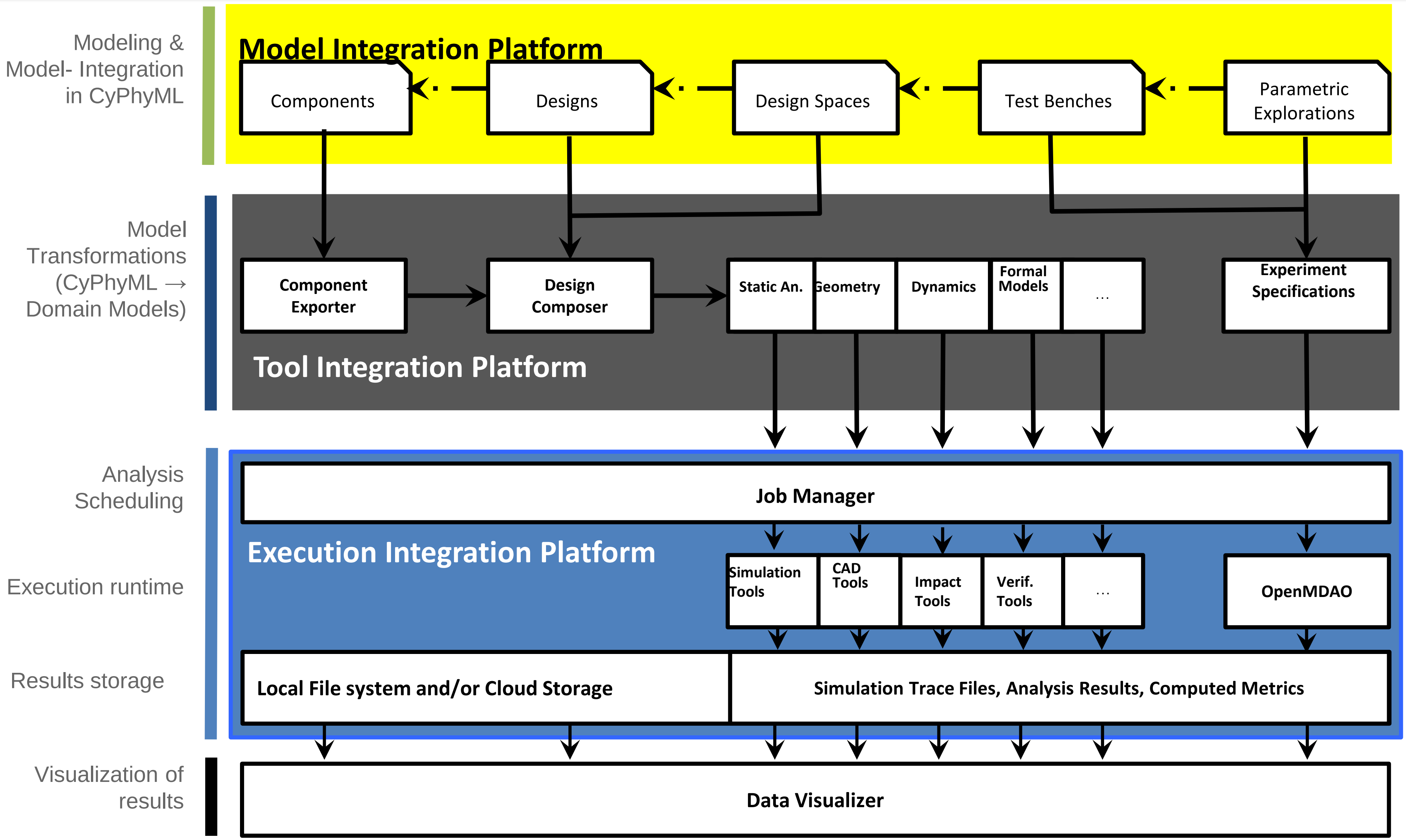
Helps medical device interoperability & integrated clinical environment ?



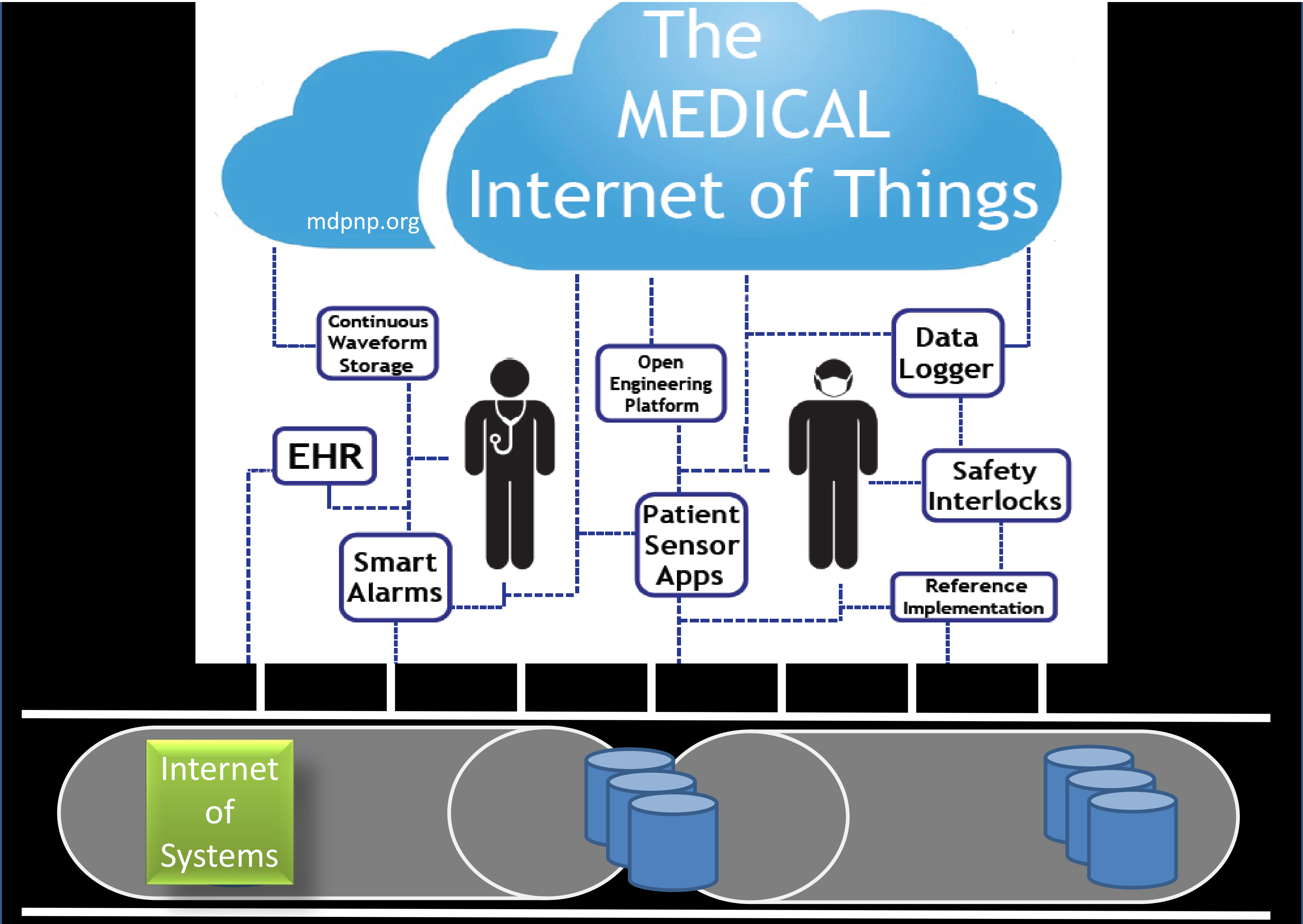
TED BAPTY, Vanderbilt

Meta Tool Suite Architecture

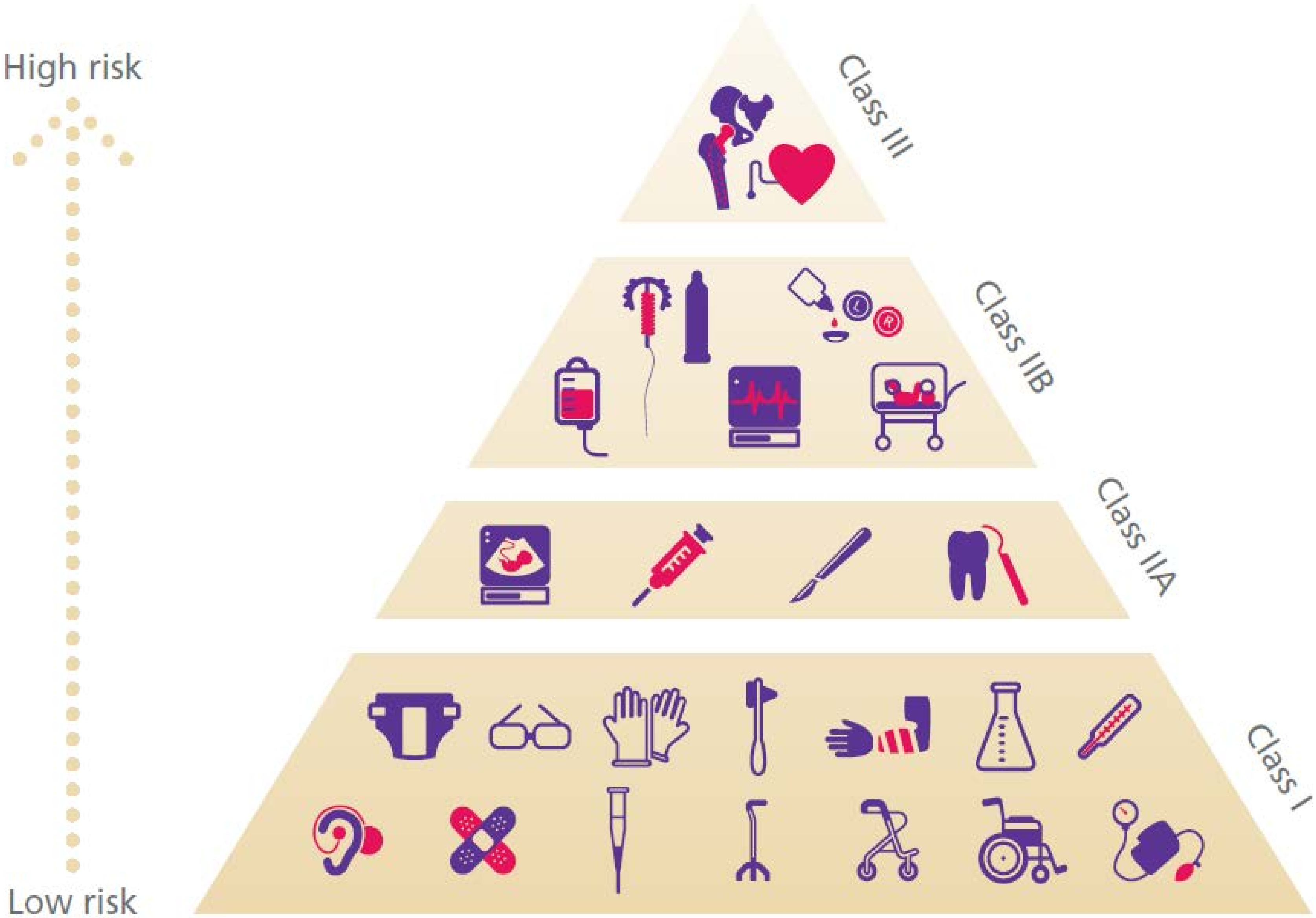
Helps medical device interoperability & integrated clinical environment ?



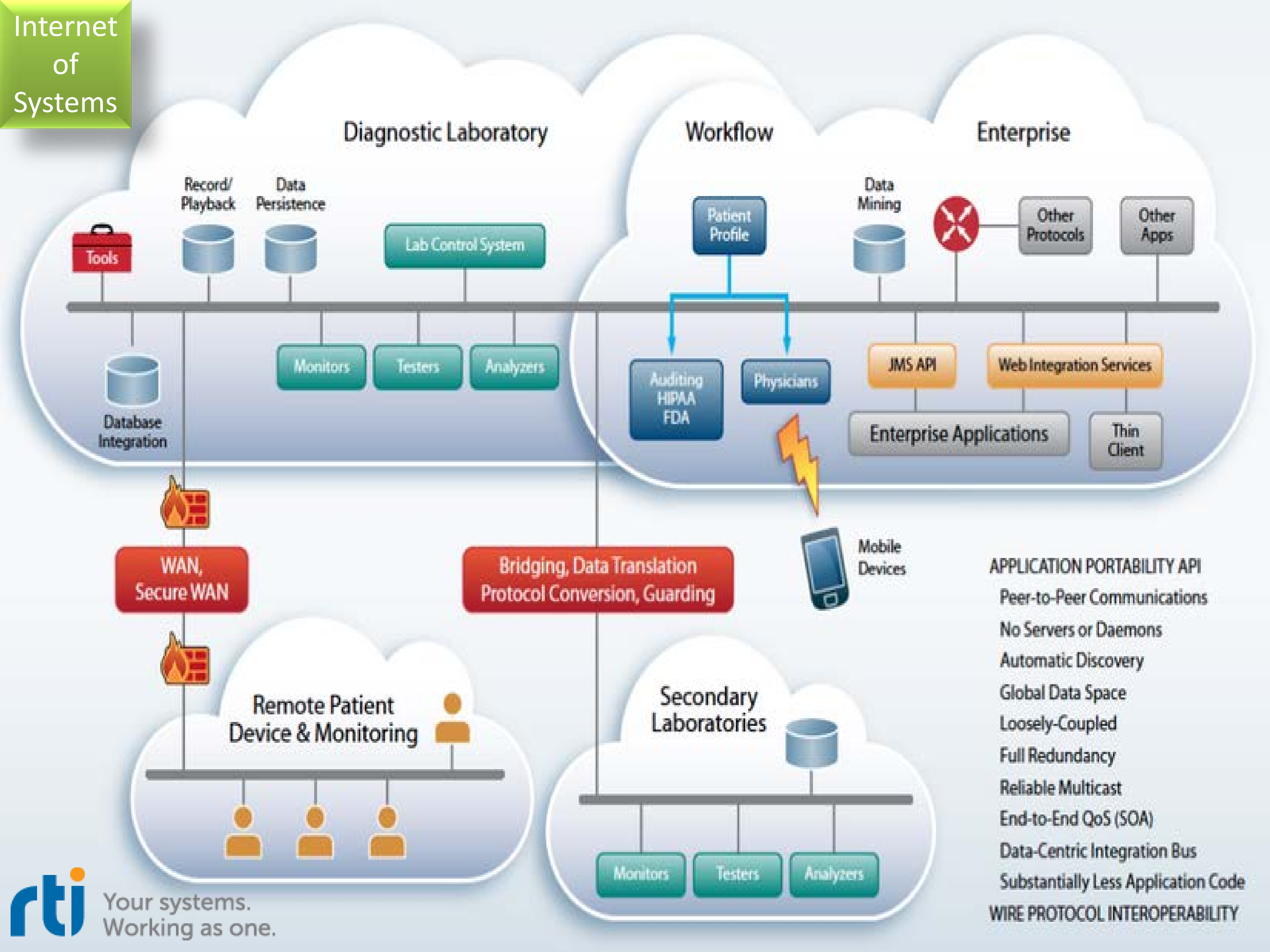
DR TED BAPTY ● www.isis.Vanderbilt.edu ● http://bit.ly/META-TOOL-SUITE http://pulse.embs.org/november-2014/solving-interoperability-challenge/



What Things? Are things part of systems?

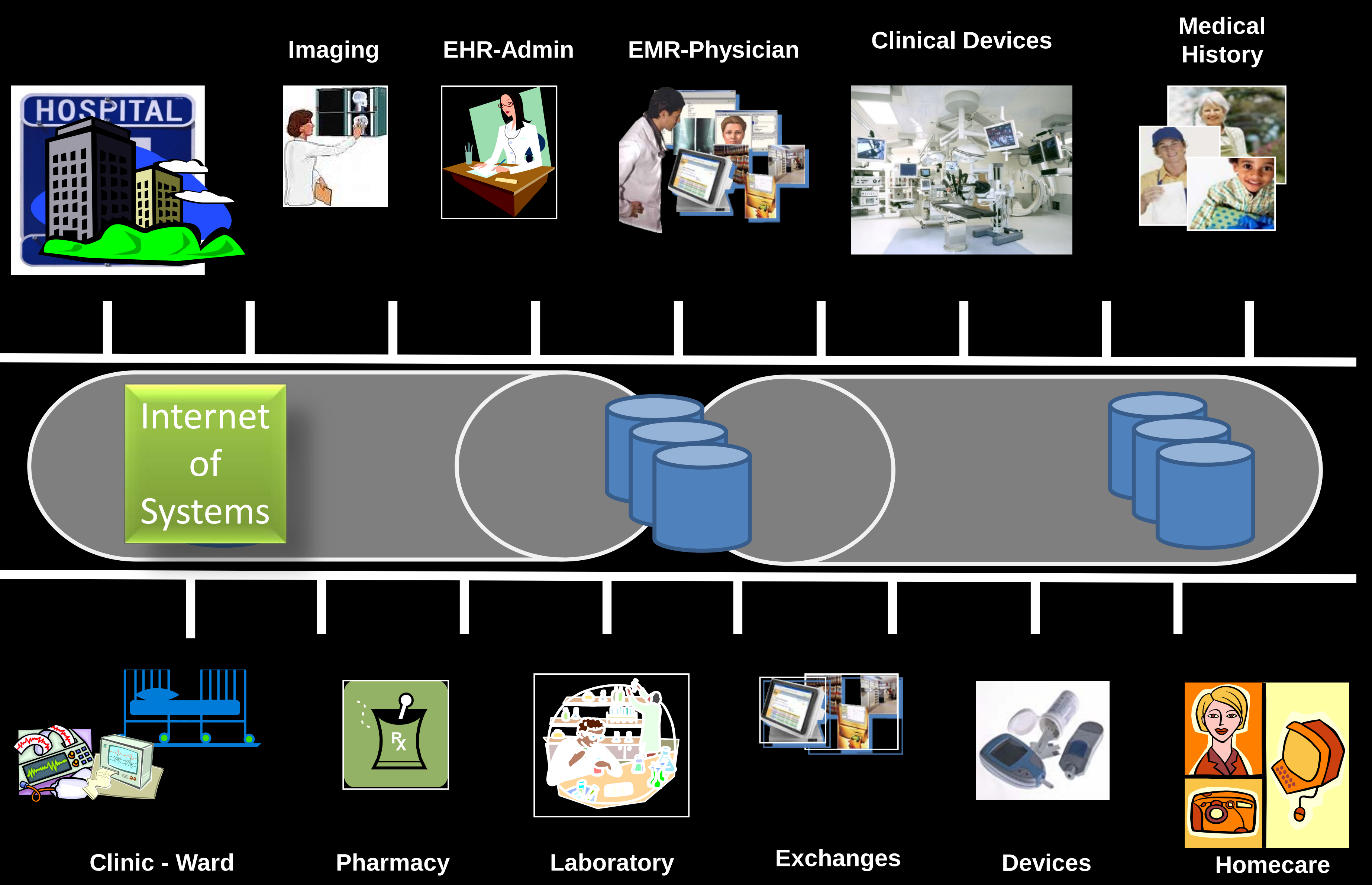


Internet of Systems



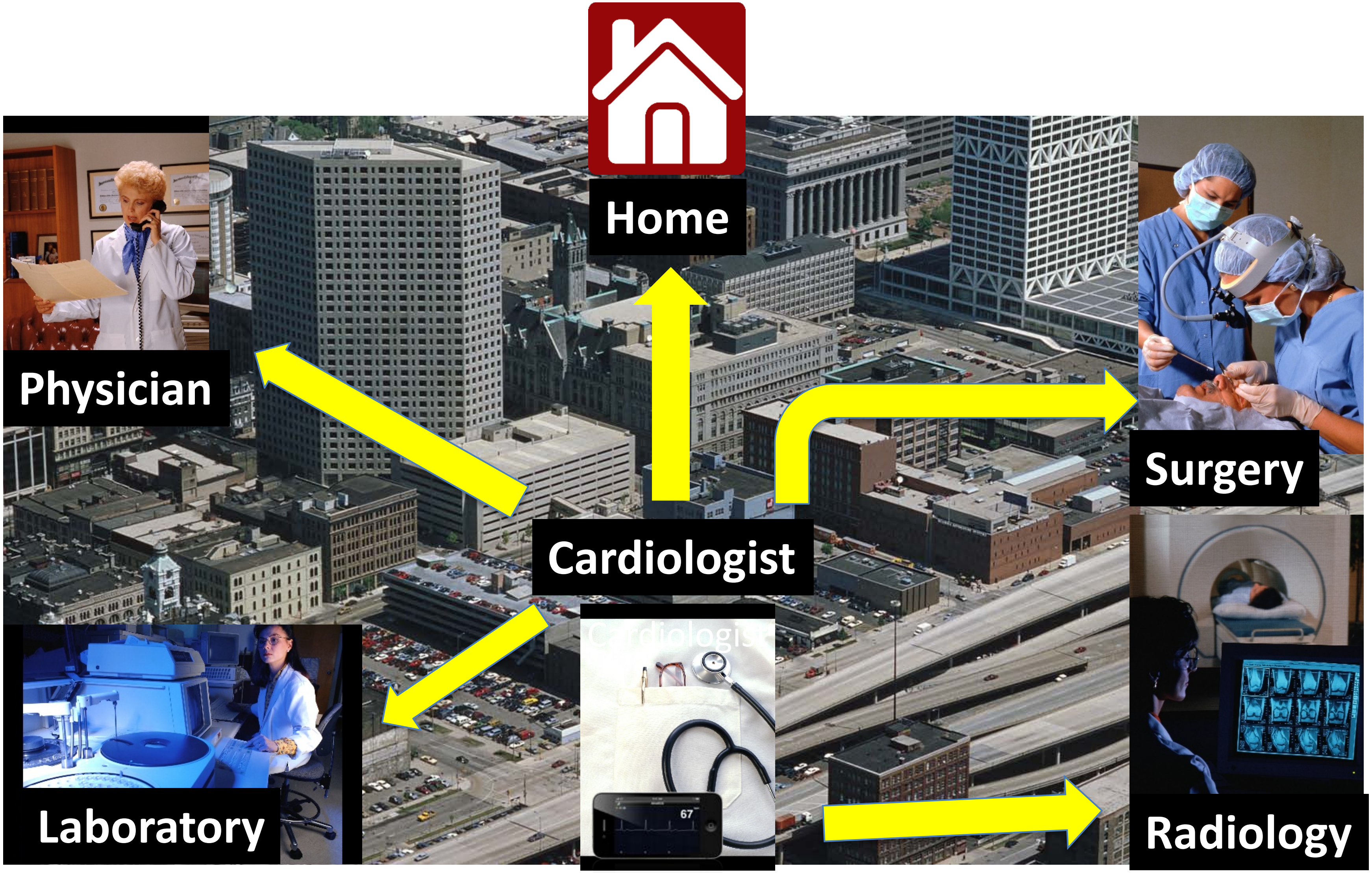
Integrated Healthcare Platforms

Data Logging and Access via Secure Interoperable Standards



Integrated Healthcare Platforms

n-Directional Data Access via Secure Interoperable Standards



Dr Ram Sriram, NIST

Congestive Heart Failure

Why should CHF claim about 5 million lives in the US?

- About 5.1 million people in the United States have heart failure.
- About half of people with CHF die within 5 years of diagnosis.
- CHF costs the nation an estimated $32 billion each year.

Abundance of prognostic biochemical markers –

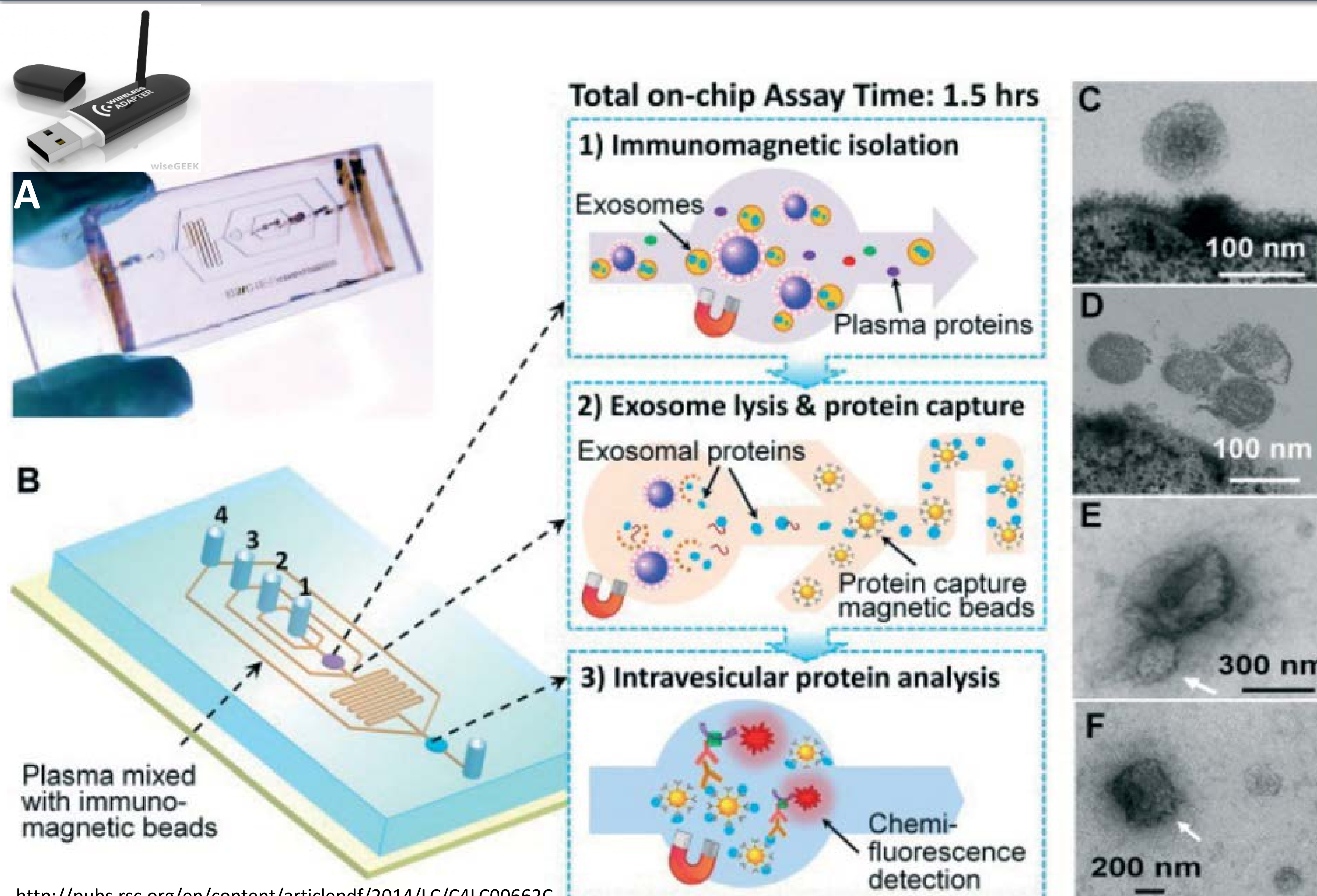
- C-reative protein (CRP5 / CRP6) – 1954 and Framingham Heart Study
- Tumour necrosis factor alpha (TNFα)
- Brain Natriuretic Peptide (1981) BNP <100 pg/ml CHF unlikely and >400 pg/ml CHF likely
- N-terminal (NT) pro-BNP <300 pg/ml CHF unlikely and >400-900 pg/ml CHF likely (age related)

48,629 patients of acute decompensated heart failure found linear correlation between BNP levels and in hospital mortality. Failure of BNP to decline during hospitalization predicts death and re-hospitalization while discharge levels of 250pg/ml or less predicts event free survival.

http://bit.ly/CHF-US
http://bit.ly/CHF-IN
http://bit.ly/CHF-JP

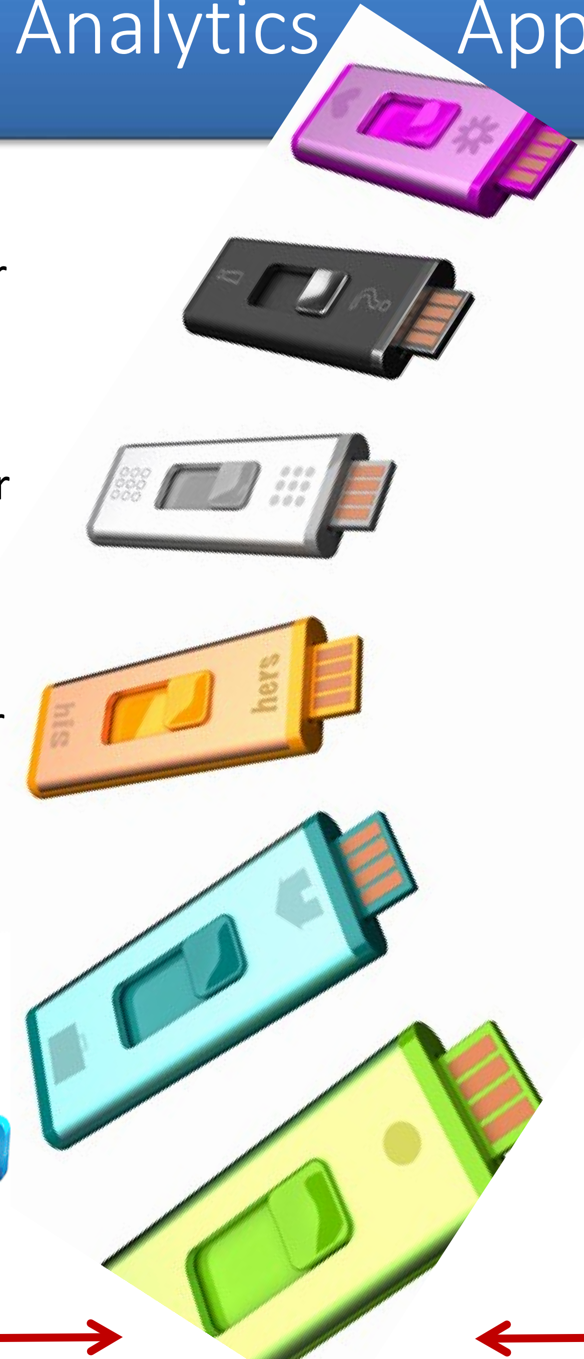
www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_heart_failure.htm

Lab on a Chip - Detection of Non-Small Cell Lung Cancer (C) and Ovarian Cancer (D)



http://pubs.rsc.org/en/content/articlepdf/2014/LC/C4LC00662C

Pay 1c Per Analytics Apps, Data Distribution Service



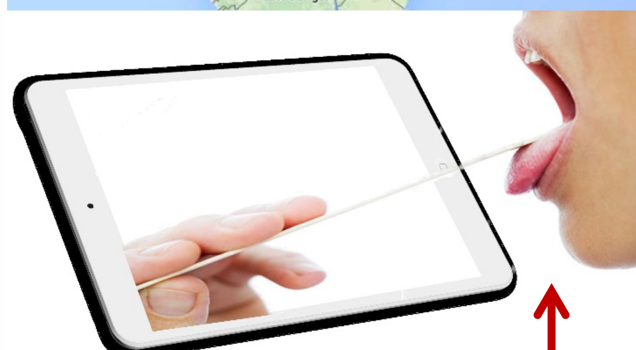
Glucose Sensor

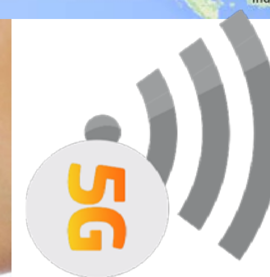
Cholesterol Sensor

BNP Sensor

What does the data suggest about my health?

Internet of Systems

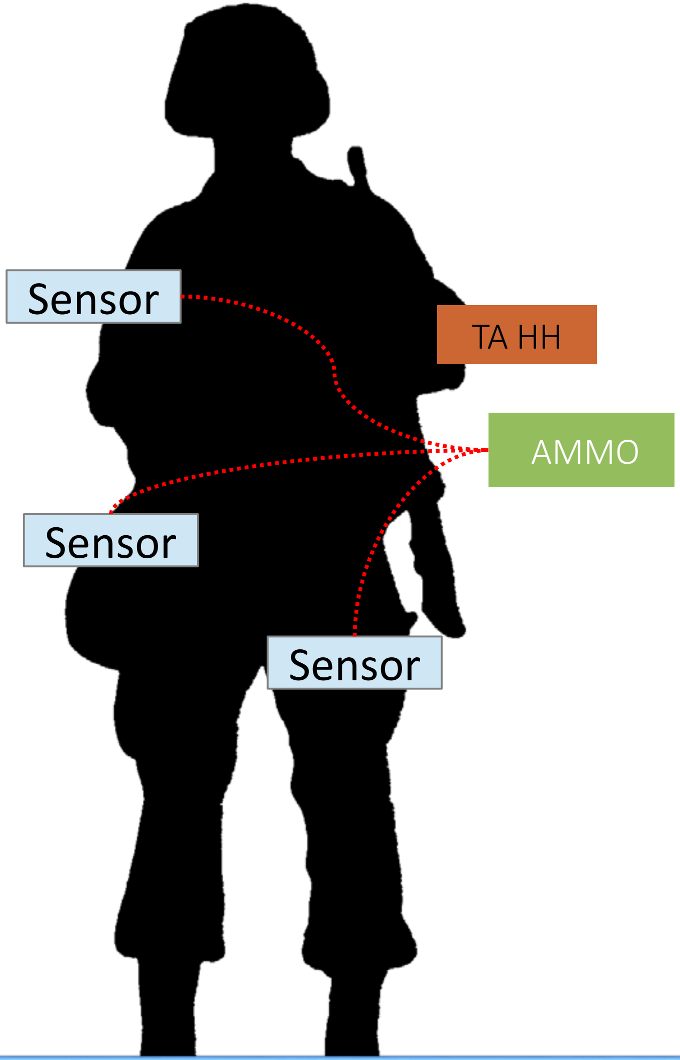




Hot swappable, modular, smart

NK Labs
ARA Prototype

BAN – Body Area Networks



- Bluetooth-enabled sensors / devices
- AMMO receives/uploads sensor data

- glucose
- heart rate
- pulse oximeter
- body temperature
- pedometer

- Soldier in desert (high temperature)
- Monitor health via sensor data / analytics
- Intervene before it is necessary / prevent A&E

POTENTIAL AMMO APPLICATIONS

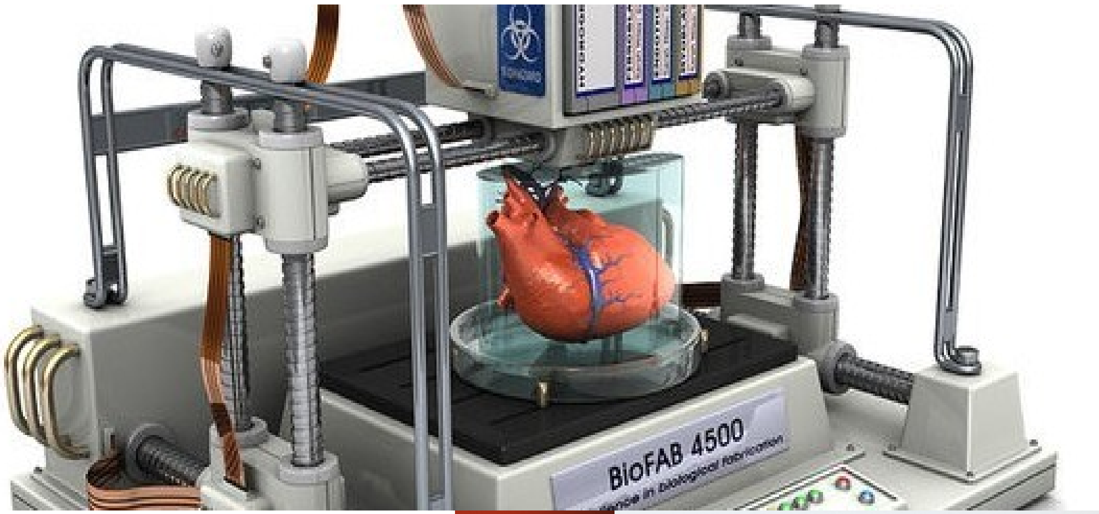
- Pre- and Post- surgery interactive care plan execution and monitoring
- Improved home-health & patient communication with social partners
- Remediate loss of HIV patients identified for anti-retro viral treatment
- Ebola Infection - patient, population and physician data / monitoring
- Adhoc mesh / zero configuration networking for search & rescue (A&E)
- Google Project Ara - integrated/on-platform tactical radio and SDR
- Novel nano-sensors with embedded sub-cutaneous radio/transmitters

Sandeep Neema

Android Mobile Middleware Objects

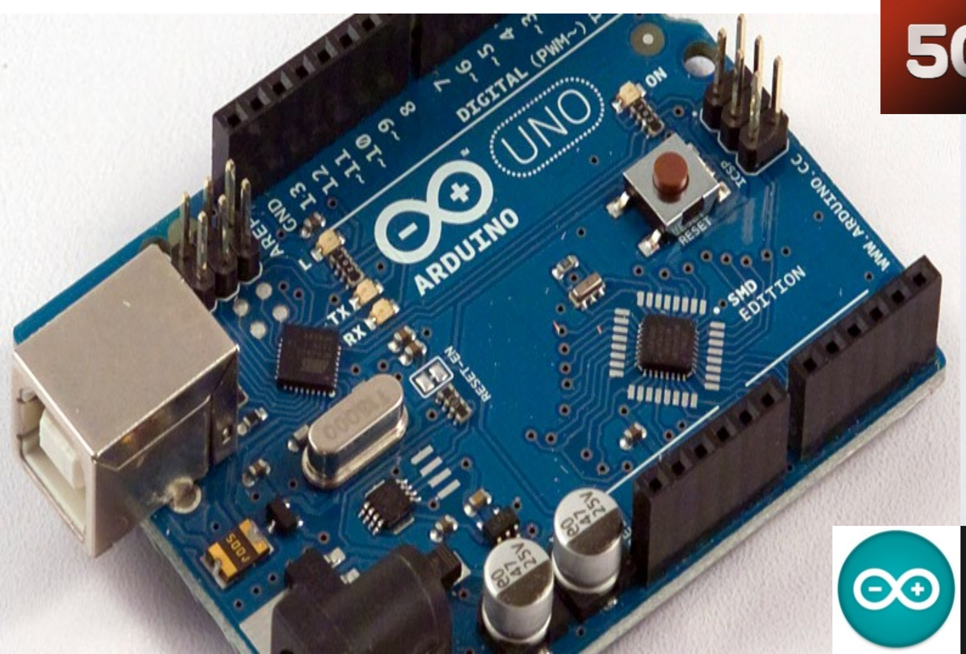
Global Healthcare Economics – Platform Shifts ?
3D Printed Medical Devices + OS Hardware / Software

arduino inside



ARDUINO AT HEART

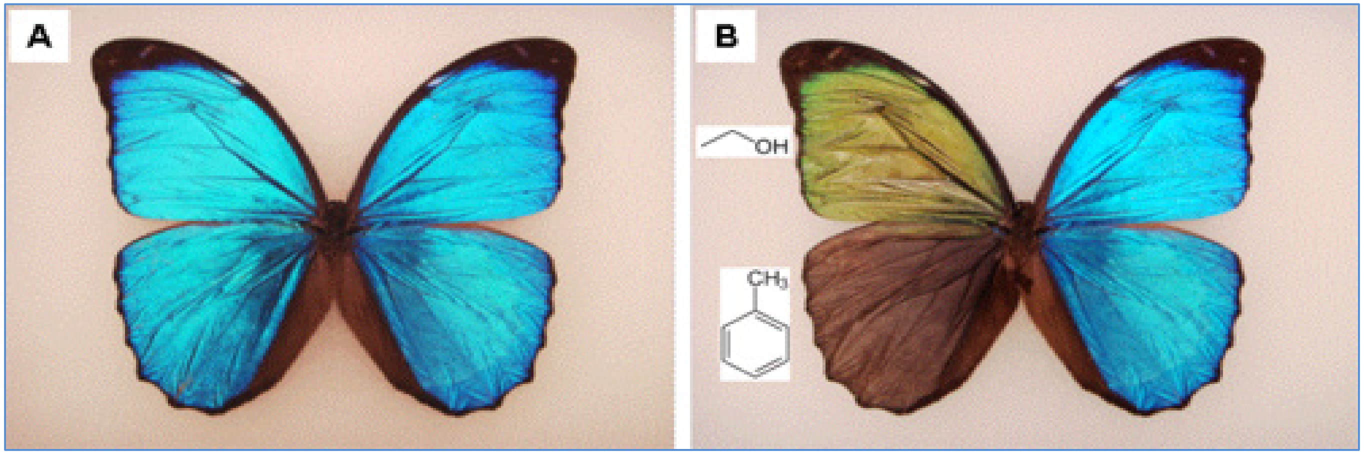
5G



Internet of Systems

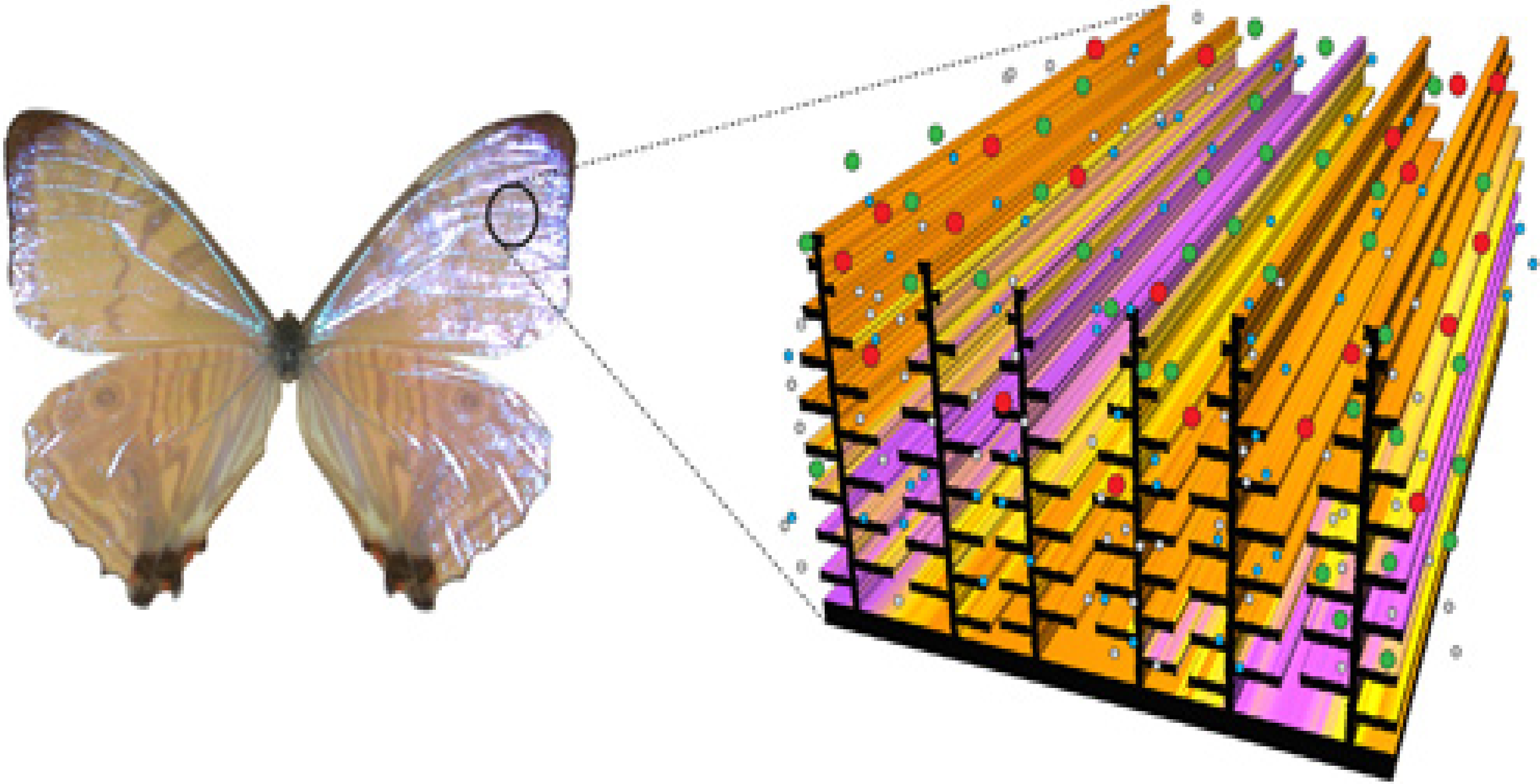
Emergence of IoS Preventive Medicine Era • Wearable Diagnostic Devices with High Performance Ultra-Sensitive Nano-Sensors

Swiss engineer George de Mestro invented Velcro after his dog came home covered with thistle burrs, Speedo learned from sharkskin to make faster swimsuits, and chemical companies designed self-cleaning paint after studying lotus leaves.



GE scientists have observed that *Morpho* wings change their color when they come into contact with heat, gases and chemicals. The normal iridescent blue color of butterfly wings (A) changes when exposed to ethanol (panel B top) or toluene (panel B bottom). Radislav Potyrailo's team at GE wants to use their findings to develop fast, ultra-sensitive thermal and chemical imaging sensors for applications in night vision goggles, super-sensitive surveillance cameras, handheld or wearable medical diagnostic devices. ☑ www.gereports.com/post/80985289914/like-a-butterfly-out-of-hell-the-next-wave-of

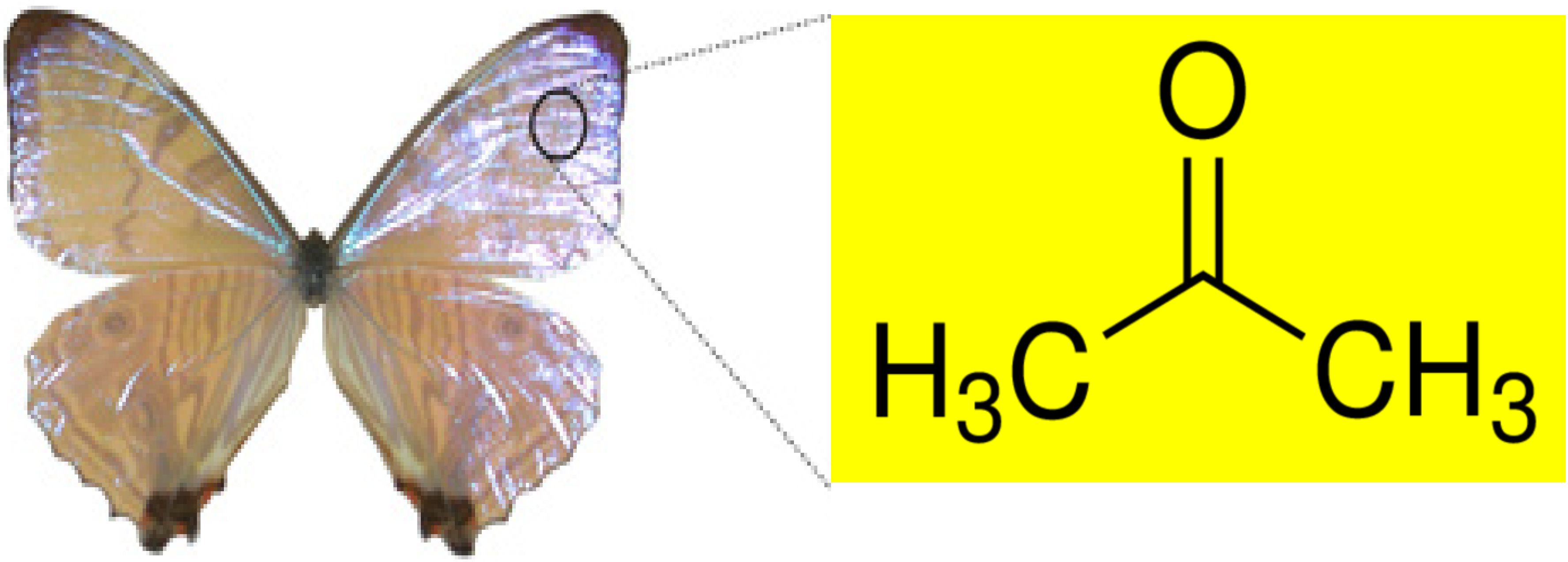
Changes to be ushered in by the connectivity potential from the IoS will shape the global economy in ways which could be limited only by our imagination



Scientists at GE Global Research discovered that the nanostructures on the wing scales of Morpho butterflies have excellent sensing capabilities. They could allow them to build sensors that can detect heat and also as many as 1,000 different chemicals. Image: GE Global Research

Can Butterflies Help Prevent Diabetes?

This is only a suggestion by the author and not a fact or system which is under investigation or is available at present.



Dual Acetone Sensors on a single chip may differentiate between acetone in the environment vs acetone in the blood, breath or urine of diabetics. Subtractive analysis alerts to blood ketones. Occurs when body uses fat instead of glucose. It signals insulin dysfunction. If undiagnosed, it may lead to diabetic ketoacidosis (DKA) which may result in diabetic coma and may be fatal. The acetone (ketone bodies) sensors may be able to detect trace levels (nano milli moles eq) and may help preventive care to stem the clinical onset of type II diabetes mellitus (glucose >120 mg/dl).

Changes to be ushered in by the connectivity potential from the IoS will shape the global economy in ways which could be limited only by our imagination

Four months ago, 16-year-old John Wall had introduced the prototype of his Atmel powered OLED smartwatch. Earlier this week, the Maker revealed that the design was on its own power and completed.

WALLTECH

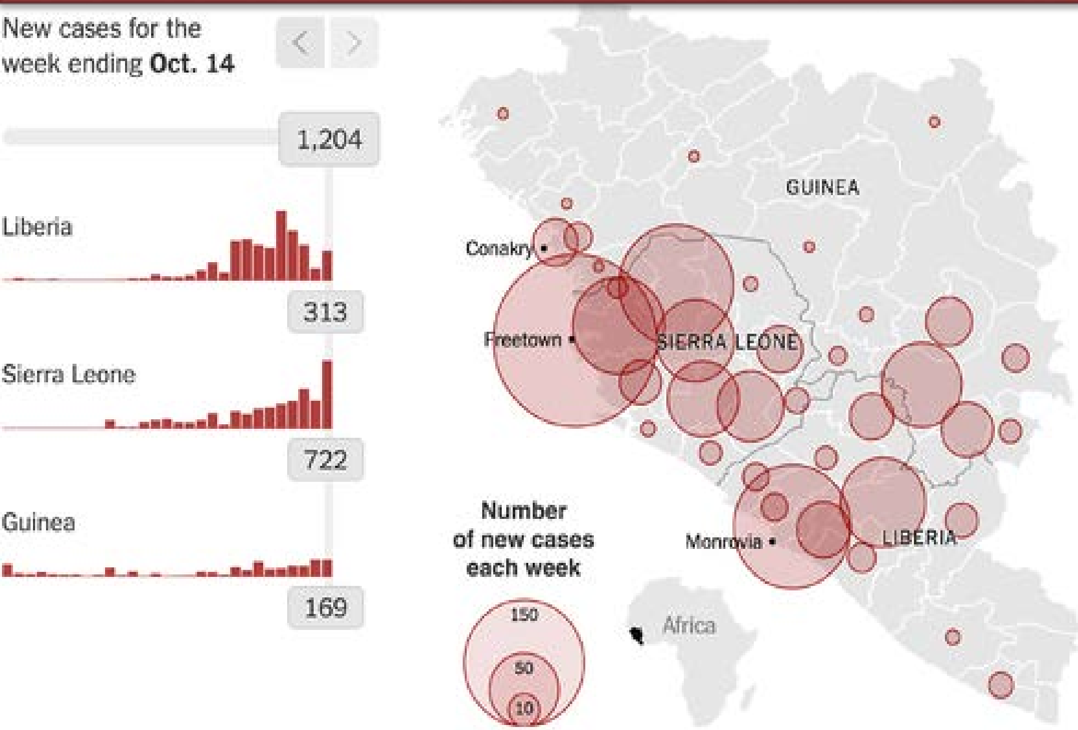
@walltechOSHW

http://bit.ly/OS-ARDUINO

Drum roll please..............My BT 4.0 arduino compatible smart watch is on its own power! My prototype is complete!

7:38 PM - 12 Oct 2014

Robotics Community Responds to Safety of Ebola Workers



Bill and Gerry Brinton of Charles Creek Winery pose with Sonoma Valley Hospital (SVH, CA) CEO Kelly Mather to display the "Lisa" aka the Germ-Zapping Robot manufactured by Xenex (pulsed xenon UV disinfection technology to rapidly reduce germ loads). The Brintons donated the robot to the hospital (SVH).

www.nytimes.com/2014/10/23/science/scientists-consider-repurposing-robots-for-ebola.html?ref=technology

Center for Integrated Healthcare Platforms?

Ebola spurs rethinking of devices at MGH

By Carolyn Y. Johnson

| GLOBE STAFF NOVEMBER 07, 2014

You cannot buy a TV without a remote. You cannot buy a medical device with a remote. Dr Julian M Goldman (MGH/HMS) MD PnP

Internet of Systems

http://bit.ly/EBOLA-MGH-HMS

SUZANNE KREITER/GLOBE STAFF

Health officials demonstrated treating an Ebola patient remotely in a mock ICU. Pictured, left to right: Eric Lynn, Julian M. Goldman, Brian Russell, and Dave Arney.

Robotic Tools in Infectious Diseases Management
Need for Medical Device Interoperability Platform

www.gereports.com/post/104422691785/hospital-hack-a-thon-attacks-ebola-with-robots

Healthcare Data Integration and Interoperability Platform is a Quintessential Global Infrastructure

Infrastructural technologies, in contrast, offer far more value when shared than when used in isolation. Imagine yourself in the early nineteenth century, and suppose that one manufacturing company held the rights to all the technology required to create a railroad. If it wanted to, that company could just build proprietary lines between its suppliers, its factories, and its distributors and run its own locomotives and railcars on the tracks. And it might well operate more efficiently as a result. But, for the broader economy, the value produced by such an arrangement would be trivial compared with the value that would be produced by building an open rail network connecting many companies and many buyers. The characteristics and economics of infrastructural technologies, whether railroads or telegraph lines or power generators, make it inevitable that they will be broadly shared—that they will become part of the general business infrastructure.

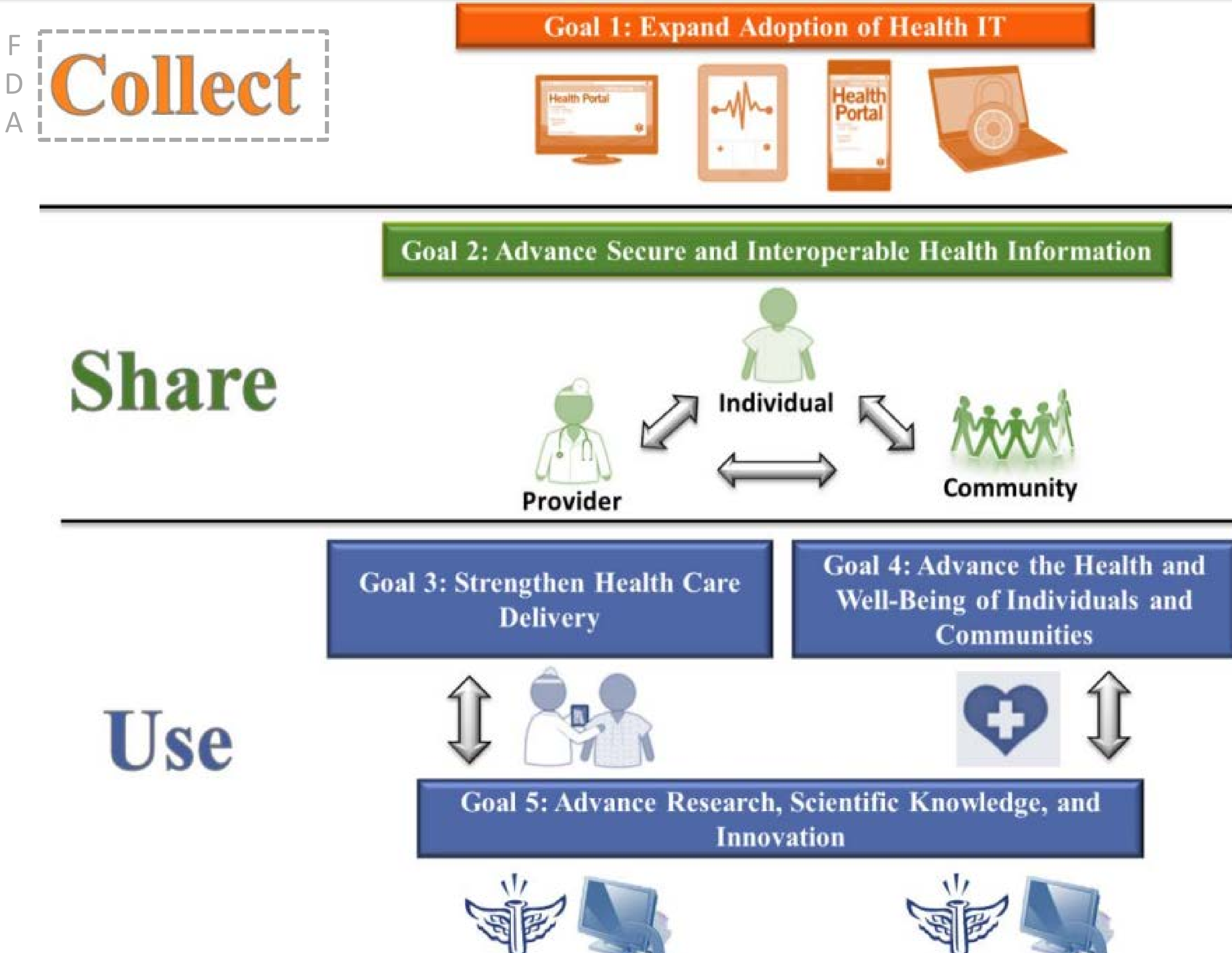
Nicholas Carr in Harvard Business Review, 2003 ● https://hbr.org/2003/05/it-doesnt-matter

Investment to Create and Deploy Integrated Healthcare Platforms

The trap that executives often fall into, however, is assuming that opportunities for advantage will be available indefinitely. In actuality, the window for gaining advantage from infrastructural technology is open only briefly. When the technology's commercial potential begins to be broadly appreciated, huge amounts of cash are inevitably invested in it, and its buildout proceeds with extreme speed. Railroad tracks, telegraph wires, power lines—all were laid or strung in a frenzy of activity. In the 30 years between 1846 and 1876, reports Eric Hobsbawm in *The Age of Capital*, the world's rail trackage increased from 17,424 km to 309,641 km. During this same period, total steamship tonnage also exploded, from 139,973 to 3,293,072 tons. The telegraph system spread even more swiftly. In Continental Europe, there were just 2,000 miles of telegraph wires in 1849; 20 years later, there were 110,000 miles. The pattern continued with electrical power. The number of central stations operated by utilities grew from 468 in 1889 to 4,364 in 1917, and the average capacity of each increased tenfold.

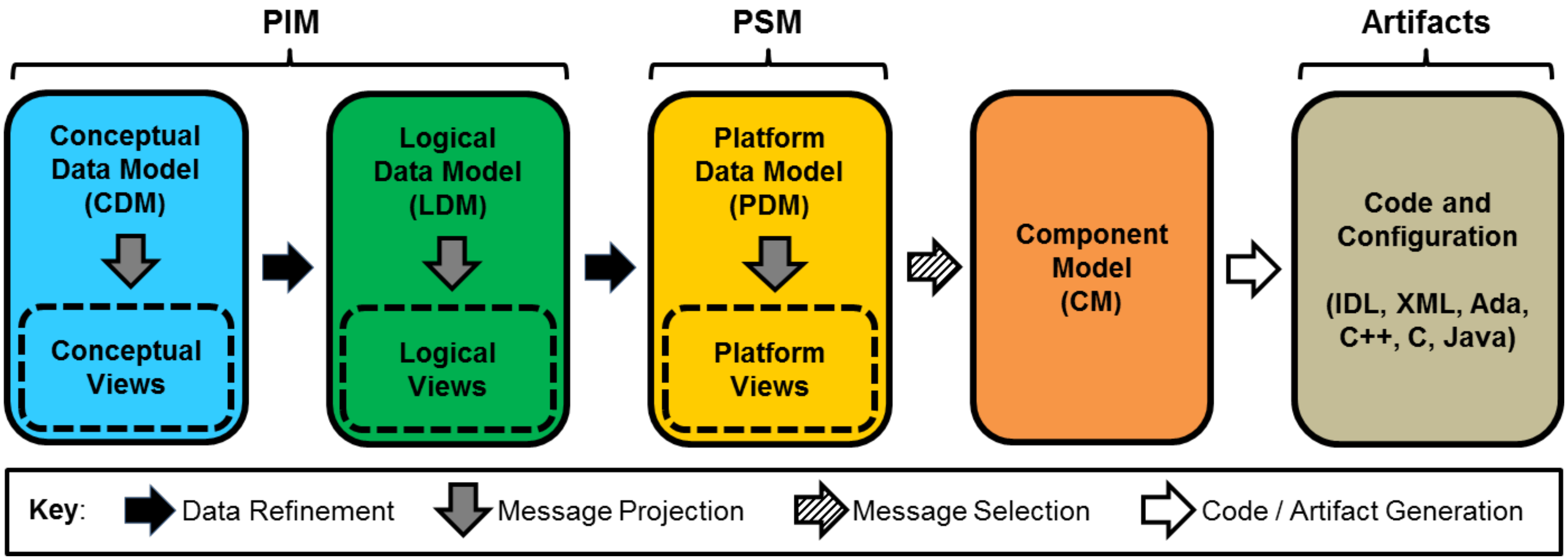
Nicholas Carr in Harvard Business Review, 2003 ● https://hbr.org/2003/05/it-doesnt-matter

US Federal HIT Goals from the ONC, US HHS



www.healthit.gov/sites/default/files/federal-healthIT-strategic-plan-2014.pdf

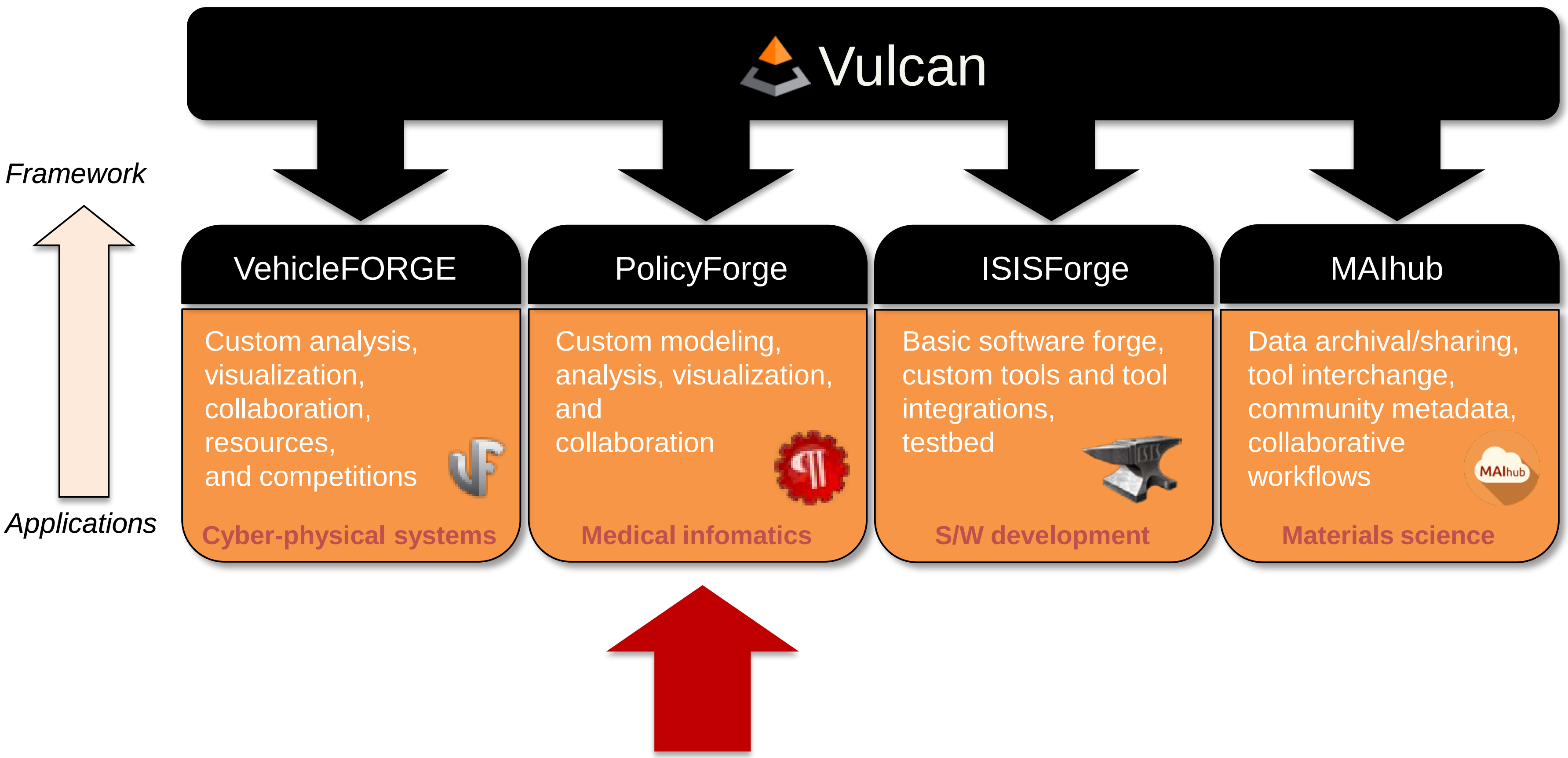
Can we adopt and adapt FACE modus operandi for healthcare platforms?



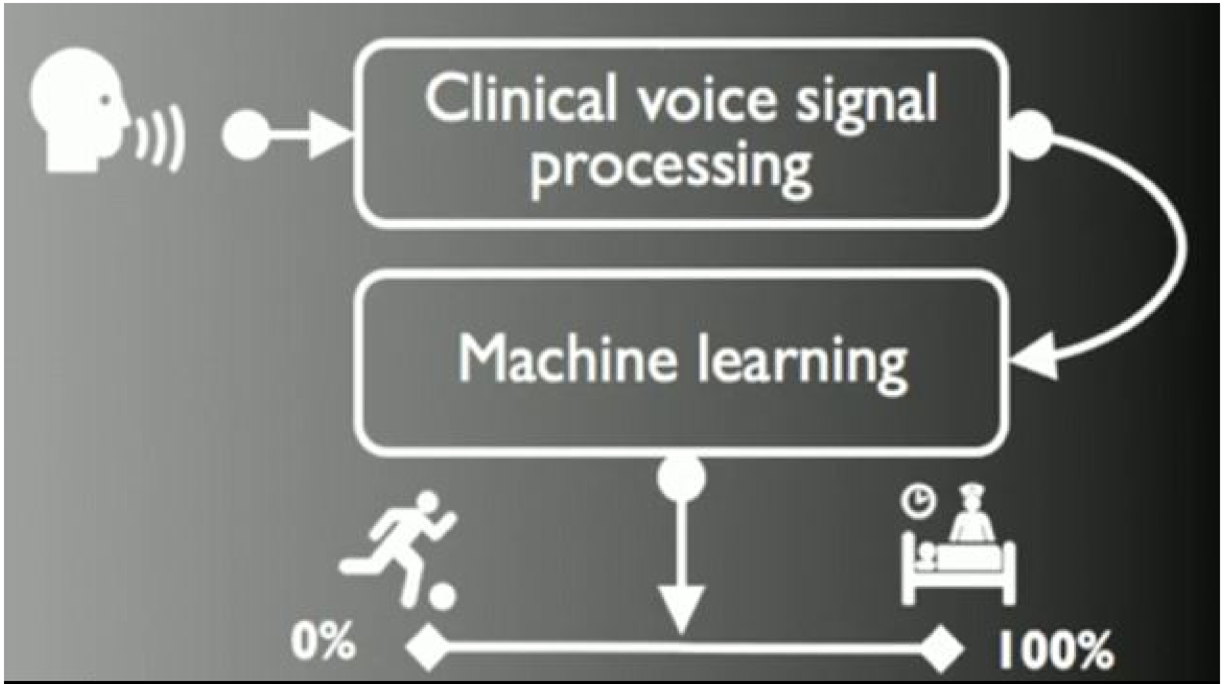
- Data and message models aligned with OMG Model Driven Architecture ™
- Addition of the Component (UoP) model allows component integration with messages and data elements in the Platform Model
- Supports definition and potentially auto-generation of code and other artifacts

Figure from FACE Technical Standard, edition 2.1 • www.opengroup.org/face/tech-standard-2.1

Can Policy Forge Aid Healthcare Platforms ?



Internet of Systems ● http://bit.ly/MIT-IOT



Clues to onset of Parkinson's Disease may be detected using a Smartphone

How to Use Data Tools ?

This type of acoustic signal processing data may be used to detect Parkinson's Disease with a smartphone or predict torrential rainfall or used in hydrogeomorphology apps.

http://www.maxlittle.net

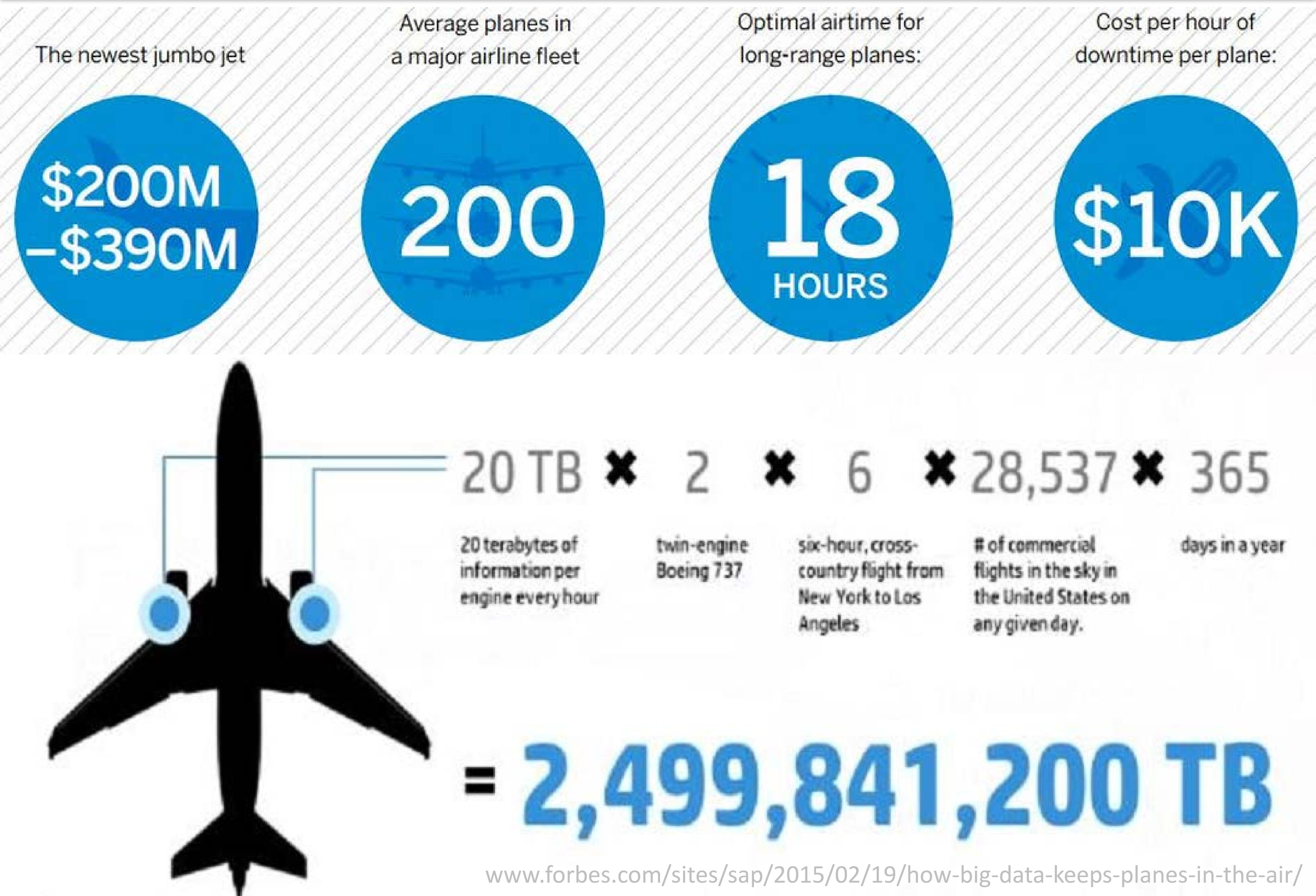
☑ Healthcare

☑ Data

Data of Things – Forecast – Cloudy

Building Castles in the Cloud

DATA and DATA ANALYTICS – UNQUESTIONABLE QUINTESSENTIAL VALUE



www.forbes.com/sites/sap/2015/02/19/how-big-data-keeps-planes-in-the-air/

With current technology you can find the haystack but with big data you can find the needle - Nils Herzberg, SAP AG

BIG DATA

A marketing hype

Michael Stonebraker wins $1 million Turing Award

CSAIL researcher invented core database concepts, turned many into companies.

Adam Conner-Simons | CSAIL
March 25, 2015

Press Inquiries

Michael Stonebraker, a researcher at MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) who has revolutionized the field of database management systems (DBMSs) and founded multiple successful database companies, has won the Association for Computing Machinery's (ACM) A.M. Turing Award, often referred to as "the Nobel Prize of computing." This year marks the first time that the Turing Award comes with a Google-funded $1 million prize.

In its announcement today, ACM said that Stonebraker "invented many of the concepts that are used in almost all modern database systems … and founded numerous companies successfully commercializing his pioneering database technology work."

An adjunct professor of computer science and engineering at MIT and a principal investigator at CSAIL, Stonebraker sometimes jokes that he didn't know what he was researching for more than 30 years. "But then, out of nowhere, some marketing guys started talking about 'big data,'" he says. "That's when I realized that I'd been studying this thing for the better part of my academic life."

Stonebraker's work over the past four decades has helped spur a multibillion-dollar "big data" industry that he himself has participated in, creating and leading nine separate companies,

PRESS MENTIONS

The ACM has awarded the A.M. Turing Award, widely regarded as the "Nobel Prize in Computing," to CSAIL researcher and adjunct professor Michael Stonebraker, reports Barb Darrow for *Fortune*. Stonebraker is "famous for arguing that database is not a one-size-fits-all category."

FORTUNE

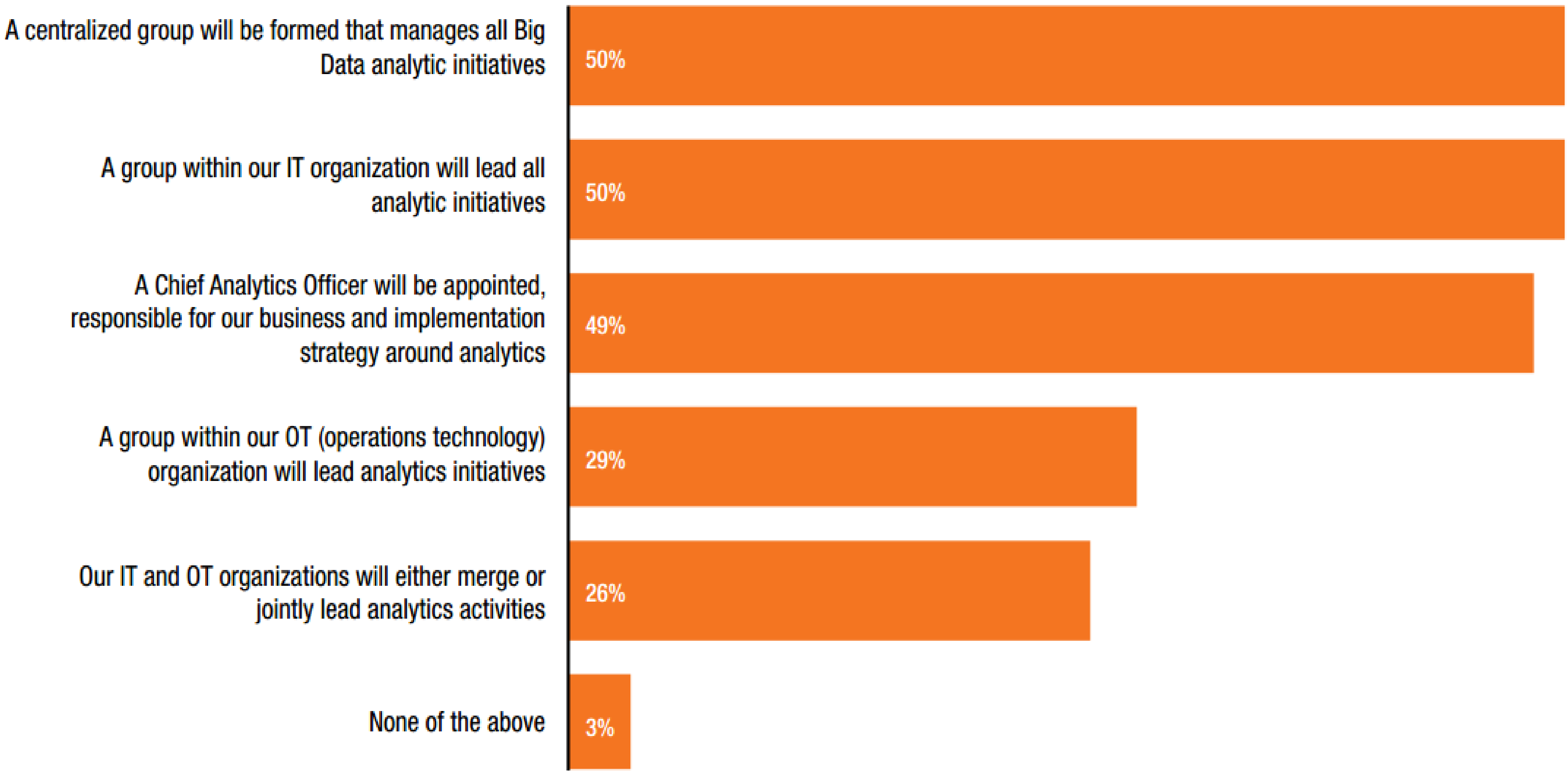
Michael Stonebraker, a principal investigator at the MIT Computer Science and Artificial Intelligence Lab and an adjunct professor at MIT, has won the A.M. Turning Award for his work with database management systems, reports Nidhi Subbaraman for *BetaBoston*. "This is every computer scientist's lifetime dream, and it came true for me," said Stonebraker.

BetaBoston

In 1959, GE recruited the reputable consulting firm of Arthur D. Little in Boston to conduct a survey to determine whether there was a market for portable TV sets that GE could now build using solid state transistors. Several months later in 1959, after spending a staggering 5 million+ in focus groups and discussions, Arthur D. Little Inc sent their analyses to GE suggesting that they do not believe there is any market for such TV sets. GE management pushed aside the project proposed by its engineers. Just before Christmas in 1959, Sony introduced a small B&W television in the US market. Sony sold more than 4 million television sets within months. Tellis and Golder in MIT Sloan Management Review 1996 and HBS Case 389-048 (1988) ● www.hbs.edu/faculty/Pages/profile.aspx?facId=6660

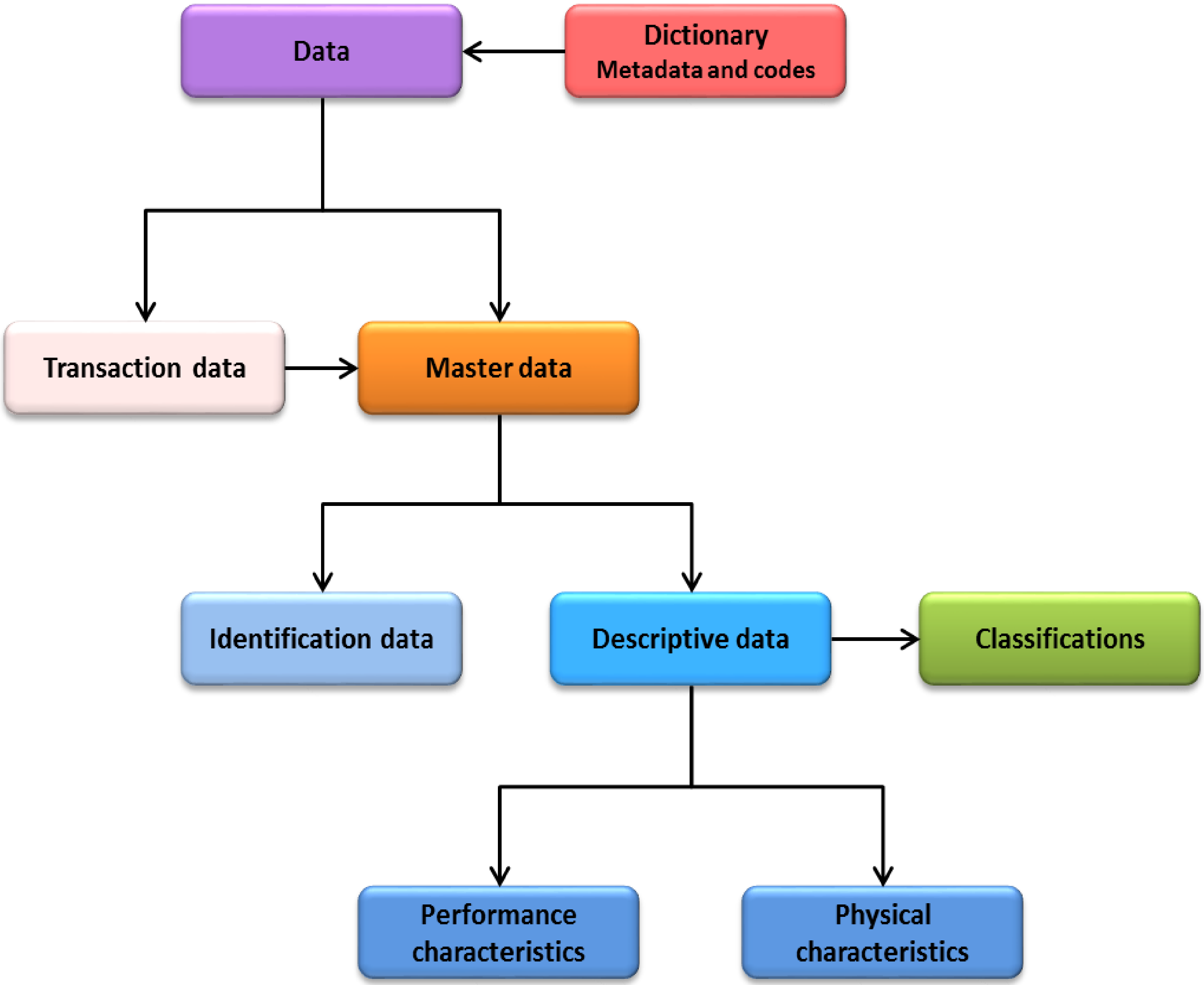
www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Industrial-Internet-Changing-Competitive-Landscape-Industries.pdf

Which of the following organizational changes have occurred or do you expect will occur to support your company's use of analytics? (Multiple responses)



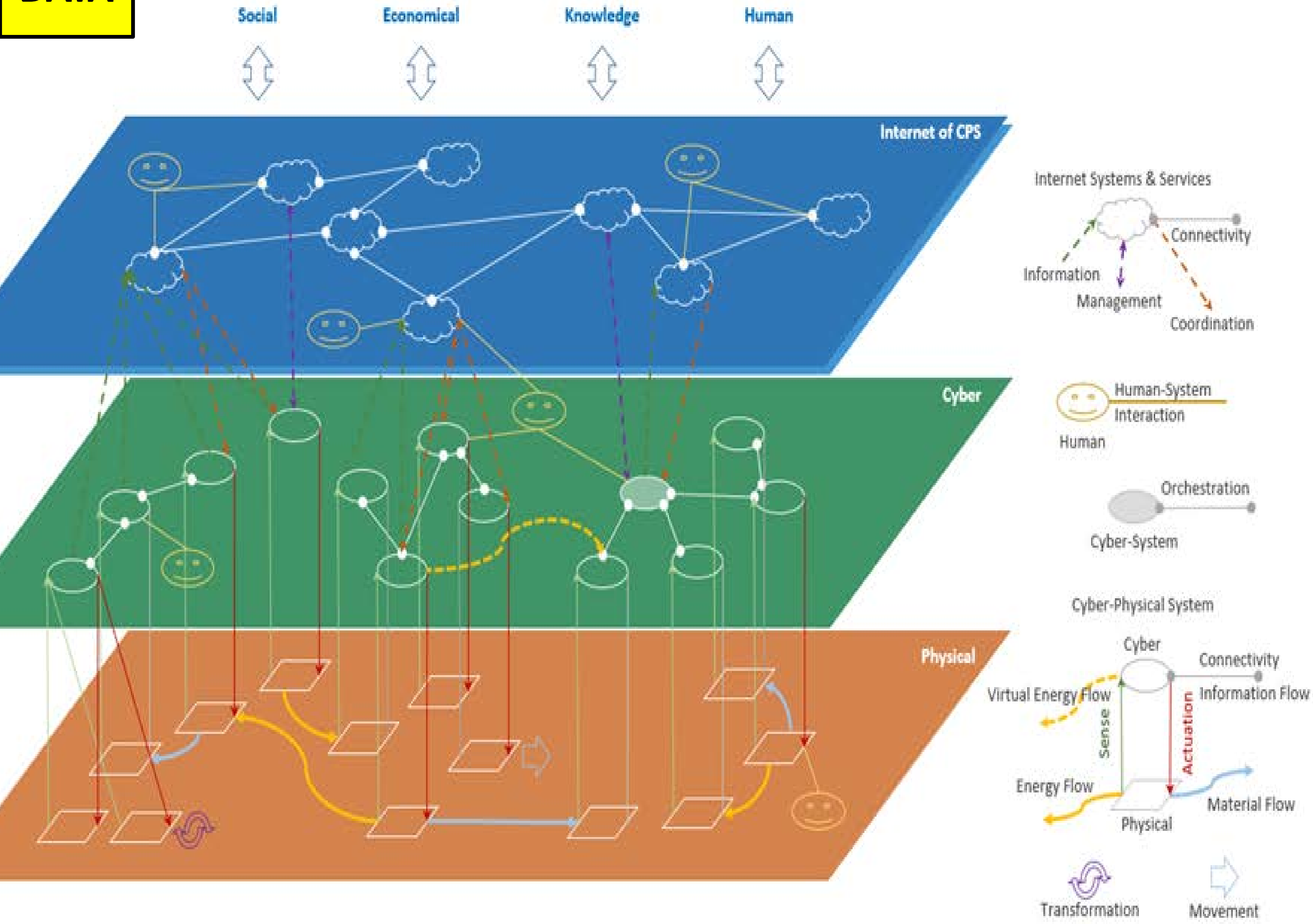
http://sloanreview.mit.edu/article/first-to-market-first-to-fail-real-causes-of-enduring-market-leadership/

TAXONOMY OF DATA

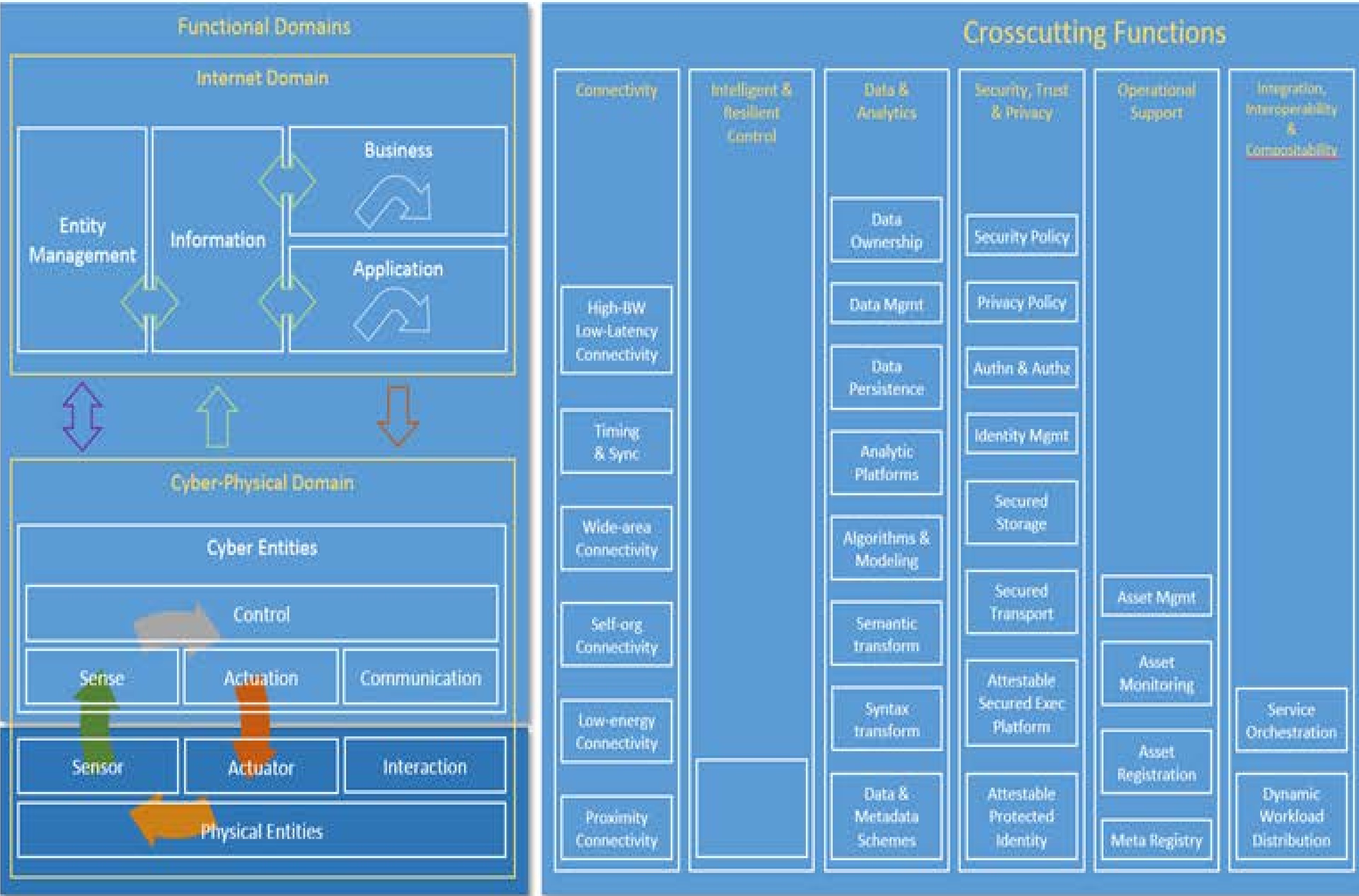


DATA

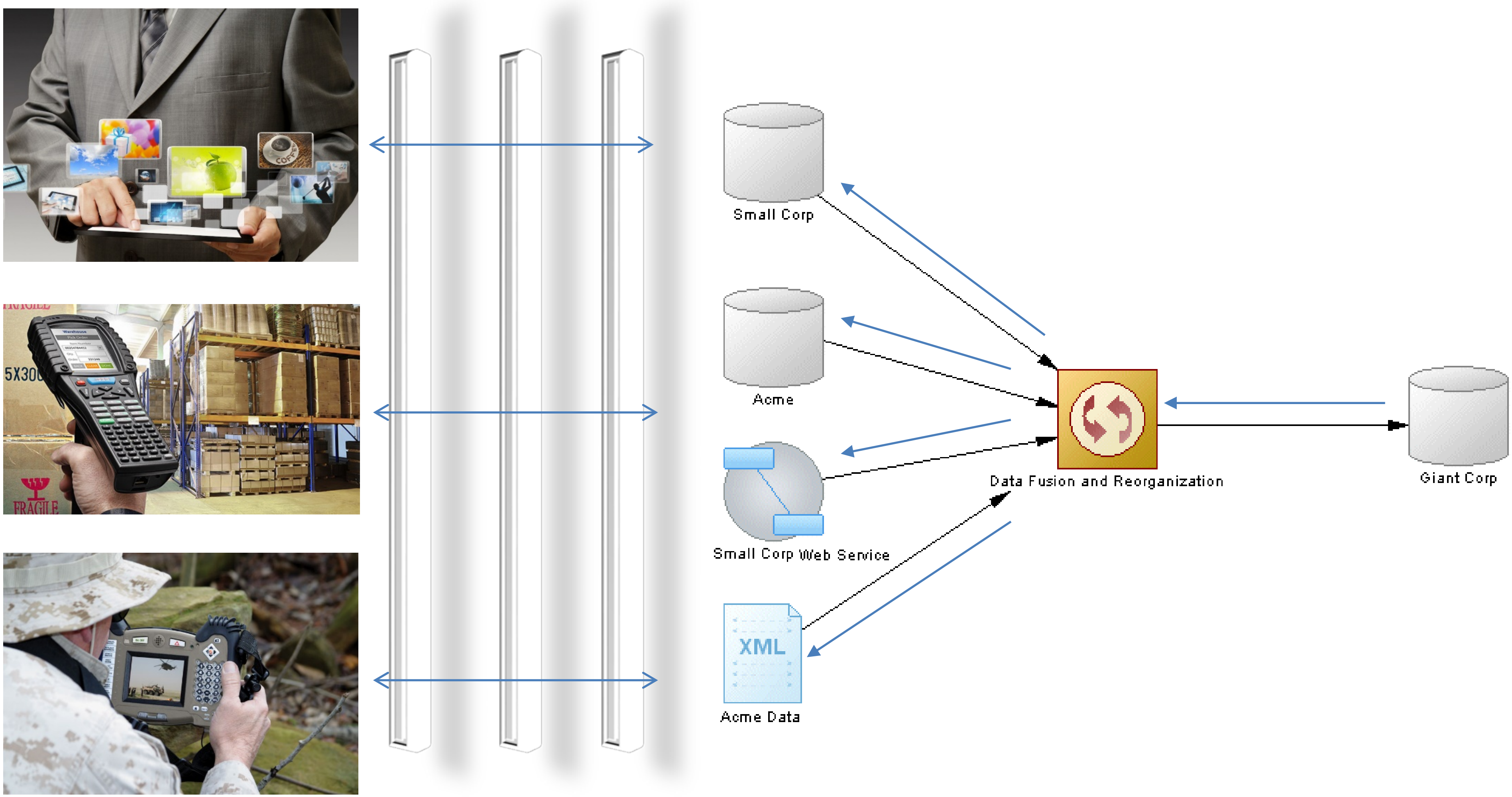
NIST CPS PWG – SYSTEM OF SYSTEMS



DATA

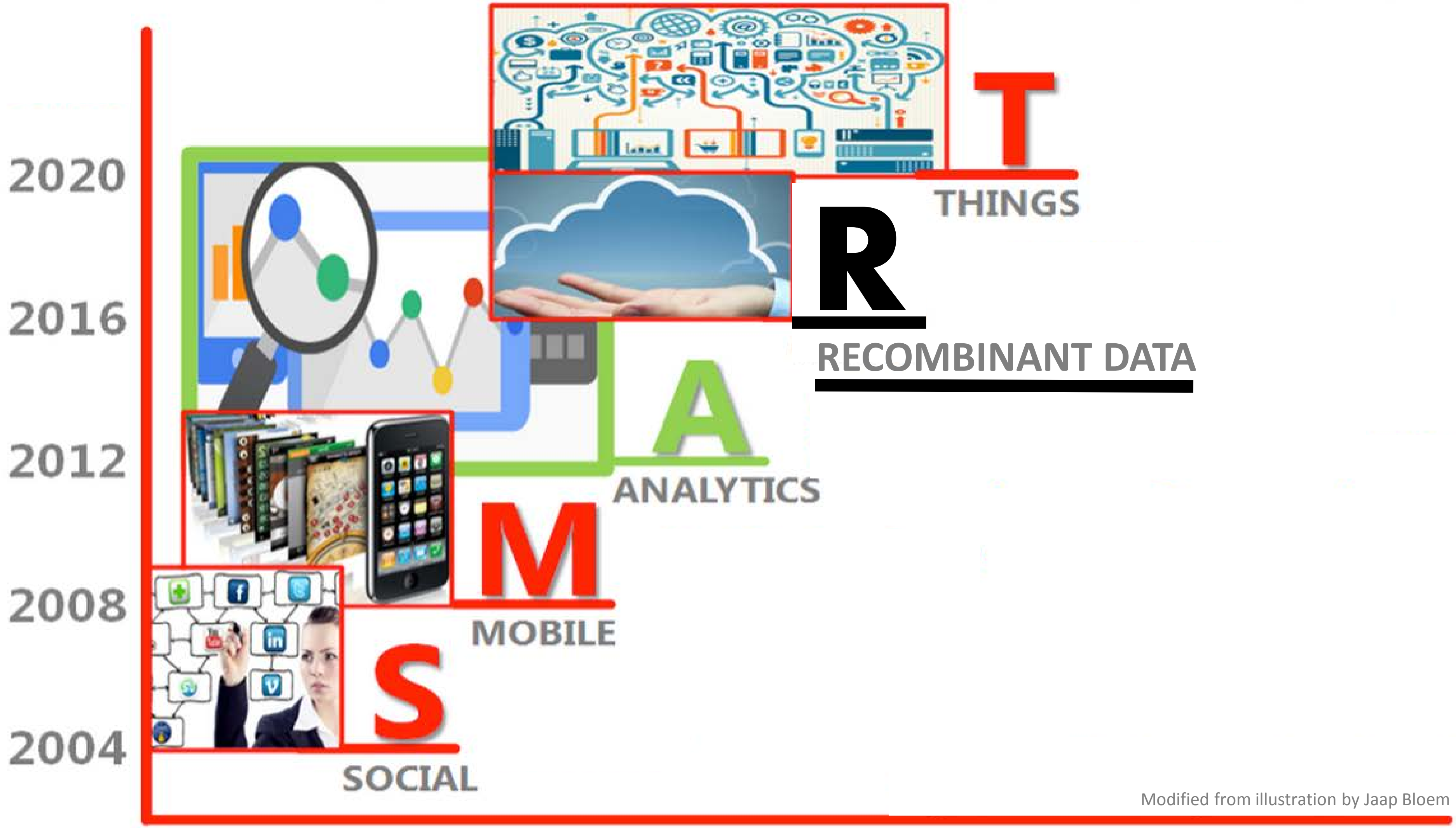

Functional Domains
Internet Domain
Entity Management
Information
Business
Application
Cyber-Physical Domain
Cyber Entities
Control
Sense
Actuation
Communication
Sensor
Actuator
Interaction
Physical Entities
Crosscutting Functions
Connectivity
High-BW Low-Latency Connectivity
Timing & Sync
Wide-area Connectivity
Self-org Connectivity
Low-energy Connectivity
Proximity Connectivity
Intelligent & Resilient Control
Data & Analytics
Data Ownership
Data Mgmt
Data Persistence
Analytic Platforms
Algorithms & Modeling
Semantic transform
Syntax transform
Data & Metadata Schemes
Security, Trust & Privacy
Security Policy
Privacy Policy
Authn & Authz
Identity Mgmt
Secured Storage
Secured Transport
Attestable Secured Exec Platform
Attestable Protected Identity
Operational Support
Asset Mgmt
Asset Monitoring
Asset Registration
Meta Registry
Integration, Interoperability & Composability
Service Orchestration
Dynamic Workload Distribution

Recombinant Data



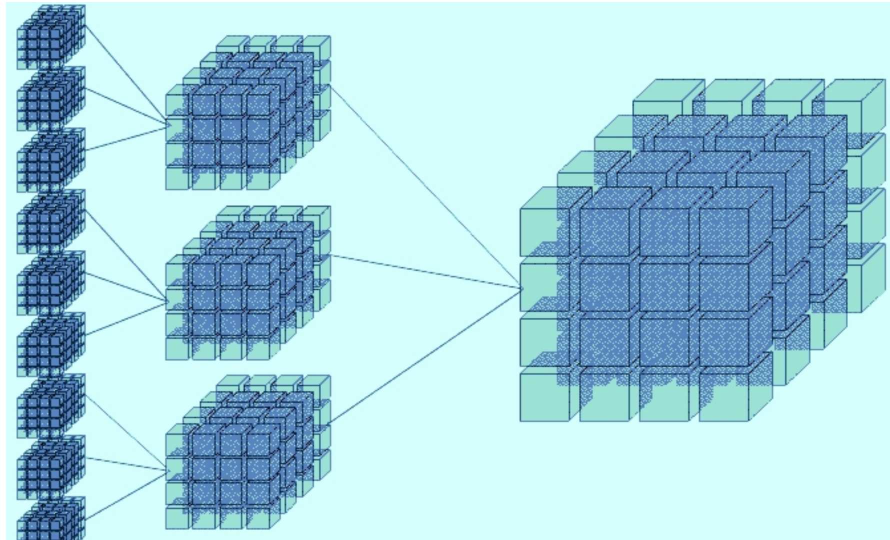
Raw Data (in any silo) is of limited value unless analyzed in conjunction with other data in temporal context of the problem-question to deliver the value the application seeks.

How smart can you make SMART ?? Depends on Recombinant Data



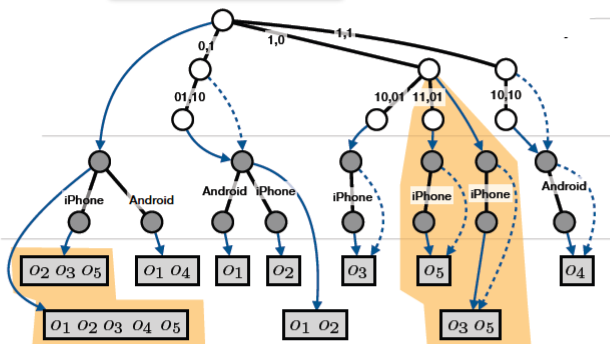
Modified from illustration by Jaap Bloem

Paradigm Shift in Data Analytics ?

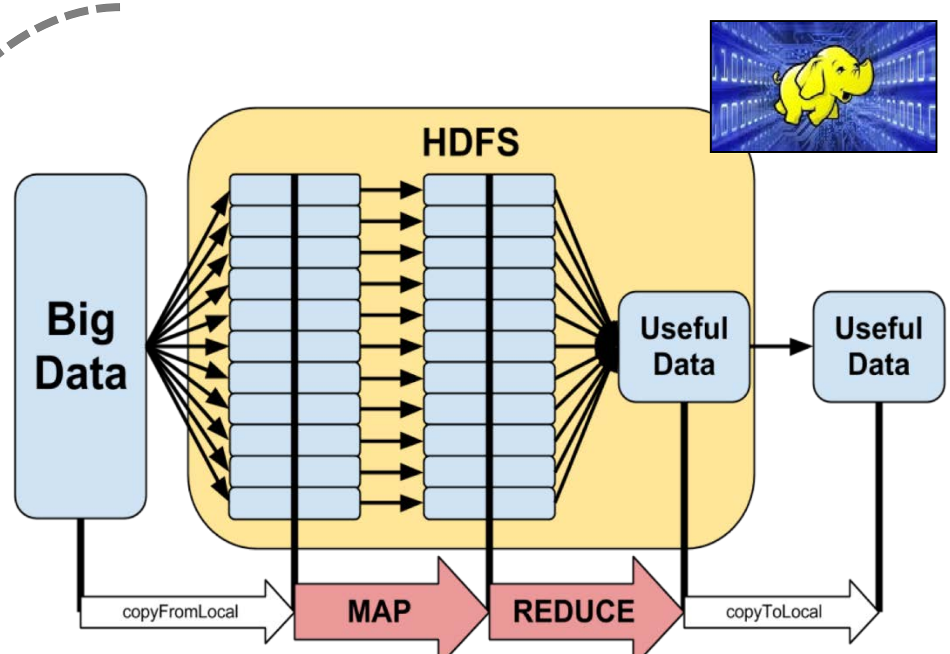


Marvin Minsky "cube on cube" (The Society of Mind, 1959)

nanocubes



www.nanocubes.net/assets/pdf/nanocubes_paper.pdf



http://bit.ly/GFS-2004

DATA ELEMENTS NEEDED FOR:

1. INCLUSION

- Principal dx of AMI

2. OUTCOME

- Arrival date/time
- Beta blocker administered (date/time)

3. EXCLUSION

- Birth date
- Admission date
- Discharge date
- Transfer from hospital/ED
- Transfer out soon after arrival
- Receiving comfort care only
- Involved in clinical trial
- Discharged to hospice
- Expired
- Left against medical advice
- HF on arrival/within 24 hr
- Shock on arrival/within 24 hr
- Bradycardia day of/ before discharge
- Heart transplant during stay
- LVAD during hospital stay
- Patient has pacemaker
- Second- or third-degree block on ECG
- Allergy to beta blocker
- Other contraindication to beta blocker

MEASURE

[Acute myocardial infarction (AMI) patients without beta-blocker contraindications who received a beta blocker within 24 hours after hospital arrival] %

PATIENT ADMINISTRATION SYSTEM (4 data elements)

EMERGENCY DEPARTMENT DOCUMENTATION (6 data elements)

MD DOCUMENTATION (7 data elements)

RN DOCUMENTATION (1 data element)

END-OF-EPISODE RECORD (11 data elements)

http://bit.ly/CSC-Healthcare

POSSIBLE SOURCES OF DATA ELEMENTS

• Data De-Identification ☑ http://bit.ly/MIT-IOT

MIT IoT – Talk 10082014

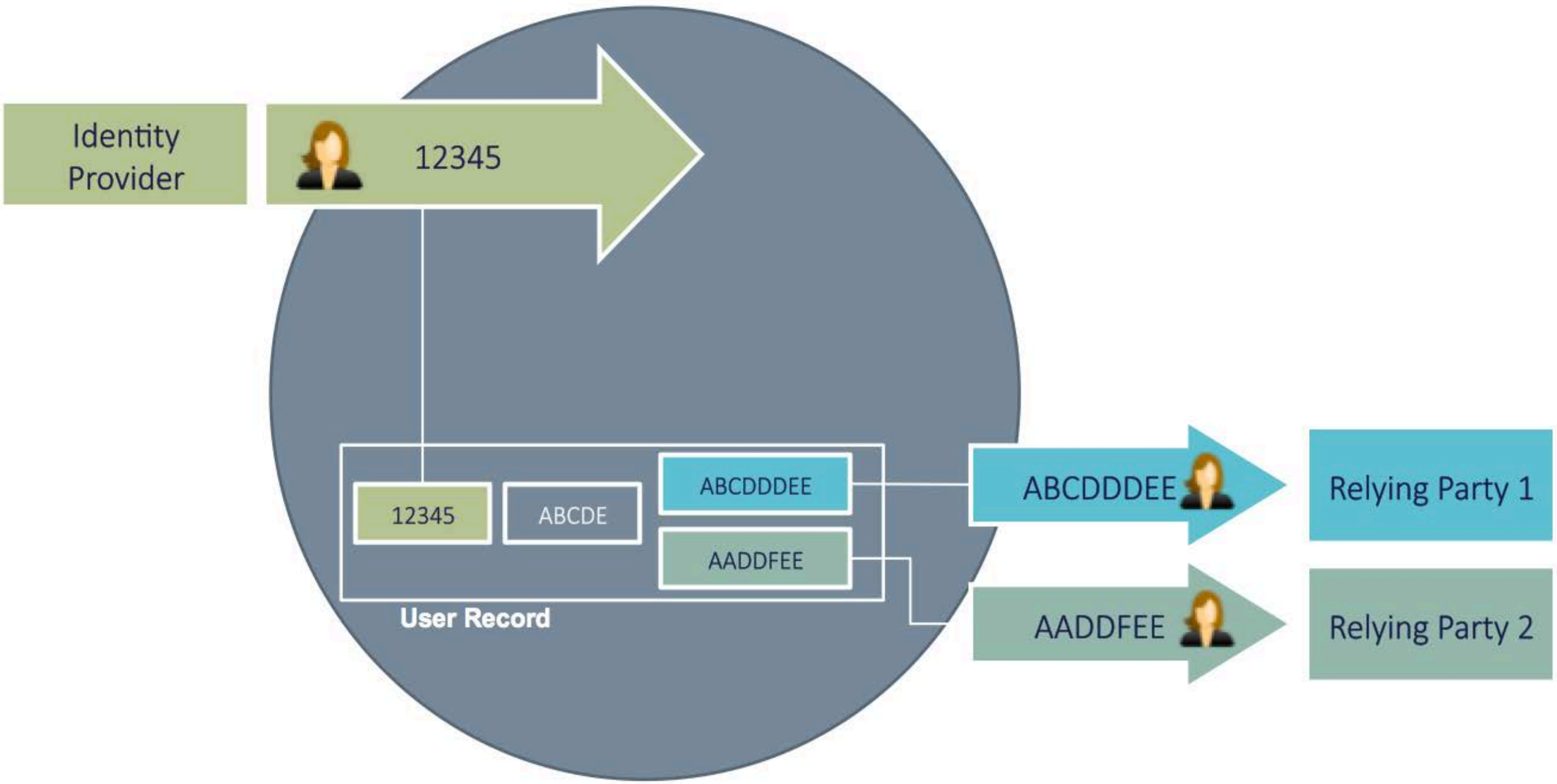
EHR and EMR Data De-identification & Re-construction

With This Tiny Box, You Can Anonymize Everything You Do Online

BY ANDY GREENBERG 10.13.14 | 6:30 AM | PERMALINK

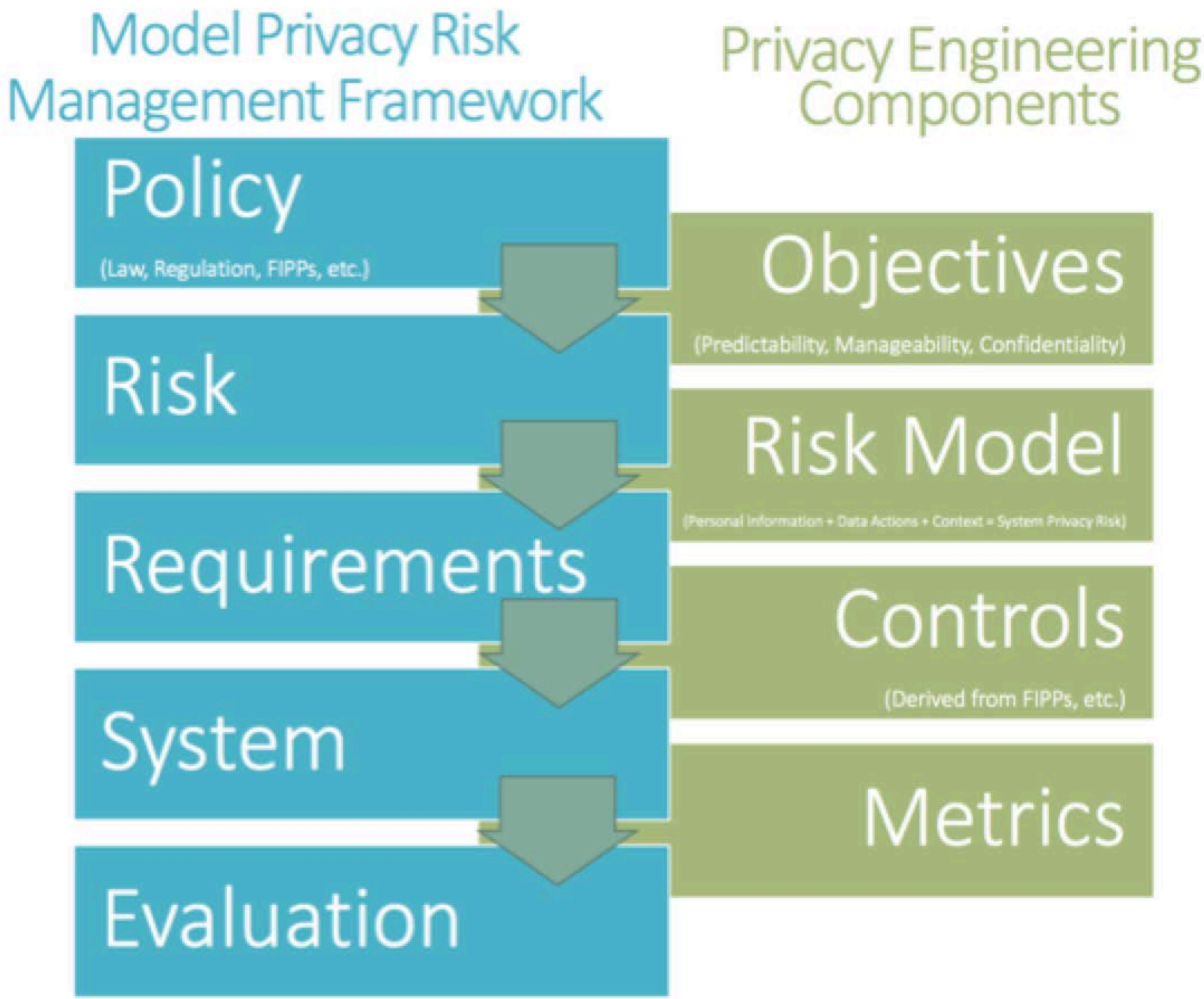
ANONABOX

Data Authentication – NIST CPS PWG Proposed Double-Blind Scheme



This model is designed specifically to ensure privacy requirements of anonymity, unlinkability and unobservability. Without the appropriate cryptography it allows user information to flow freely through the broker (blue-gray circle).

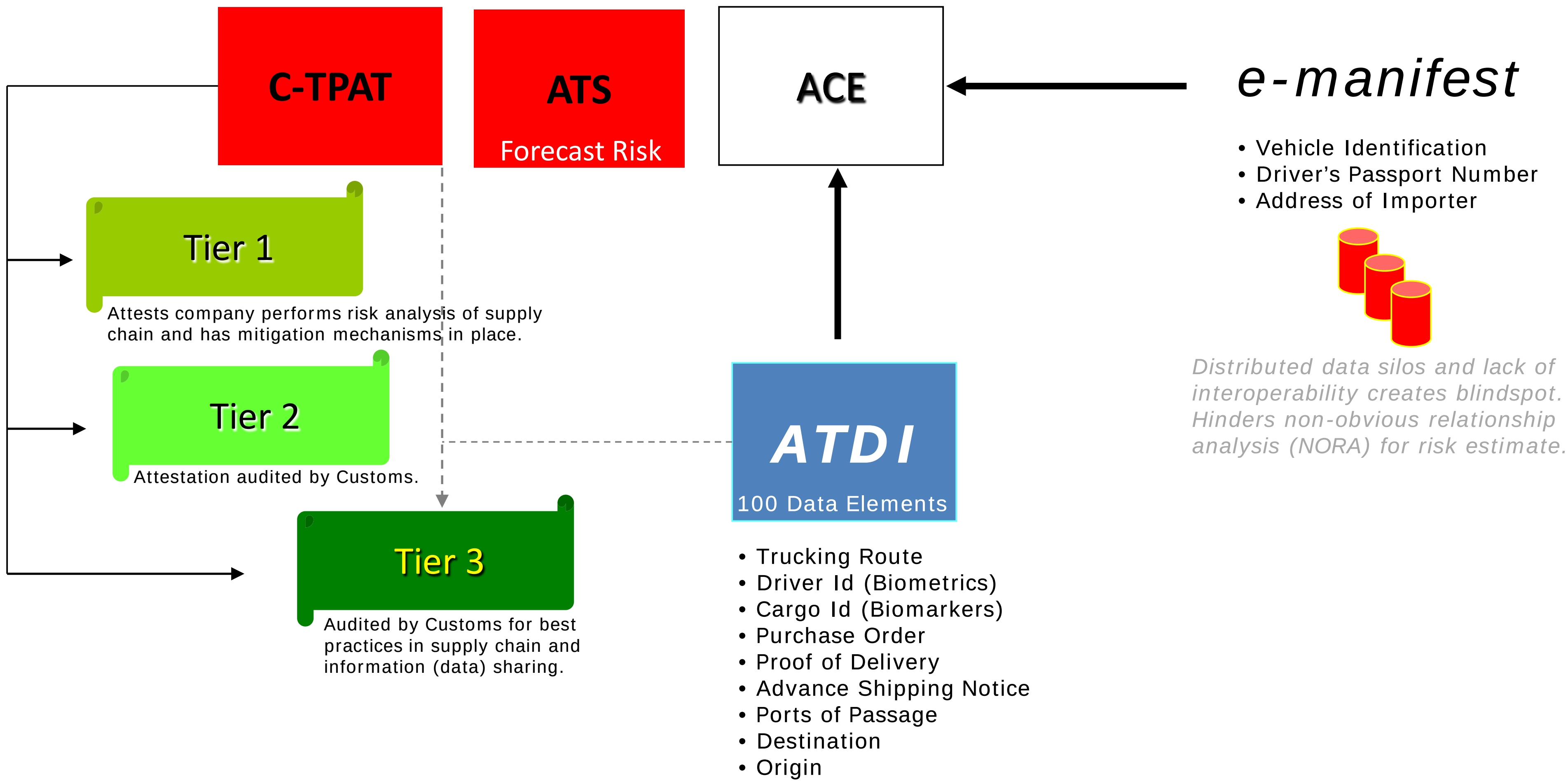
Data – Dynamic Privacy Risk Management – NIST CPS PWG



Data Elements in Internet of Systems

www.nitrd.gov/bigdata/rfi/02102014.aspx

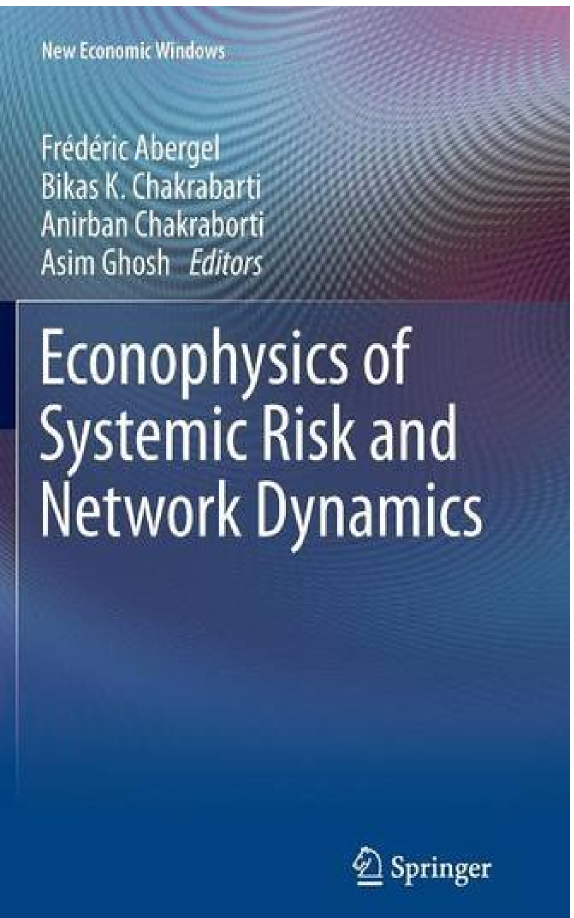
Department of Homeland Security • Operation Safe Commerce

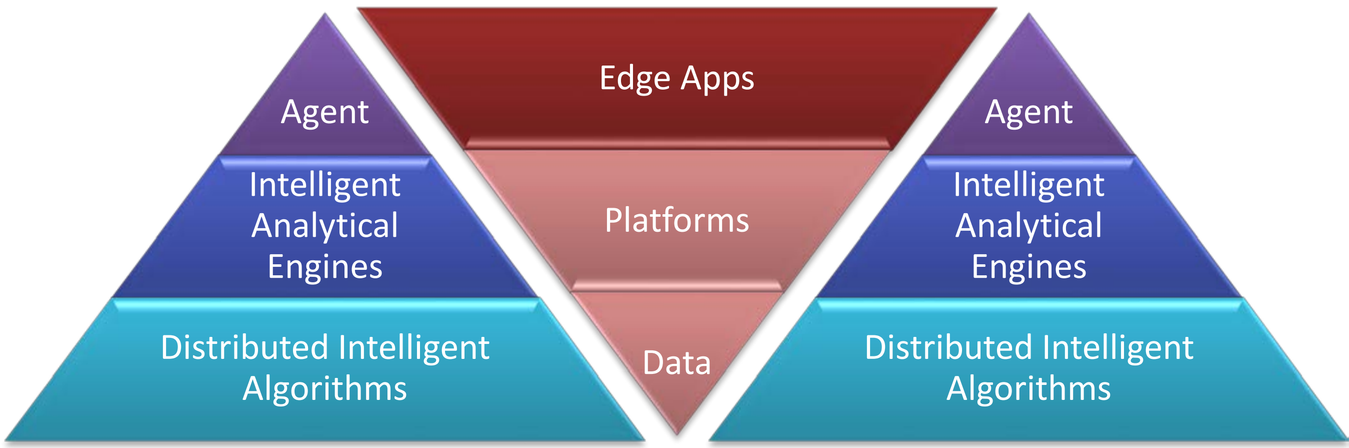


C-TPAT	> Customs-Trade Partnership Against Terrorism
ACE	> Automated Commercial Environment (the enterprise system equivalent)
ATDI	> Advanced Trade Data Initiative (necessary for C-TPAT Tier 3)
ATS	> Automated Targeting System (in operation since 1990's)

Making Sense of and Extracting Value from Data

Using a combination of systems engineering, learning algorithms and econophysics





Semantics of Time in Sense and Response

0.1 sec Run-Time?

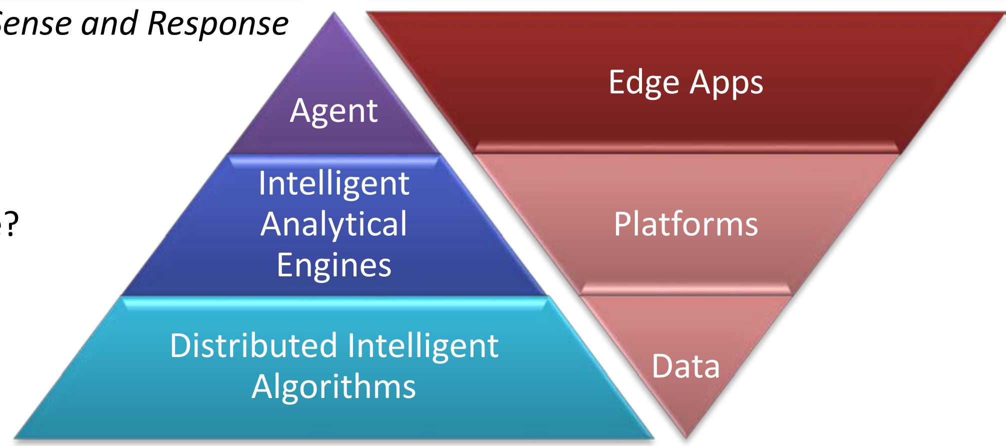
1.0 sec Real-Time?

10 sec Near-Real Time?

100 sec Just in Time?

1,000 sec Right Time?

10,000 sec Any Time?



The latest US influenza season is more severe and has caused more deaths than usual.

EPIDEMIOLOGY

When Google got flu wrong

US outbreak foxes a leading web-based method for tracking seasonal flu.

BY DECLAN BUTLER

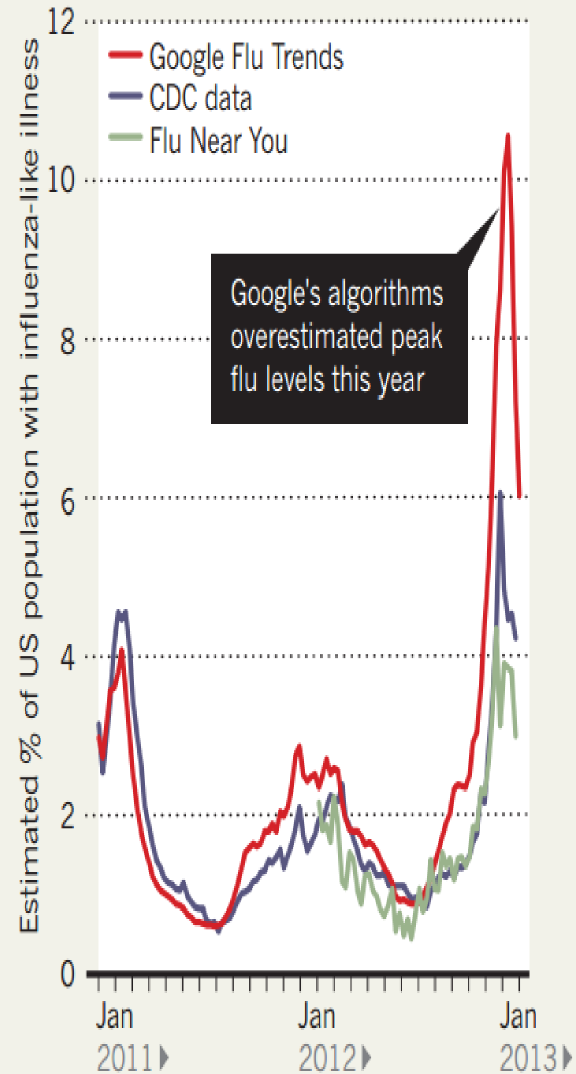
When influenza hit early and hard in the United States this year, it quietly claimed an unacknowledged victim: one of the cutting-edge techniques being used to monitor the outbreak. A comparison with traditional surveillance data showed that Google Flu Trends, which estimates prevalence from flu-related Internet searches, had drastically overestimated peak flu levels. The glitch is no more than a temporary setback for a promising strategy, experts say, and Google is sure to refine its algorithms. But as flu-tracking techniques based on mining of web data and on social media proliferate, the episode is a reminder that they will complement, but not substitute for, traditional epidemiological surveillance networks.

"It is hard to think today that one can provide disease surveillance without existing systems," says Alain-Jacques Valleron, an epidemiologist at the Pierre and Marie Curie University in Paris, and founder of France's Sentinelles monitoring network. "The new systems depend too much on old existing ones to be able to live without them," he adds.

This year's US flu season started around November and seems to have peaked just after Christmas, making it the earliest flu season since 2003. It is also causing more serious illness and deaths than usual, particularly among the elderly, because, just as in 2003, the predominant strain this year is H3N2 — the most

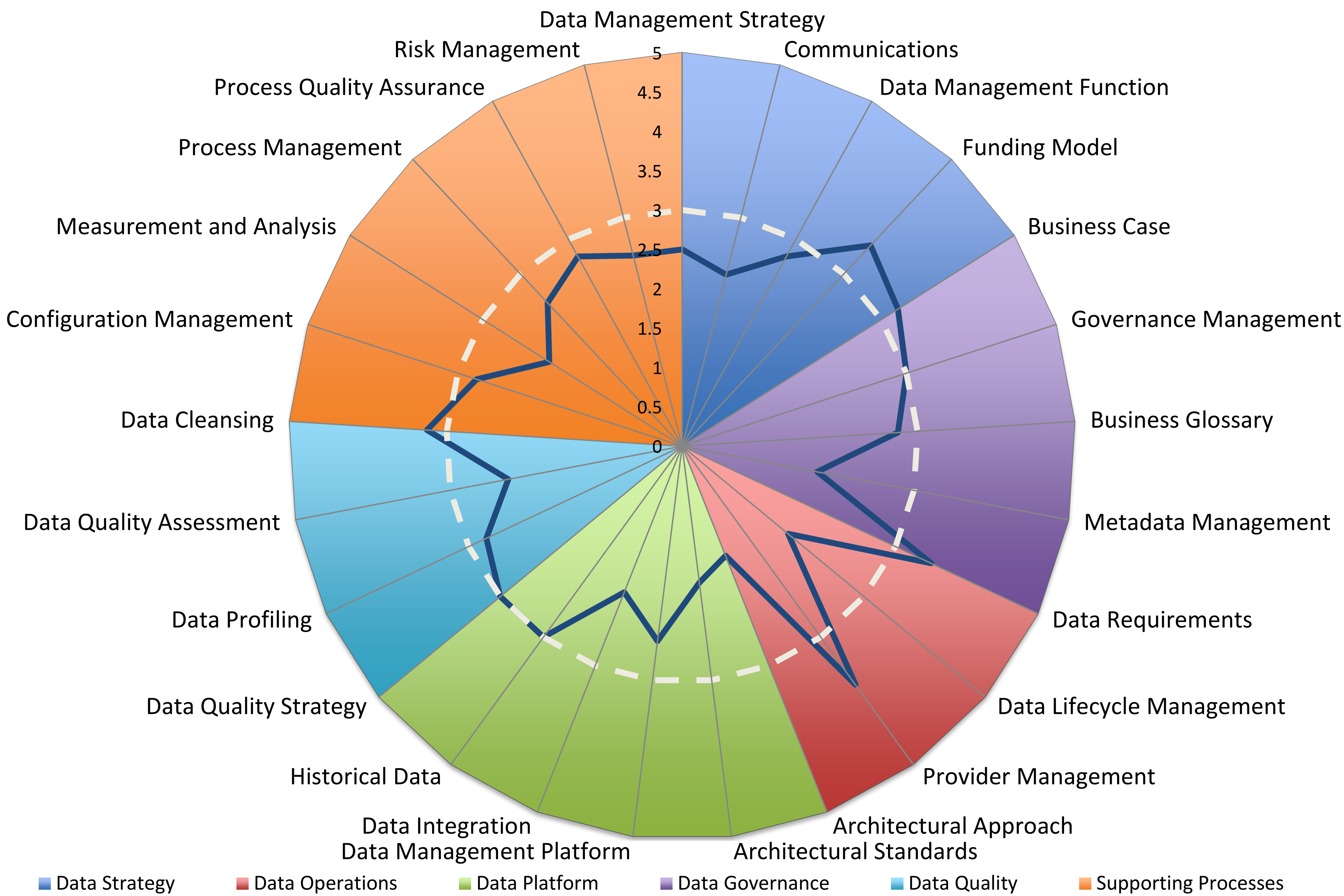
FEVER PEAKS

A comparison of three different methods of measuring the proportion of the US population with an influenza-like illness.



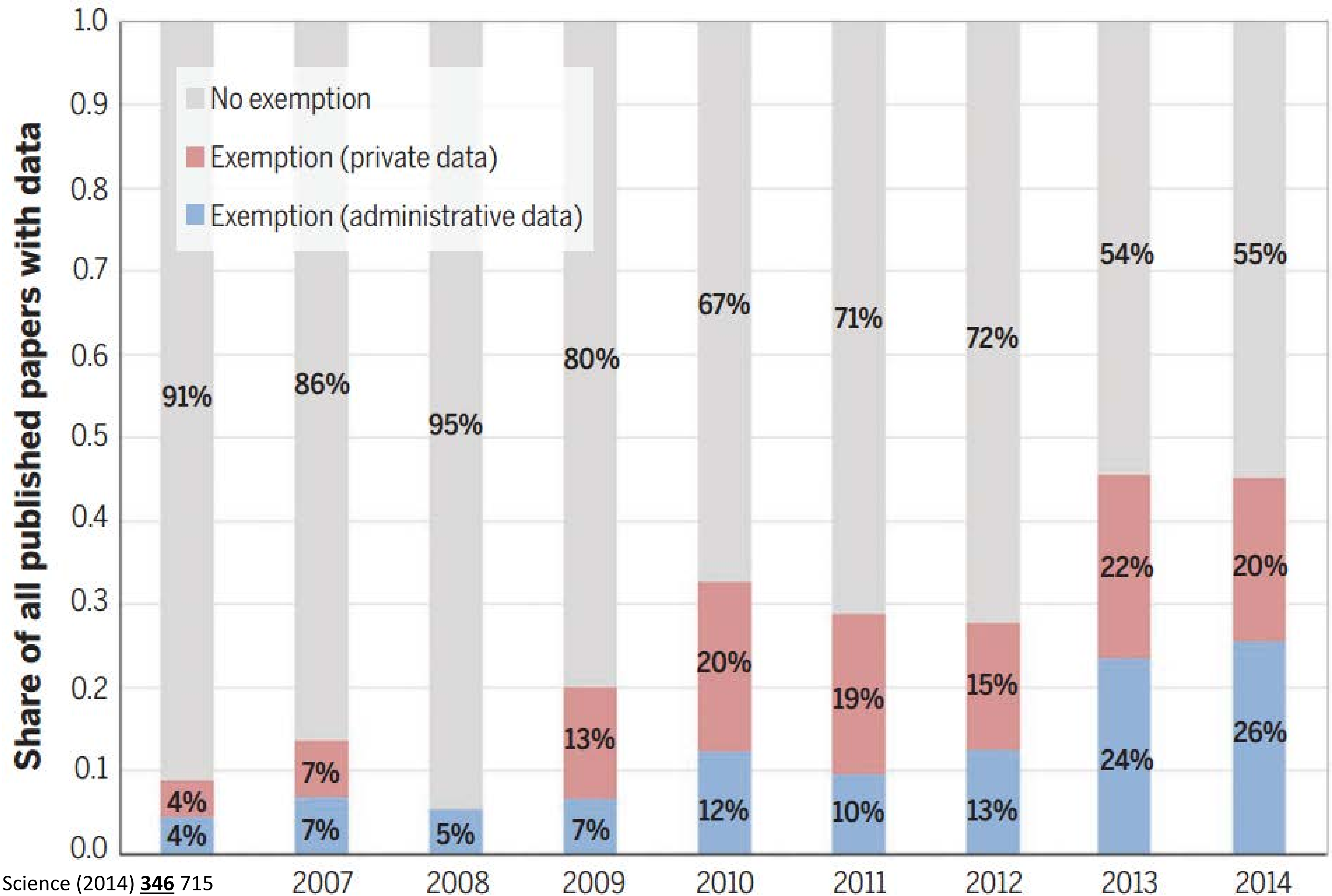
The bottom line – Data must be analyzed in context

Data Management Maturity Model



www.sei.cmu.edu/cmmi/

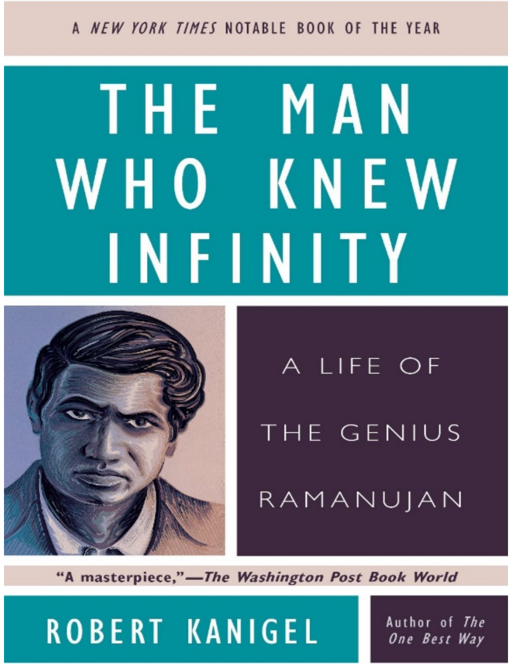
Economics in the Age of Big Data ● Non-Publicly Available Data in Economic Research



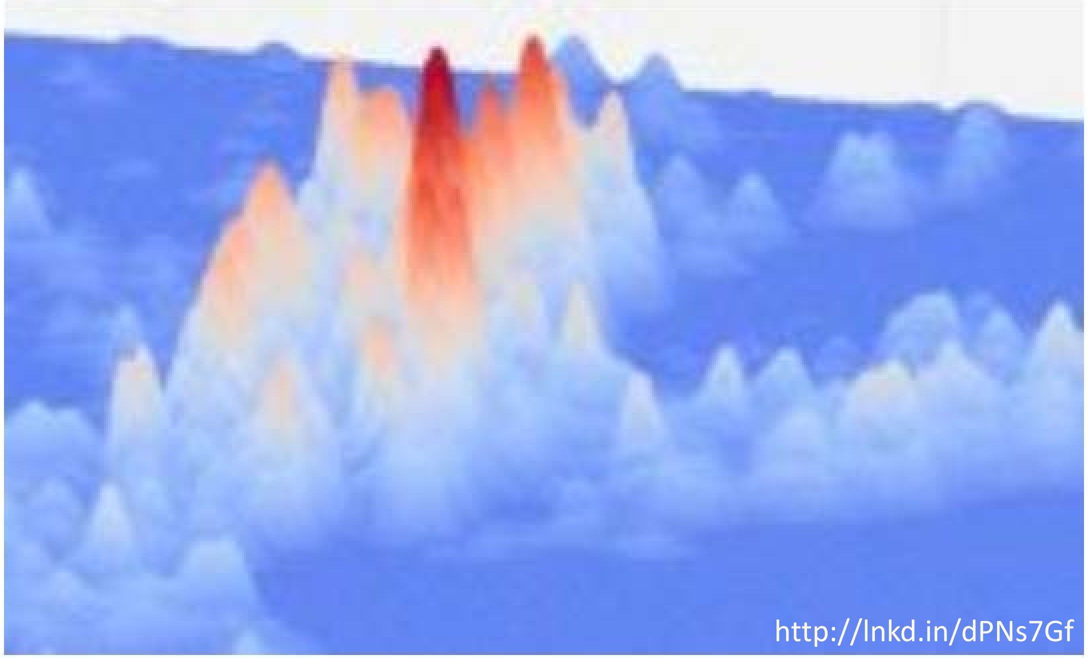
Science (2014) **346** 715

How much more data can we expect?

Can you imagine infinity ?

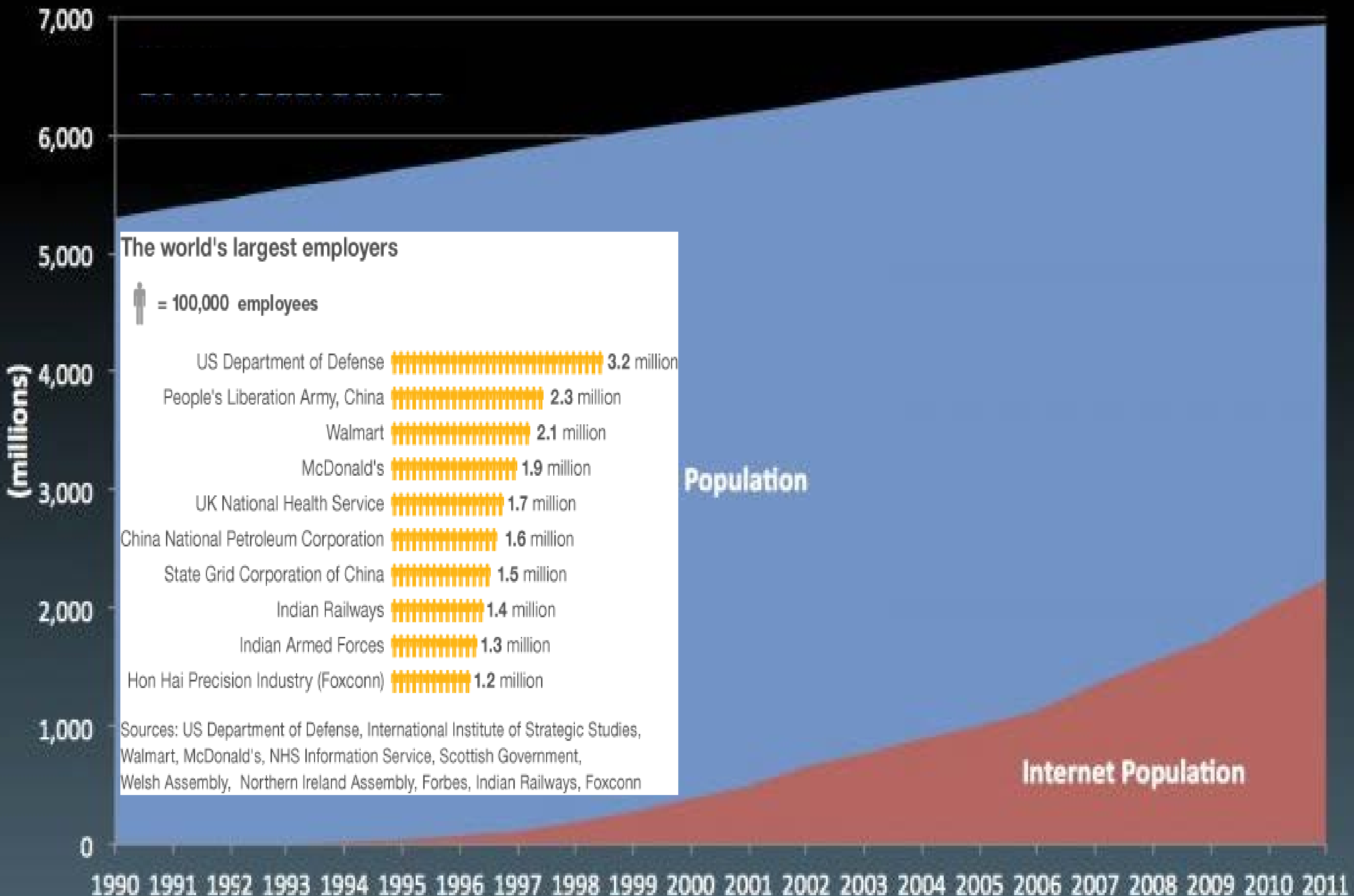


Don’t confuse data with drivel



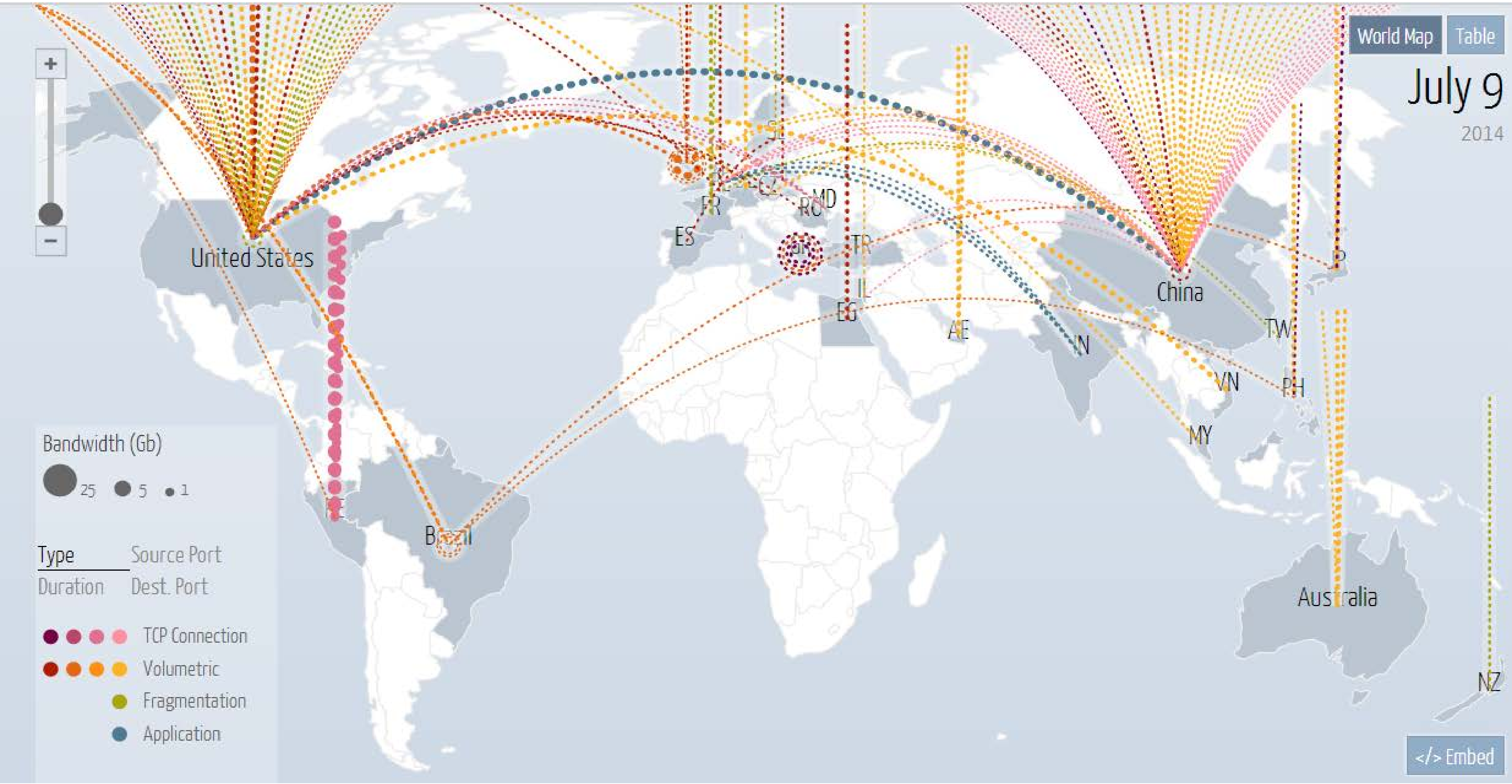
Twitter use in New York City

Data – Imagine what happens if 50% of the population were connected

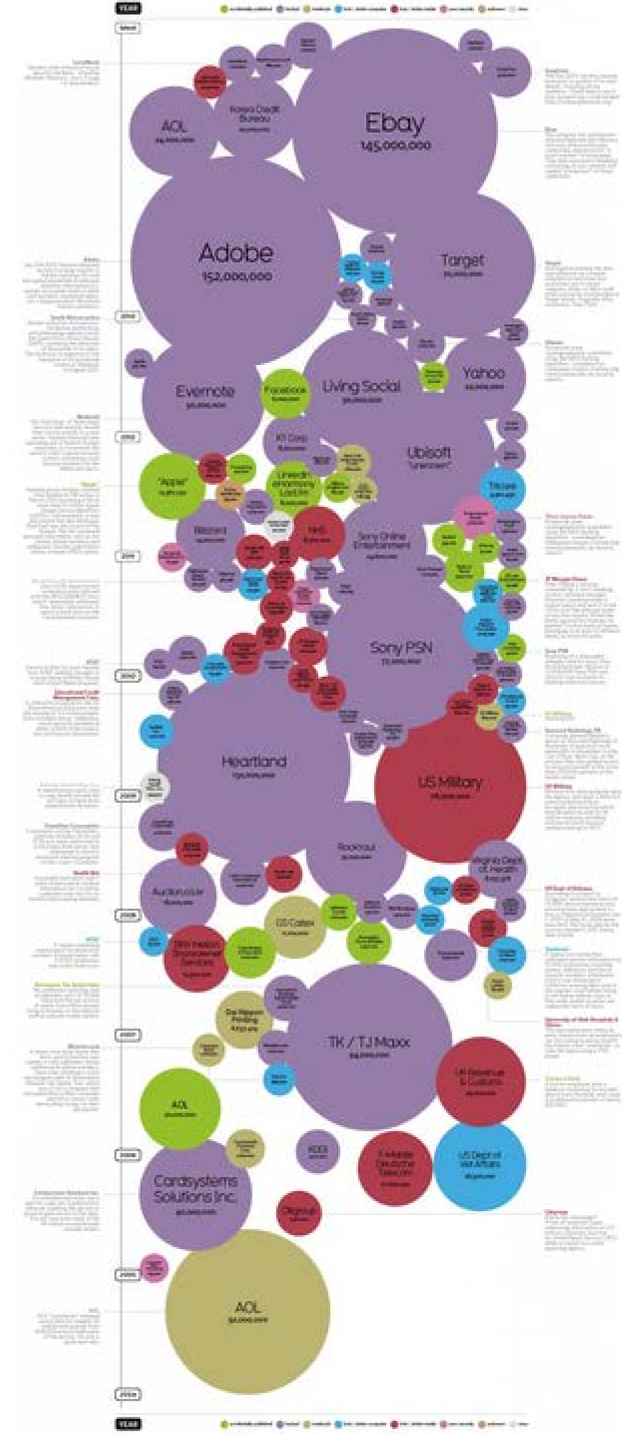


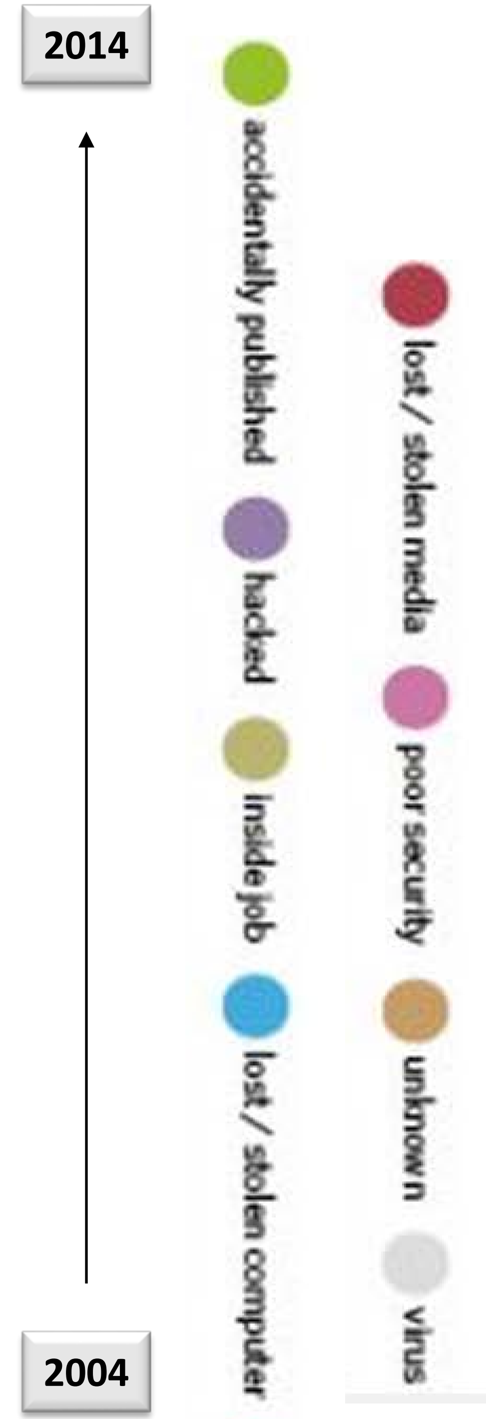
Source: International Communication Union, Google

Data Cybersecurity – Digital Attack Map – The Prelude to Cyber Warfare



Data Breaches





www.businessinsider.com/data-breaches-infographic-2014-12

- EQM – Elusive Quest for Monetization (pre-proposal available on request)

- **Connect, Converge, Combine → Obvious, Non-Obvious, Unusual**

[a] Space-time-node engine

[b] Stigmergic computation

[c] Cognitive matrices

[d] Dynamic networks

[e] Semantics of time

[f] Spatio-temporal detection of unusual behavior

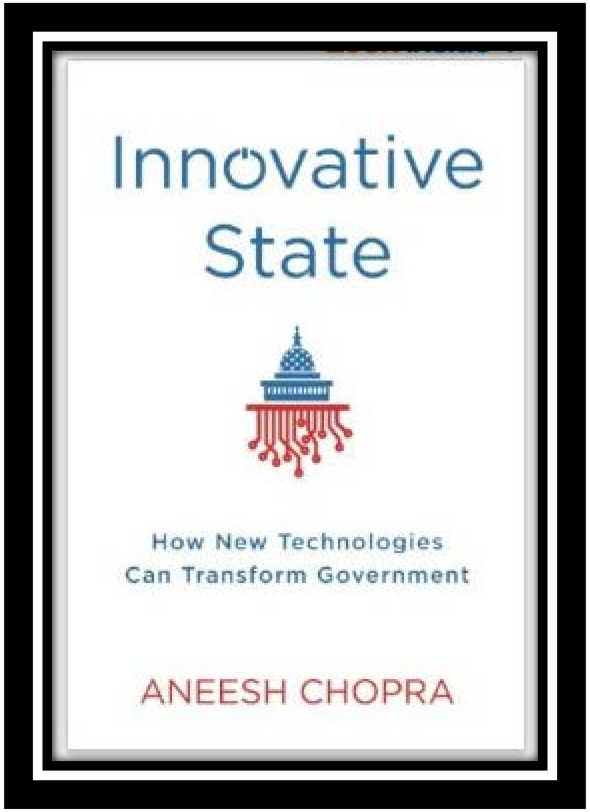
[g] Artificial retina pattern recognition in high volume data

[h] CLA + temporally integrated software/embedded systems

[i] Conventional (time series, GARCH, OR, machine learning)

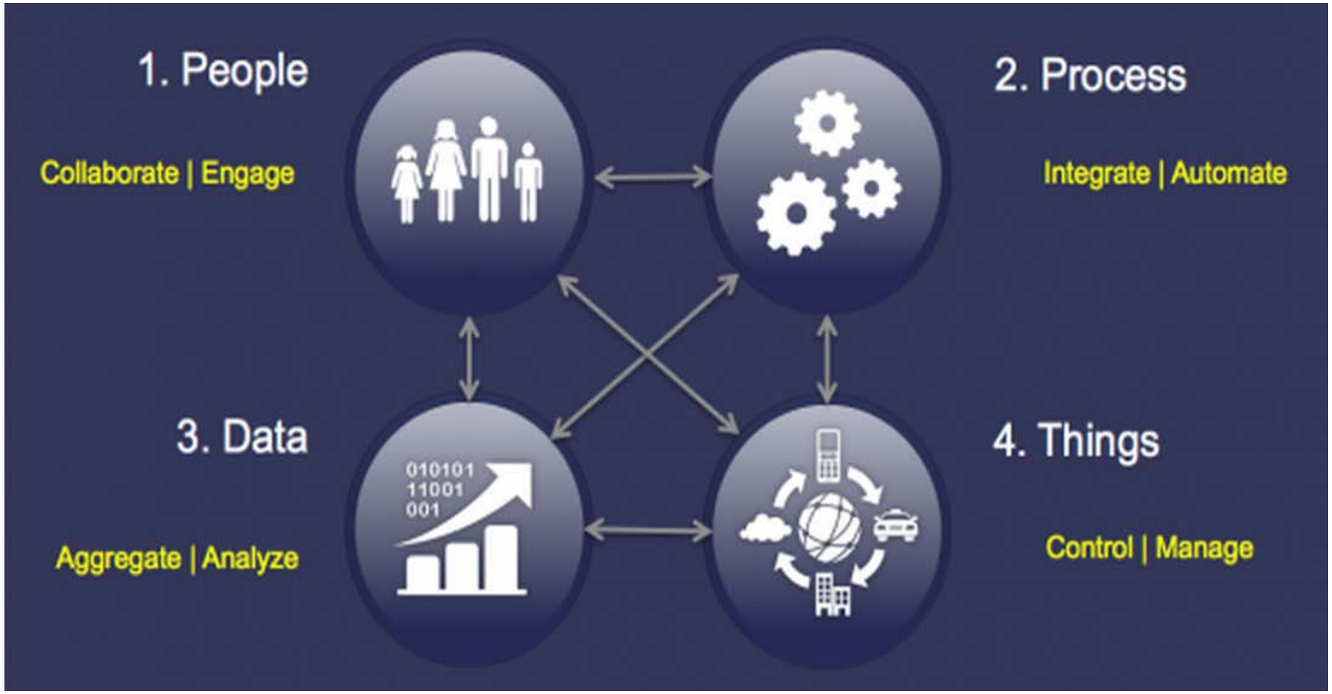
[j] Neural Image Caption Generator

MONETIZE DATA ?



Elusive Quest for Monetization ☑ http://bit.ly/MIT-IOT

OPEN DATA INTEROPERABILITY



Socio-Economic Disequilibrium ☑ http://bit.ly/MIT-IOT

[A Systematic Review of Barriers to Data Sharing in Public Health]

All data are not created equal

DON'T USE MY DATA

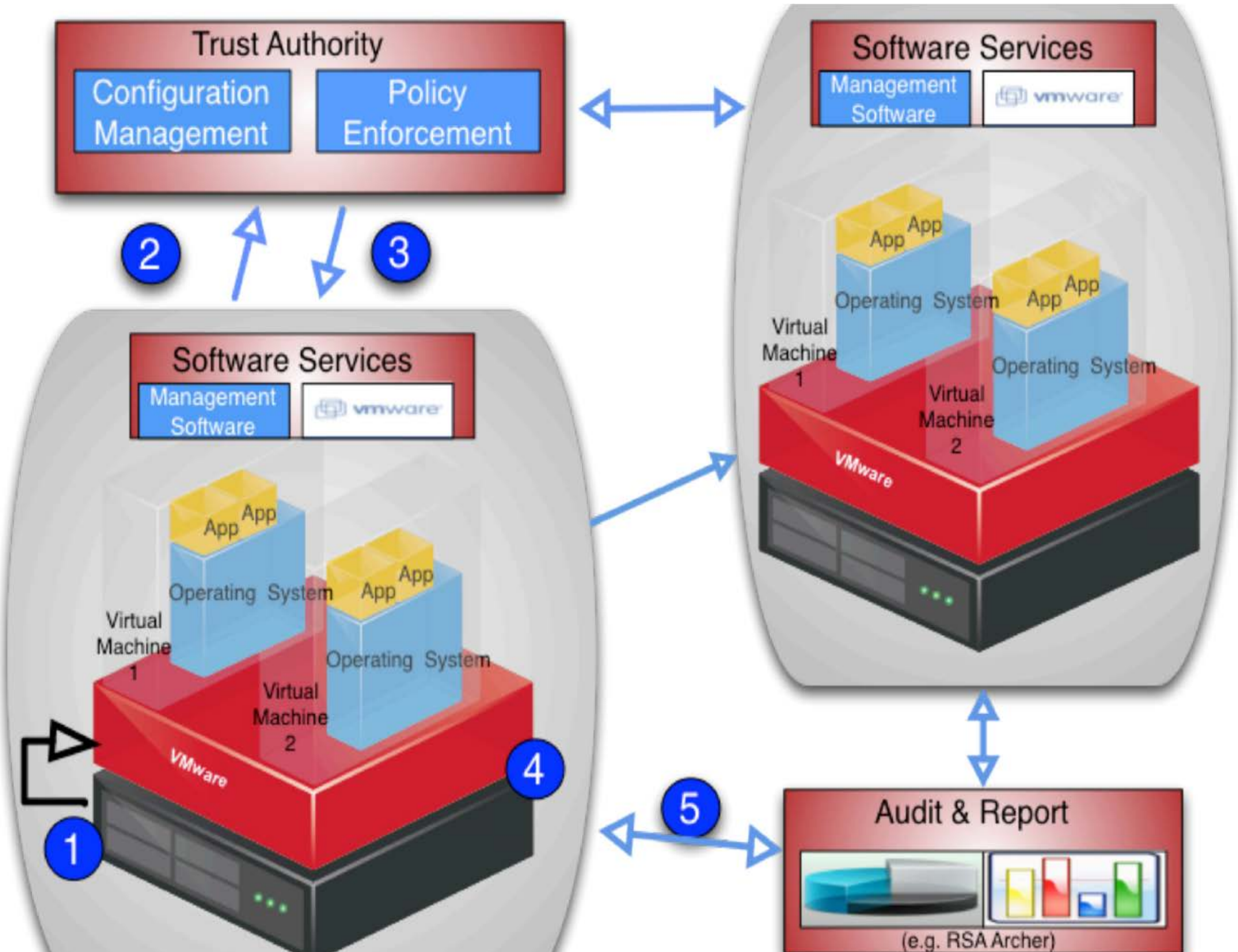
© MARK ANDERSON WWW.ANDERTOONS.COM

"Before I write my name on the board, I'll need to know how you're planning to use that data."

Healthcare Data Neutering

De-Identified Data

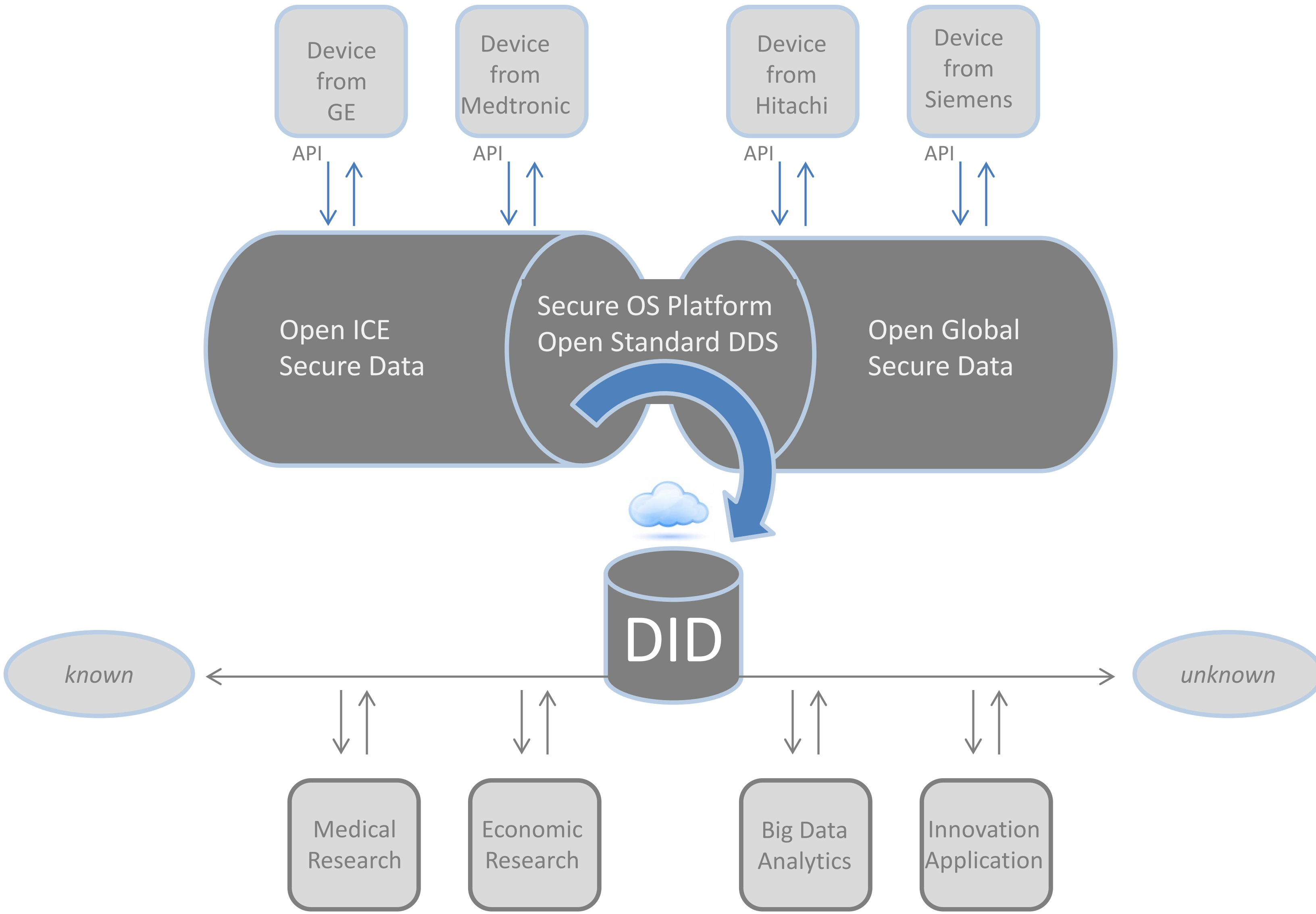
Trusted GeoLocation in the Cloud (NIST NCCOE) – Is this an adequate solution for health data?



Server B

http://csrc.nist.gov/publications/drafts/ir7904/draft_nistir_7904.pdf
http://csrc.nist.gov/nccoe/health-it/index.html

De-identified Data (DID) will drive Research – Management Science – Policy – Funding



Note: In certain instances, CPS related time constraints may render traditional cloud based D2D architecture unacceptable [QoS] due to latency.

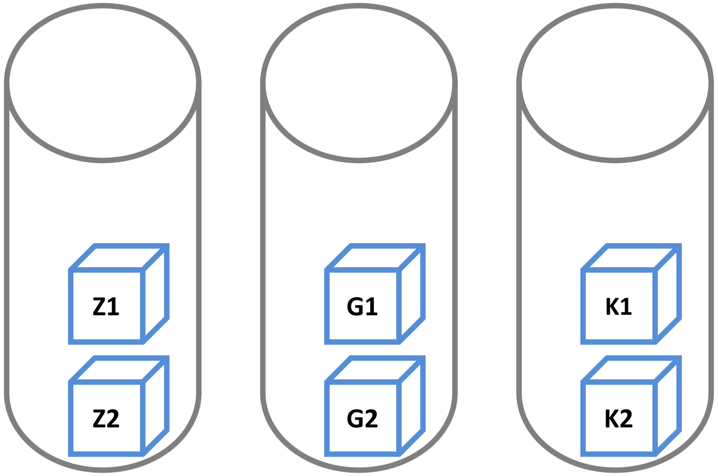
Data Dissociation using meta data to identify/label data type

Clinic VIEW

Name	SSN-UID	Street Address	Zip Code	Blood Glucose	Weight in kg
Jane Does Tag N1	123-45-6789 Tag S1	77 Mass Ave Tag A1	02139 Tag Z1	190 mg/dl Tag G1	190 Tag K1
John Does-Not Tag N2	123-45-6790 Tag S2	86 Brattle St Tag A2	02138 Tag Z2	109 mg/dl Tag G2	159 Tag K2

DID VIEW

Name	SSN-UID	Street Address	Zip Code	Blood Glucose	Weight in kg
			02139 Tag Z1	190 mg/dl Tag G1	190 Tag K1
			02138 Tag Z2	109 mg/dl Tag G2	159 Tag K2



Data Re-association using De-Identified Data (DID) Stack

QUESTION

Same data but different correlation

http://www.biomedcentral.com/content/pdf/1471-2458-14-1144.pdf

Same Data ← Different Questions → Extracting Information from DID

Epedimiologists

Economists

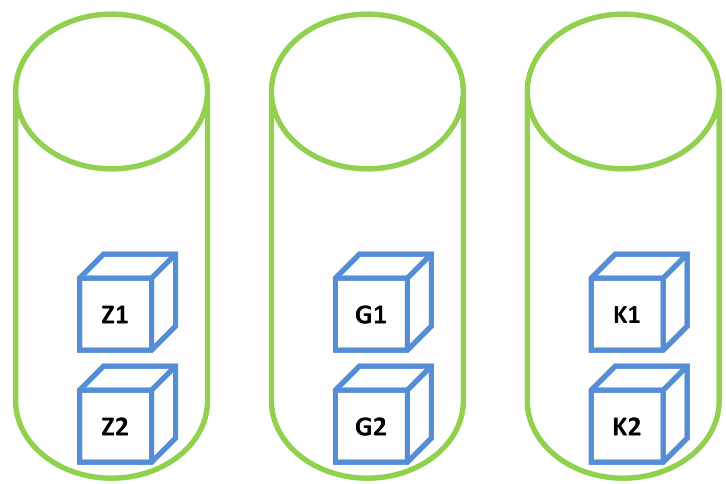
Physician

What is the distribution of potential diabetics by zip code?

Is there a relationship between per capita income and body fat?

Can we correlate high blood glucose with increased body weight?

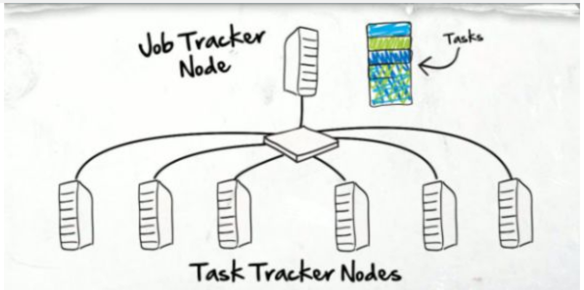
Name	SSN-UID	Street Address	Zip Code	Blood Glucose	Weight in kg
			02139 Tag Z1	190 mg/dl Tag G1	190 Tag K1
			02138 Tag Z2	109 mg/dl Tag G2	159 Tag K2

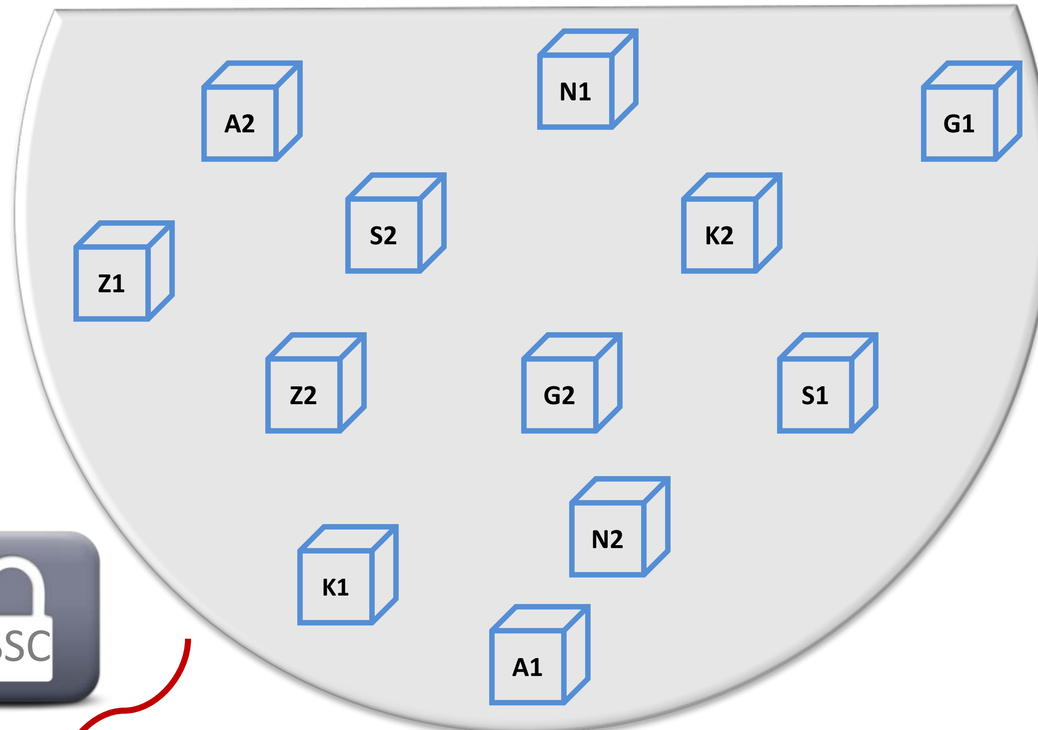


This is a suggestion by the author. Not a proven concept in practice.

Secured Data <> Re-association of De-Identified Data (DID)

Re-sequence DID → HADOOP-esque concept ?





Name	SSN-UID	Street Address	Zip Code	Blood Glucose	Weight in kg
Jane Does Tag N1	123-45-6789 Tag S1	77 Mass Ave Tag A1	02139 Tag Z1	190 mg/dl Tag G1	190 Tag K1
John Does-Not Tag N2	123-45-6790 Tag S2	86 Brattle St Tag A2	02138 Tag Z2	109 mg/dl Tag G2	159 Tag K2

This is a suggestion by the author. Not a proven concept in practice.

Re-stitch De-Identified Data - create Secure Sequencing Code (SSC)

PRIVACY

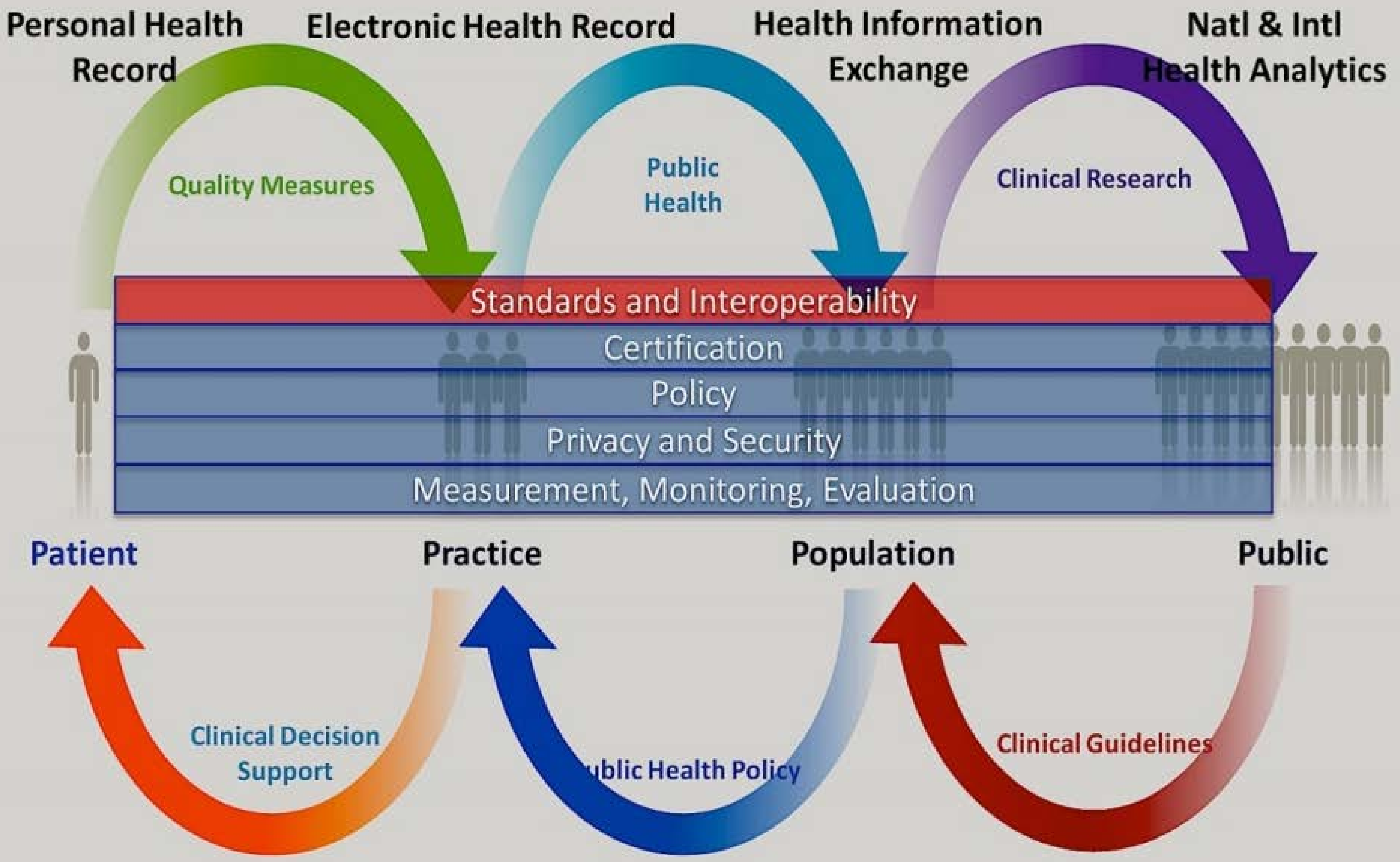
Privacy is a complex topic; there's no black and white. … The question becomes: Are providers of the service trustworthy? This idea stretches back to Shakespeare and beyond. In *Othello*, Iago spells out the importance of reputation:

Good name in man and woman, dear my lord,
Is the immediate jewel of their souls:
Who steals my purse steals trash; 'tis something, nothing;
'Twas mine, 'tis his, and has been slave to thousands;
But he that filches from me my good name
Robs me of that which not enriches him
And makes me poor indeed.

In this world of data and information, both people and companies must maintain their reputations. People will be very reluctant to transact with those they can't trust. Reputation, I think, will guide the kinds of decisions people make in the future.

Dr Joe Salvo in The Economist ● http://gelookahead.economist.com/future-scope/futurescope-joseph-salvo/#sthash.8iy07Sd3.dpuf

Platform for Trusted Data Access via Secure Standards and Interoperability



Healthcare Data Interoperability & Standards

… semantics, data dictionaries, billing codes

- Terminology
  - SNOMED, LOINC
- Classification Systems
  - ICD10, CPT
- Devices
  - IEEE 11073
- EHR-Related
  - DICOM, HL7 (CDA)
- Interoperability
  - DICOM, HL7 Messaging, HIPAA Transactions, NCPDP
- Language Formats
  - XML, X12

Increase in computational time may be compensated by a relaxed priority queue which allows throughput scaling for large number of threads. Hence, parallelizing common algorithms to work on multicore chips: ***The SprayList*** www.mit.edu/~jerryzli/SprayList-CR.pdf

DIAGNOSIS CODES for SPRAINED & STRAINED ANKLES

ICD-9

845.00 Sprain and strain of ankle unspecied site
845.01 Sprain and strain of ankle, Deltoid ligament/ Internal collateral ligament
845.02 Sprain and strain of ankle, Calcaneobular (ligament)
845.03 Sprain and strain of ankle, Tibiobular (ligament) distal

ICD-10

S93.401A Sprain of unspecied ligament of right ankle – initial encounter
S93.401D Sprain of unspecied ligament of right ankle – subsequent encounter
S93.401S Sprain of unspecied ligament of right ankle – sequela
S93.402A Sprain of unspecied ligament of left ankle – initial encounter
S93.402D Sprain of unspecied ligament of left ankle – subsequent encounter
S93.402S Sprain of unspecied ligament of left ankle – sequela
S93.409A Sprain of unspecied ligament of unspecied ankle – initial encounter
S93.409D Sprain of unspecied ligament of unspecied ankle - subsequent encounter
S93.409S Sprain of unspecied ligament of unspecied ankle – sequela
S93.412D Sprain of calcaneobular ligament of left ankle – subsequent encounter
S93.412S Sprain of calcaneobular ligament of left ankle – sequela
S93.419A Sprain of calcaneobular ligament of unspecied ankle – initial encounter
S93.419D Sprain of calcaneobular ligament of unspecied ankle – subsequent encounter
S93.419S Sprain of calcaneobular ligament of unspecied ankle
S93.431A Sprain of tibiobular ligament of right ankle – initial encounter
S93.431D Sprain of tibiobular ligament of right ankle – subsequent encounter
S93.431S Sprain of tibiobular ligament of right ankle – sequela
S93.432A Sprain of tibiobular ligament of left ankle – initial encounter
S93.432D Sprain of tibiobular ligament of left ankle – subsequent encounter
S93.432S Sprain of tibiobular ligament of left ankle – sequela
S93.439A Sprain of tibiobular ligament of unspecied ankle – initial encounter
S93.439D Sprain of tibiobular ligament of unspecied ankle – subsequent encounter
S93.439S Sprain of tibiobular ligament of unspecied ankle – sequela
S93.491A Sprain of other ligament of right ankle (Internal collateral/ talobular) initial encounter
S93.491D Sprain of other ligament of right ankle (Internal collateral/ talobular) subsequent encounter
S93.491S Sprain of other ligament of right ankle (Internal collateral/ talobular) sequela
S93.492A Sprain of other ligament of left ankle, initial encounter
S93.492D Sprain of other ligament of left ankle subsequent encounter
S93.492S Sprain of other ligament of left ankle sequela
S93.499A Sprain of other ligament of unspecied ankle initial encounter
S93.499D Sprain of other ligament of unspecied ankle subs encounter
S93.499S Sprain of other ligament of unspecied ankle (Internal collateral/talobular) sequela
S96.211A Strain of intrinsic muscle and tendon at right ankle and foot level initial encounter
S96.211D Strain of intrinsic muscle and tendon at right ankle and foot level subsequent encounter
S96.211S Strain of intrinsic muscle and tendon at right ankle and foot level sequela
S96.212A Strain of intrinsic muscle and tendon at left ankle and foot level initial encounter
S96.212D Strain of intrinsic muscle and tendon at left ankle and foot level subsequent encounter
S96.212S Strain of intrinsic muscle and tendon at left ankle and foot level sequela
S96.219A Strain of intrinsic muscle and tendon at ankle and foot level, unspecied side initial encounter
S96.219D Strain of intrinsic muscle and tendon at ankle and foot level, unspecied side subs encounter
S96.219S Strain of intrinsic muscle and tendon at ankle and foot level, unspecied side
S96.811A Strain of other muscles and tendons at right ankle and foot level initial encounter
S96.811D Strain of other muscles and tendons at right ankle and foot level subsequent encounter
S96.811S Strain of other muscles and tendons at right ankle and foot level sequela
S96.812A Strain of other muscles and tendons at left ankle and foot level initial encounter
S96.812D Strain of other muscles and tendons at left ankle and foot level subsequent encounter
S96.812S Strain of other muscles and tendons at left ankle and foot level sequela
S96.819A Strain of other muscles and tendons at ankle and foot level, unspecied side initial encounter
S96.819D Strain of other muscles and tendons at ankle and foot level, unspecied side subs encounter
S96.819S Strain of other muscles and tendons at ankle and foot level, unspecied side sequela
S96.911A Strain of unspecied muscle and tendon at right ankle and foot level initial encounter
S96.911D Strain of unspecied muscle and tendon at right ankle and foot level subs encounter
S96.911S Strain of unspecied muscle and tendon at right ankle and foot level sequela
S96.912A Strain of unspecied muscle and tendon at left ankle and foot level initial encounter
S96.912D Strain of unspecied muscle and tendon at left ankle and foot level subs encounter
S96.912S Strain of unspecied muscle and tendon at left ankle and foot level sequela
S96.919A Strain of unspecied muscle and tendon at ankle and foot level, unspec. side initial encounter
S96.919D Strain of unspecied muscle and tendon at ankle and foot level, unspec. side subs encounter
S96.919S Strain of unspecied muscle and tendon at ankle and foot level, unspec. side sequela

CONVERGENCE : DIAGNOSIS CODE and SEMANTIC INTEROPERABILITY ?

ICD-9

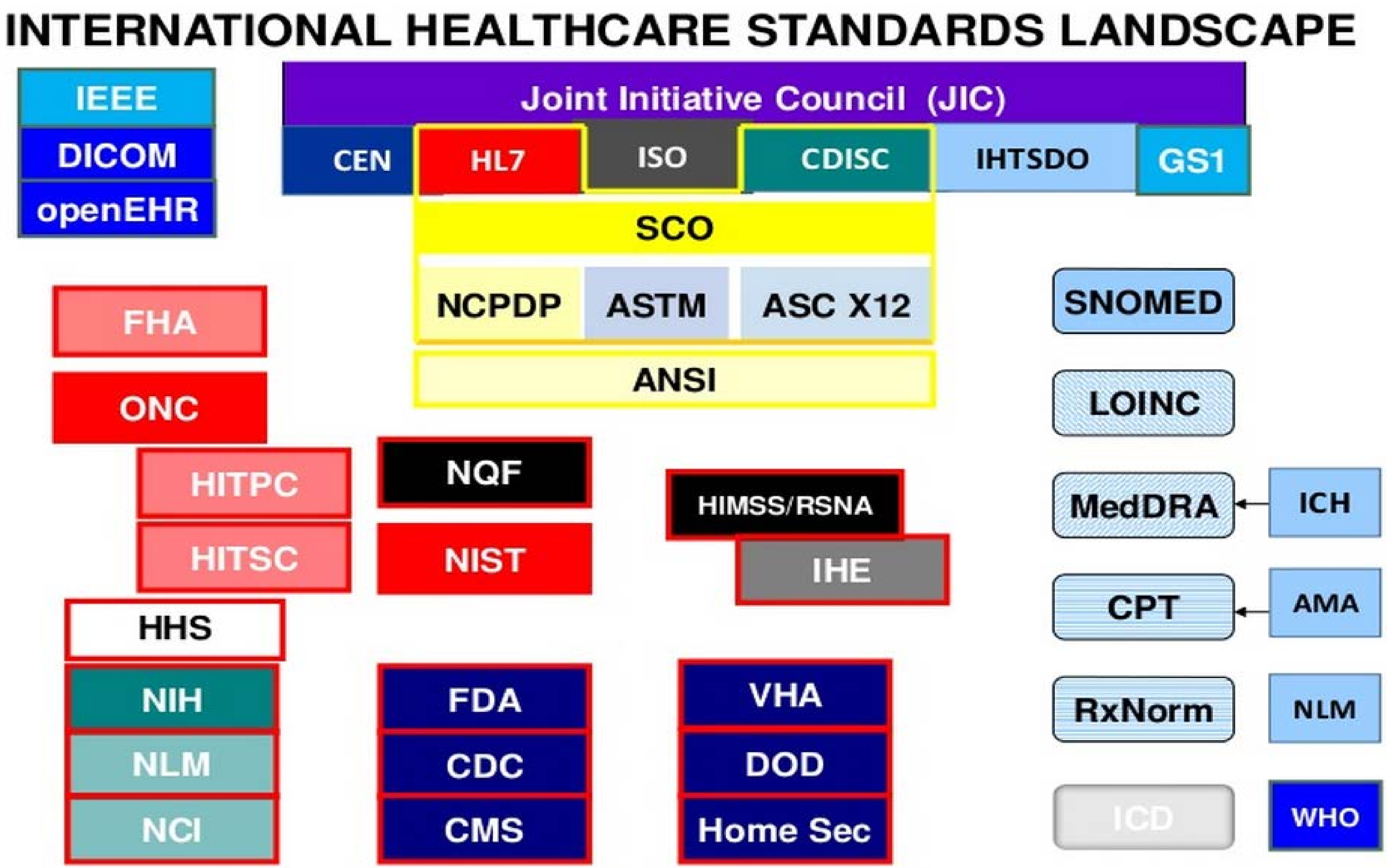
845.00 Sprain and strain of ankle unspecied site
845.01 Sprain and strain of ankle, Deltoid ligament/ Internal collateral ligament
845.02 Sprain and strain of ankle, Calcaneobular (ligament)
845.03 Sprain and strain of ankle, Tibiobular (ligament) distal

ICD-10

S93.401A Sprain of unspecied ligament of right ankle – initial encounter
S93.401D Sprain of unspecied ligament of right ankle – subsequent encounter
S93.401S Sprain of unspecied ligament of right ankle – sequela
S93.402A Sprain of unspecied ligament of left ankle – initial encounter
S93.402D Sprain of unspecied ligament of left ankle – subsequent encounter
S93.402S Sprain of unspecied ligament of left ankle – sequela
S93.409A Sprain of unspecied ligament of unspecied ankle – initial encounter
S93.409D Sprain of unspecied ligament of unspecied ankle - subsequent encounter
S93.409S Sprain of unspecied ligament of unspecied ankle – sequela
S93.412D Sprain of calcaneobular ligament of left ankle – subsequent encounter
S93.412S Sprain of calcaneobular ligament of left ankle – sequela
S93.419A Sprain of calcaneobular ligament of unspecied ankle – initial encounter

Proprietary closed semantic data dictionaries (EPIC) and heterogeneity of billing codes are contributors to lack of semantic interoperability and inhibitor for OS platforms

Barriers to Interoperability – Role of Ontology and Semantics in the Healthcare Standards Landscape



Interoperability between systems

Many more systems to come …

Sensor enabled wearables - appropriate attributes may improve prevention, prediction and protection

Hands-Free
- Voice / gesture control

Always-On
- Low power consumption
- Instant wake
- Background working / sensing

Environment-Aware
- GPS
- Accelerometer
- Compass
- Camera
- Microphone
- Other Sensors

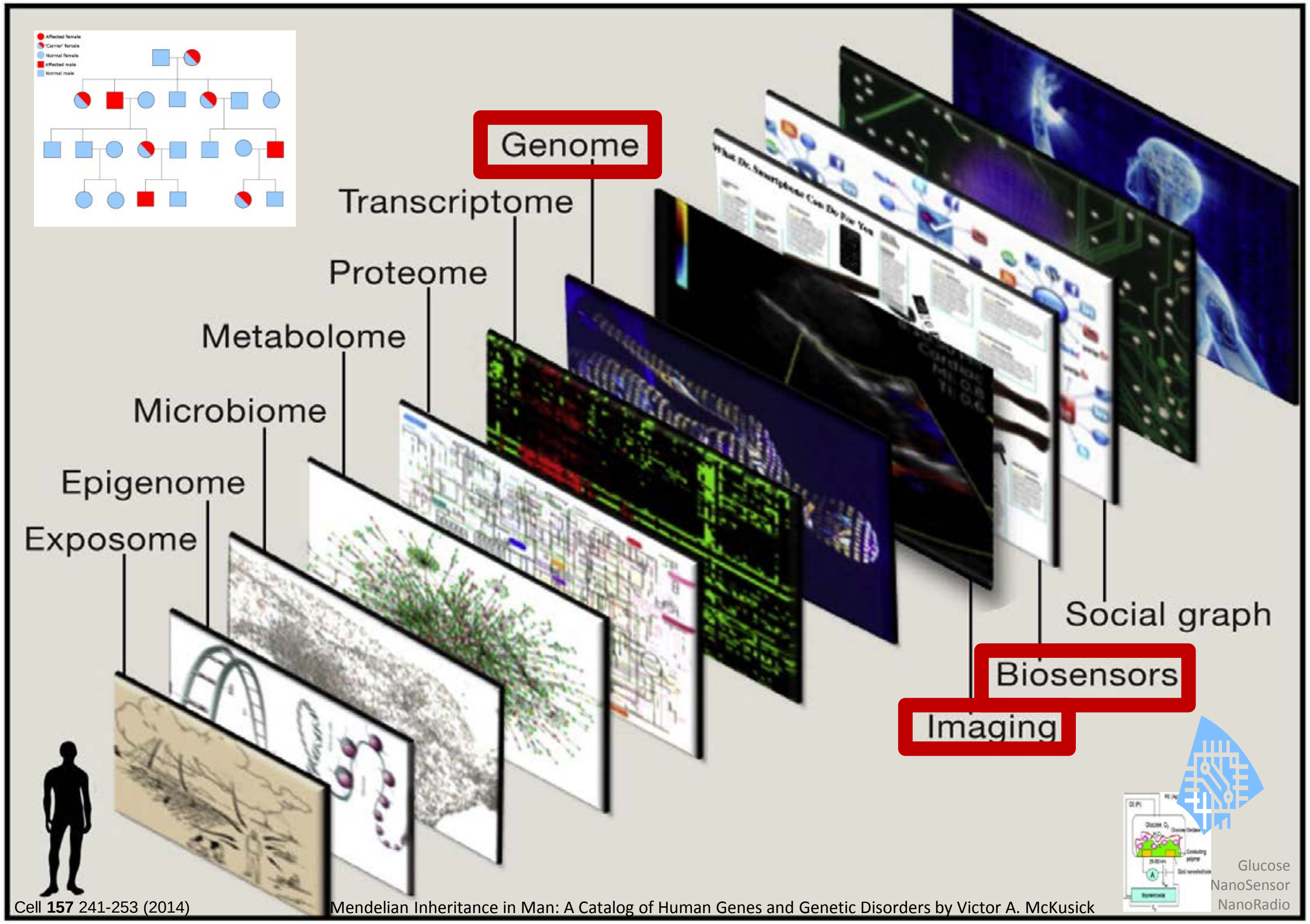
Connected
- Wi-Fi
- 3G / 4G
- Bluetooth
- NFC

Attention-Getting
- Less distracting when receiving alerts / reminders / messages

Development Platform
- 3rd party apps
- API partners
- Accessories

MIT

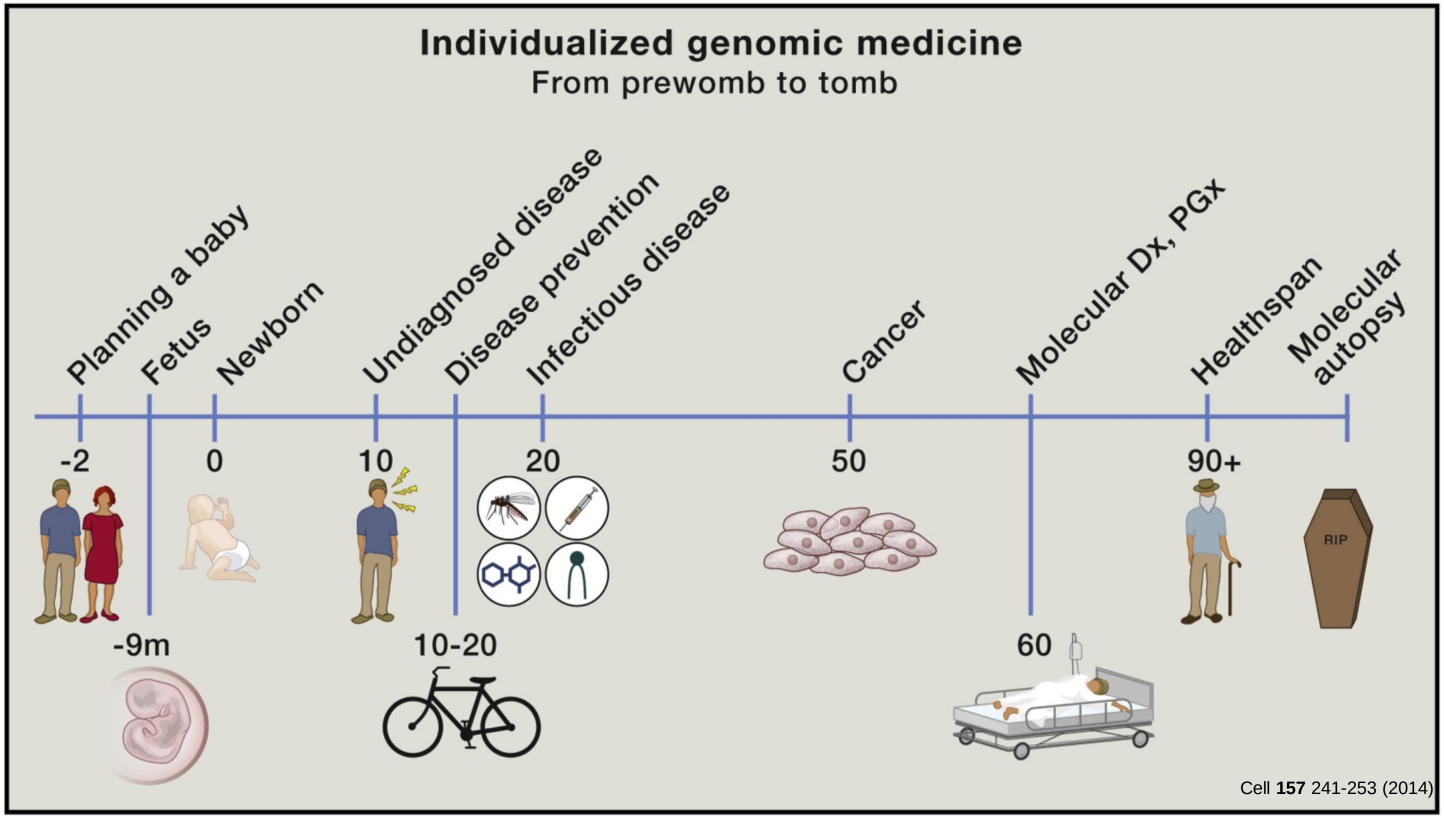
Human Genomics in the IoS era – is your genome connected to mine?



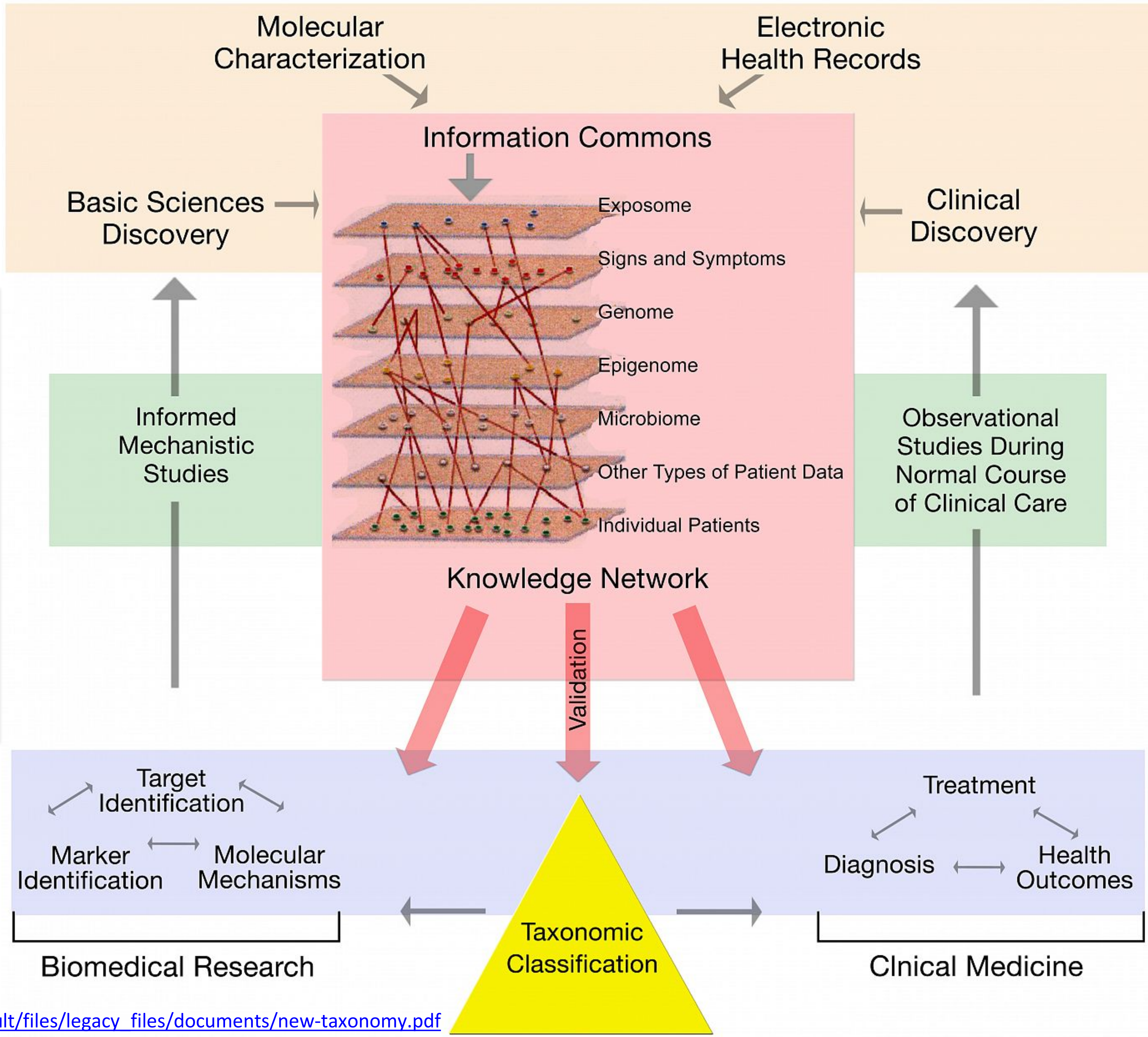
Cell **157** 241-253 (2014)

Mendelian Inheritance in Man: A Catalog of Human Genes and Genetic Disorders by Victor A. McKusick

Human Genomics in Precision Medicine



How do we integrate data from these systems with open source healthcare platform?



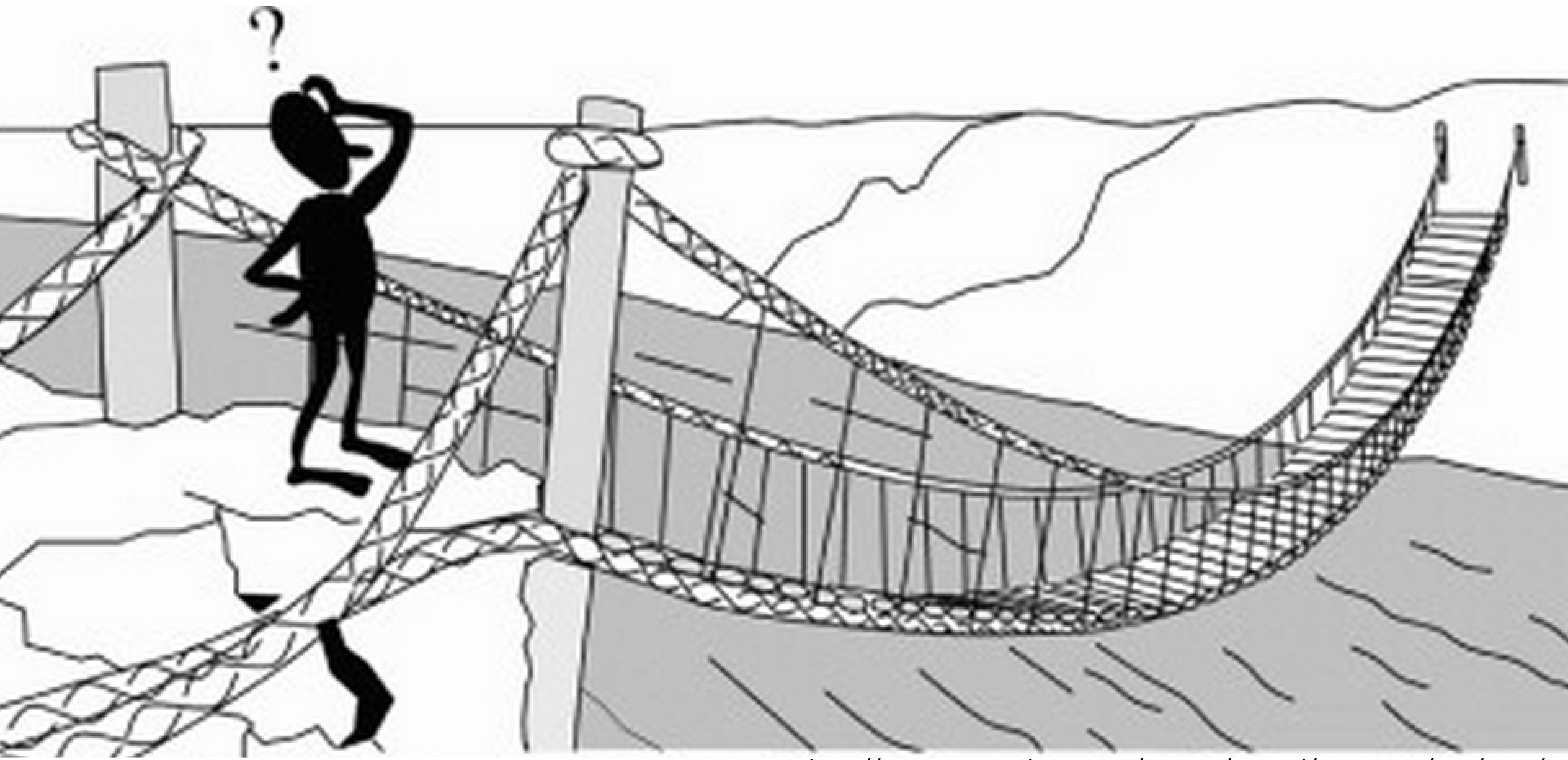
www.ucsf.edu/sites/default/files/legacy_files/documents/new-taxonomy.pdf

Healthcare
Integrated
Intelligent
Platforms

[Build bridges to create secure healthcare data platforms?]

The complexity of healthcare is inextricably linked with regulatory compliance, security and privacy. The top down approach to create interoperable systems may be short of impossible but the bottom up approach to create bridges for data interoperability may help vendors continue with their system sales but enables practitioners to use the data, via open platforms, effectively.

Handrails – Constraints or Opportunities to Cross the River



http://www.sciencedirect.com/science/journal/03032647/123/supp/C

ANALYTICS

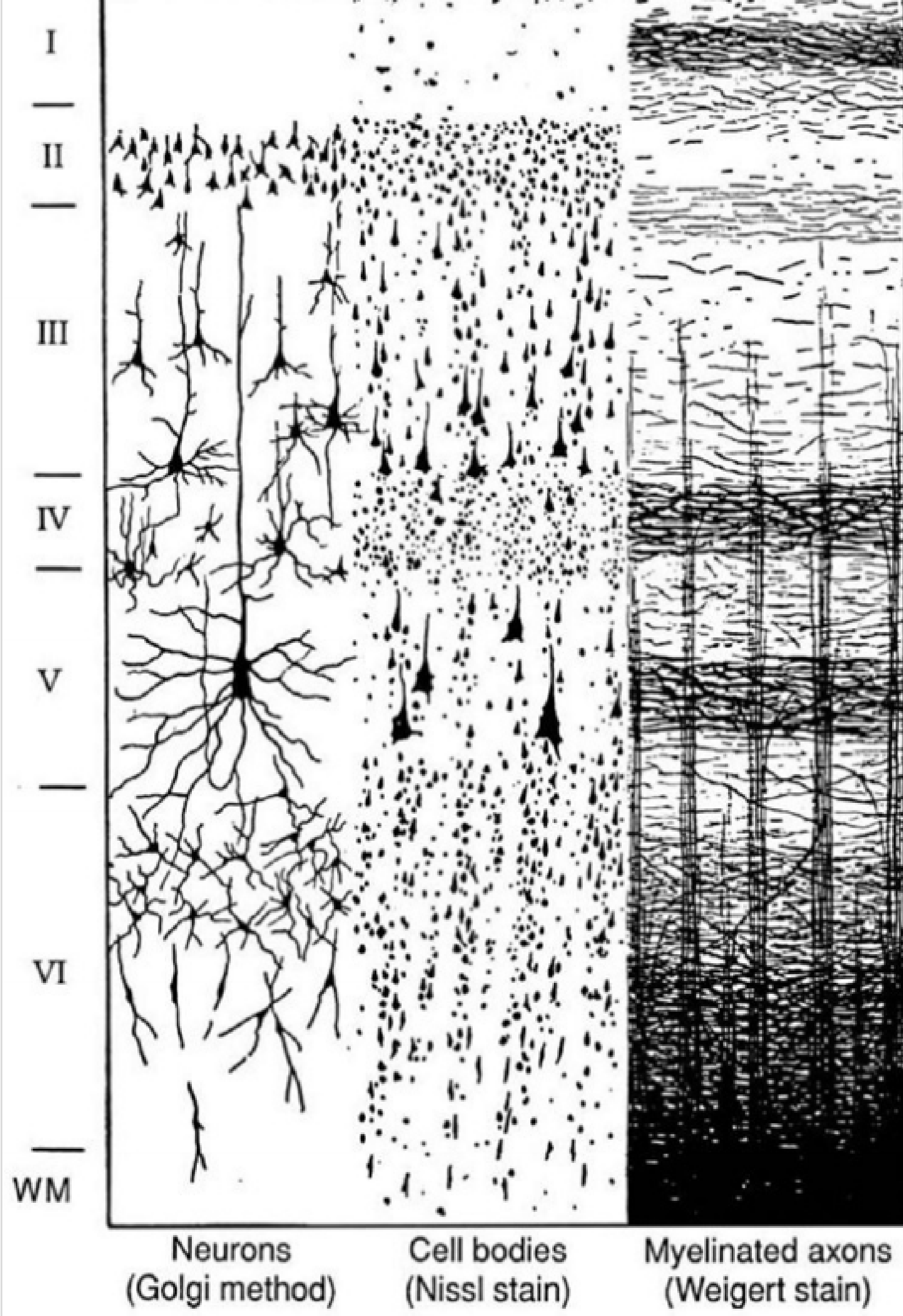
Think and Connect like a Neuron

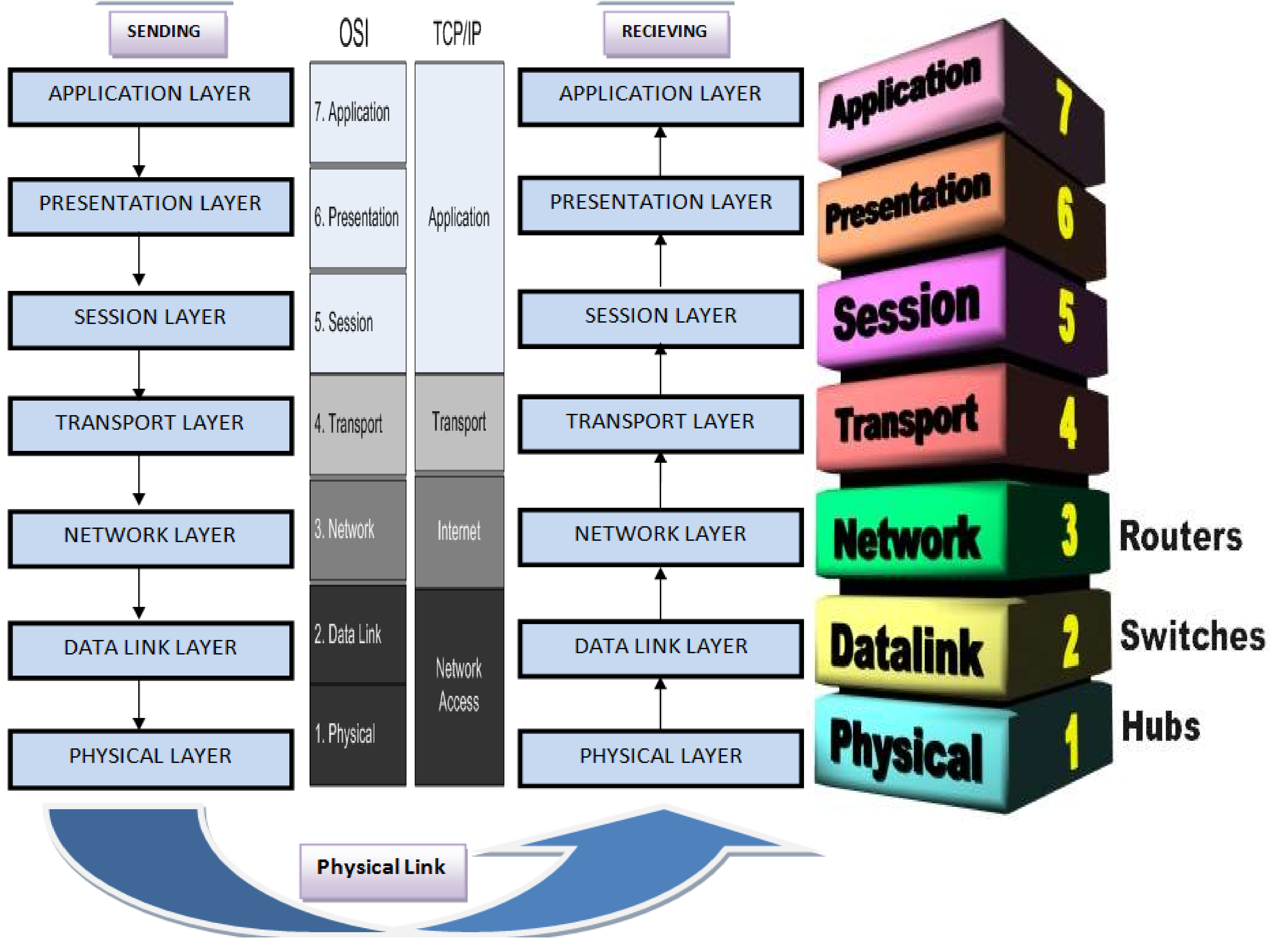
Extracting value from data to generate information

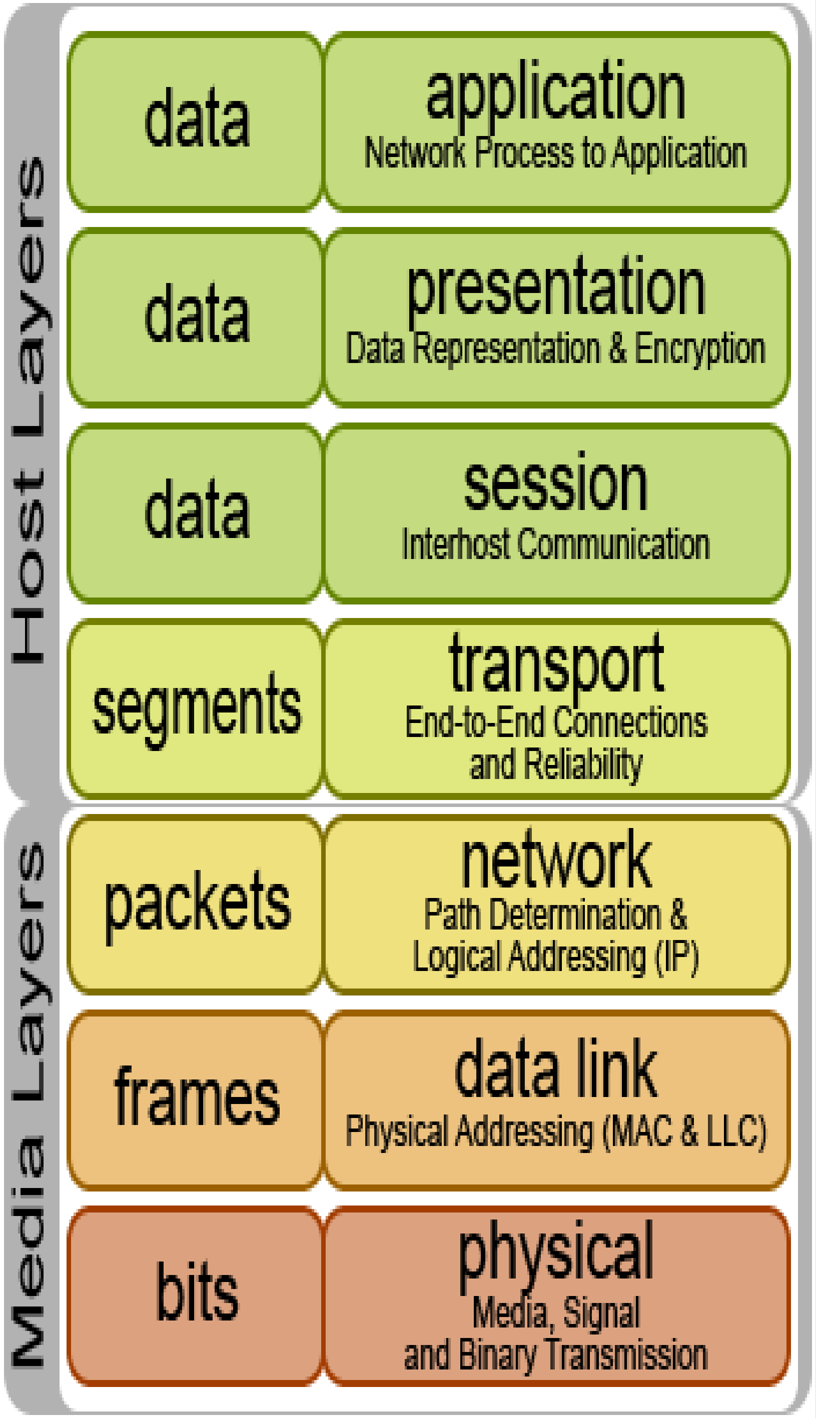
Santiago Ramón y Cajal

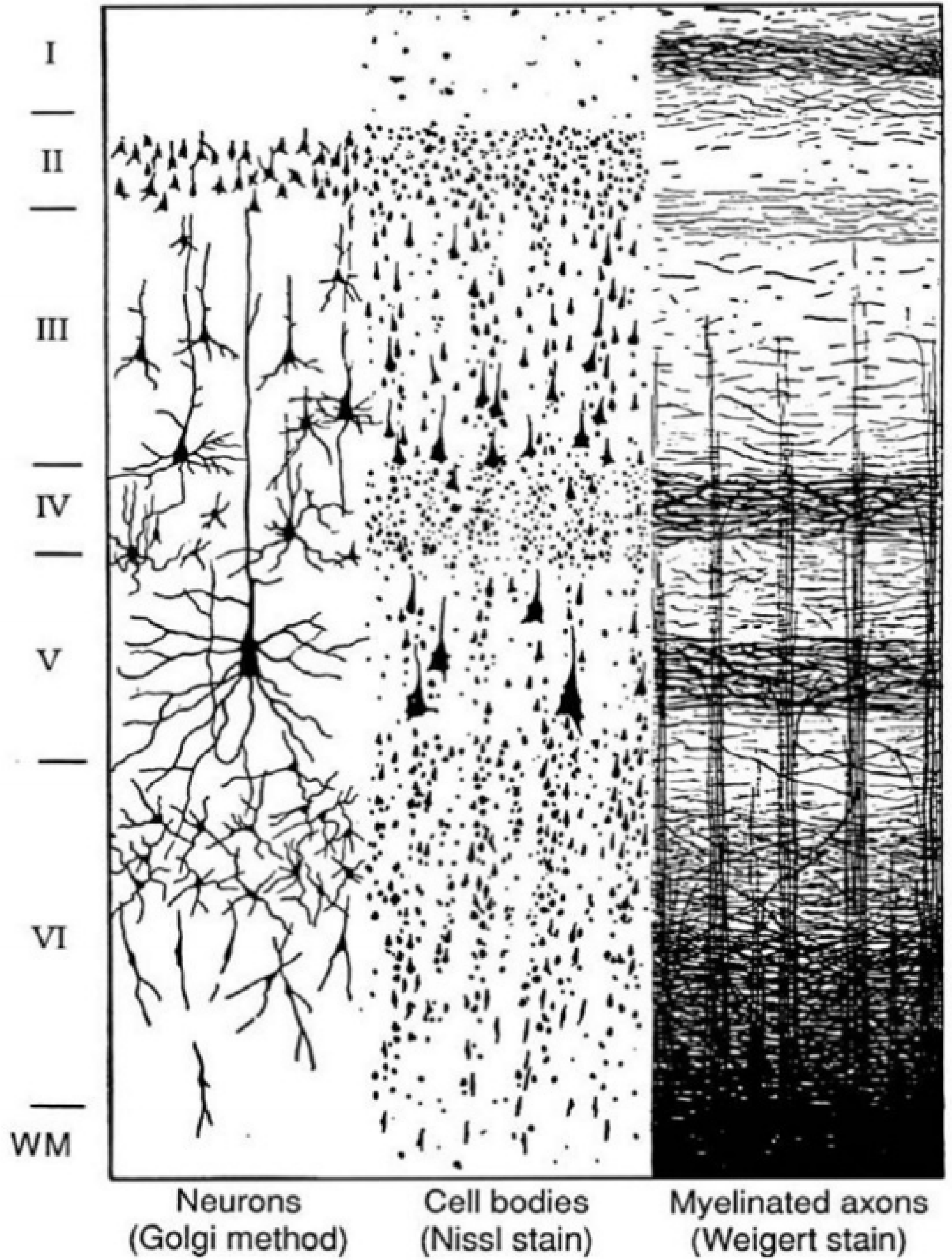
Slice of neo-cortex, as identified by Cajal. Every cubic mm contains about 100,000 neurons and 2-4 km of axons and dendrites. Layers I-VII on the right = 2mm vertical distance.

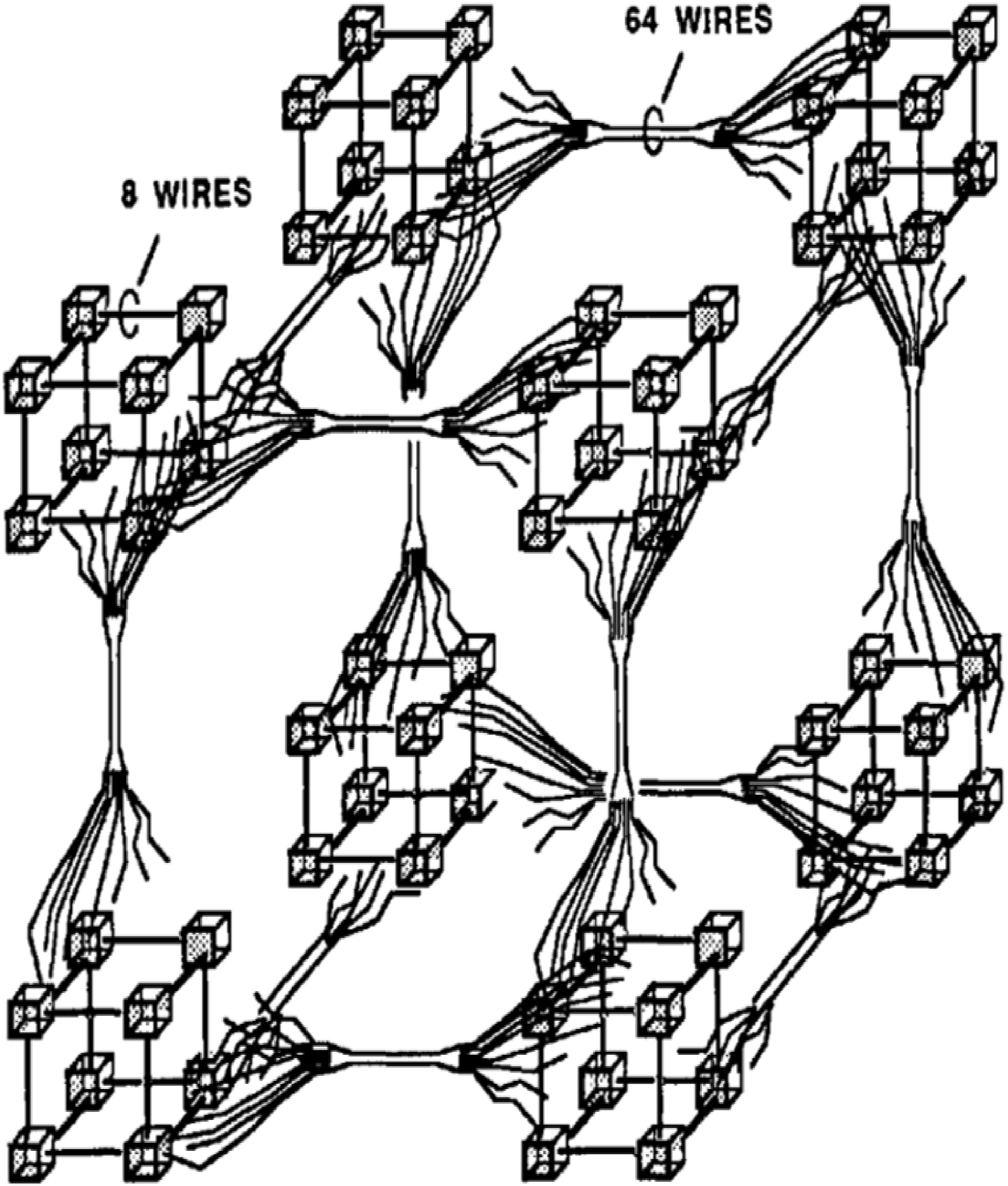
Born	1 May 1852 [Petilla de Aragón](), [Navarre](), [Spain]()
Died	18 October 1934 (aged 82) [Madrid](), [Spain]()




SENDING
OSI
TCP/IP
RECIEVING
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data Link
1. Physical
Application
Transport
Internet
Network Access
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
Application 7
Presentation 6
Session 5
Transport 4
Network 3 Routers
Datalink 2 Switches
Physical 1 Hubs
Physical Link


Host Layers
data
application
Network Process to Application
data
presentation
Data Representation & Encryption
data
session
Interhost Communication
segments
transport
End-to-End Connections and Reliability
Media Layers
packets
network
Path Determination & Logical Addressing (IP)
frames
data link
Physical Addressing (MAC & LLC)
bits
physical
Media, Signal and Binary Transmission


I
II
III
IV
V
VI
WM
Neurons (Golgi method)
Cell bodies (Nissl stain)
Myelinated axons (Weigert stain)



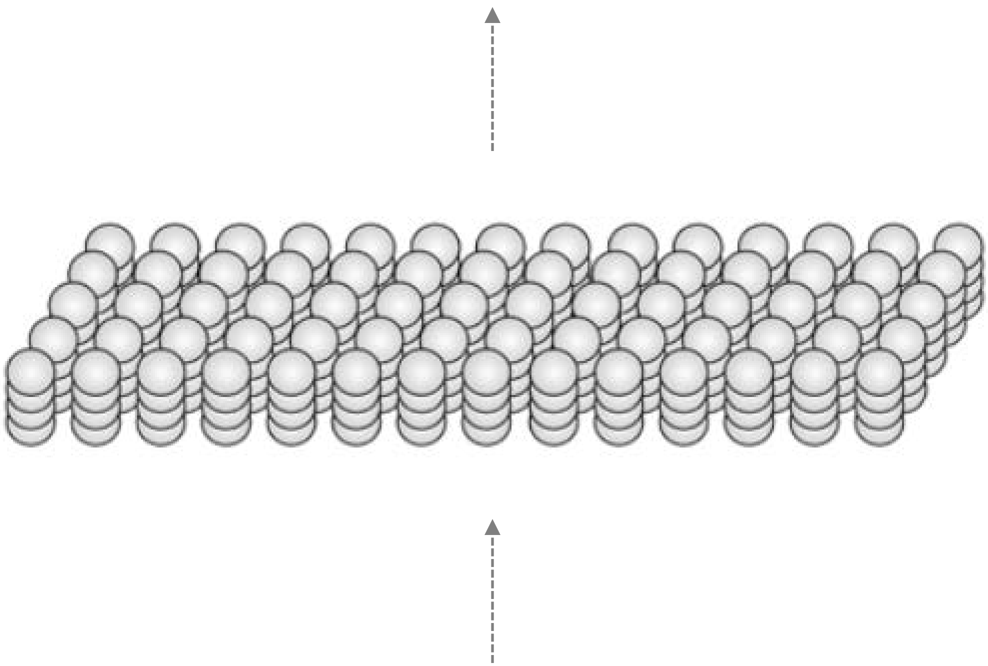
Here, 8 agents make a little cube, and 8 such cubes make a 64-agent supercube.

If we join 8 of these supercubes, we'll have 512 agents. And if we repeat this cube-on-cube pattern ten times, the resulting supercube will contain a billion agents!

But if we link each agent to 30 others instead of only 6, then each agent could communicate with a billion others in only 6 steps.

THE SOCIETY OF MIND
Marvin Minsky (1959)

Hierarchical Temporal Memory (HTM), a form of ANN



Section of a HTM region, equivalent to 1 layer of neurons in the neocortical region (layer 3). Each 4-cell column connects to a subset of the input and each cell connects to other cells in the region (connections are not shown). The principle of this connectivity was abstracted in Minsky's cube-on-cube.

Numenta

HTM (CLA) attributes include time and context – essential for many CPS (cyberphysical systems) applications and data analytics (context)

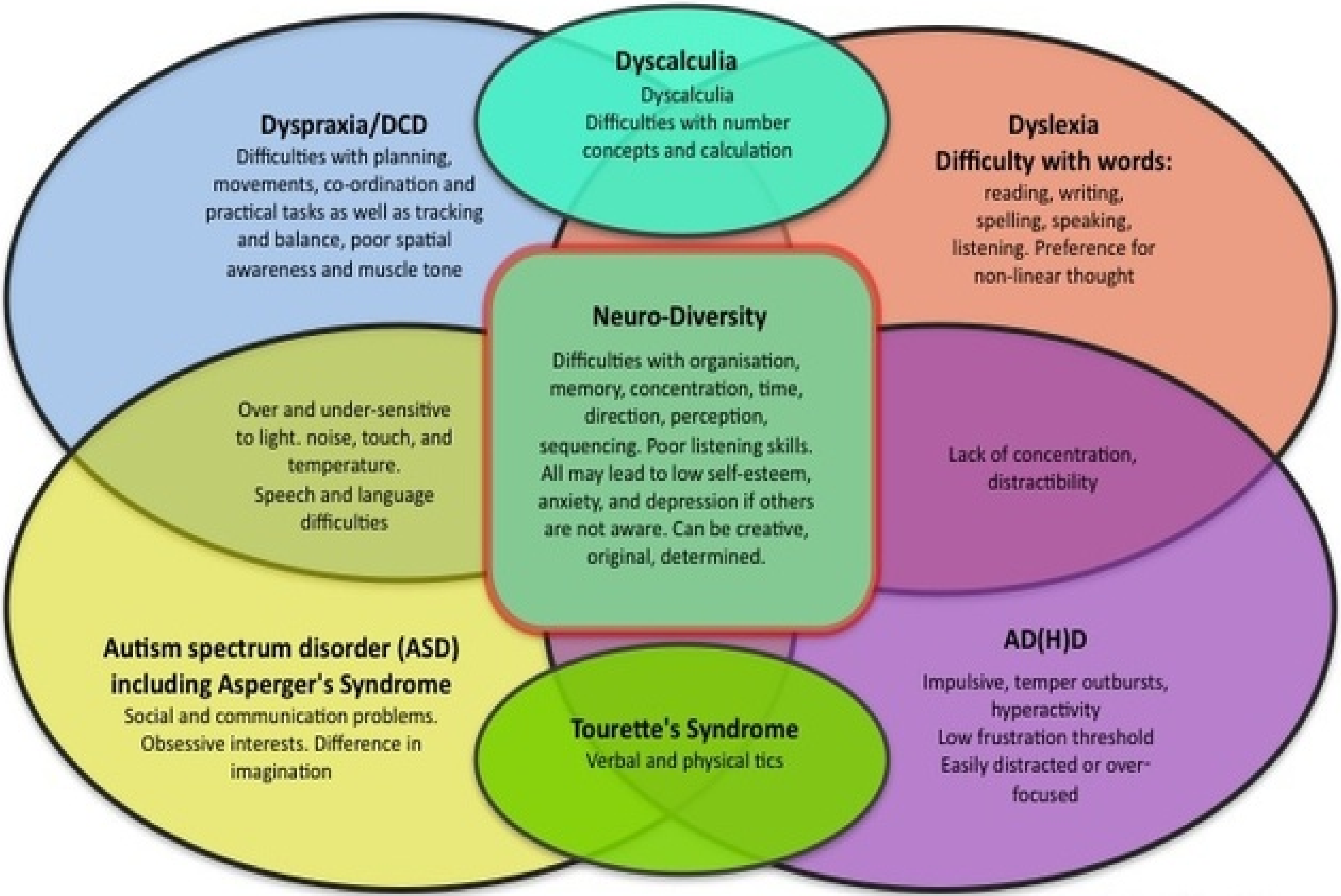
Hierarchical Temporal Memory (HTM) is a machine learning tool to capture the structural and algorithmic properties of the neocortex which is the seat of intelligent thought in the mammalian brain. High level vision, hearing, touch, movement, language and planning are performed by the neocortex. Given such a diverse suite of cognitive functions, the neocortex may be expected to implement an equally diverse suite of specialized neural algorithms. In reality, the neocortex displays a remarkably uniform pattern of neural circuitry. In other words, the neocortex implements a common set of algorithms to perform many different intelligence functions. It may be analogous to an abstraction which is used in a systemic context.

Programming HTM cortical learning algorithms require training through exposure to a stream of sensory data (capabilities are determined largely by exposure). HTM is a memory based ANN system. HTM networks are trained on time varying data and rely on storing a large set of patterns and sequences. A crucial distinction of HTM is embedded in the semantics of time which is an important element in applications relating to cyberphysical systems (CPS). Classic computer memory has a flat organization and does not have an inherent notion of time because the semantics of time are not available in the ISA (instruction set architecture). Therefore, in the classical programming environment, we can implement any kind of data organization and structure on top of the flat computer memory and control how and where information is stored.

HTM memory is more restrictive. HTM memory has a hierarchical organization and is inherently time based. Information is always stored in a distributed fashion. HTM user is expected to specify the size of the hierarchy and what to train the system on but the HTM controls where and how information is stored (data, patterns, text, sequences). Hence, HTMs are learning and prediction machines that can be applied to many types of problems through the inherent abstractions in the system. Although an HTM region is equivalent to only one portion of a neocortical region (layer 3), it can perform inference and prediction on complex data streams. Hence the significance of HTMs in data analytics in multiple domains or verticals.

Although neurons in the neocortex are highly interconnected, inhibitory neurons guarantee that only a small percentage of the neurons are active at one time. Thus, information in the brain is always represented by a small percentage of active neurons within a large population of neurons. This kind of encoding is called a "sparse distributed representation" where a small percentage of neurons are active at one time. "Distributed" refers to the characteristic that the activation of many neurons are required in order to represent something. A single active neuron conveys some meaning but it must be interpreted within the context of a population of neurons to convey the full or complete meaning relevant to the context.

Understanding the neurological basis of certain anomalies provides clues to information/data processing



Created by Mary Colley

Neurons connect to process data and information using the mechanism of pattern recognition as a tool

Syntactic Web

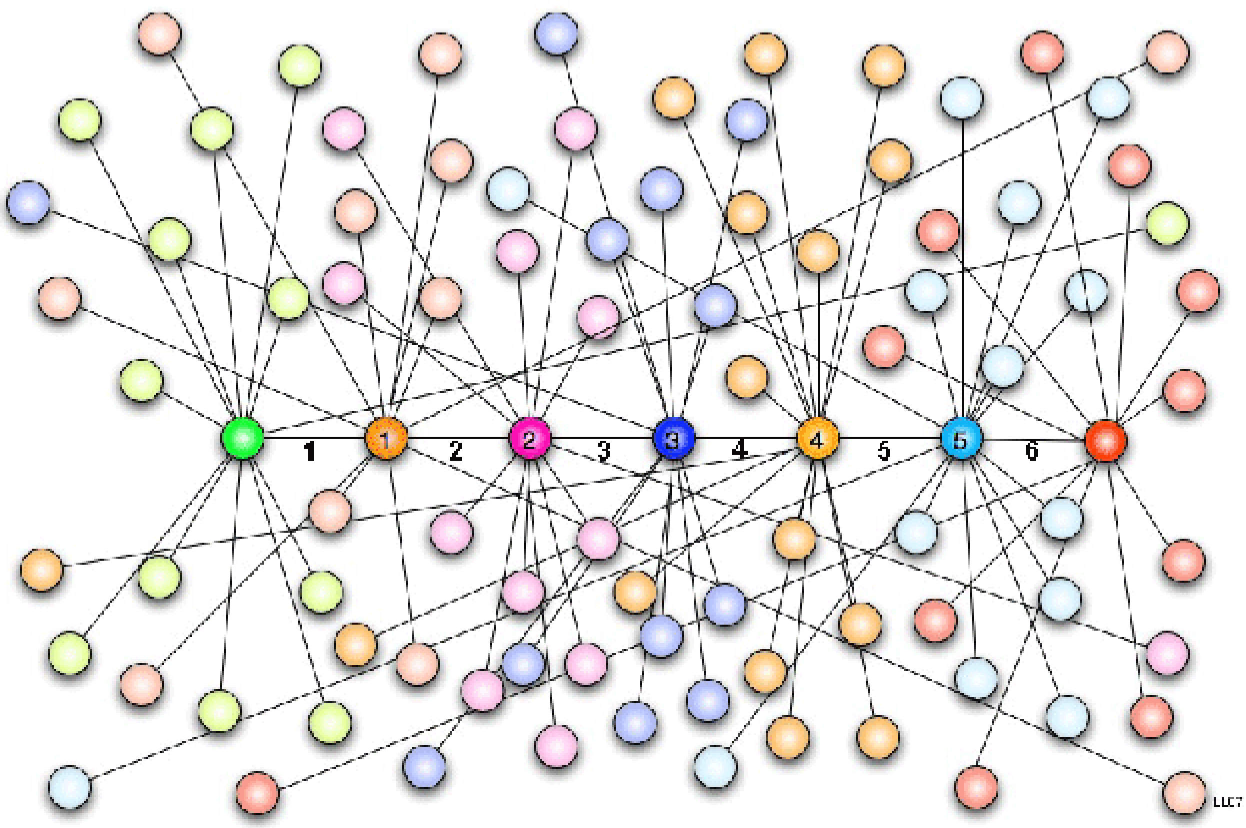
Semantic Web

Synapses can connect, converge and coalesce data from various regions to generate the precise response

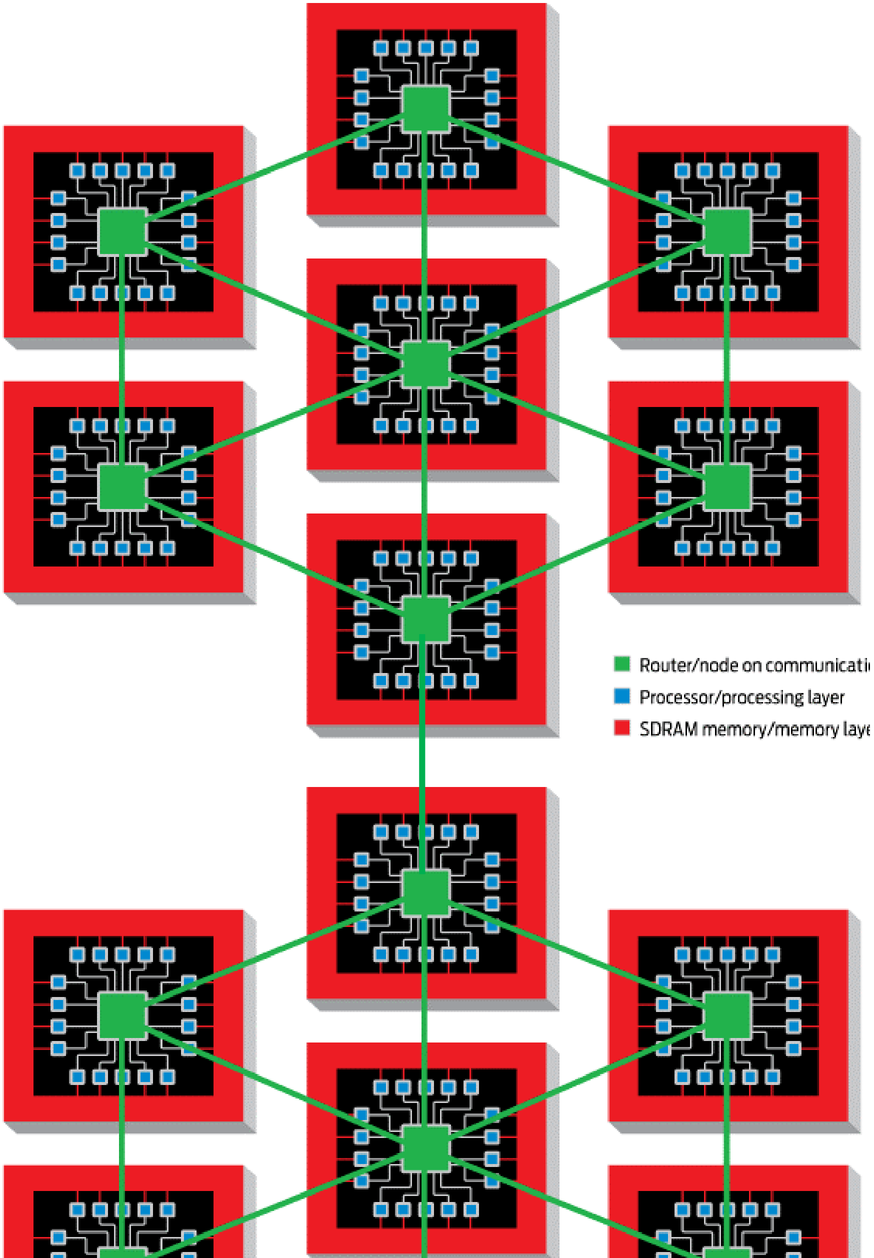
Syntactic Web

Semantic Web

Synaptic Web

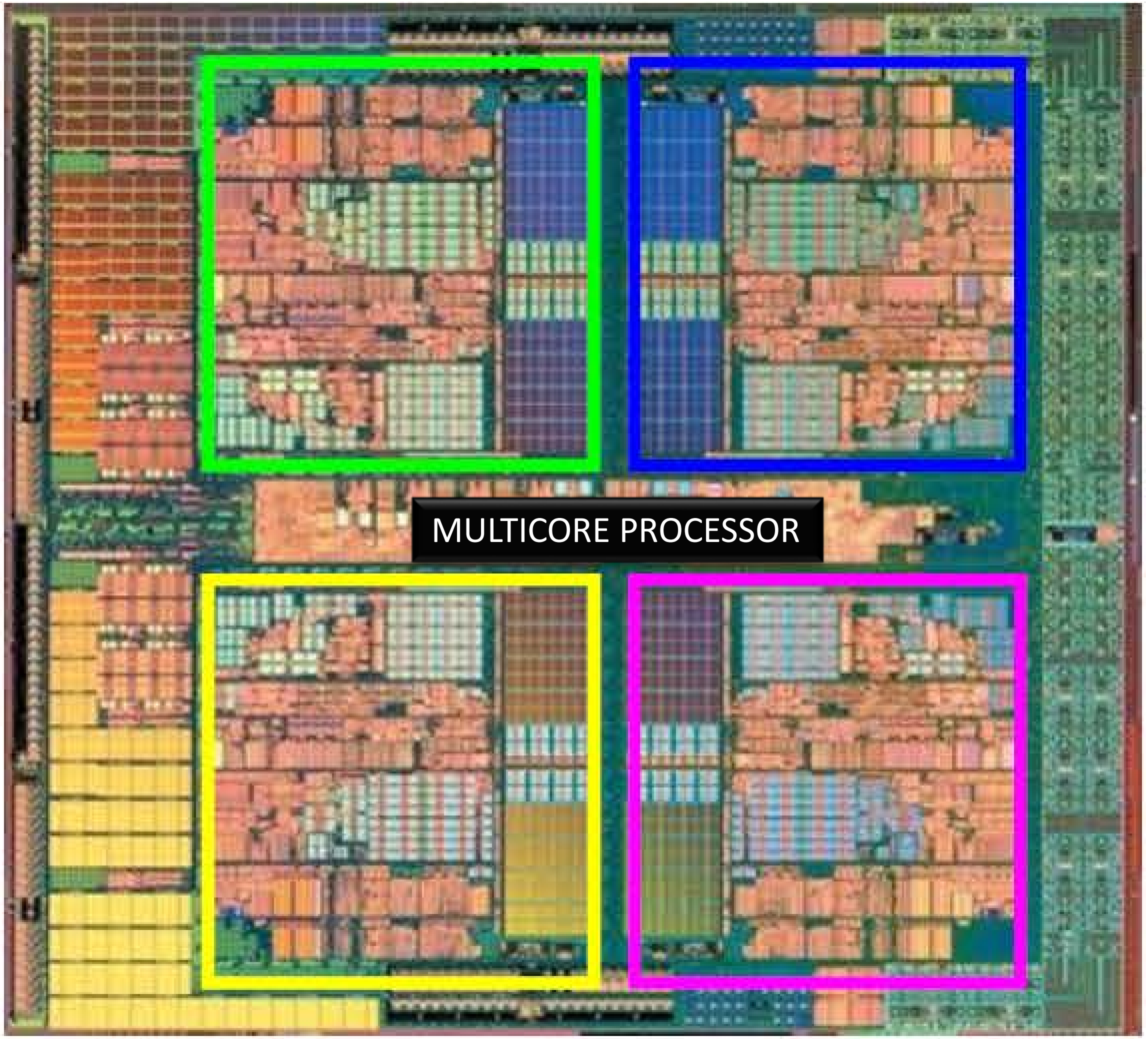


Neuro-Synaptic Chips & Multi-core platforms for parallel processing of noisy, multi-modal, unstructured data



Multi-Core Analytical Platforms

Data Driven
Anomaly Detection



Model Based
Fault Detection

Software Monitors
FDI Supervisor

Control Algorithms
Signal Processing

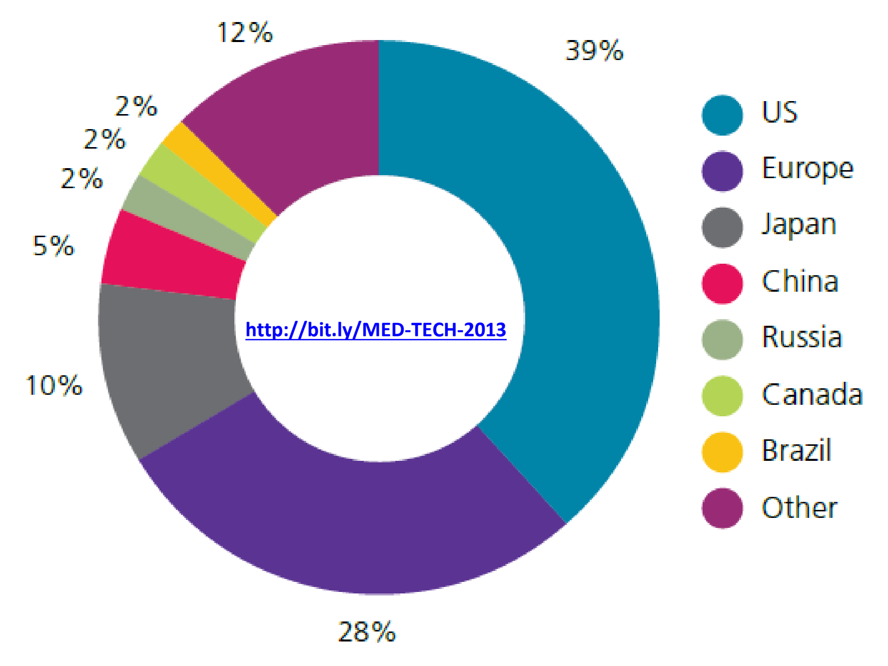
Perimeter - Distributed API for data ● Core - holds matrix of questions

Devices will generate data

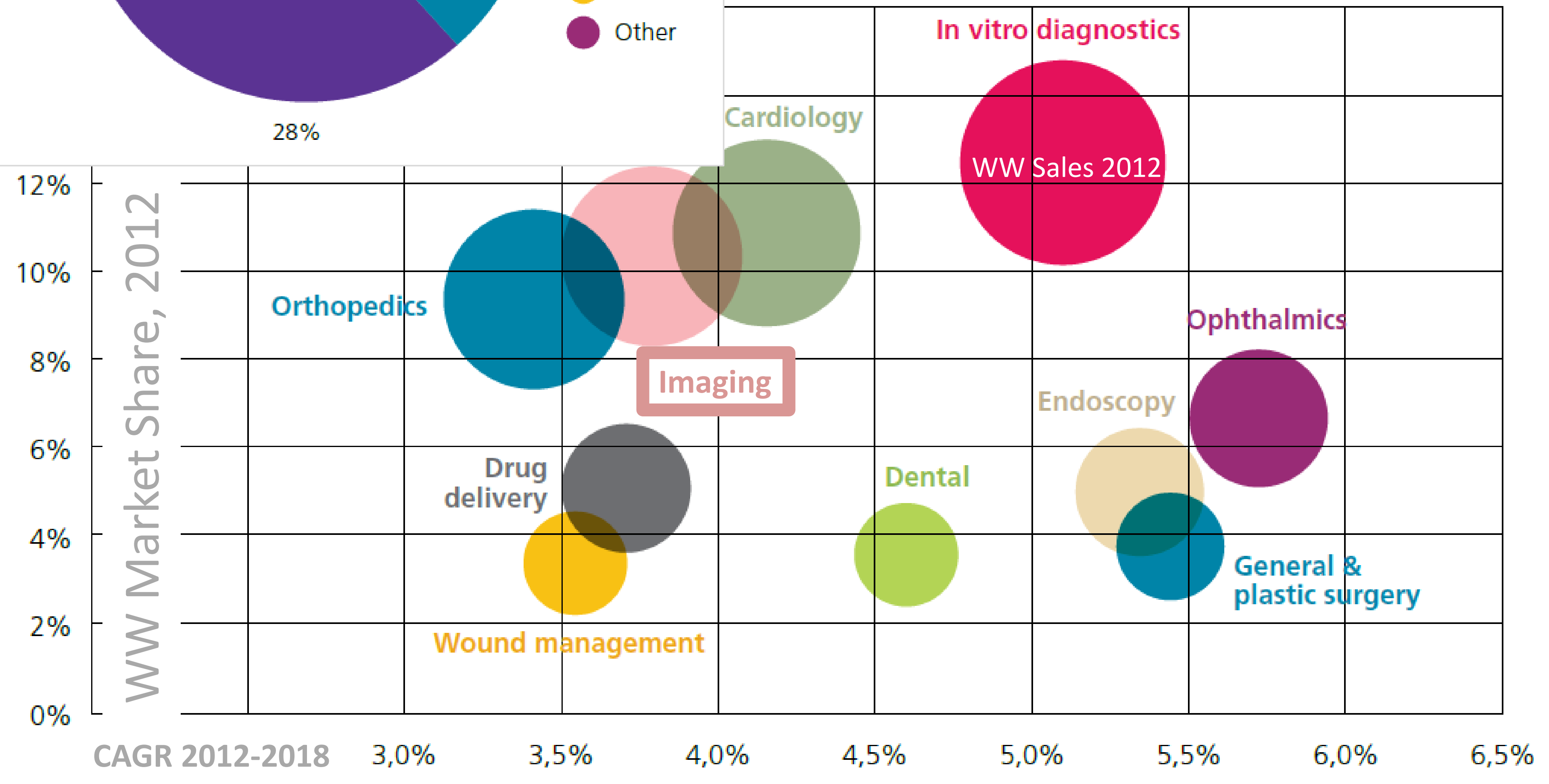
Healthcare Platform

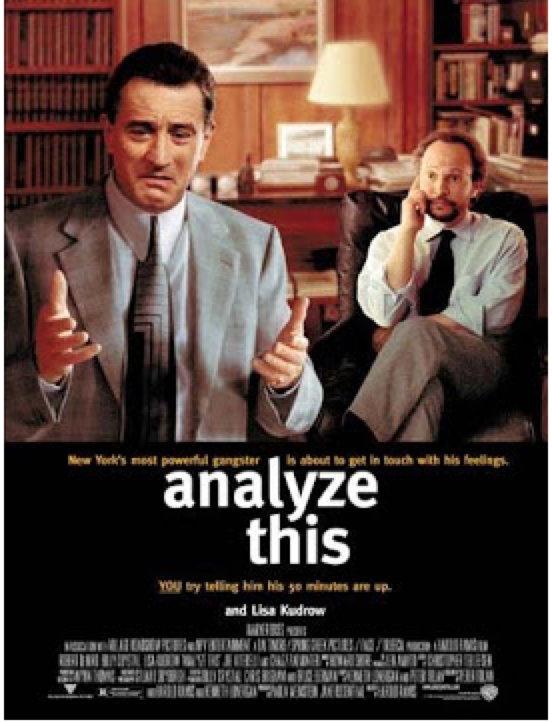
Global Top 40 Medical Device Manufacturers

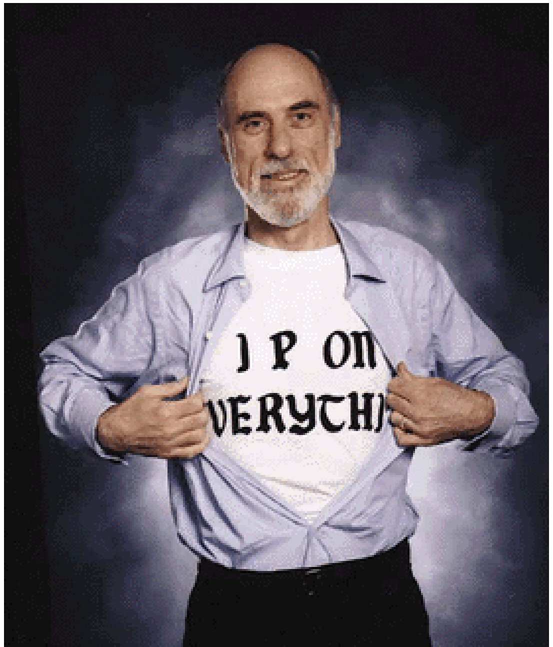
2014			Revenue	MKT CAP
1	Johnson & Johnson	NYSE: JNJ	$28.7 billion	$294.2 billion
2	General Electric Co.	NYSE:GE	$18.1 billion	$243.6 billion
3	Medtronic Inc.	NYSE:MDT	$17.1 billion	$61.2 billion
4	Siemens AG	DB:SIE	$17.0 billion	$92.2 billion
5	Baxter International Inc.	NYSE:BAX	$16.4 billion	$38.7 billion
6	Fresenius Medical Care AG & Co. KGAA	DB:FME	$15.2 billion	$21.1 billion
7	Koninklijke Philips NV	ENXTAM:PHIA	$11.8 billion	$26.1 billion
8	Cardinal Health Inc.	NYSE:CAH	$11.0 billion	$25.1 billion
9	Novartis AG[1]	SWX:NOVN	$10.7 billion	$227.5 billion
10	Covidien plc	NYSE:COV	$10.4 billion	$40.1 billion
11	Stryker Corp.	NYSE:SYK	$9.3 billion	$30.8 billion
12	Becton, Dickinson and Co.	NYSE:BDX	$8.3 billion	$21.8 billion
13	Boston Scientific Corp.	NYSE:BSX	$7.2 billion	$15.6 billion
14	Essilor International SA	ENXTPA:EI	$7.2 billion	$22.9 billion
15	Allergan Inc.	NYSE:AGN	$6.7 billion	$53.4 billion
16	St. Jude Medical Inc.	NYSE:STJ	$5.6 billion	$17.2 billion
17	3M Co.	NYSE:MMM	$5.5 billion	$84.0 billion
18	Abbott Laboratories[2]	NYSE:ABT	$5.5 billion	$61.9 billion
19	Zimmer Holdings Inc.	NYSE:ZMH	$4.7 billion	$17.0 billion
20	Terumo Corp.	TSE:4543	$4.7 billion	$9.0 billion
21	Smith & Nephew plc	LSE: SN	$4.4 billion	$14.9 billion
22	Toshiba Corp.	TSE:6502	$3.9 billion	$17.6 billion
23	CareFusion Corp.	NYSE:CFN	$3.8 billion	$9.2 billion
24	Getinge AB	OM:GETI B	$3.8 billion	$6.0 billion
25	Olympus Corp.	TSE:7733 OTC: OCPNY	$3.7 billion	$11.7 billion
26	Bayer AG[3]	DB:BAYN	$3.2 billion	$115.0 billion
27	CR Bard Inc.	NYSE:BCR	$3.1 billion	$10.6 billion
28	Varian Medical Systems Inc.	NYSE:VAR	$3.0 billion	$8.3 billion
29	DENTSPLY International Inc.	NasdaqGS:XRAY	$3.0 billion	$6.4 billion
30	Ship Healthcare Holdings Inc.	TSE:3360	$2.5 billion	$1.3 billion
31	Paul Hartmann AG	DB:PHH2	$2.5 billion	$1.4 billion
32	Hologic Inc.	NasdaqGS:HOLX	$2.5 billion	$6.6 billion
33	Nipro Corp.[4]	TSE:8086	$2.3 billion	$1.4 billion
34	Coloplast A/S	CPSE:COLO B	$2.2 billion	$17.9 billion
35	Sonova Holdings	SWX:SOON	$2.2 billion	$10.4 billion
36	Danaher Corp.[5]	NYSE:DHR	$2.1 billion	$38.6 billion
37	Edwards Lifesciences	NYSE:EW	$2.1 billion	$11.0 billion
38	Intuitive Surgical Inc.	NasdaqGS:ISRG	$2.1 billion	$16.6 billion
39	MIRACA Holdings Inc.	TSE:4544	$2.0 billion	$2.4 billion
40	Dragerwerk AG & Co. KGa[6]	DB:DRW3	$2.0 billion	$1.4 billion



Global Medical Technology Product Market 2012



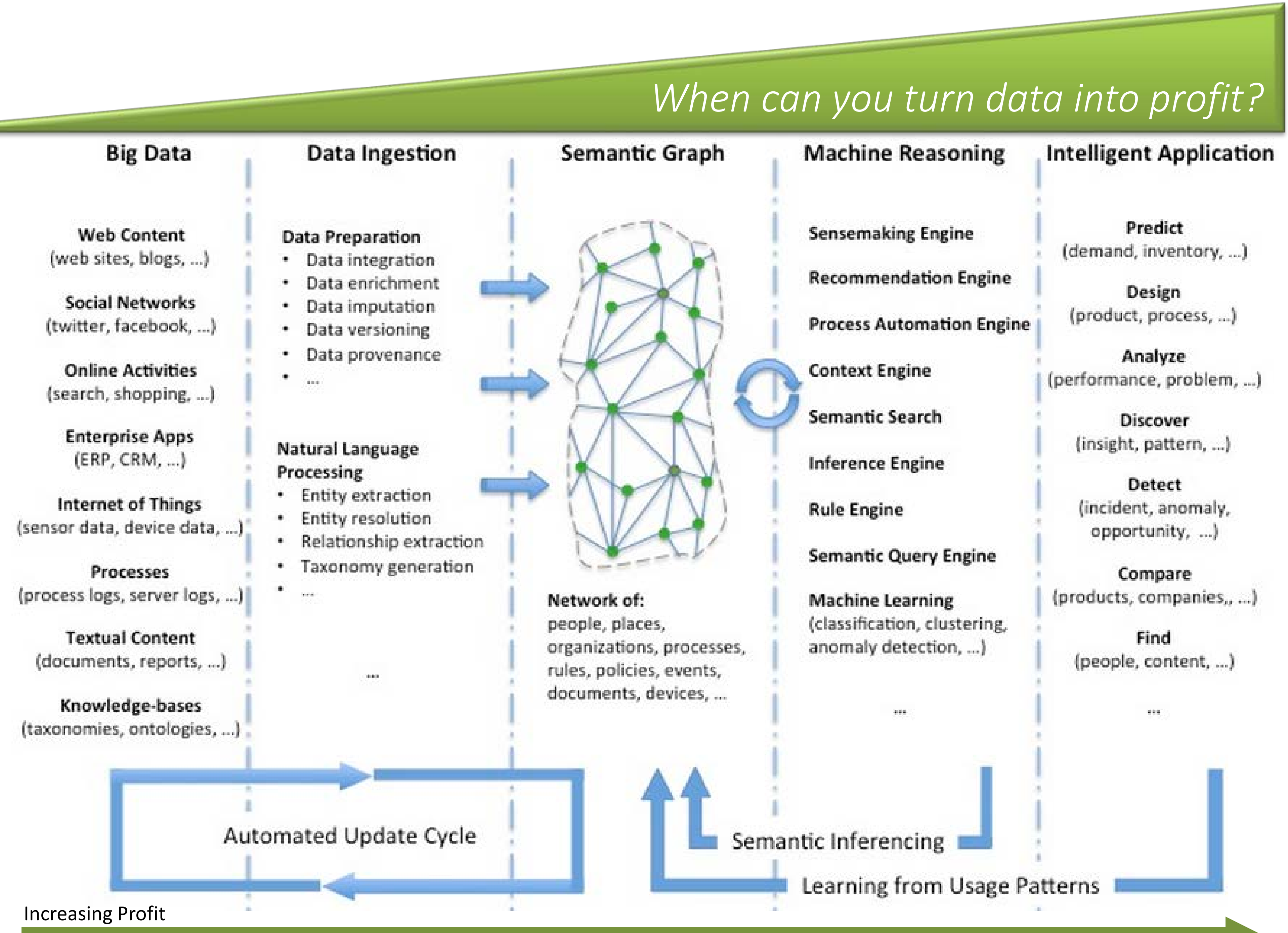




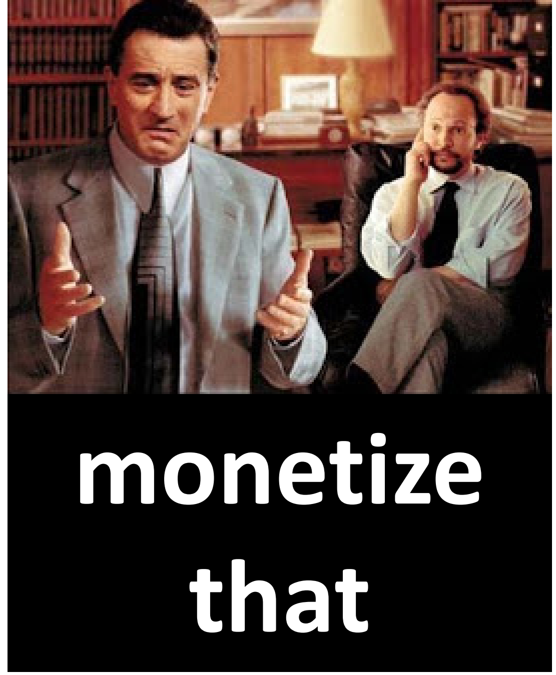
I pee on everything – Vint Cerf

How do you make sense of data?

When analytics can add value to applications



Cirrus Shakeri



PAY-PER-ANALYTICS

Samsung, UCSF Partner to Accelerate New Innovations in Preventive Health Technology

Pair Will Work to Validate Promising New Sensors and Analytics for Next-Generation Digital Health Solutions

02/21/2014

How deep is the disruptive core when Samsung invests in medical analytics?

Old world product business is dead?

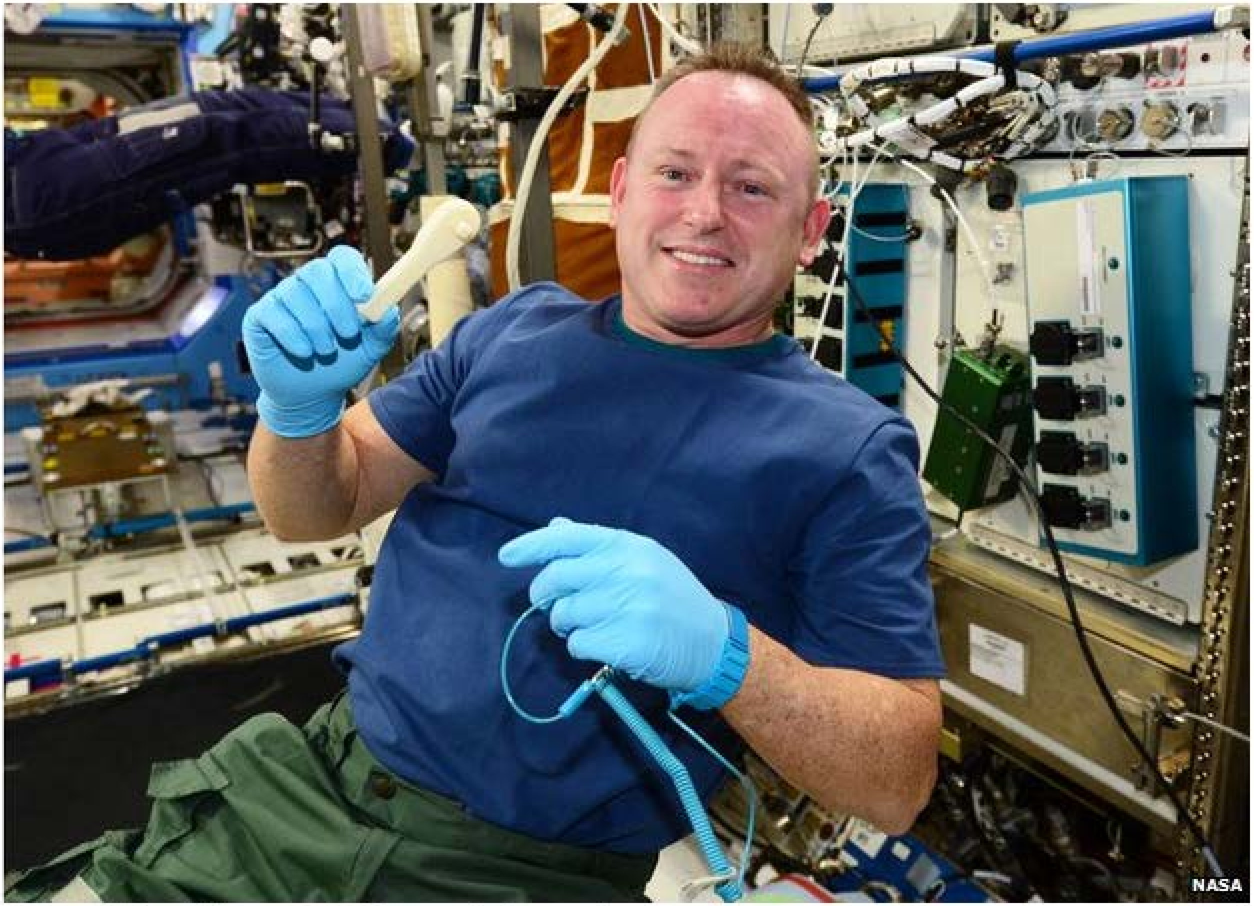
Paradigm Shift?
What if every product is a data service?

Old world product business is dead

Data-Dependent / Data-Driven Paradox

Email the product. Charge for service.

Nasa emails spanner to space station



Astronaut Barry Wilmore asked for a ratcheting socket wrench

Astronauts on the International Space Station have used their 3-D printer to make a wrench from instructions sent up in an email.

It is the first time hardware has been "emailed" to space.

Nasa was responding to a request by ISS commander Barry Wilmore for a ratcheting socket wrench.

Previously, if astronauts requested a specific item they could have waited months for it to be flown up on one of the regular supply flights.

Related Stories

Nasa plans 3D printer space launch

Engineers build 'flying 3D printer'

International Space Station goes 3D

19 December 2014

Paradox? Paradigm?

Rolls Royce does not sell jet engines. It sells "thrust hours" guaranteed uptime and service levels based on sensor data from turbines.

MRI 2 mining trucks pay per use pricing based on service.

Products will be the vehicles for service LT micro-revenue.

Disposable Printed Circuits – disrupts business models with IoS – transform products to services

- Bohr's principle of complementarity is the cornerstone of quantum mechanics.

- Complementarity is fundamental to structure of DNA & biological regulation.

- Complementarity is crucial to the future of business and profitability

Revisiting BPC with a quantum device ● Jian-Shun Tang, Yu-Long Li, Chuan-Feng Li and Guang-Can Guo
Phys. Rev. A 88, 014103 – Published 22 July 2013 – DOI: http://dx.doi.org/10.1103/PhysRevA.88.014103

Evidence for Complementarity

Business of Disruptive Convergence ?

http://bit.ly/ALIBABA-AND-40-DRONES

Software is becoming Hard

COMPLEMENTARITY

Hardware is becoming Soft

Software is becoming Hard

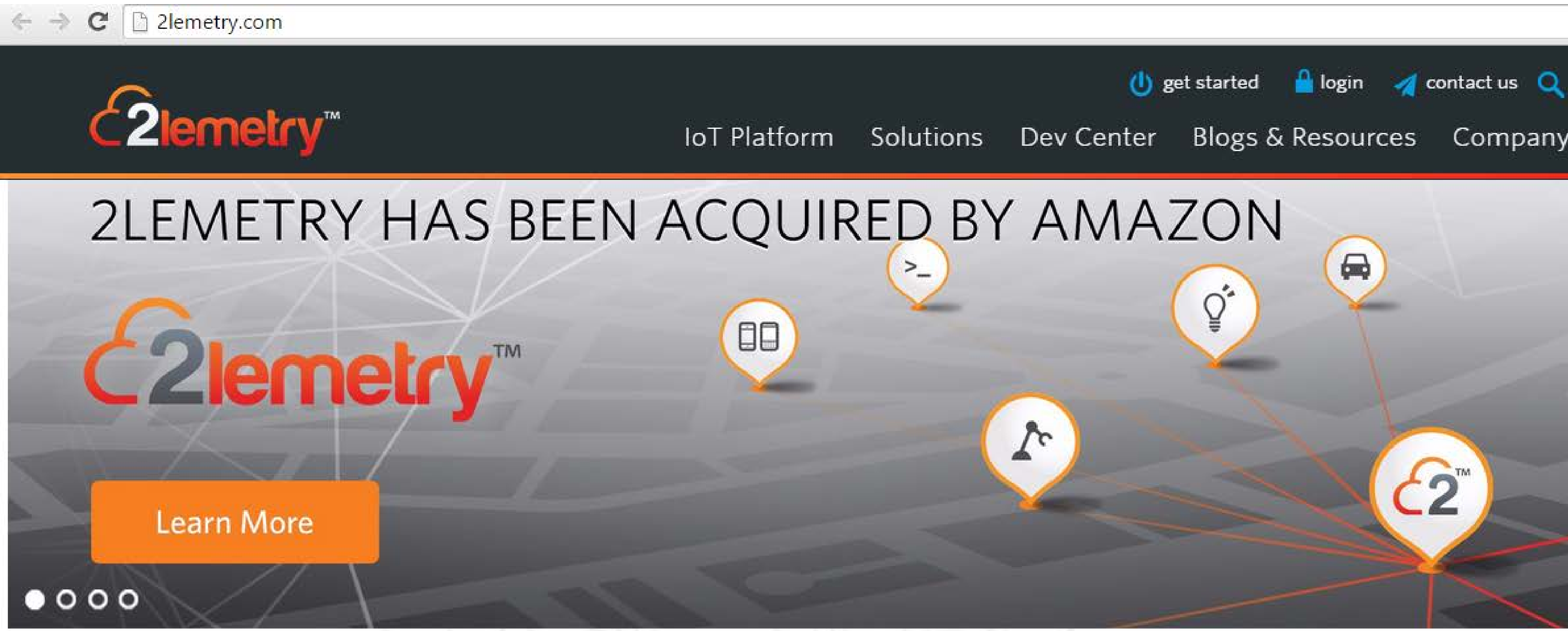
- Google
- Purchases 8 robotics companies in 6 months
- Amazon
- Kindle, Fire, Phone, Echo, Drones, 2lemetry
- Facebook
- Oculus, Ascenta, Drones
- Paypal
- Registers, Dongle, card readers

http://gizmodo.com/a-humans-guide-to-googles-many-robots-1509799897
http://www.cbsnews.com/news/google-buys-8-robotics-companies-in-6-months-why/
http://wearableworldnews.com/2014/11/07/amazon-moves-deeper-hardware-business-new-speaker-assistant/
http://www.reuters.com/article/2014/03/27/us-facebook-internet-idUSBREA2Q27420140327
http://www.ft.com/intl/cms/s/0/b8a6524a-b627-11e3-b40e-00144feabdc0.html#slide0
http://hothardware.com/news/PayPal-Here-A-New-Mobile-Payment-Dongle

Amazon Warehouse – Amazing Software Company?

Obsolescence imminent? http://bit.ly/BEAM-ME-UP-SCOTTY

Amazon



2lemetry is an Internet of Things platform and technology company that powers the connected enterprise, tying people, processes, data and devices together—transforming raw data into real-time actionable intelligence.

Hardware is becoming Soft

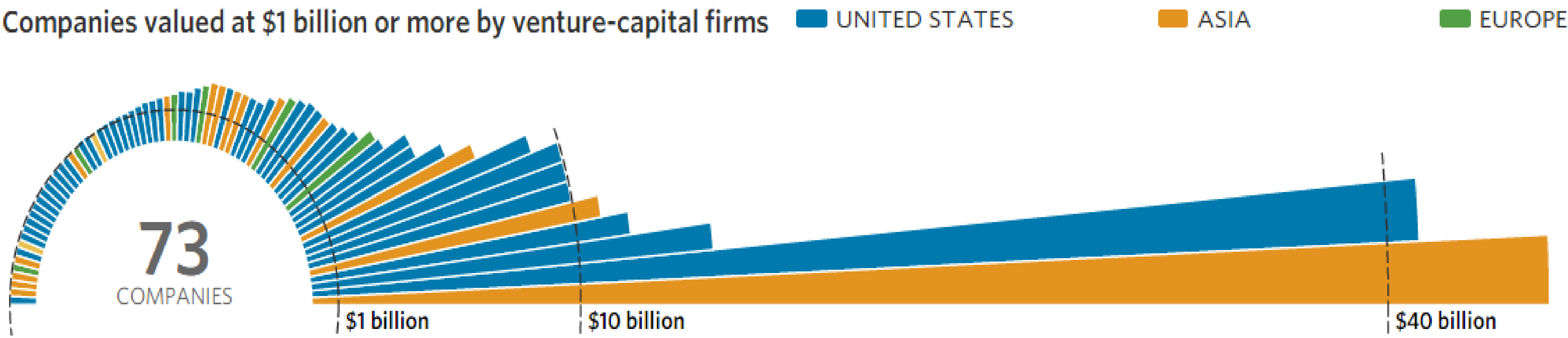
- GE
- Monsanto
- John Deere
- Nokia

- Quirky, Pivotal, GE GRC Software
- Climate Company, Precision Planting
- Farm Manager App in Apple's App Store
- Is now Microsoft

http://www.economist.com/news/business/21605916-it-has-taken-ges-boss-jeffrey-immelt-13-years-escape-legacy-his-predecessor-jack
http://www.forbes.com/sites/bruceupbin/2013/10/02/monsanto-buys-climate-corp-for-930-million/
http://www.wsj.com/articles/SB10001424052702304707604577422162132896528
https://stellarsupport.deere.com/en_US/categories/downloads/apex-update/
http://www.zdnet.com/article/microsoft-the-hardware-company/

Software still the prime target

Companies valued at $1 billion or more by venture-capital firms



Valuations as of **February 2015**

http://graphics.wsj.com/billion-dollar-club/

TOP COUNTRIES:

United States	50
China	8
India	4
Germany	2
United Kingdom	2

TOP INDUSTRIES:

Software	23
Consumer Internet	15
E-Commerce	15
Financial Services	5
Hardware	4

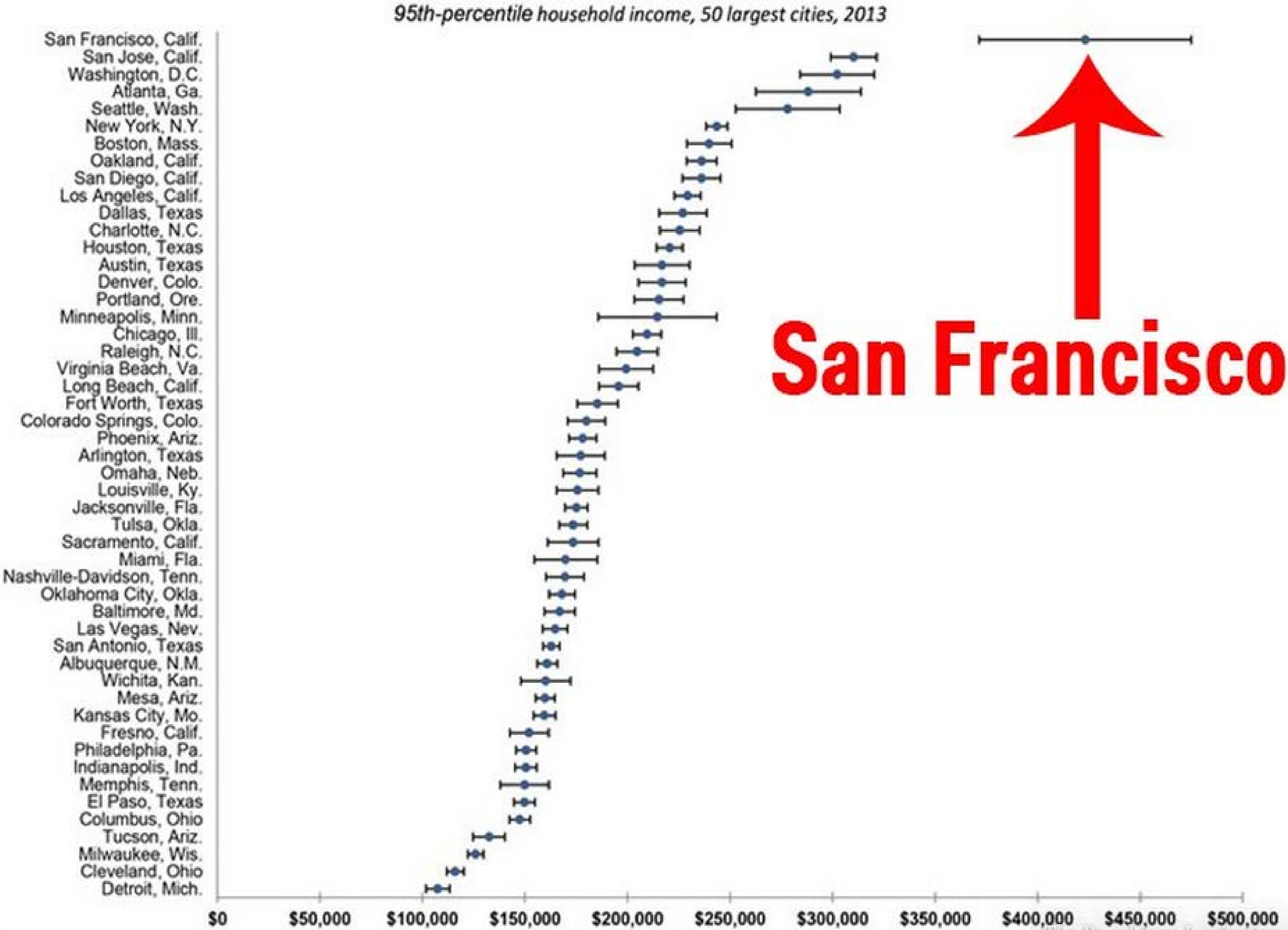
SOFT

TOP CITIES:

San Francisco, Calif.	20
New York, N.Y.	5
Beijing, China	4
Palo Alto, Calif.	4
London, UK	2

TOP INVESTORS:

Sequoia Capital	17
Kleiner Perkins Caufield & Byers	15
Tiger Global Management	11
Accel Partners	10
Andreessen Horowitz	10



Source: Brookings Institution analysis of 2013 American Community Survey data. Bars denote 90% confidence interval.

Tread softly

In 2015 Uber, the world's largest taxi company owns no vehicles, Facebook the world's most popular media owner creates no content, Alibaba, the most valuable retailer has no inventory and Airbnb the world's largest accommodation provider owns no real estate.

Market Cap of Software Services (2001-2011)

2001

2008

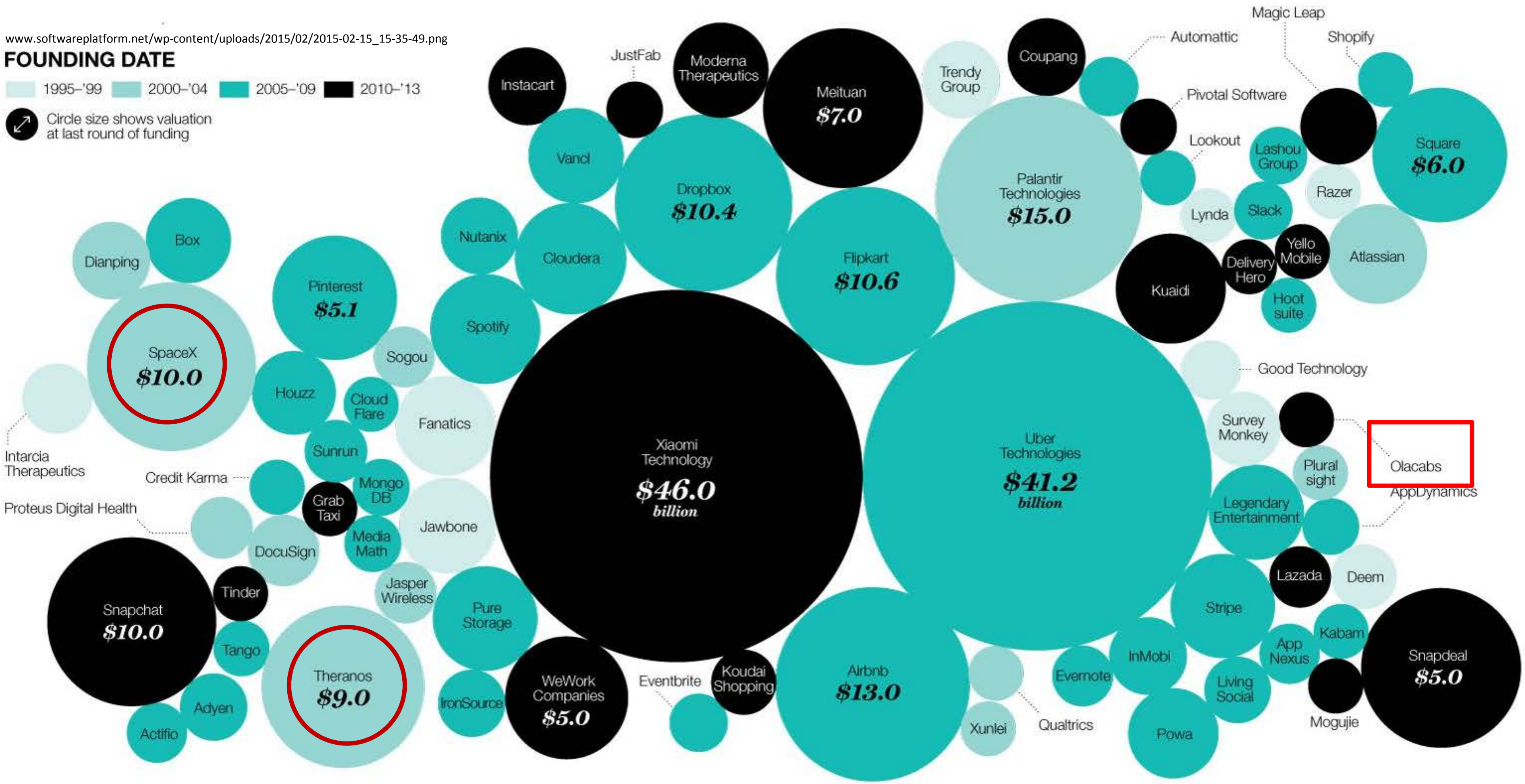
2011

2001	Name	HQ	Industry	Market Cap USD million
1	GE	US	Various	477,406
2	Cisco	US	Network	304,699
3	Exxon Mobil	US	Oil & Gas	286,367
4	Pfizer	US	Pharma	263,996
5	Microsoft	US	Software	258,436
6	Wal-Mart	US	Retail	250,955
7	Citigroup	US	Banking	250,143
8	Vodafone	UK	Telco	227,175
9	Intel	US	Computer	227,048
10	Royal Dutch Shell	NL/UK	Oil & Gas	206,340

2008 [3]	Name	HQ	Industry	Market Cap USD m
1	Exxon Mobil	US	Oil and gas	403,366
2	Petrochina	China	Oil and gas	325,320
3	GE	US	Various	253,674
4	Microsoft	US	Software	243,687
5	Wal-Mart	US	Retail	235,605
6	P&G	US	Retail	211,460
7	Industrial Commercial Bank of China	China	Banking	208,397
8	Berkshire Hathaway	US	Insurance	202,901
9	China Mobile	China	Telco	198,558
10	J & J	US	Health care	193,602

	2011 [1]
1	Exxon Mobil 417,166.7
2	PetroChina 326,199.2
3	Apple Inc. 321,072.1
4	Industrial and Commercial Bank of China 251,078.1
5	Petrobras 247,417.6
6	BHP Billiton 247,079.5
7	China Construction Bank 232,608.6
8	Royal Dutch Shell 226,128.7
9	Chevron Corporation 215,780.6
10	Microsoft 213,336.4

Recent tech start-ups valued at over $1 billion



SOFTWARE

First funding & per-capita location quotients of venture capital deals

BY NUMBER

		LQ	Number
(1)	San Francisco-San Mateo-Redwood City,CA	24.9	368
(2)	New York-Wayne-White Plains, NY-NJ	3.4	319
(3)	San Jose-Sunnyvale-Santa Clara, CA	14.3	220
(4)	Los Angeles-Long Beach-Santa Ana, CA	1.6	128
(5)	Cambridge-Newton-Framingham, MA	6.1	76
(6)	Boston-Quincy, MA	4.8	74
(7)	Washington-Arlington-Alexandria DC-VA	1.9	69
(8)	Seattle-Bellevue-Everett, WA	3.0	67
(9)	Austin-Round Rock, TX	3.8	58
(10)	Chicago-Naperville-Joliet, IL	0.9	56
(11)	San Diego-Carlsbad-San Marcos, CA	1.9	48
(12)	Oakland-Fremont-Hayward, CA	2.0	42
(13)	Atlanta-Sandy Springs-Marietta, GA	0.9	39
(14)	Houston-Baytown-Sugar Land, TX	0.8	39
(15)	Philadelphia, PA	1.0	33
(16)	Santa Ana-Anaheim-Irvine, CA	1.3	32
(17)	Dallas-Plano-Irving, TX	0.8	28
(18)	Baltimore-Towson, MD	1.2	27
(19)	Denver-Aurora, CO	1.2	26
(20)	Phoenix-Mesa-Scottsdale, AZ	0.7	25
	United States	**1.0**	**2,520**
	These 20 metros' share of U.S. total		**70%**

BY LOCATION QUOTIENT

		LQ	Number
(1)	San Francisco-San Mateo-Redwood City,CA	24.9	368
(2)	San Jose-Sunnyvale-Santa Clara, CA	14.3	220
(3)	Boulder, CO	7.2	18
(4)	Cambridge-Newton-Framingham, MA	6.1	76
(5)	Ann Arbor, MI	4.9	14
(6)	Boston-Quincy, MA	4.8	74
(7)	Austin-Round Rock, TX	3.8	58
(8)	New York-Wayne-White Plains, NY-NJ	3.4	319
(9)	Champaign-Urbana, IL	3.2	6
(10)	Wilmington, DE-MD-NJ	3.0	17
(11)	Seattle-Bellevue-Everett, WA	3.0	67
(12)	Charleston-North Charleston, SC	3.0	17
(13)	Charlottesville, VA	2.4	4
(14)	Lincoln, NE	2.4	6
(15)	Santa Cruz-Watsonville, CA	2.3	5
(16)	Salt Lake City, UT	2.0	19
(17)	Santa Barbara-Santa Maria-Goleta, CA	2.0	7
(18)	Provo-Orem, UT	2.0	9
(19)	Oakland-Fremont-Hayward, CA	2.0	42
(20)	San Diego-Carlsbad-San Marcos, CA	1.9	48
	United States	**1.0**	**2,520**
	These 20 metros' share of U.S. total		**55%**

About one quarter of all VC deals in US are in CA

http://bit.ly/2014-BROOKINGS

Hardly soft

Softly hard

Apple Inc.

NASDAQ: AAPL - Feb 17 7:59 PM ET

127.83 0.75 (0.59%)

After-hours: 127.67 0.16 (0.13%)

1 day	5 day	1 month	3 month	1 year	5 year	max

Open	127.49	**Market cap**	**740.9B**
High	128.88	P/E ratio (ttm)	17.22
Low	126.92	Dividend yield	1.47%

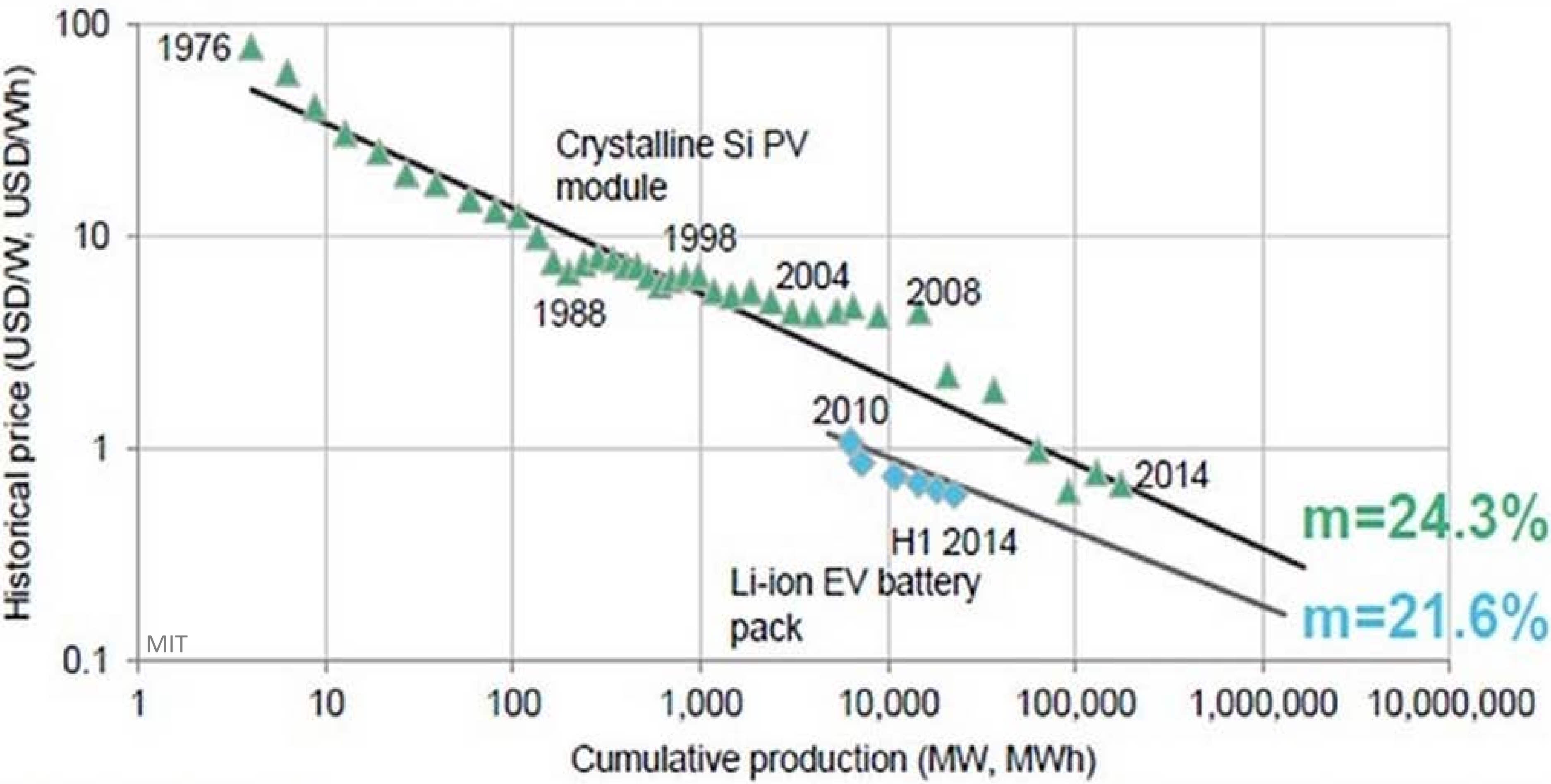
Autonomous Connected Service - Apple, Google

Is this the Supply Chain Revolution of the Future?

One Supply Chain Revolution of the Future is Here

FT

Another Supply Chain Revolution – *is in progress*



Li-ion battery costs (in US$, 2014) down 60% from 2010. Solar PV costs have plunged.

Apple Car or the Apple Cart ?

In case you missed it, at least three reports have swept through the business media on this topic in the past 48 hours.

- The Financial Times (paywall) was out first with a story that said Apple was hiring experts for a new car research lab, in a move that suggested "an electric car could be in the works."
- The Wall Street Journal (paywall) followed up with more details on project "Titan," which reportedly involves hundreds of people secretly working on an electric vehicle that "resembles a mini-van."
- Reuters later reported that Apple is "learning how to make a self-driving electric car." (This contradicts the Journal, which says "a self-driving car is not part of Apple's current plan.")

http://qz.com/344760/one-radical-theory-behind-apples-sudden-interest-in-cars/ ● Feb 14, 2015

Anybody can write software and program from a tiny hut in India

Apple iCar: Designed in California,
Manufactured by Foxconn

Jason Calacanis

Apple will buy Tesla for $75b

Feb 15, 2015

Can anybody stop you from printing a car in your own garage in China?

3D Printing ● It took about 30 years

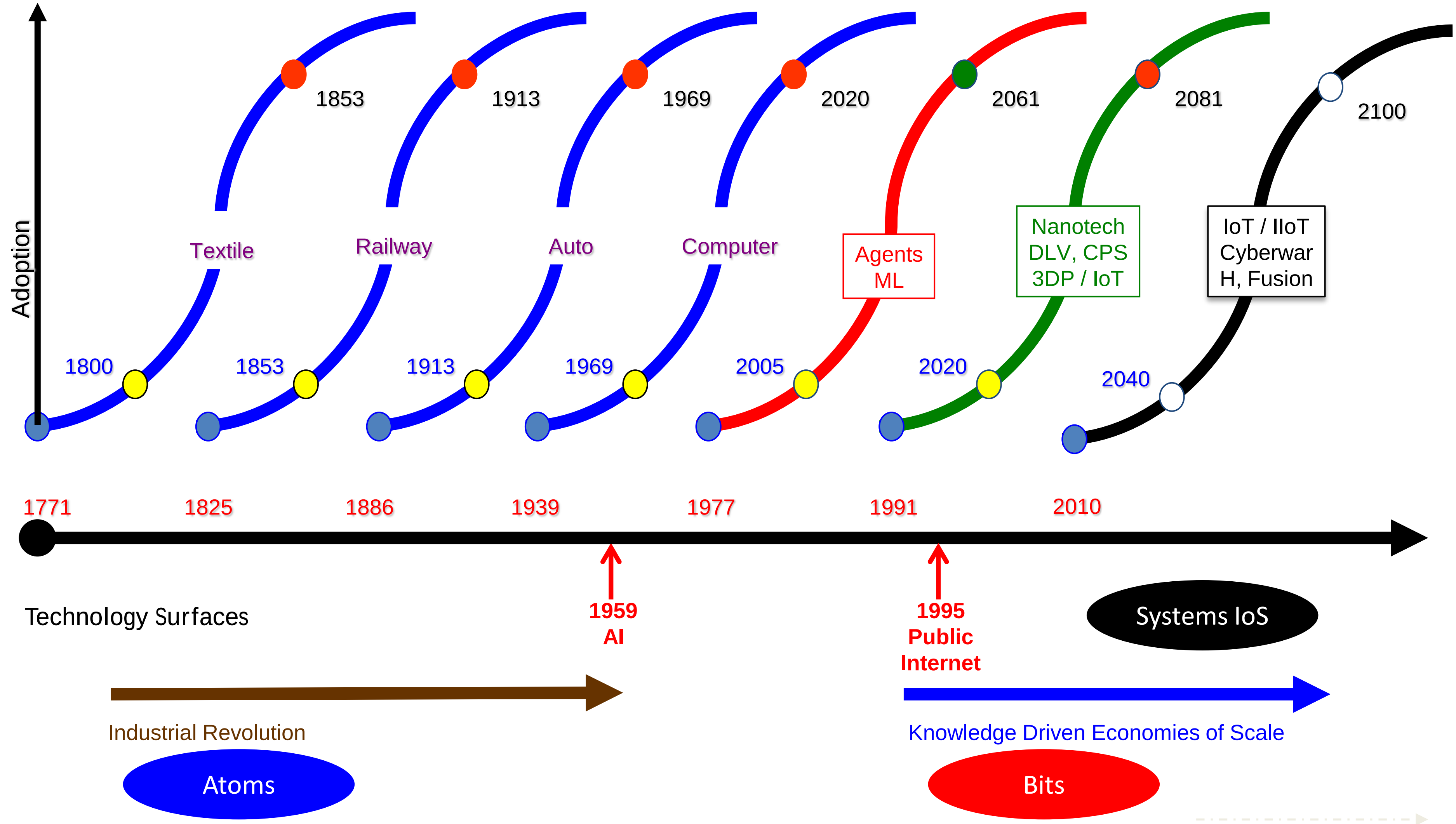
In 1984, Carl Deckard started his PhD with Professor Joseph Beaman at UT Austin. They commercialized one of the first forms of 3D printing, called Selective Laser Sintering (SLS). In 1988, New York Times attempted to explain SLS (http://bit.ly/3D-PRINTING-NYT-1988). About 30 years later, at the 2015 Detroit Auto Show the Shelby Cobra is 3D printed by ORNL (Oak Ridge National Laboratory, DOE). The Industrial Internet Consortium is exploring 3D printing in an autonomous (self-assembly, self-organizing) manufacturing test bed proposal.

http://energy.gov/eere/amo/3d-printed-shelby-cobra

It takes about 28-30 years for an idea to be socialized before it is accepted and adopted. 1999 was the birth year for IoT concept. We expect exponential growth of IoS by 2030.

The Wealth of Nations ● Nature of the Firm (Transaction Cost Economics)

Economic history and data related to Textile, Railway, Automobiles and Computers taken from work by Norman Poire



It takes about 28-30 years for an idea to be socialized before it is accepted and adopted. 1999 was the birth year for IoT concept. We expect exponential growth of IoS by 2030.

COMPLEMENTARITY

During the week of 9th Feb 2015, American retailer Under Armour spent half a billion to purchase health tracking app MyFitnessPal. What is the significance? Signals the use of personal information for product design. Collecting massive amounts of customer data has transformed product marketing/sales. Now it changes product design/development.

is pervasive … not limited to hardware and/or software

In 1854, Ferdinand de Lesseps obtained a concession from Sa'id Pasha, the Khedive of Egypt and Sudan, to create a company to construct a canal open to ships of all nations. De Lesseps convened the *Commission Internationale pour le percement de l'isthme des Suez* consisting of 13 experts from seven countries. The commission produced a unanimous report in December 1856 containing a detailed description of the canal complete with plans and profiles. The Suez Canal Company (*Compagnie universelle du canal maritime de Suez*) came into being on 15 December 1858 and work started on the shore of the future Port Said on 25 April 1859. International opinion was sceptical and Suez Canal Company shares did not sell well overseas. Britain, United States, Austria and Russia did not buy a significant number of shares. All French shares were quickly sold in France. A contemporary British sceptic claimed:

One thing is sure our local merchant community doesn't pay practical attention at all to this grand work and it is legitimate to doubt that the canal's receipts could ever be sufficient to recover its maintenance fee. It will never become a large ship's accessible way in any case.

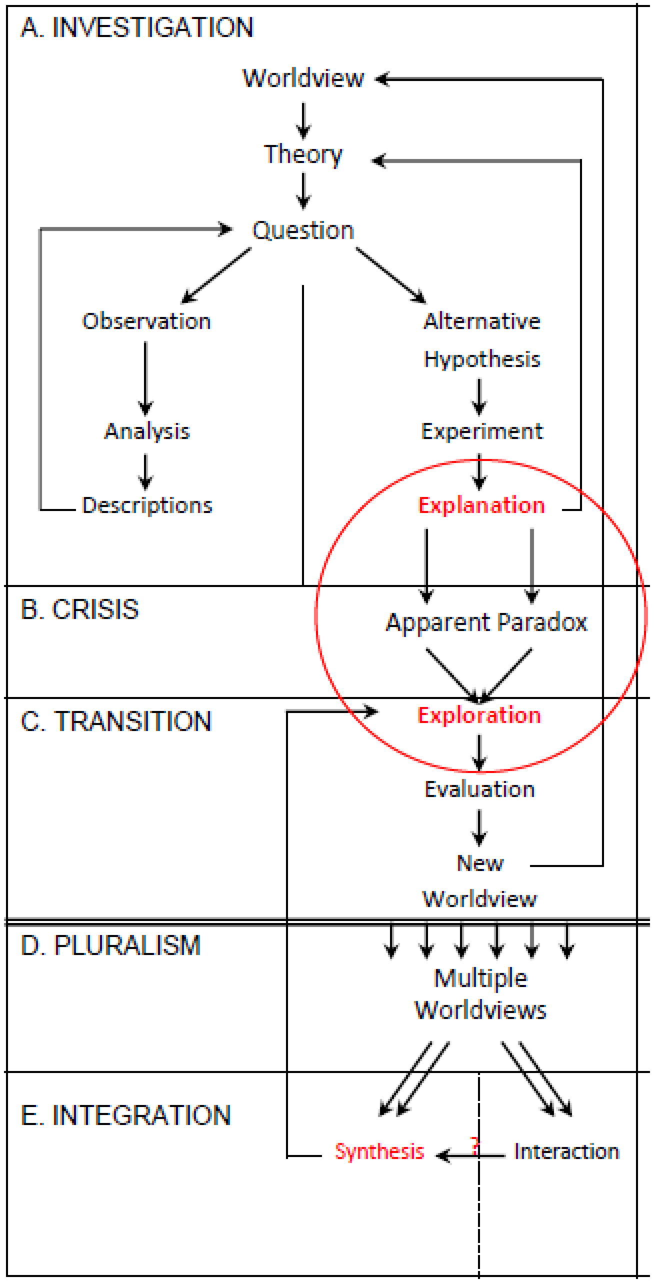
The British government had opposed the project from the outset to its completion. The canal opened on 17 November 1869.

The first ship through the canal was the British P&O liner *Delta*. Although *L'Aigle* was officially the first vessel through the canal, HMS *Newport*, captained by George Nares, passed through it first. On the night before the canal was due to open, Captain Nares navigated his vessel, in darkness and without lights, through the mass of waiting ships until it was in front of *L'Aigle*. When dawn broke the French were horrified to find that the Royal Navy was first in line and that it would be impossible to pass them. Nares received both an official reprimand and an unofficial vote of thanks from the British Admiralty for his actions in promoting British interests and demonstrating such superb seamanship.

After the opening the Suez Canal Company was in financial difficulties. Less than 500 ships passed during the first few years. External debts forced Said Pasha's successor, Isma'il Pasha, to sell his country's share in the canal for £4 million (about £86 million in 2013) to the United Kingdom in 1875 but French shareholders still held the majority. Prime Minister Benjamin Disraeli was accused by William Ewart Gladstone of undermining Britain's constitutional system, because he had not obtained consent from Parliament when purchasing the shares with funding from the Rothschilds.

In 2012, nearly 20,000 ships used The Suez Canal. On an average, 50 ships navigate the canal daily, carrying more than 300 million tons of goods per year. On August 5, 2014, President Sisi of Egypt announced the building of a new Suez Canal project to add 45-mile parallel lane to allow more ships to use this freight transportation option (www.theguardian.com/world/2014/aug/05/egypt-build-new-suez-canal).

Boil the Ocean



The Scientific Process

Disciplinary Science

Holistic Science

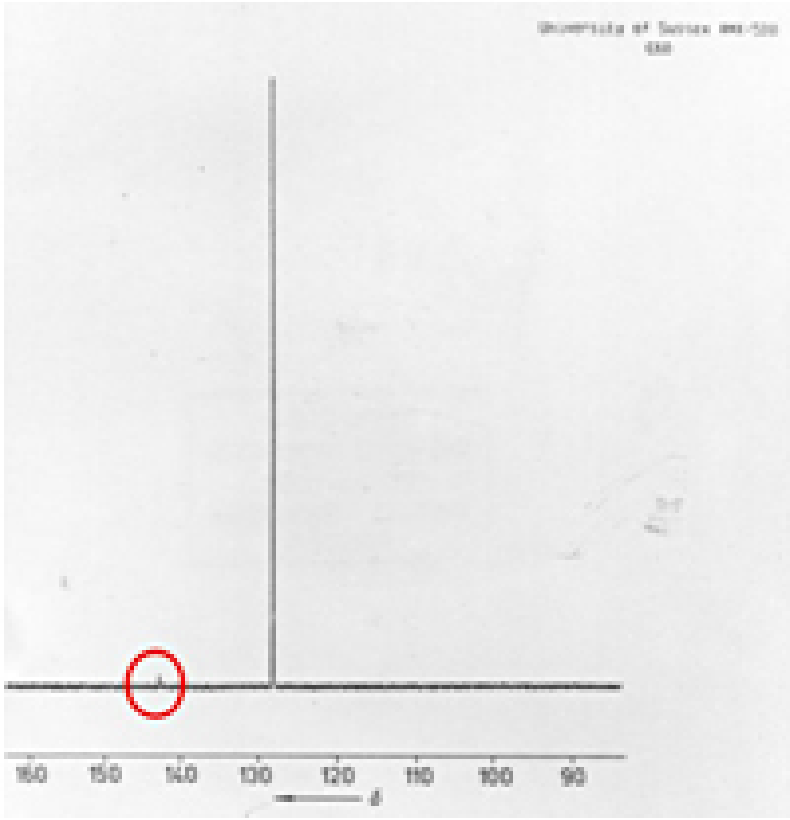
Underlying Beliefs

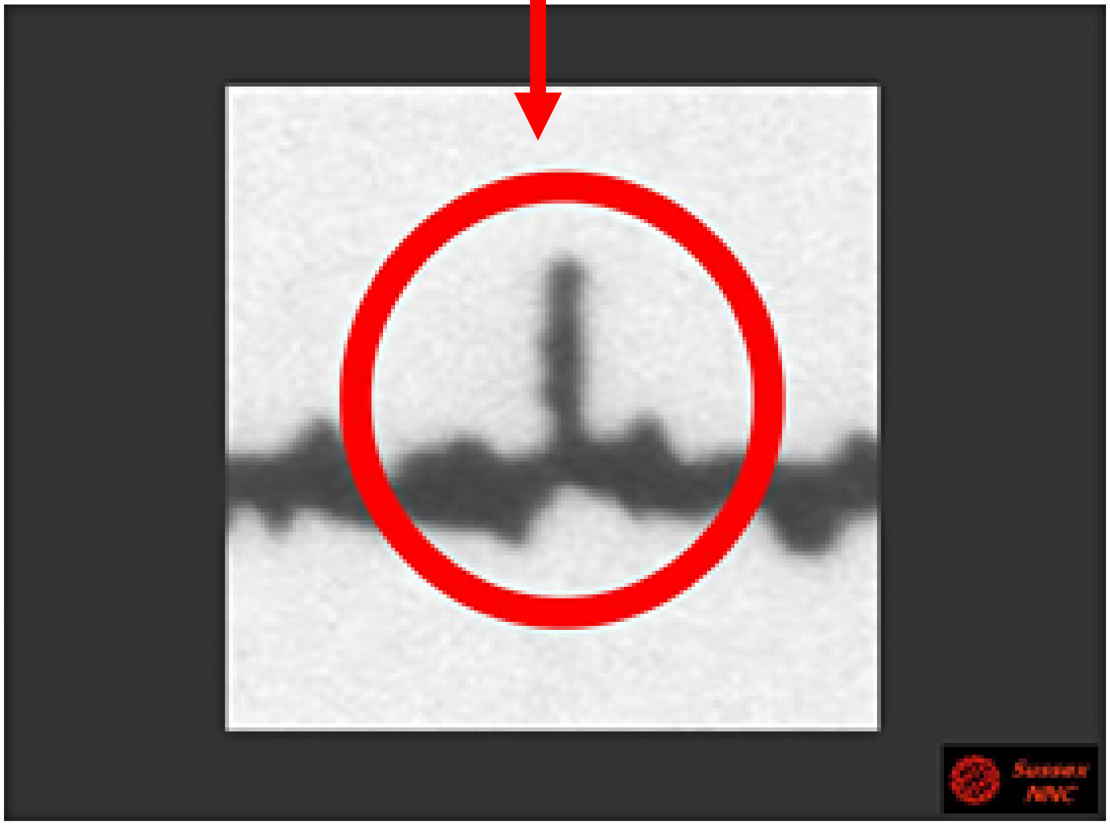
Criteria:

1. Formality
2. Consistency
3. Parsimony
4. Necessity
5. Generality
6. Productivity

HOW TO BOIL THE OCEAN – Invest in Basic Science Research

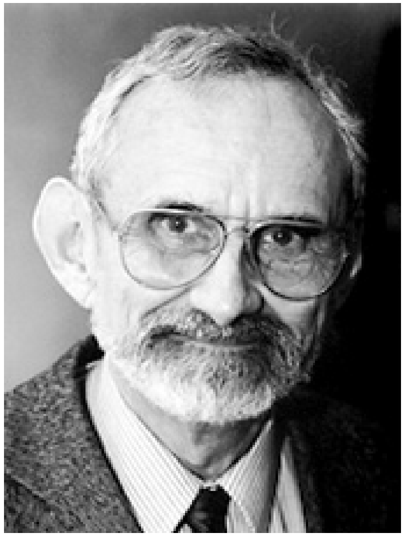
Trillion Dollar Economy



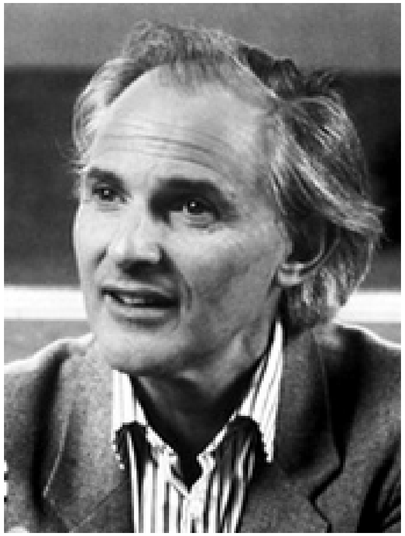


The Nobel Prize in Chemistry 1996
Robert F. Curl Jr., Sir Harold Kroto, Richard E. Smalley

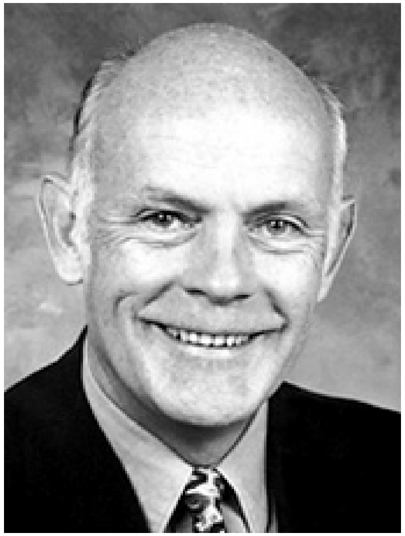
The Nobel Prize in Chemistry 1996



Robert F. Curl Jr.
Prize share: 1/3



Sir Harold W. Kroto
Prize share: 1/3



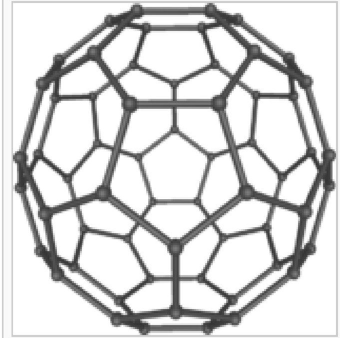
Richard E. Smalley
Prize share: 1/3

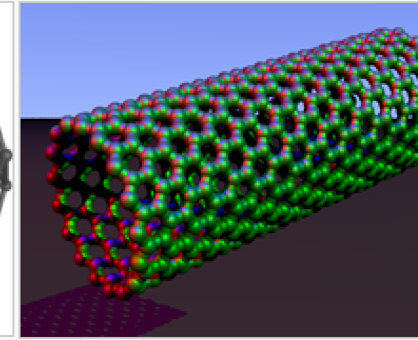
The Nobel Prize in Chemistry 1996 was awarded jointly to Robert F. Curl Jr., Sir Harold W. Kroto and Richard E. Smalley *"for their discovery of fullerenes"*.

Robert F Curl
1995

A **fullerene** is a molecule of carbon in the form of a hollow sphere, ellipsoid, tube, and many other shapes. Spherical fullerenes are also called **buckyballs**, and they resemble the balls used in football (soccer). Cylindrical ones are called carbon nanotubes or buckytubes. Fullerenes are similar in structure to graphite, which is composed of stacked graphene sheets of linked hexagonal rings; but they may also contain pentagonal (or sometimes heptagonal) rings.[1]

The first fullerene molecule to be discovered, and the family's namesake, buckminsterfullerene (C_{60}), was prepared in 1985 by Richard Smalley, Robert Curl, James Heath, Sean O'Brien, and Harold Kroto at Rice University. The name was a homage to Buckminster Fuller, whose geodesic domes it resembles. The structure was also identified





Buckminsterfullerene C_{60} (left) and carbon nanotubes (right) are two examples of structures in the fullerene family.

Graphene Electronics, Unzipped

By unrolling tiny carbon tubes, you can produce superthin sheets with truly extraordinary electronic properties

By Alexander Sinitskii, James M. Tour [

Posted 29 Oct 2010 | 15:59 GMT

How graphene breakthrough is revolutionising green technology

Ultra-efficient solar panels, cost-effective battery technologies, electric cars that c recharge in seconds - all could be made possible by emerging graphene-based technologies

By Alasdair Cameron | 18 Jul 2013 | 0 Comments

The Nobel Prize in Physics 2010
Andre Geim, Konstantin Novoselov

Share this: 51

The Nobel Prize in Physics 2010

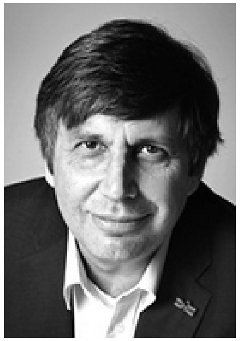


Photo: U. Montan

Andre Geim

Prize share: 1/2

Photo: U. Montan

Konstantin Novoselov

Prize share: 1/2

The Nobel Prize in Physics 2010 was awarded jointly to Andre Geim and Konstantin Novoselov *"for groundbreaking experiments regarding the two-dimensional material graphene"*

Power … Reimagined

http://bit.ly/CHANGE-LIVES-WITH-GRAPHENE

Direct Laser Sintering (precursor to 3D Printing)

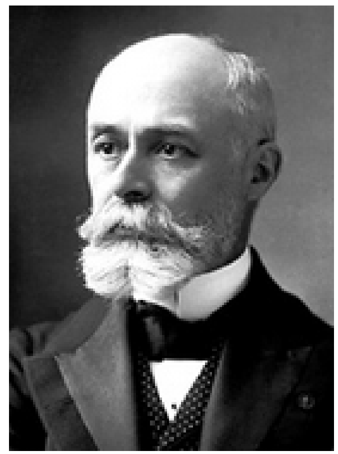
In 1979, Joseph Beaman, with a doctorate from MIT, goes to the University of Texas (Austin) and discovers "solid freeform fabrication". The invention of **laser radiation** sintering takes place in his lab. First laser sintering 3d printing patent number is 4863538, issued to Carl Deckard, a graduate student who earned his PhD at UT Austin under the supervision of Joseph Beaman. The second and third key patents (direct metal laser sintering and 3D printing) was issued to Michael Cima at MIT and Suman Das, another PhD student of Joseph Beaman.

A European-style laser warning symbol

Eve Curie, 1997 (NY)

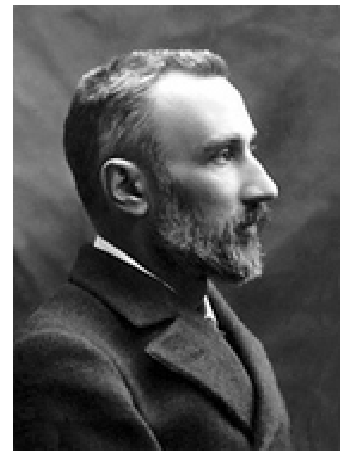
The Nobel Prize in Physics 1903
Henri Becquerel, Pierre Curie, Marie Curie

The Nobel Prize in Physics 1903



Antoine Henri Becquerel

Prize share: 1/2



Pierre Curie

Prize share: 1/4

Marie Curie, née Sklodowska

Prize share: 1/4

The Nobel Prize in Physics 1903 was divided, one half awarded to Antoine Henri Becquerel *"in recognition of the extraordinary services he has rendered by his discovery of spontaneous radioactivity"*, the other half jointly to Pierre Curie and Marie Curie, née Sklodowska *"in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel"*.

A European-style laser warning symbol

510 Birge Hall at UC Berkeley (1995)

The Nobel Prize in Physics 1964
Charles H. Townes, Nicolay G. Basov, Aleksandr M. Prokhorov

The Nobel Prize in Physics 1964

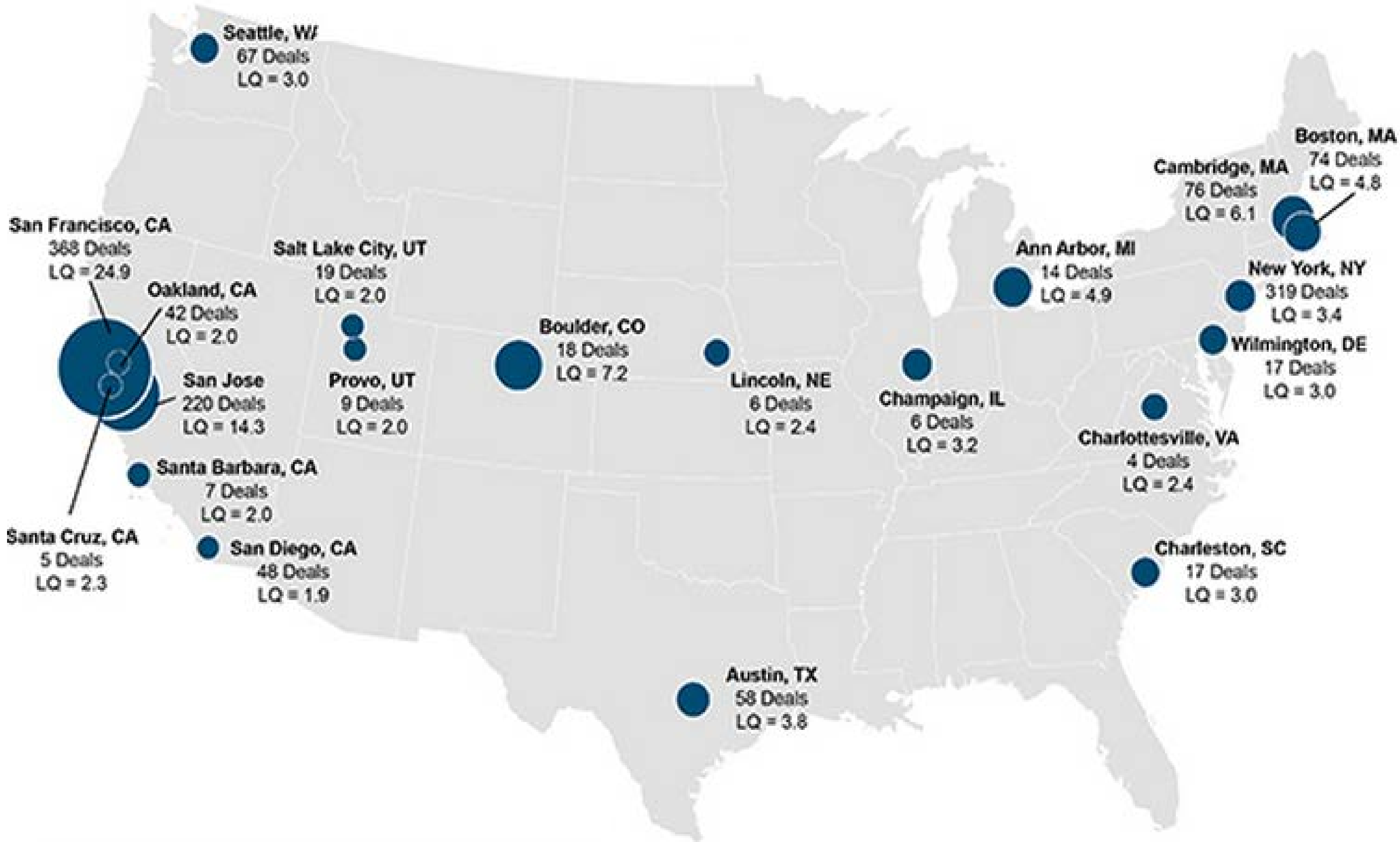
Charles Hard Townes
Prize share: 1/2

Nicolay Gennadiyevich Basov
Prize share: 1/4

Aleksandr Mikhailovich Prokhorov
Prize share: 1/4

The Nobel Prize in Physics 1964 was divided, one half awarded to Charles Hard Townes, the other half jointly to Nicolay Gennadiyevich Basov and Aleksandr Mikhailovich Prokhorov *"for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle".*

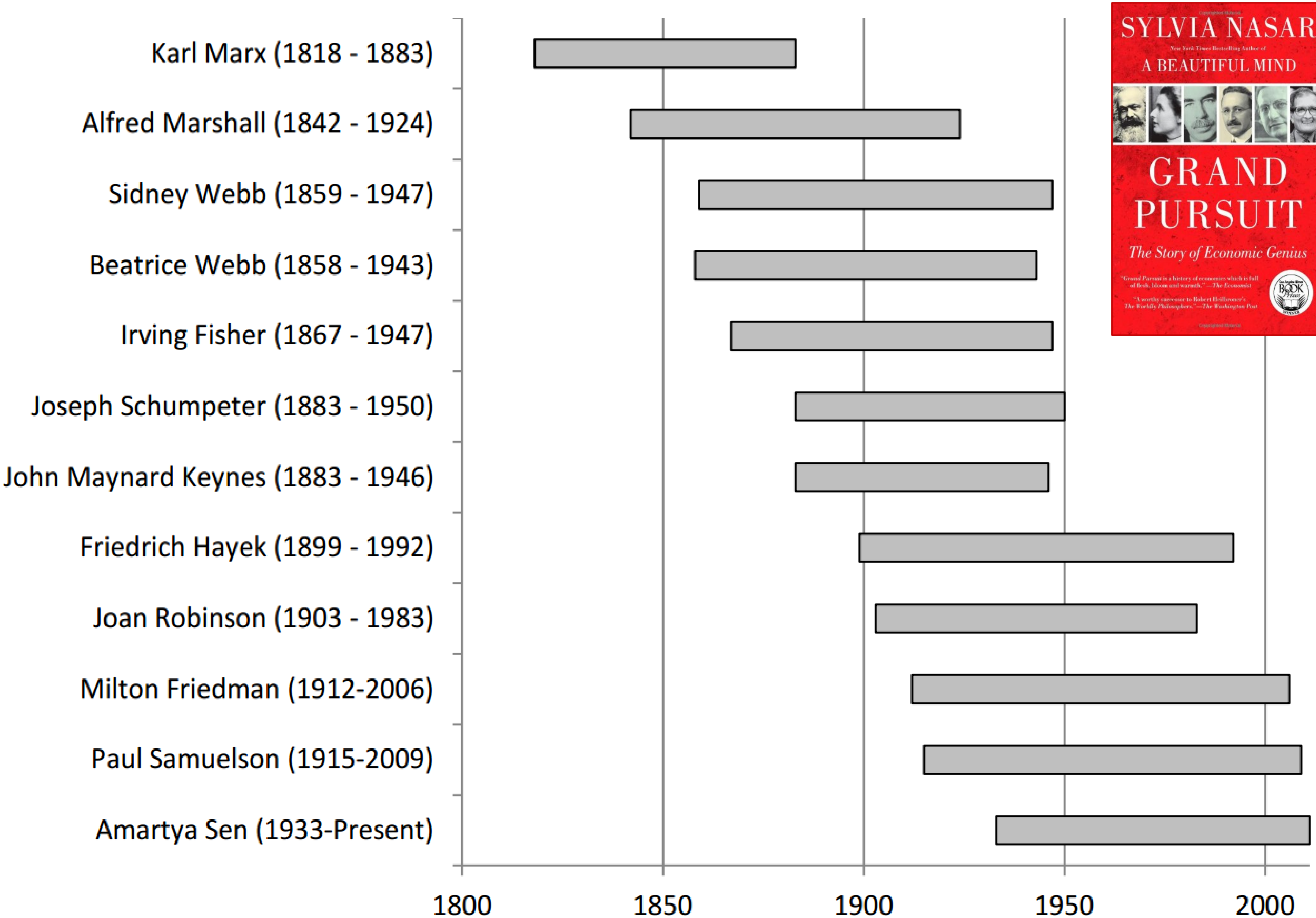
Is there a relationship between location and VC deals in the US?



Investment correlates with proximity to location of academic excellence

http://bit.ly/2014-DEAL-DENSITY

HOW TO BOIL THE OCEAN – Economics and Business

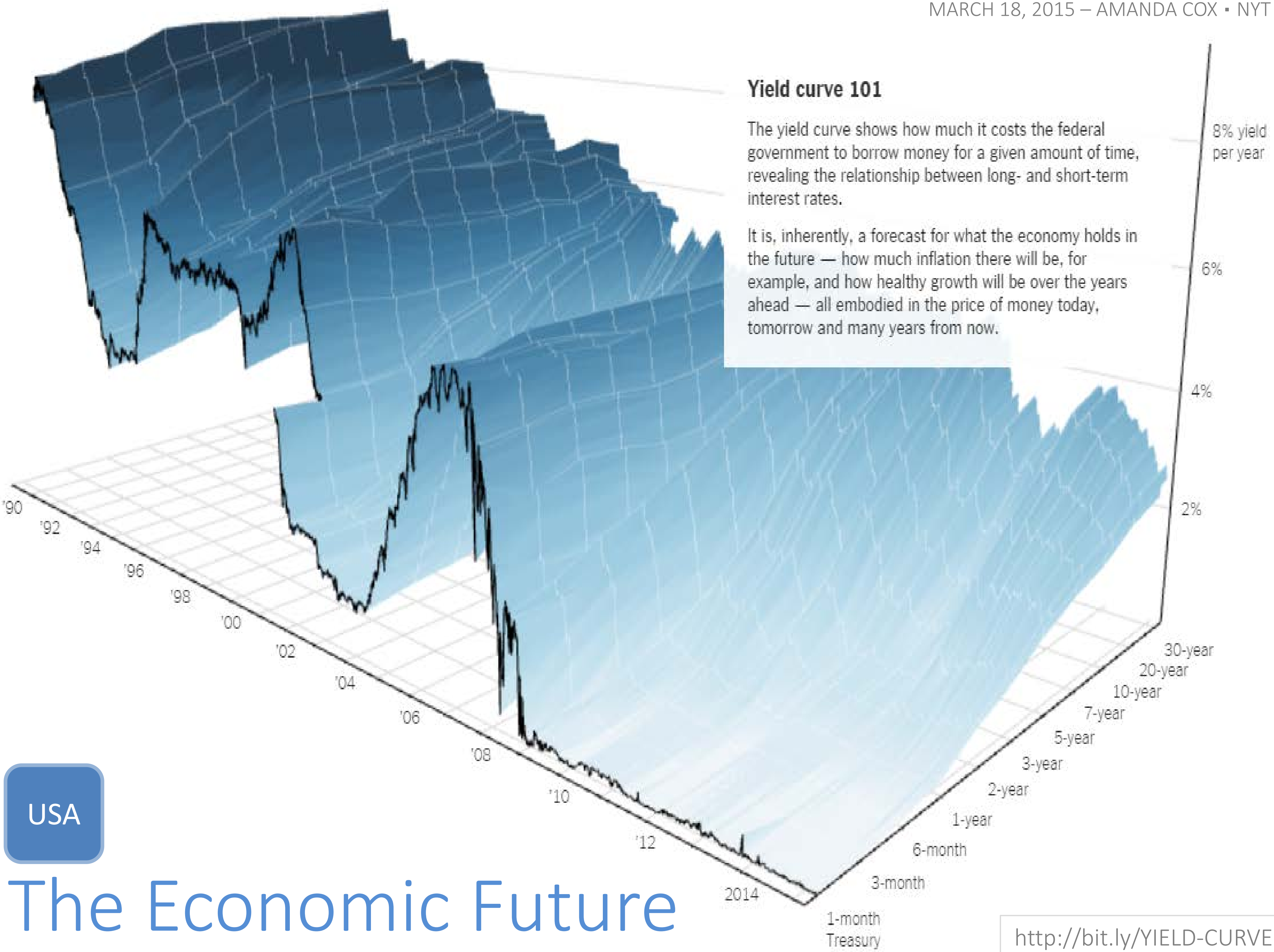


Global VC Funding (2010-2014)

http://bit.ly/PETER-EVANS

In past 5 years, $54 billion of the $82 billion (66%) is in the US

MARCH 18, 2015 – AMANDA COX • NYT

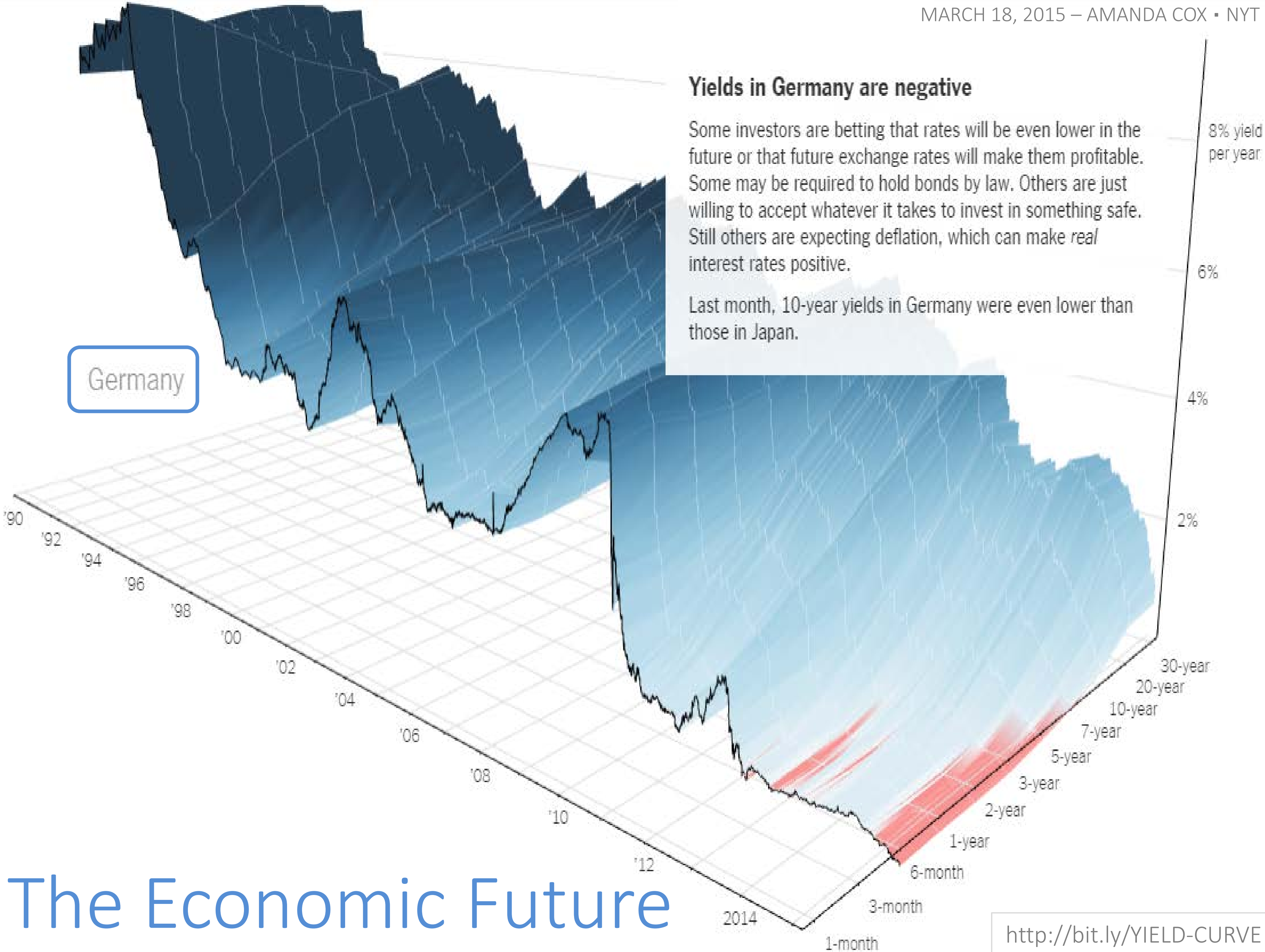


USA

The Economic Future

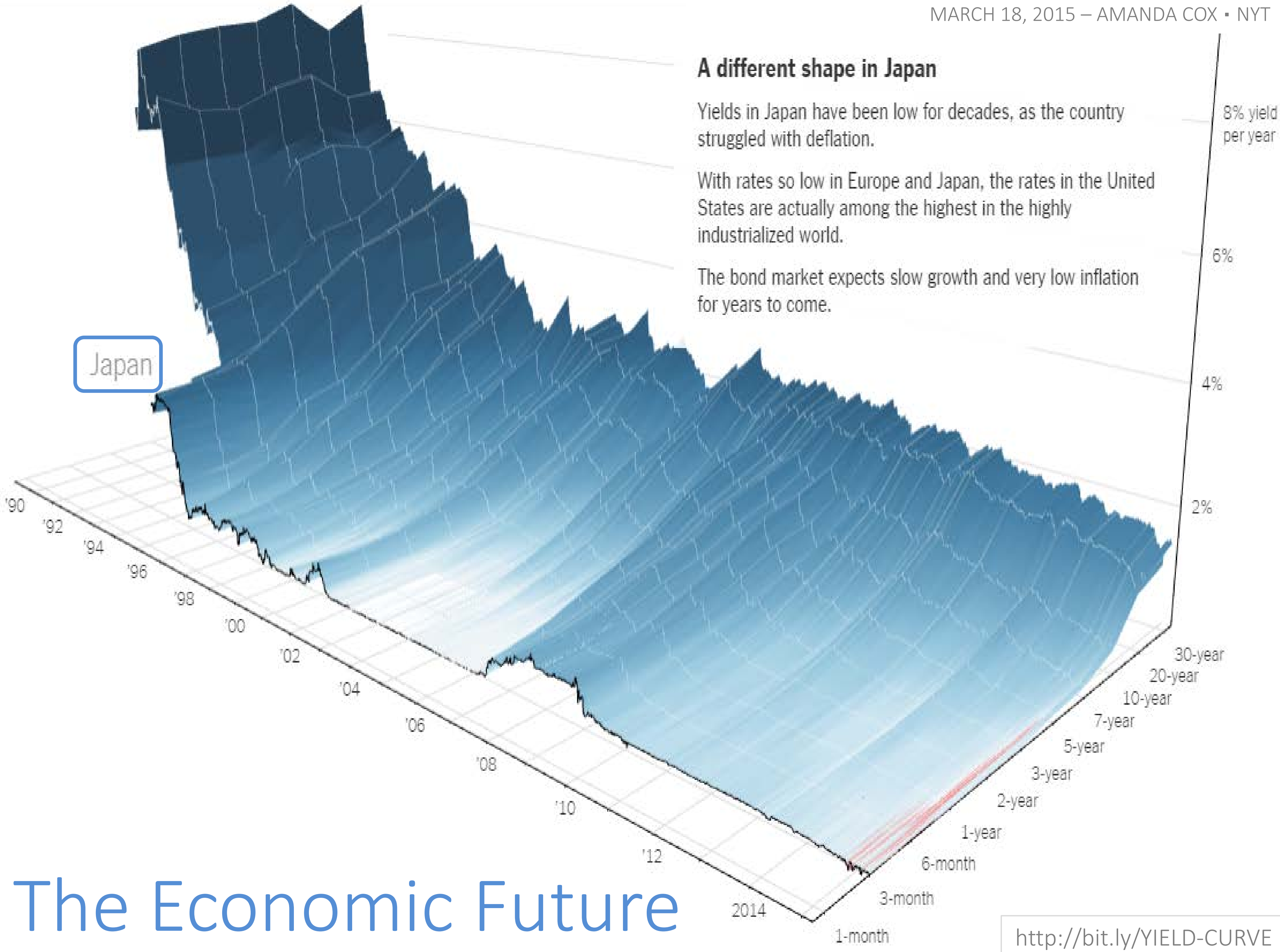
http://bit.ly/YIELD-CURVE

MARCH 18, 2015 – AMANDA COX • NYT



The Economic Future

http://bit.ly/YIELD-CURVE

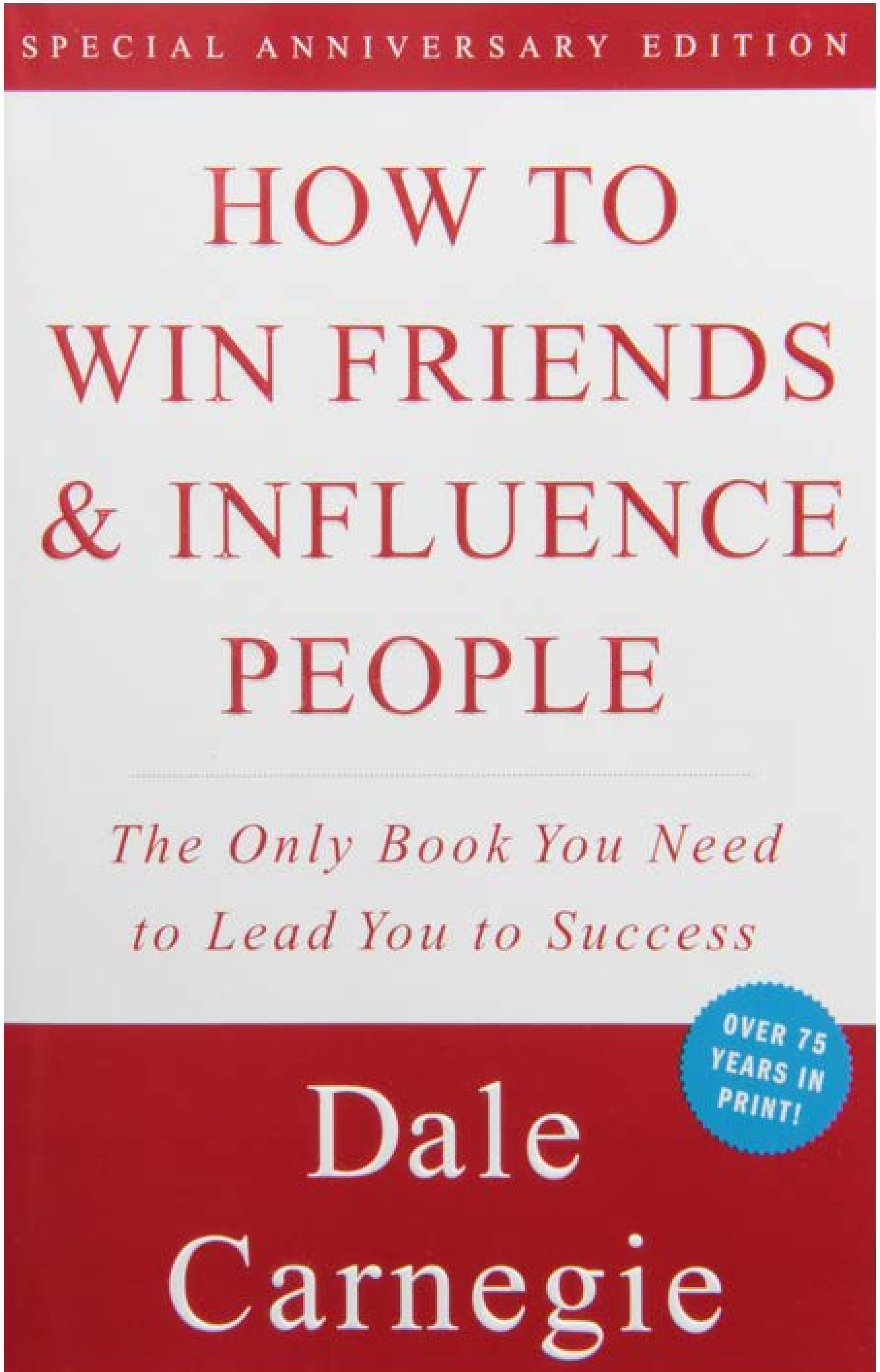


The Economic Future

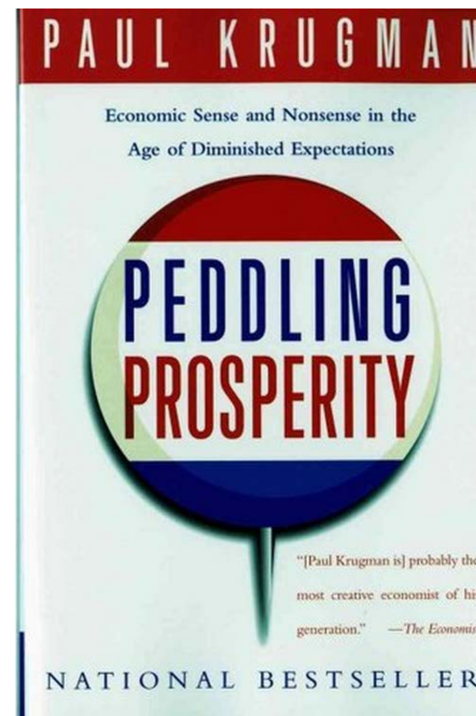
http://bit.ly/YIELD-CURVE

BOIL THE OCEAN TO CREATE A BETTER WORLD ?

#	Maslow's Needs Hierarchy (1943/54)	Goals	Universal Declaration of Human Rights (1948)	Preamble of the European Constitution (2004)
8	Transcendence	*overcome limitations and transform ego*	----------	
7	Fulfilment	*pursue life's inherent meaning, value and purpose*	Personality development	Social progress
6	Harmony	*alignment of values and lifestyles*	Quality of life, Cultural activities	Culture, Peace
5	Understanding	*understanding, prediction*	Education	Learning
4	Esteem	*freedom, fairness, sharing, compassion*	Justice, Freedom	Justice, Freedom, Equality
3	Acceptance, Belonging	*sympathy, dignity cooperation*	Dignity, Social participation	Democracy, Solidarity
2	Safety, Security	*control, leverage, optimisation*	Security, Property ownership	Prosperity, Security
1	Survival	*access to essential resources*	Life	



http://bit.ly/DALE-CARNEGIE



White House Appoints Its First Federal CIO

President Barack Obama Thursday appointed the District of Columbia's chief technology officer, Vivek Kundra, as the federal government's first CIO. The decision to appoint a CIO is an apparent move by the White House to give it more control over the US$80 billion that federal agencies spend annually on technology.

THE WHITE HOUSE

Office of the Press Secretary

FOR IMMEDIATE RELEASE
March 5, 2009

President Obama Names Vivek Kundra Chief Information Officer

WASHINGTON, DC – Today, President Barack Obama named Vivek Kundra the Federal Chief Information Officer (CIO) at the White House.

The Federal Chief Information Officer directs the policy and strategic planning of federal information technology investments and is responsible for oversight of federal technology spending. The Federal CIO establishes and oversees enterprise architecture to ensure system interoperability and information sharing and ensure information security and privacy across the federal government. The CIO will also work closely with the Chief Technology Officer to advance the President's technology agenda.

President Obama said, "Vivek Kundra will bring a depth of experience in the technology arena and a commitment to lowering the cost of government operations to this position. I have directed him to work to ensure that we are using the spirit of American innovation and the power of technology to improve performance and lower the cost of government operations. As Chief Information Officer, he will play a key role in making sure our government is running in the most secure, open, and efficient way possible."

The following announcement was made today:

Vivek Kundra, Federal Chief Information Officer
Vivek Kundra formerly served in Mayor Fenty's cabinet as the Chief Technology Officer (CTO) for the District of Columbia, responsible for technology operations and strategy for 86 agencies. He has been recognized among the top 25 CTO's in the country and as the 2008 IT Executive of the Year for his pioneering work to drive transparency,

Former U.S. CIO Vivek Kundra Joins Salesforce As EVP Of Emerging Markets

Posted Jan 16, 2012 by Leena Rao (@leenarao)

CRM and cloud giant Salesforce has announced a key hire today—former U.S. Chief Information Officer Vivek Kundra. Kundra has joined the company as executive vice president of emerging markets.

Kundra joined the Obama administration in March of 2009. As the first Chief Information Officer of the United States, Kundra managed more than $80 billion in technology investments and was an early evangelist of cloud computing in the public sector. Kundra also authored the 'Cloud-First policy,' which aims to guide government IT organizations around the world on how to be efficient with fewer resources.

Kundra also spearheaded the Data.gov initiative, which aimed to democratize data access; and launched the Federal IT Dashboard, which gives an assessment of the cost of large government IT projects

"Vivek Kundra is an amazing technology visionary who opened the eyes of millions to the transformational power of cloud computing," said Salesforce CEO and founder Marc Benioff "His disruptive leadership is just what the industry needs to accelerate the social enterprise."

Prior to serving as U.S. CIO, Kundra was the chief technology officer for Washington D.C. and was the assistant secretary of commerce and technology for the state of Virginia. Last June, Kundra stepped down from his position as CIO to take a fellowship at Harvard University, which was a joint program with the Kennedy School and the Berkman Center for Internet and Society.

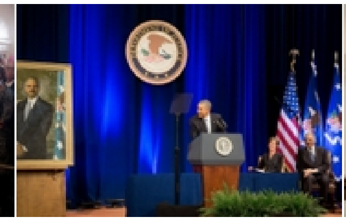
The White House Blog

Subscribe

Our Top Stories


President Obama Marks the 50th Anniversary of the Marches from Selma to Montgomery


Honoring the African American Experience: The White House Celebrates Black History Month


President Obama on Attorney General Holder: "He Has Been One of Our Finest"


My Brother's Keeper: A Year Later

White House Profile

Subscribe

Aneesh Chopra

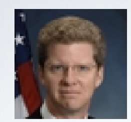
Former U.S. Chief Technology Officer

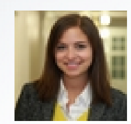
Aneesh Chopra was the Chief Technology Officer and in this role served as an Assistant to the President and Associate Director for Technology within the Office of Science & Technology Policy. He worked to advance the President's technology agenda by fostering new ideas and encouraging government-wide coordination to help the country meet its goals from job creation, to reducing health care costs, to protecting the homeland.

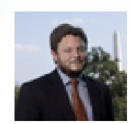
Aneesh was sworn in on May 22nd, 2009. Prior to his appointment, he served as the fourth Secretary of Technology for the Commonwealth of Virginia from January 2006 until April 2009. Prior to his appointment by then-Governor Timothy M. Kaine, he served as Managing Director with the Advisory Board Company, a publicly-traded healthcare think tank. Chopra was named to Government Technology magazine's Top 25 in their Doers, Dreamers, and Drivers issue in 2008.

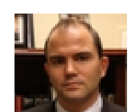
Aneesh Chopra received his B.A. from The Johns Hopkins University and his M.P.P. from Harvard's Kennedy School.

More White House Profiles


Shaun Donovan
Director of the Office of Management and Budget
See Blog Posts


Kori Schulman
Director of Online Engagement for the Office of Digital Strategy
See Blog Posts


Jesse Lee
Director of Progressive Media and Online Response
See Blog Posts


Ben Rhodes
Assistant to the President and Deputy National Security Advisor for Strategic Communications and Speechwriting
See Blog Posts

Sanju Bansal
Chief Executive Officer

Sanju Bansal is the co-founder of MicroStrategy (NASDAQ: MSTR), a worldwide provider of enterprise software platforms for business intelligence (BI), mobile software, big data and cloud-based services. He served as the company's vice chairman of the board of directors and executive vice president till November 14, 2013. From 1993-2012, he served as chief operating officer of MicroStrategy. Bansal serves as a member of the board of directors of Cvent (NYSE: CVT), a cloud-based event management software provider, and The Advisory Board Company (NASDAQ:ABCO), a research services company.

Aneesh Chopra
Co-Founder and Executive Vice President

Aneesh is the former (and first) U.S. Chief Technology Officer. As an Assistant to the President, he designed the National Wireless Initiative, helped launch Startup America, and executed an "open innovation" strategy across the government built on private sector collaboration – opening up data, convening on standards and staffing "lean government startups." He is the author of the book, "Innovative State: How New Technologies can Transform Government" focused on how the country can tap entrepreneurial problem solvers to address challenges in health, energy and education markets among other public and regulated sectors.

Dan Ross
Co-Founder and Executive Vice President

Dan is the former Managing Director of Claraview, a business intelligence and analytics company. Over a 10-year career with the company, Dan was at the forefront of Claraview's growth and rising influence in the business intelligence and analytics market, becoming its chief executive in 2010 following an acquisition by Teradata Corporation (NYSE: TDC).

Prior to his tenure with Claraview and Teradata, Dan held senior management roles at subsidiaries of General Dynamics and Eastman Chemical. He was an early employee at MicroStrategy (NASDAQ: MSTR), and rose through the ranks to a

White House Sends CTO Todd Park Back to Silicon Valley As Recruiter-in-Chief

By Tekla Perry

Share | Email | Print

Posted 3 Sep 2014 | 14:00 GMT

Obama names Google exec Megan Smith as new US chief technology officer

Former Twitter lawyer and NSA resister Alex Macgillivray is second-in-command

By Adrianne Jeffries on September 4, 2014 11:45 am Email @adrjeffries

Former Google lawyer Michelle Lee will run the US patent office

by Jon Fingas | @jonfingas | March 10th 2015 at 3:03 am

It's official: after four months of waiting, former Google legal counsel Michelle Lee has been confirmed as the head of the US Patent and Trademark Office. She was already serving as the acting director (the position has technically been vacant since 2013), but this gives her a more secure footing. The nod is potentially a big help to the agency.

White House Hires Chief Data Scientist, New CIO

Senior executives from Salesforce subsidiary and VMware join the Obama administration.

BY NEWS STAFF / FEBRUARY 5, 2015 0

DJ Patil has joined the White House as its chief data scientist in residence. FLICKR/ KMERON

Big data is a big deal for the Obama administration, which said Thursday it has hired one of Silicon Valley's top data scientists.

DJ Patil, formerly of LinkedIn and RelateIQ, a subsidiary of Salesforce, now serves as chief data scientist in residence for the White House. He'll focus on health-care data, said John Podesta, counselor to the president, during a Feb. 5 press call about the administration's recent big data efforts.

'DATA SCIENCE IS A TEAM SPORT': DJ PATIL SPENDS FIRST DAY PITCHING SILICON VALLEY ON JOINING GOVERNMENT

Just a day after the White House **officially named** DJ Patil the government's first-ever U.S. chief data scientist, the administration's already putting him to work, sending the Silicon Valley alumni to a West Coast tech conference to recruit fellow data scientists to join government

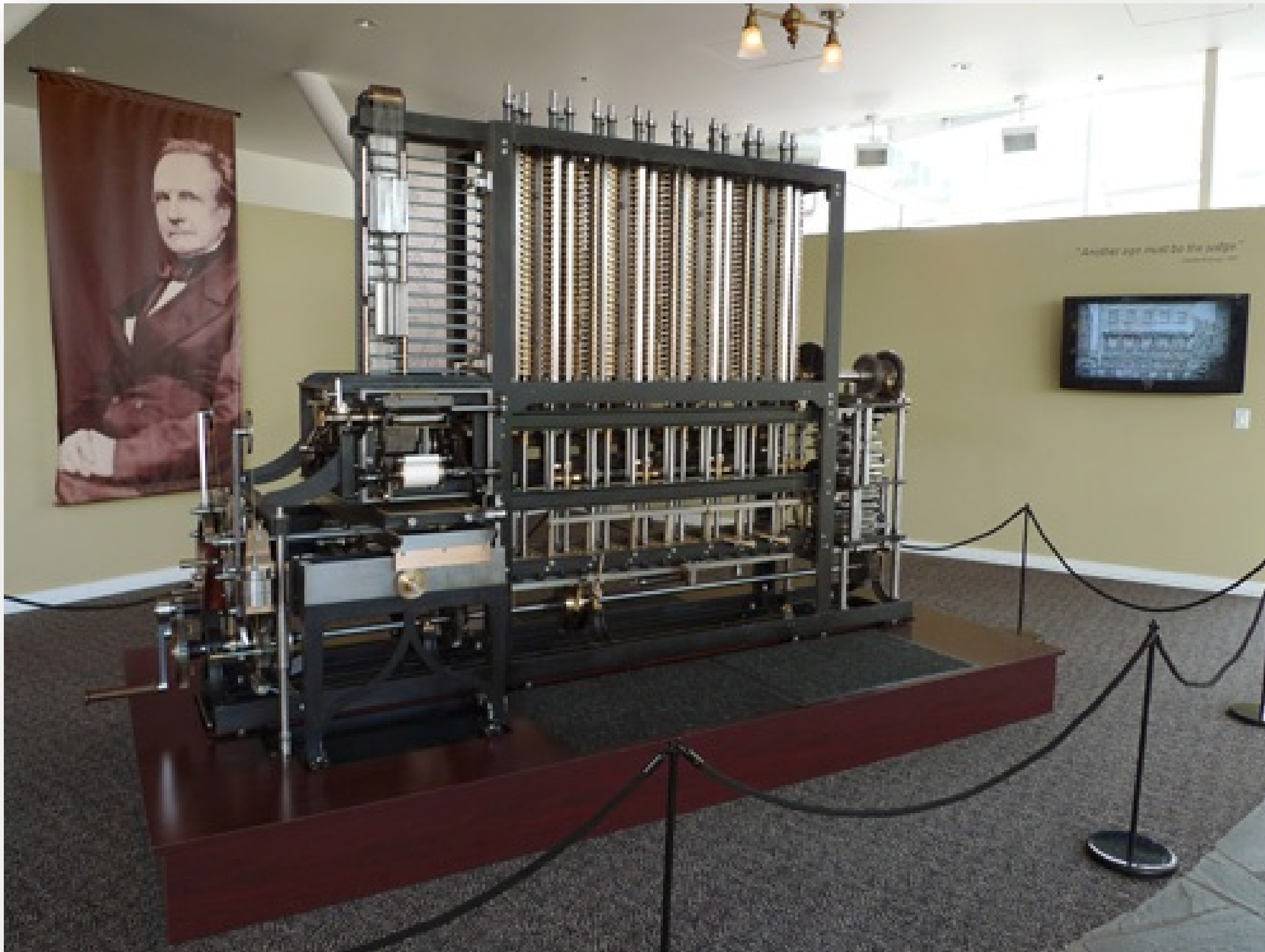
"Data science is a team sport, and we can't do this without you," Patil told attendees of the **"Strata + Hadoop" big data conference** in San Jose on Thursday. "We really need your help ... You don't have to be a U.S. citizen. You don't have to relocate to D.C. There's all sorts of ways to jump in."

Value from data analysis depends on the ability to craft the *contextually relevant*

QUESTION

TRANSACTIONAL QUESTION

Babbage Engine



Charles Babbage (1791-1871), computer pioneer, designed the first automatic computing engines. He invented computers but failed to build them. The first complete Babbage Engine was completed in 2002 in London, 153 years after it was designed. Difference Engine No 2, built faithfully to the original drawings, consists of 8,000 parts, weighs 5 tons and measures 11 feet long. The photograph (above) is an identical Engine completed in March 2008 which is on display at the Computer History Museum at 1401 N Shoreline Blvd, Mountain View, CA 94043.

On two occasions I have been asked [by members of the British Parliament],

'Pray, Mr. Babbage, if you put in the machine the wrong figures, will the right answers come out?'

I am not able to apprehend the kind of confusion of ideas that could provoke such a question.

CHARLES BABBAGE

The next big thing is bigger than big data

it is the

BIG QUESTION

TRANSACTIONAL QUESTION

LABOR REPLACED

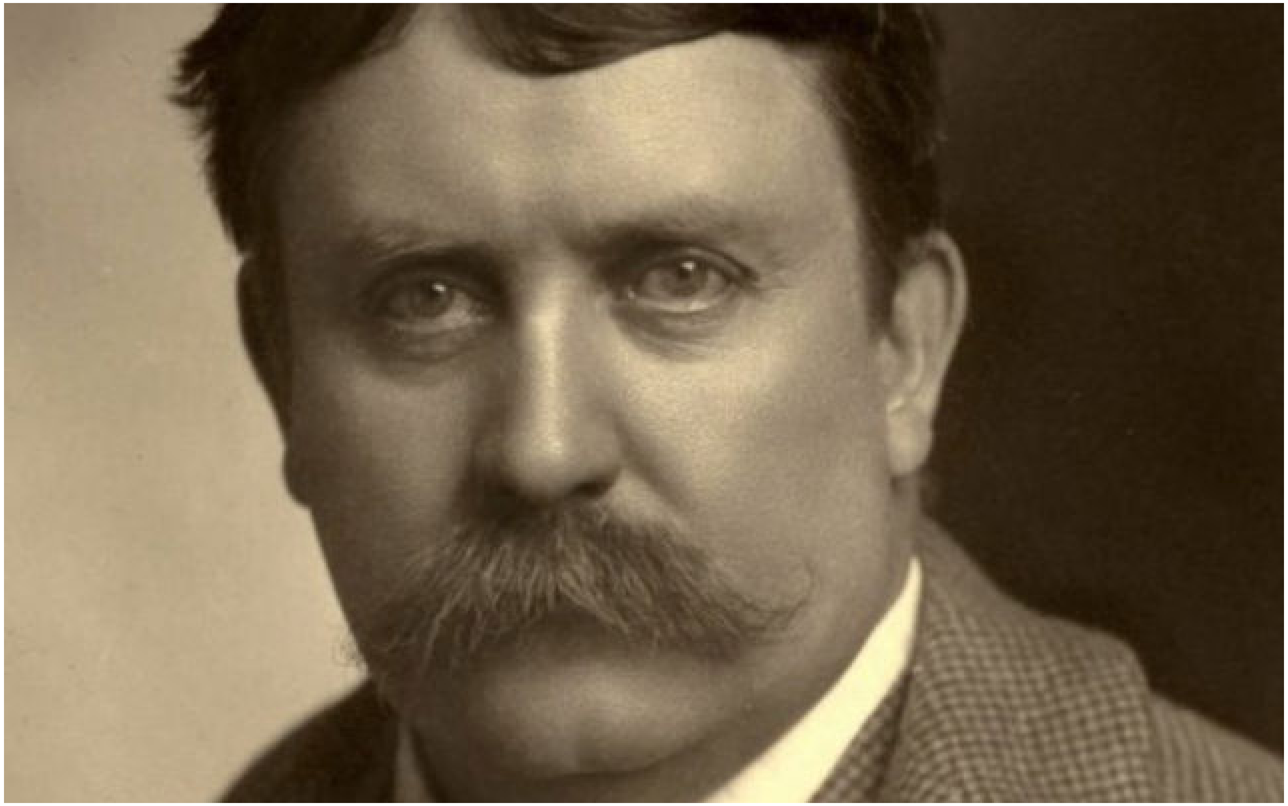
- **Kodak**
  - 1988 ● 145,000 employees
  - 2012 ● Files for bankruptcy
- **Instagram**
  - 2012 ● 13 employees
  - 2012 ● 30 million customers

Sensors, voice recognition, AI, big data, text-mining and pattern-recognition may create robots capable of replacing human

KNOWLEDGE REPLACED ?

www.alternet.org/print/robert-reich-our-horrifying-future-very-few-people-will-have-work-or-make-money

Make no little plans; they have no magic to stir men's blood and probably themselves will not be realized. Make big plans; aim high in hope and work.



Daniel Hudson Burnham (1846-1912) ● www.pbs.org/program/make-no-little-plans/

What is stemming our quantum leap?

STEM Groups	% of STEM Postings	Job Postings
Healthcare	42%	2,451,513
Information Technology	37%	2,201,570
Engineering & Advanced Manufacturing	14%	829,567
Analysts (Math)	4%	216,760
Sciences	3%	187,857

STEM Groups	% of STEM Postings	Average Salary	Entry-Level Postings
BA+ TOTAL	---	**$66,123**	**1,373,628**
Healthcare	56%	$70,095	793,636
Information Technology	27%	$62,184	382,830
Engineering & Advanced Manufacturing	8%	$61,829	115,246
Sciences	5%	$51,337	70,046
Analysts (Math)	3%	$62,326	45,597

Sub-BA
Average Salary
$47,000

www.burning-glass.com/media/3326/Real-Time%20Insight%20Into%20The%20Market%20For%20Entry-Level%20STEM%20Jobs.pdf

21st Century Jobs

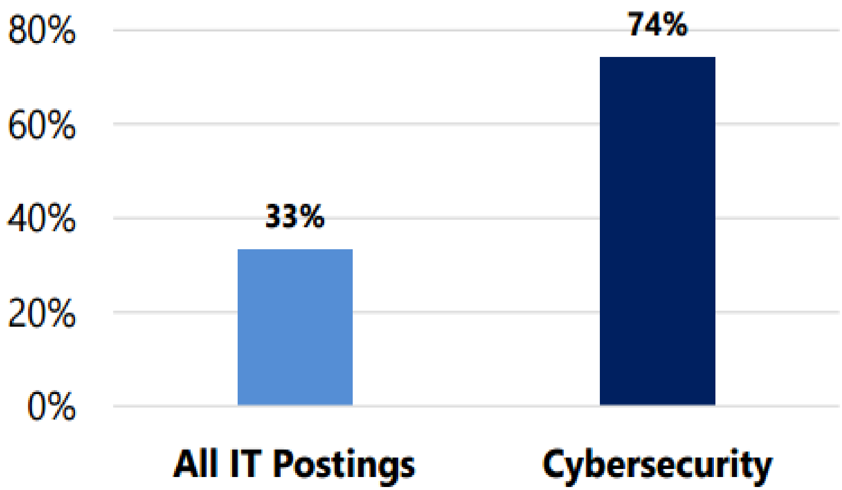
CYBERSECURITY

- In 2013, there were 209,749 postings for cybersecurity-related jobs nationally. **Cybersecurity jobs account for nearly 10% of all IT jobs.**
- Cybersecurity postings have **grown 74%** from 2007-2013. This growth rate is over 2x faster than all IT jobs.

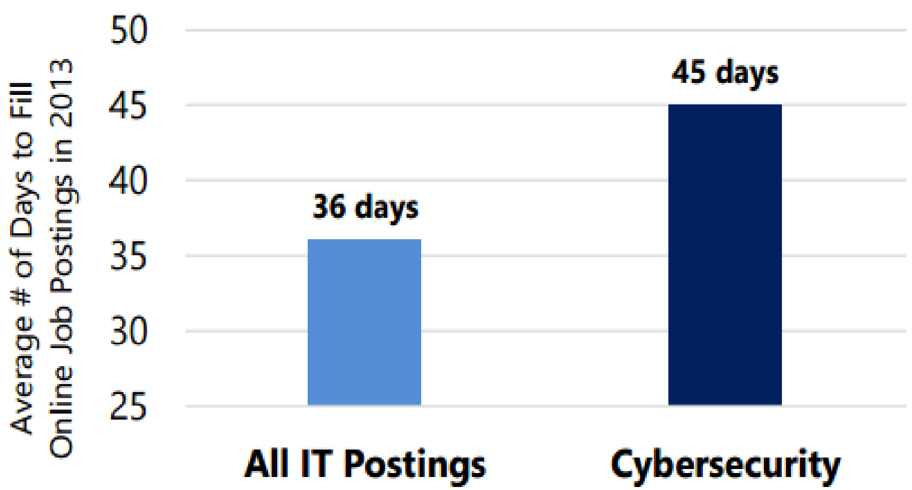
Demand for Cybersecurity Talent Is Outstripping Supply

- Cybersecurity job postings took **24% longer to fill than all IT job postings and 36% longer than all job postings.**
- The demand for cybersecurity talent appears to be outstripping supply. In the US, employers posted 50,000 jobs requesting CISSP, recruiting from a pool of only 60,000 CISSP holders.

Growth in Job Postings (2007-2013)



Posting Duration (2013)



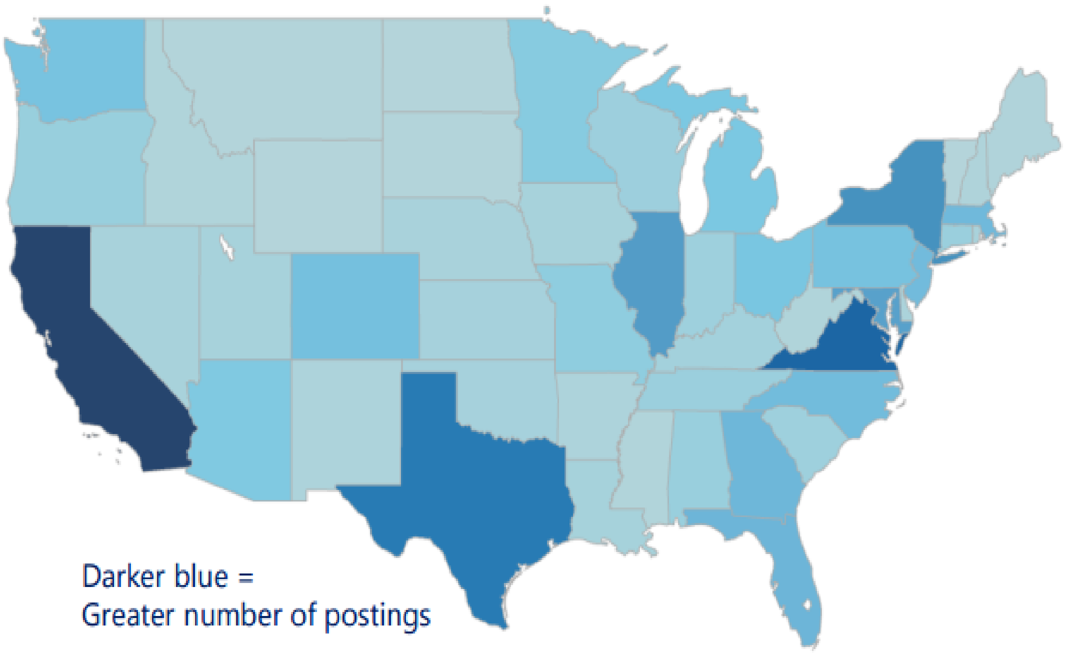
http://www.burning-glass.com/media/4187/Burning%20Glass%20Report%20on%20Cybersecurity%20Jobs.pdf

CYBERSECURITY

Top States by Total Postings*

	State	Total Postings	Postings/ 10,000 Residents	% Growth (2007-2013)
1	California	27,084	7.1	64%
2	Virginia	20,507	25.1	53%
3	Texas	16,376	6.3	97%
4	New York	12,405	6.3	59%
5	Illinois	11,136	8.6	116%
6	Maryland	10,627	18.1	94%
7	Florida	7,923	4.1	46%
8	Georgia	7,539	7.6	214%
9	Massachusetts	7,107	10.7	76%
10	New Jersey	6,814	7.7	12%
11	North Carolina	6,676	6.8	129%
12	Colorado	6,039	11.6	158%
13	Pennsylvania	5,630	4.4	22%
14	Washington	5,444	7.9	76%
15	Ohio	5,086	4.4	34%

Cybersecurity Job Postings in 2013 By State



CYBERSECURITY

Top Cities by Total Postings

	City [redacted]	Total Postings	% Growth (2007-2013)
1	Washington D.C.	23,457	35%
2	New York	15,632	38%
3	San Francisco/ San Jose	12,697	67%
4	Chicago	9,723	115%
5	Dallas	7,669	110%
6	Los Angeles	7,123	38%
7	Boston	6,336	87%
8	Atlanta	5,883	204%
9	Baltimore	4,514	116%
10	Seattle	4,470	63%

Top Cities by Growth

	City [redacted]	Total Postings	% Growth (2007-2013)
1	Atlanta	5,883	204%
2	Denver	3,482	200%
3	Austin	1,979	172%
4	Charlotte	2,410	127%
5	Portland (OR)	1,981	119%
6	Baltimore	4,514	116%
7	Chicago	9,723	115%
8	Phoenix	2,885	114%
9	San Diego	3,665	112%
10	Dallas	7,669	110%

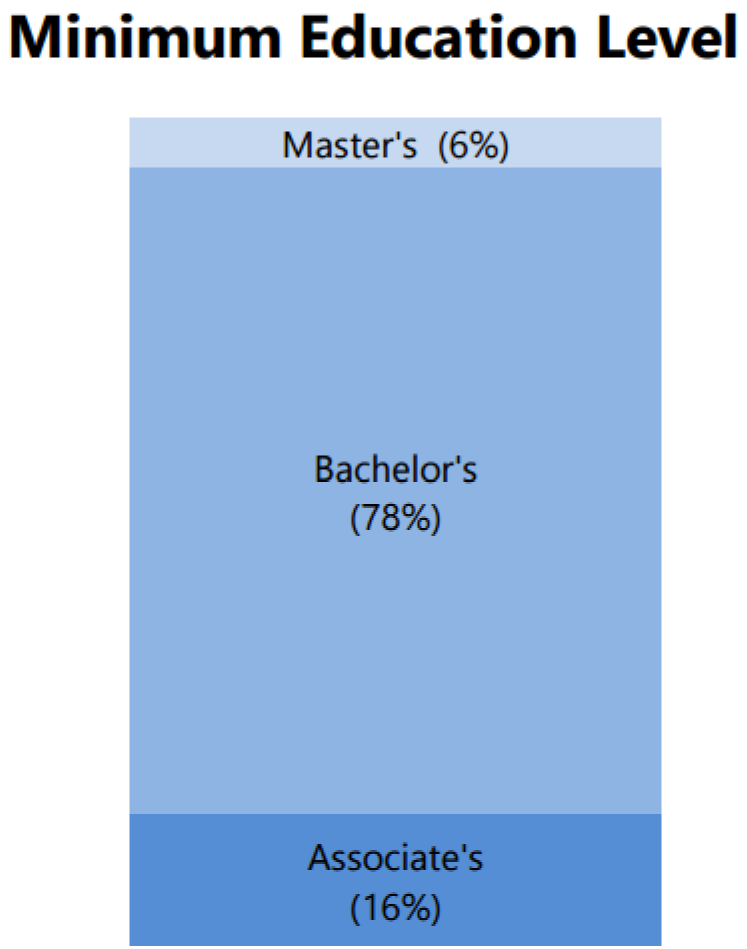
CYBERSECURITY

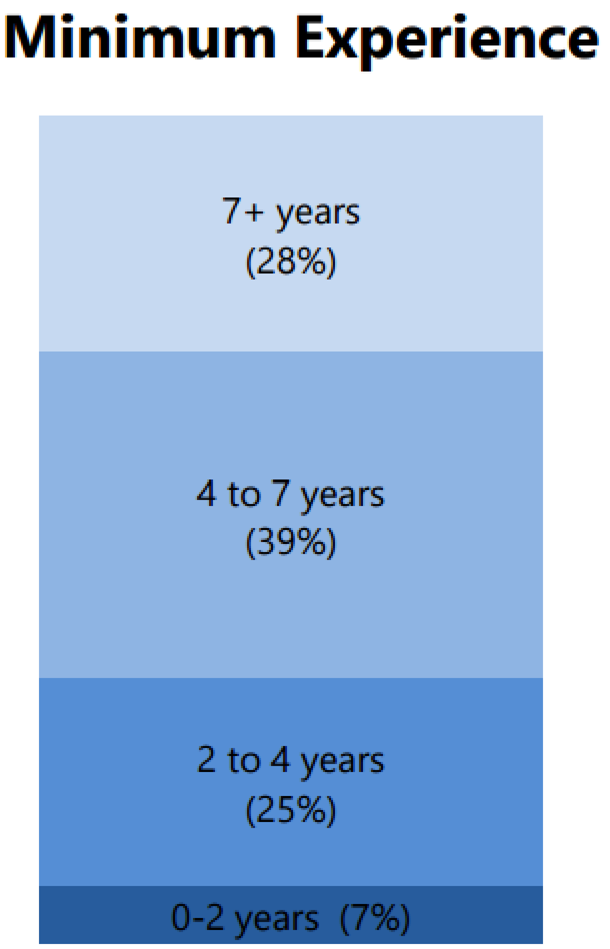
Industry Sector	% of Cybersecurity Postings	Number of Cybersecurity Postings (2013)	2010-2013 Postings Growth
Professional Services	38%	80,446	29%
Manufacturing & Defense*	14%	28,331	16%
Finance and Insurance	12%	24,145	89%
Information	8%	15,820	36%
Health Care	6%	12,257	73%
Public Administration	5%	11,204	N/A**
Retail Trade	5%	10,203	94%
Other	13%	27,384	N/A**

CYBERSECURITY

Title	% of Cybersecurity Postings	Number of Cybersecurity Postings (2013)
Engineer (e.g. Security Engineer, Information Assurance Engineer)	28%	40,898
Manager/Administrator (e.g. Data Security Administrator, Information Security Manager)	19%	28,310
Analyst (e.g. IT Security Analyst, Cyber Intelligence Analyst)	18%	26,219
Specialist/Technician (e.g. IT Security Specialist, Infosec Technician)	9%	13,154
Auditor (e.g. IT Auditor, IT Sarbanes-Oxley Auditor)	5%	7,307
Architect (e.g. Security and Privacy Architect, Network Security Architect)	5%	6,670
Consultant (e.g. Network Security Consultant, Infrastructure Security Consultant)	4%	6,121

CYBERSECURITY





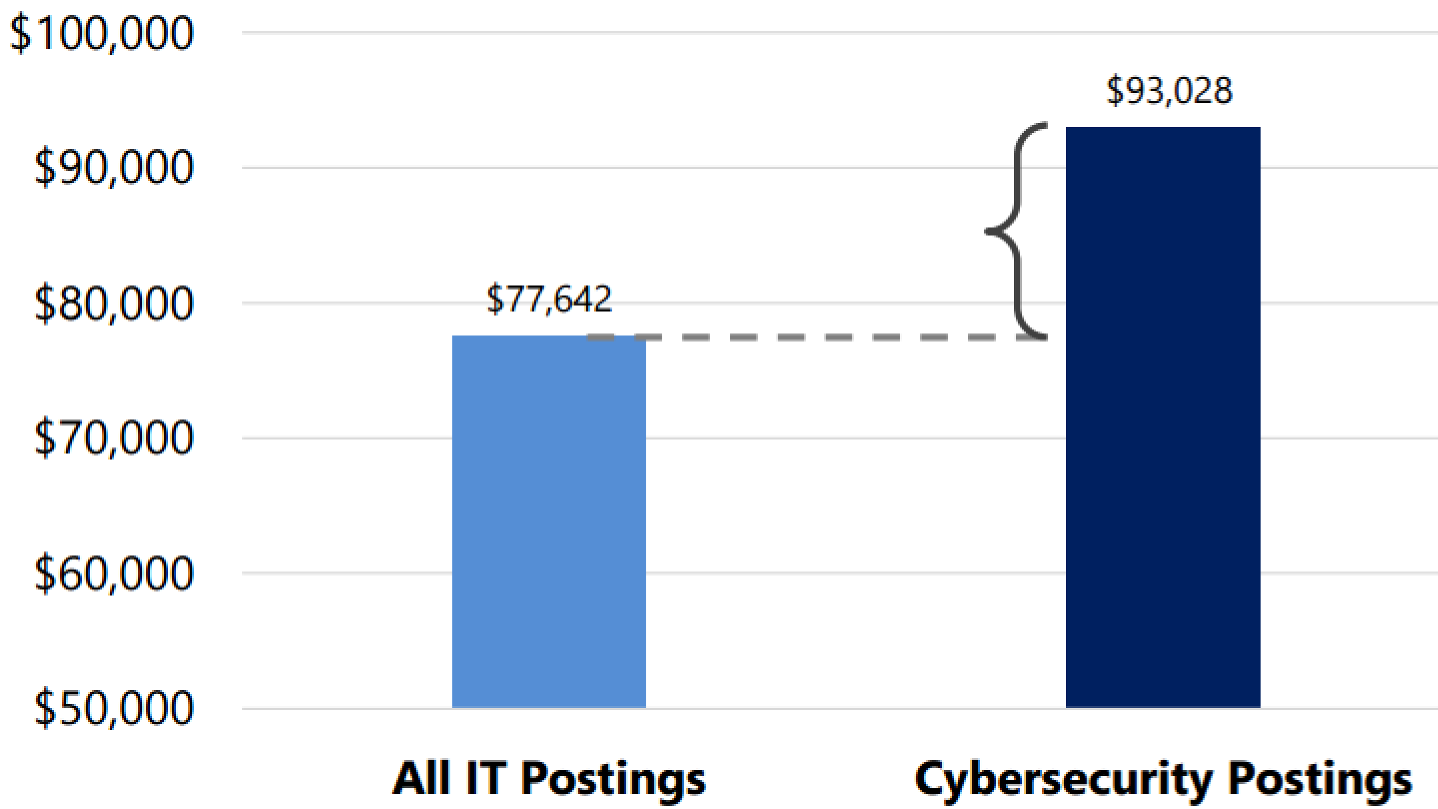
CYBERSECURITY

Certification requirements are more common in cybersecurity roles than in IT generally.

- 51% of all cybersecurity positions request at least one of the certifications listed below.
- 14% of all IT positions request a certification of any kind.

Certification*	% of Cybersecurity Postings	Number of Cybersecurity Postings (2013)
CISSP Certified Information System Security Professional	24%	49,522
CISA Certified Information Systems Auditor	16%	33,290
Security+ Certified Information Security Manager	8%	17,019
CISM Certified Information Security Manager	7%	15,083
GIAC Security Essentials	3%	5,639
CIPP Certified Information Privacy Professional	2%	4,168
SSCP Systems Security Certified Practitioner	2%	4,039
GIAC GCIH GIAC Certified Incident Handler	2%	3,163

CYBERSECURITY



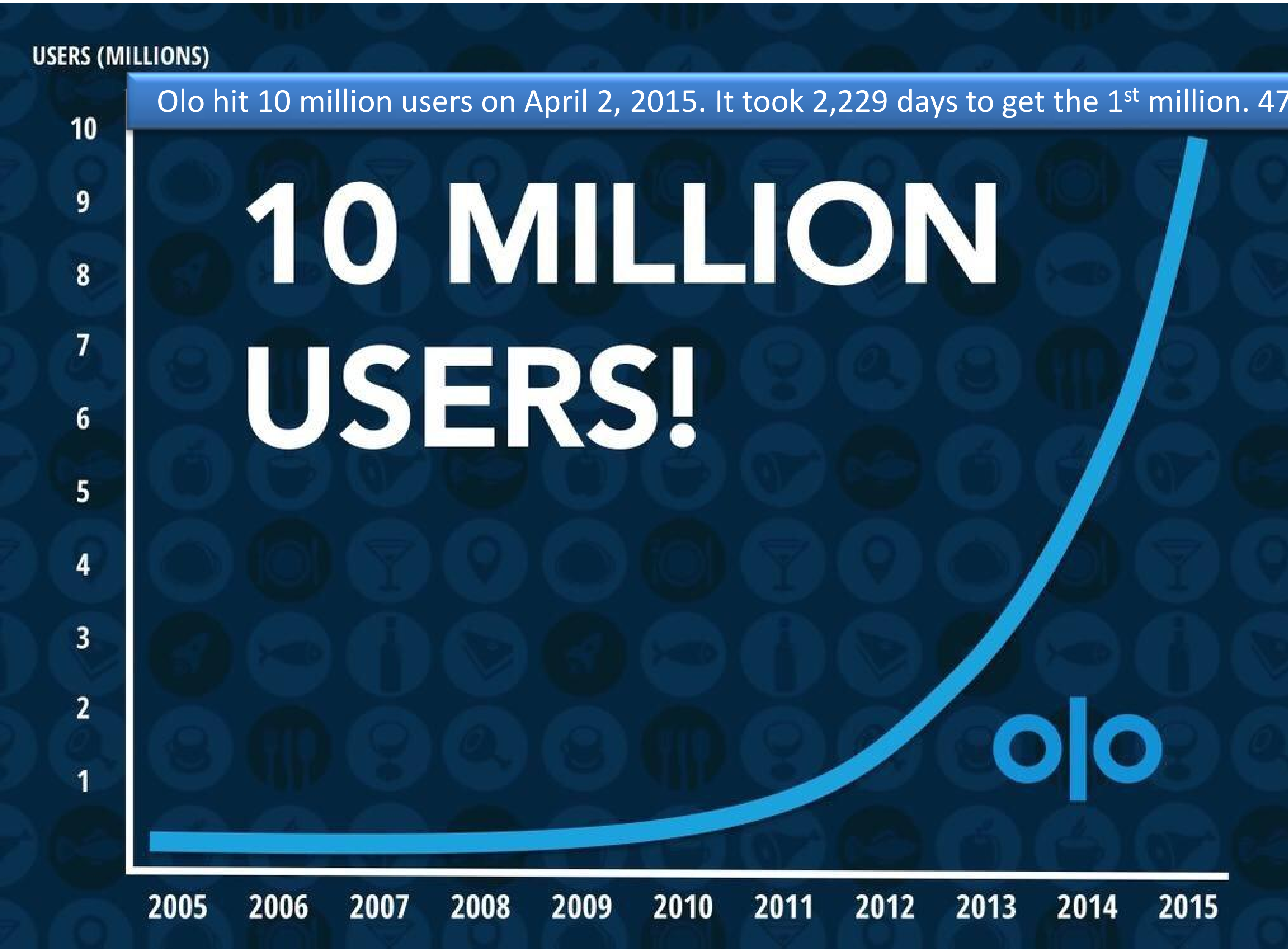
www.burning-glass.com/research/cybersecurity/

What is stemming our quantum leap?

Roadblocks to a Resplendent Future

Perseverance

Olo hit 10 million users on April 2, 2015. It took 2,229 days to get the 1st million. 47 days to get to the last

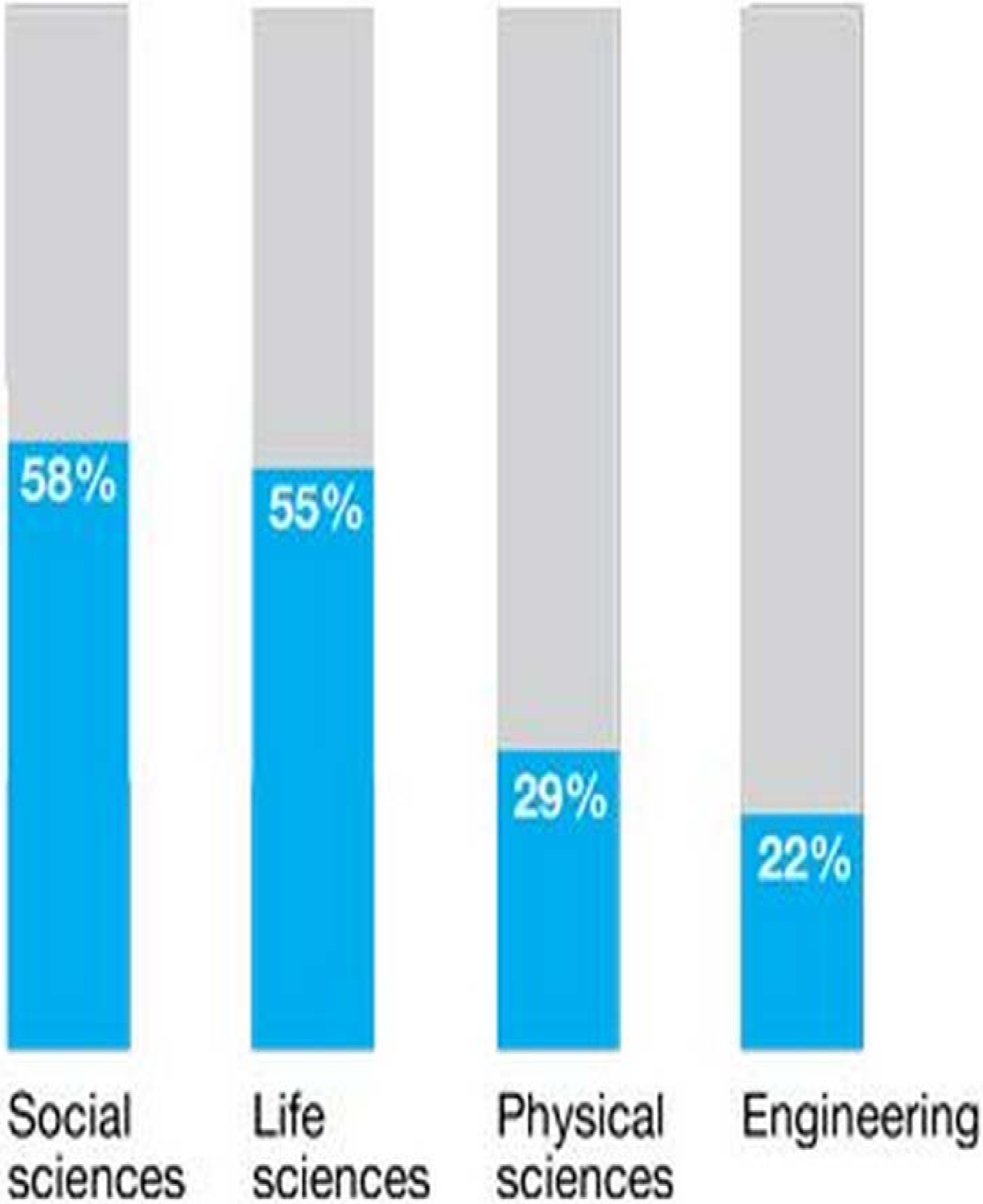


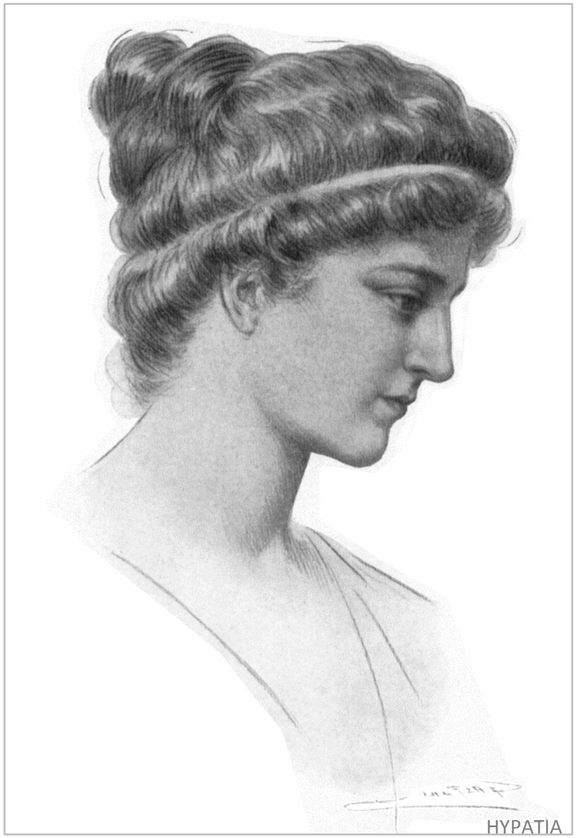
But was the Newton a failure? The timing of Newton's entry into the handheld market was akin to the timing of the Apple II into the desktop market. It was a market-creating, disruptive product targeted at an undefinable set of users whose needs were unknown to either themselves or Apple. On that basis, Newton's sales should have been a pleasant surprise to Apple's executives: It outsold the Apple II in its first two years by a factor of more than three to one. But while selling 43,000 units was viewed as an IPO-qualifying triumph in the smaller Apple of 1979, selling 140,000 Newtons was viewed as a failure in the giant Apple of 1994.

http://bit.ly/INNOVATORS-DILEMMA

- Apple Developers Conference, Santa Clara Convention Center (March 2014)

Doctorates awarded to female candidates (NSF, 2012)





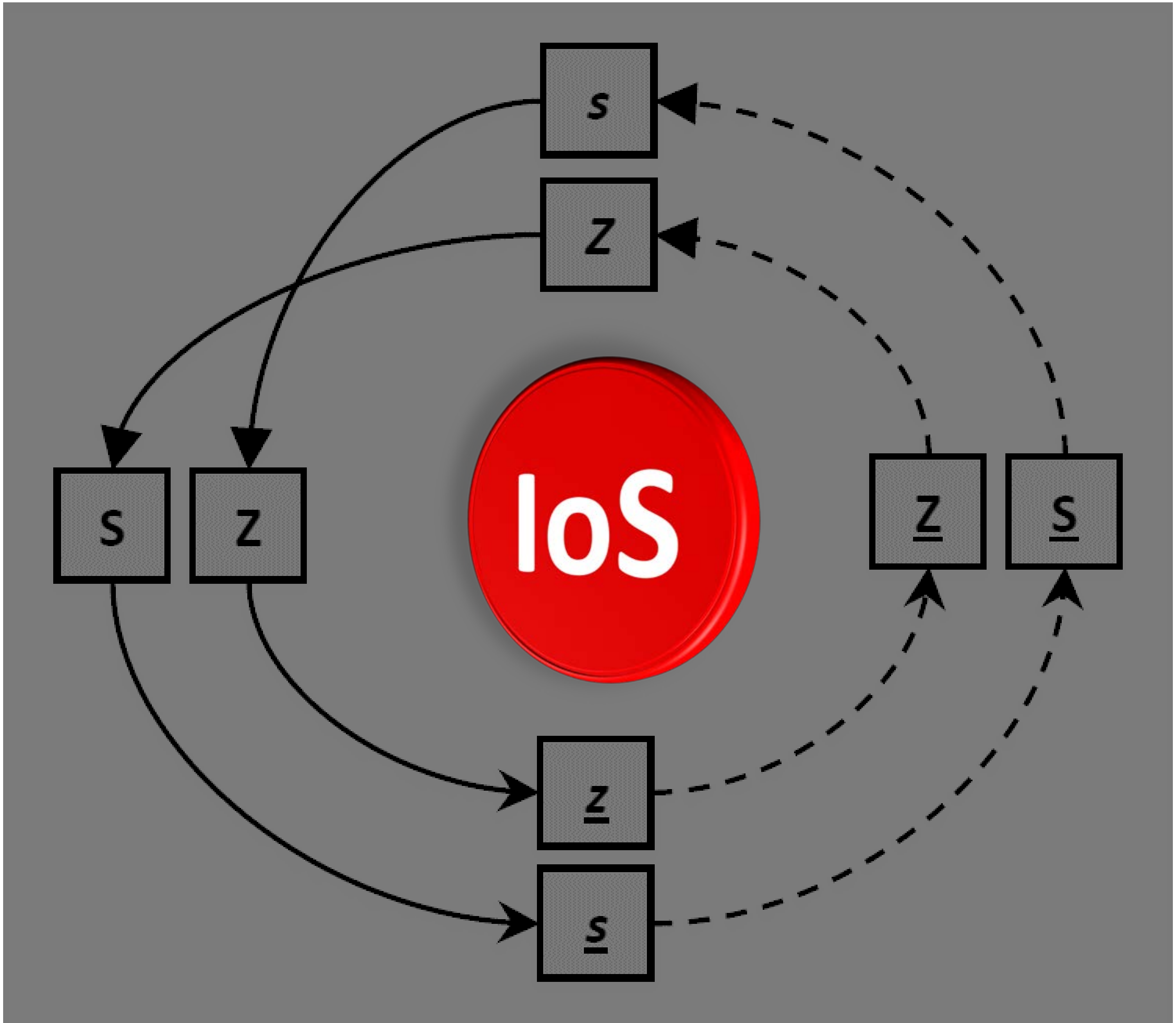
http://bit.ly/Water-Gate

Top 10 emerging technologies of 2015 from the +**World Economic Forum** :

1. Fuel cell vehicles
2. Next-generation robotics
3. Recyclable thermoset plastics
4. Precise genetic engineering techniques
5. Additive manufacturing
6. Emergent artificial intelligence
7. Distributed manufacturing
8. 'Sense and avoid' drones
9. Neuromorphic technology
10. Digital genome

https://agenda.weforum.org/2015/03/top-10-emerging-technologies-of-2015-2/

Internet of Systems



s
Z
S
Z
IoS
Z
S
z
s

Disclaimer

The contents presented here by the author should not be mistaken to reflect or represent the brilliance or skills of the author. The author has neither created anything new nor invented any portion of this collective thinking. The references to material from scientists at MIT, CMU, HMS and other institutions are borrowed and aggregated by the author to suggest potential confluence of ideas. Many of these ideas are common and should not be viewed as ideas due to the author, alone. The meteoric accomplishments and the august institutional image of MIT and other organizations are solely due to the scientists and their scientific genius. There is absolutely no connectivity between these works and the author. The author neither represents the science nor the scientists. The author is not a contributor (unless specifically mentioned here) but merely a collector. This is not an attempt by the author to masquerade under any institutional banner of excellence. The author does not claim to be a part of the rigorous standards of excellence exemplified by MIT or imply that the author is a part of that intellectual fabric that one perceives about the elite institutions which may be mentioned in this presentation. The author has merely borrowed the material to spin a yarn to depict a resplendent future. The progress of civilization is due to science by the scientists. The author is an external observer of that magnificent process of evolution which creates a sense of the future. Please enjoy the ride.