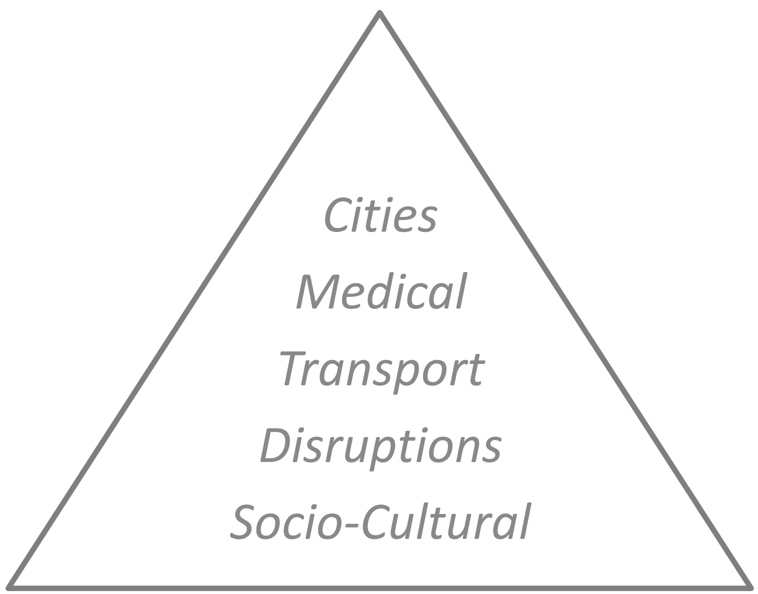
This is a connected series of presentations which discusses the following topics. It is divided into segments simply for the sake of convenience. It may be better if reviewed as a continuum to extract the sense one wishes to convey.

Platforms

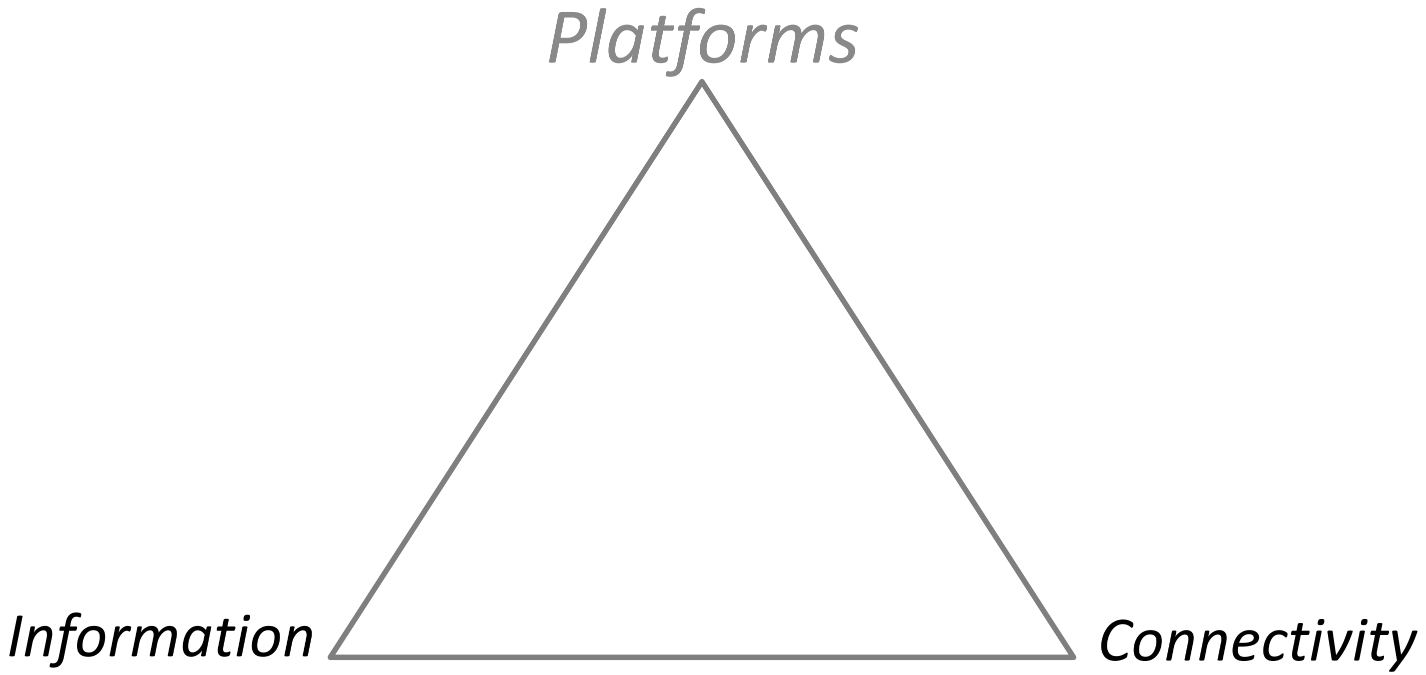


Dr Shoumen Palit Austin Datta ● Senior Vice President, IIC ● Research Affiliate, MIT ● shoumen@mit.edu ● datta@iiconsortium.org

Platforms are indivisible but better understood if discussed as

Platform as a Principle = Information

Platform as a Practice = Connectivity



Platform as a Principle

Information

The Information Age is not over. It started with the Big Bang which created the Solar System and it may persist *ad infinitum* as long as the Solar System continues its physical existence. It is the mother of all platforms and the most fundamental fabric of connectivity. Our understanding of the difference between hydrogen and oxygen is based on information. The difference between bauxite and the material of the Coke can is information. Information is the differentiator between Apple Newton which died prematurely vs the almost identical Palm Pilot that once climbed the luminous summit. Information changes when the car you are driving is suddenly crushed in a collision with a truck. Think about the approximately 500 inhabitants of Mureybet, Syria in 8000BC and compare their information content to the approximately 1500 modern day inhabitants of Dingle village in County Kerry (Ireland) which boasts of at least 50 pubs in this miniscule hamlet near the Atlantic. Information has grown. Described by Claude Shannon in 1948 as informational entropy, it has been shown that the interpretation of entropy (formula) provided by Ludwig Boltzmann (the Boltzmann equation) becomes the Shannon equation, thus mathematically linking entropy and information.

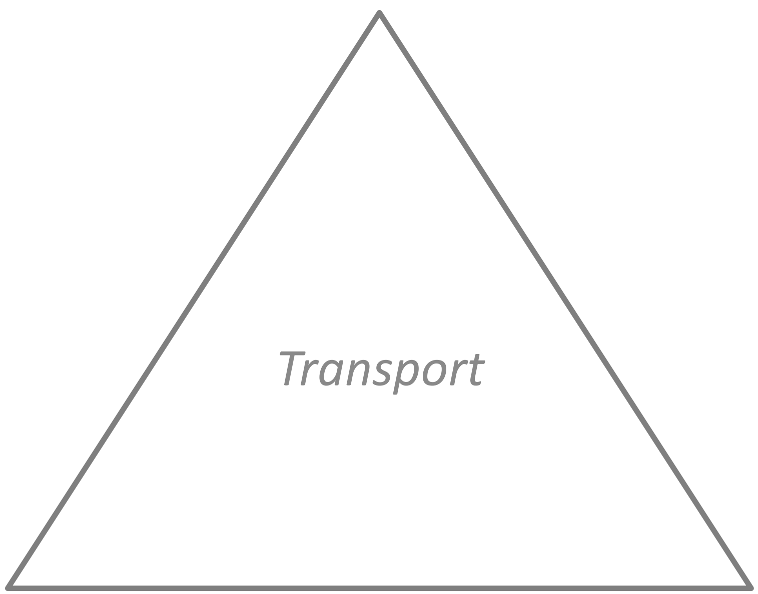
Platform as a Practice

Connectivity

Is it a new theme? Isn't it fundamentally pervasive in every entity – physical, metaphysical and cyberphysical? Doesn't it transcend the sub-nano realm and the super-macro domain? Doesn't it define the astronomical universe, all biological systems and everything conceptual in between? The mobility of ancient civilizations to explore new worlds were physical connections between atoms. The bargain hunter's app to compare prices between various retailers is the new sense of value which connects bits with atoms. All things and processes are about connectivity. Invention and innovation was, is and will be about connecting the dots, real and/or virtual, perceived and/or imagined. Human thought, technological progress and the future of synaptic neuromorphic quantum dots are manifestations of connectivity, convergence and confluence of concepts. The sense of connectivity is germane to life. Its ubiquity makes us oblivious to its quintessential nature. To evoke the central theme of connectivity, therefore, is not an insight but rather recognizing the fabric of the future which is hiding in plain sight. This series highlights some of these old ideas.

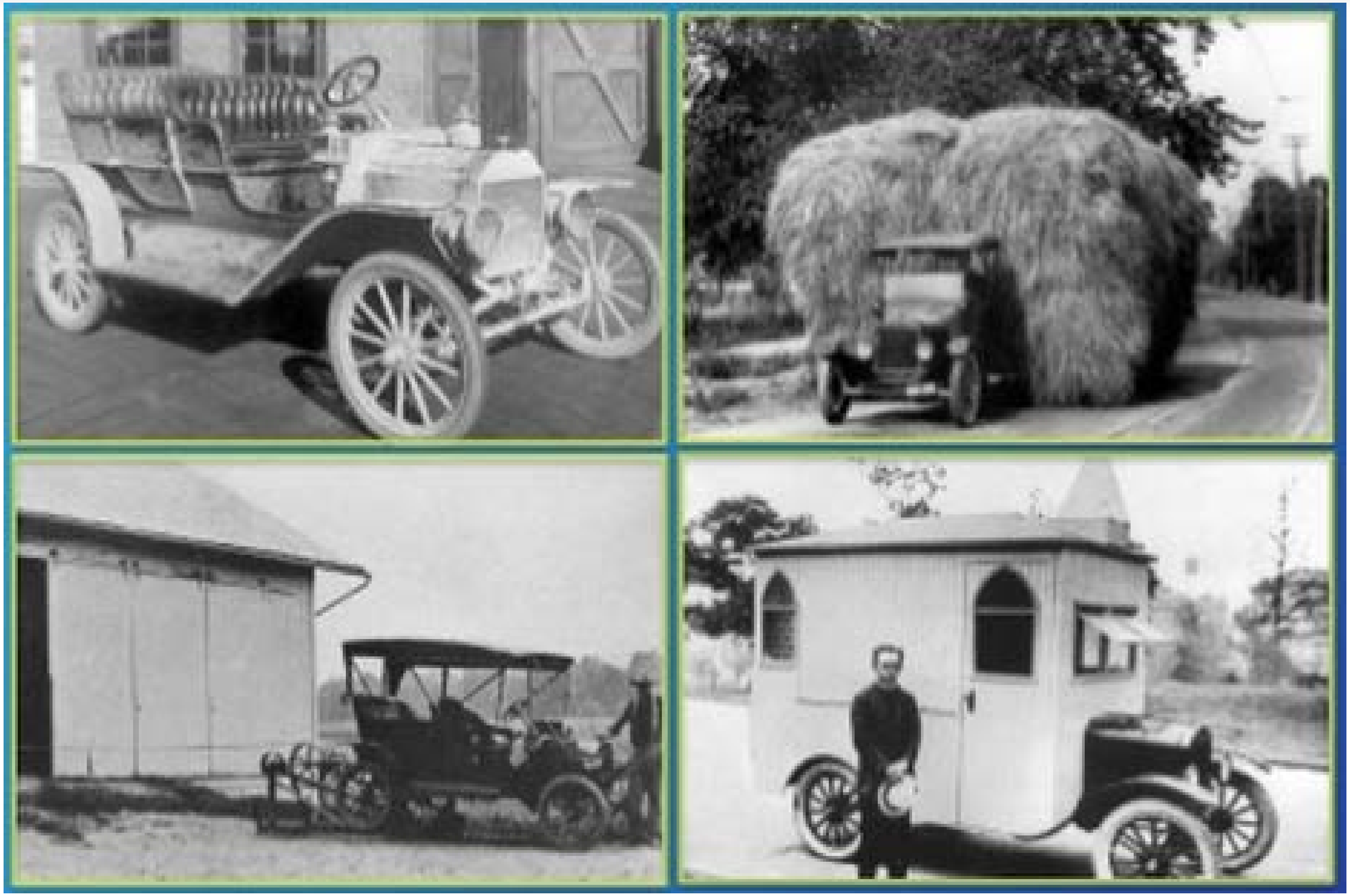
This is an introductory segment which is loosely focused on

Transportation



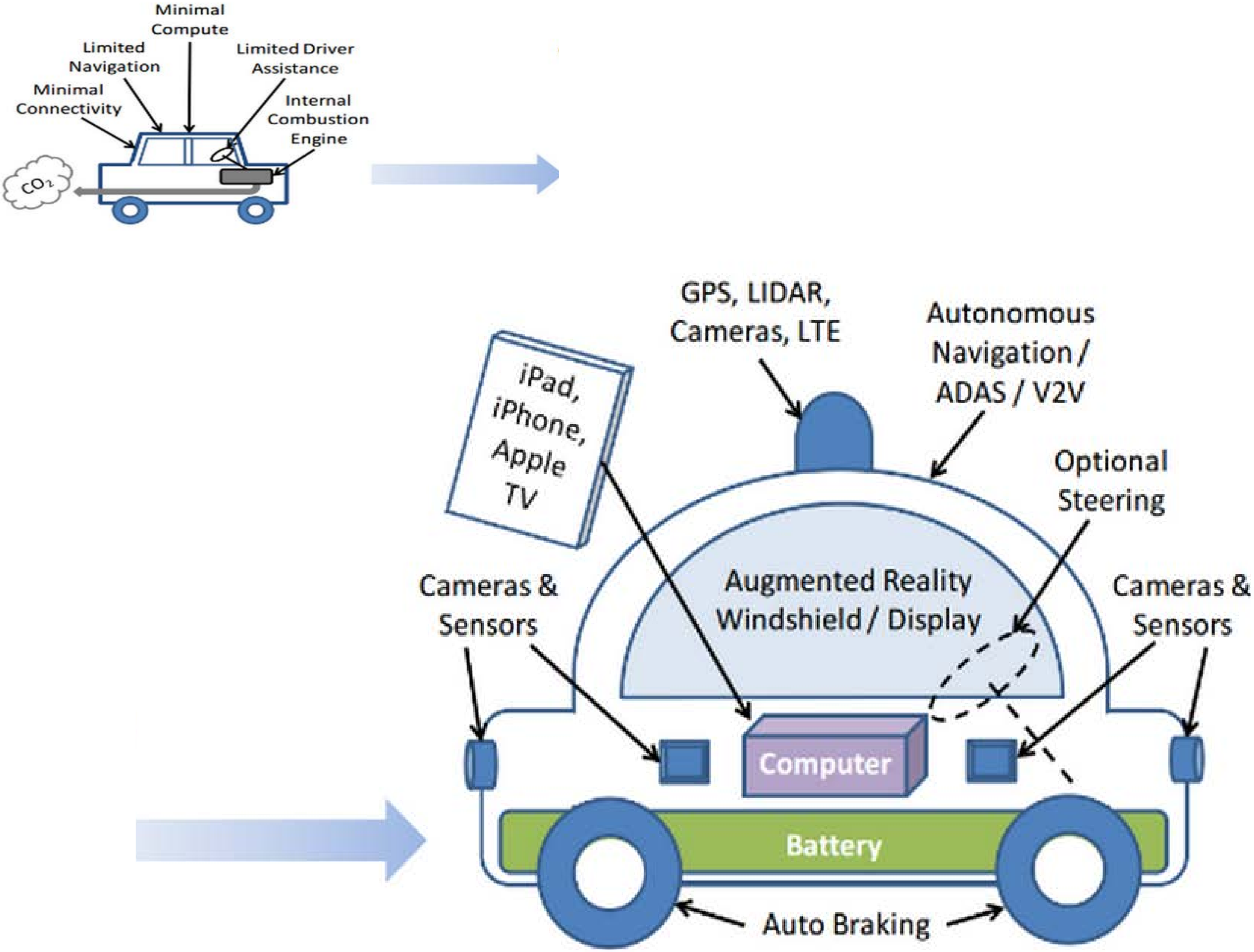
http://bit.ly/MIT-IOT

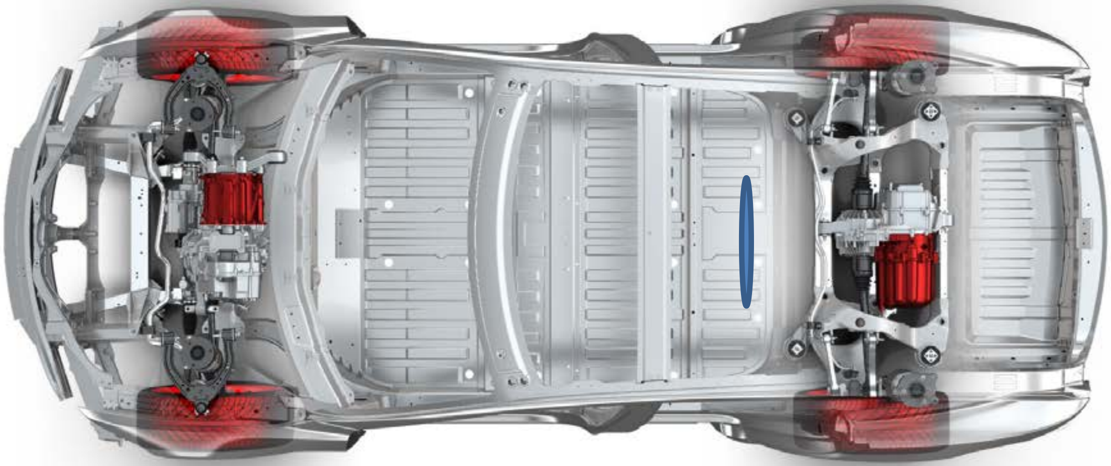
20th Century Transport



The Ford Model T Mobile Flour Mill-on-Wheels

The Ford Model T Mobile Church-on-Demand

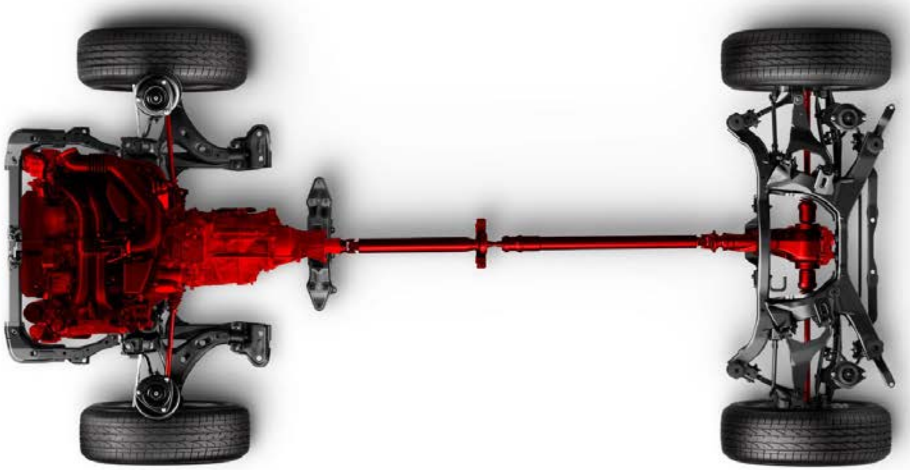

Minimal
Compute
Limited
Navigation
Limited Driver
Assistance
Minimal
Connectivity
Internal
Combustion
Engine
CO2
GPS, LIDAR,
Cameras, LTE
Autonomous
Navigation /
ADAS / V2V
iPad,
iPhone,
Apple
TV
Optional
Steering
Cameras &
Sensors
Augmented Reality
Windshield / Display
Cameras &
Sensors
Computer
Battery
Auto Braking



ELECTRIC ALL-WHEEL DRIVE

VS

MECHANICAL ALL-WHEEL DRIVE



21st Century Transport

Autonomy in the 21st Century ??

EHANG 184

www.digitaltrends.com/cool-tech/ehang-184-drone-flying-taxi-ces-2016/

'airport for drones'

By Jacopo Prisco, for CNN
Updated 5:49 AM ET, Mon October 5, 2015

'airport for drones'

RWANDA

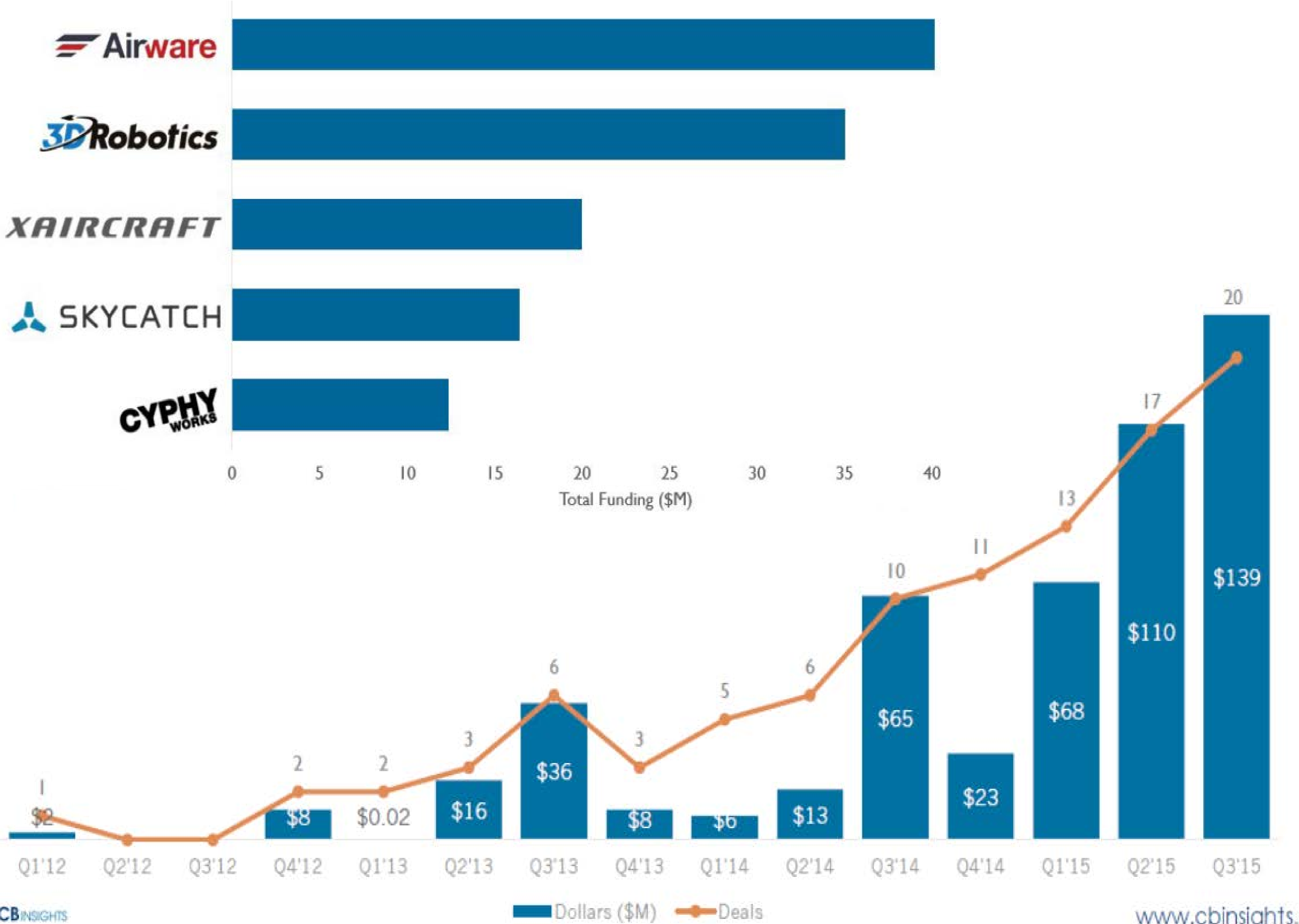
By Jacopo Prisco, for CNN
Updated 5:49 AM ET, Mon October 5, 2015

11 photos: Rwanda to get world's first airport for drones

Fleets of drones carrying crucial goods such as medicine will soon streak the skies of Rwanda, putting the small east-central African country at the forefront of a technological revolution.

Designed to be cheap, simple and robust, the drones will have payloads of up to 100 kg (220lb), while the droneports will function as hubs to allow recharging, cargo loading and dropoff, as well as repairs.

Top 5 Most Well-Funded Drone Startups



Autonomy in the 22nd Century ??

25 Corporations Not Named Google Working On Driverless Cars

Audi
Bai du 百度
BMW
BOSCH
DAIMLER
DELPHI
Ford
GM
SAIC 上汽集团 SAIC MOTOR
Google
HONDA
HYUNDAI
JAGUAR
LAND-ROVER
Mercedes-Benz
MOBILEYE
NISSAN
RENAULT
SCANIA
TATA ELXSI engineering creativity
TESLA
TOYOTA
UBER
Volkswagen
VOLVO
YUTONG

BREAKING NEWS U.S. oil settles below $30 a barrel for first time in 12 years

BUSINESS | AUTOS & TRANSPORTATION | AUTOS

U.S. Proposes Spending $4 Billion to Encourage Driverless Cars

Obama administration aims to remove hurdles to making autonomous cars more widespread

http://bit.ly/MIT-edX-Cybersecurity

http://bit.ly/DSED-EN-FR-CN-ES

http://bit.ly/FIVE-EQUATIONS

http://bit.ly/MIT-edX-IoT

http://bit.ly/MIT-IOT

The Obama administration proposes spending nearly $4 billion over 10 years to speed adoption of driverless cars. Regulators are a to develop guidelines and possible rules for their use.

By MIKE SPECTOR and MIKE RAMSEY

Updated Jan. 14, 2016 9:08 p.m. ET

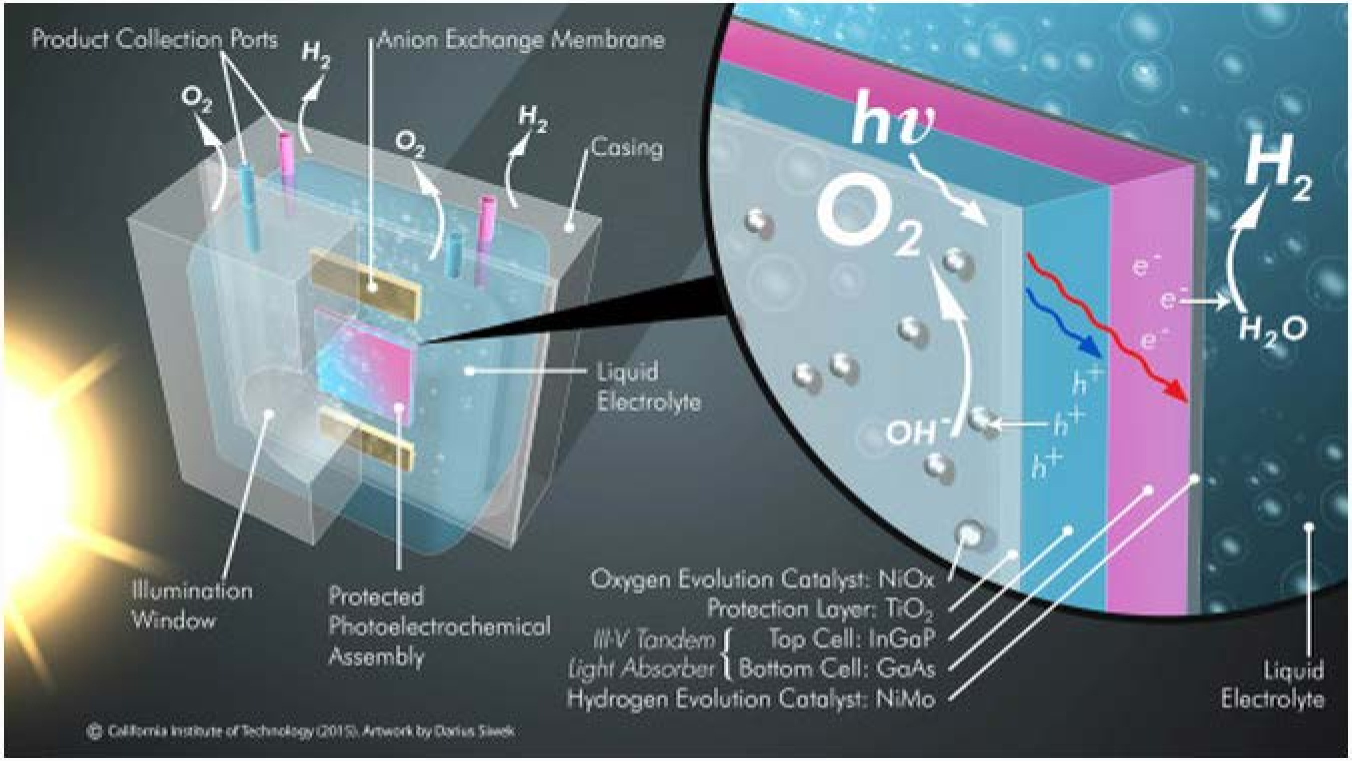
APPLE'S ELECTRIC CAR MAY HIT THE ROAD IN 2019

By **Trevor Mogg** — September 22, 2015

21st Transport Landing Pad is in progress

Transport and Energy are inextricably linked

The Holy Grail of Renewable Energy – Artificial Photosynthesis



Artificial photosynthesis **isn't new**, as the concept has existed since 1912. It has been researched ever since, but as with many **renewable technologies**, the cost of production has always been too high. Finding materials and creating a stable system have also been major challenges. After five years of work, JCAP has pioneered new technology that can bridge the gap, creating a process that's not only efficient, but also stable and cost effective.

http://inhabitat.com/new-artificial-leaf-technology-could-revolutionize-renewable-energy-production/

http://bit.ly/LEAF-CALTECH-HYDROGEN

1 Dirham = US 27 c
3.785 L = 1 US gal
4.546 L = 1 UK gal

Fuel prices announcement 2015 (Dh/litre)

Implemented August 1

Petrol	Current price	New price	Per cent change
Super 98	1.83	2.25	↑ 24%
Special 95	1.72	2.14	↑ 24%
E Plus 91	1.61	2.07	↑ 28%
Diesel*	2.90	2.05	↓ 29%

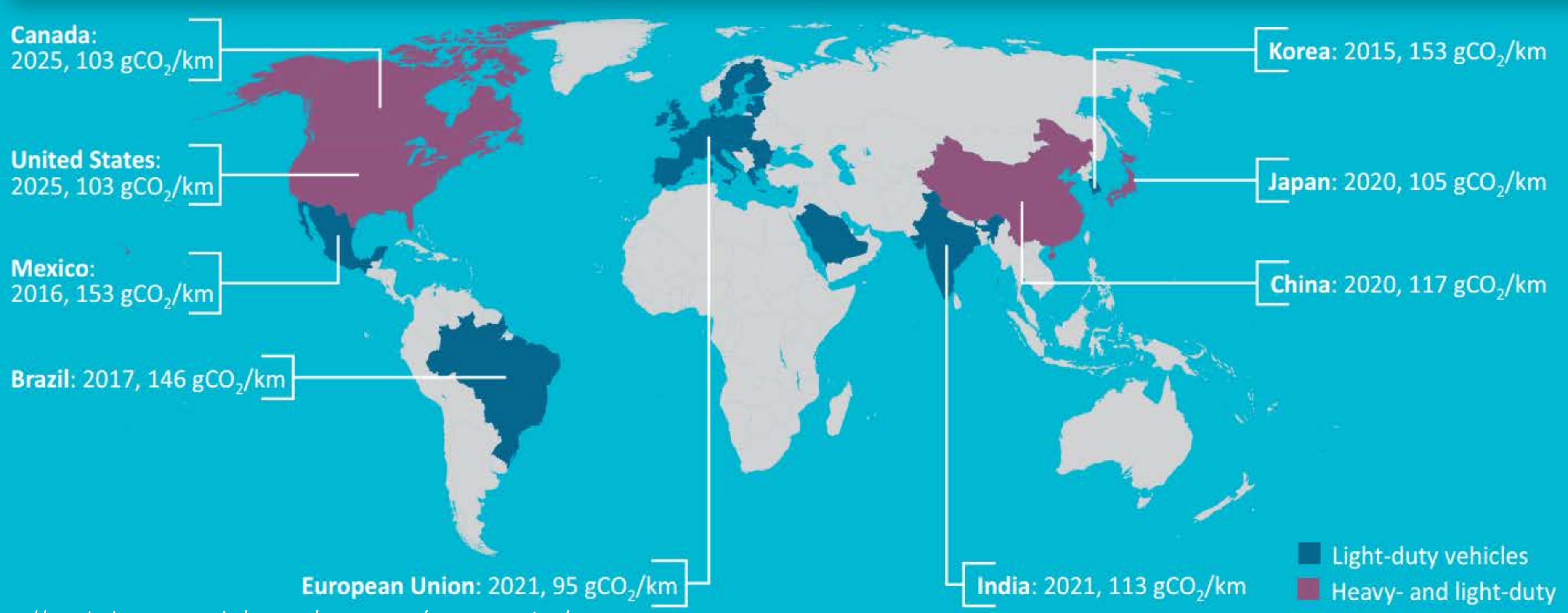
Petrol prices (Dh/litre)

* Diesel in Abu Dhabi was 2.35 a litre and 2.90 in Dubai and the Northern Emirates. All diesel will now be priced at 2.05 - a decrease of 12 per cent in Abu Dhabi, and almost 30 per cent in Dubai and the Northern Emirates.

Source: Ministry of Energy, globalpetrolprices.com, xe.com

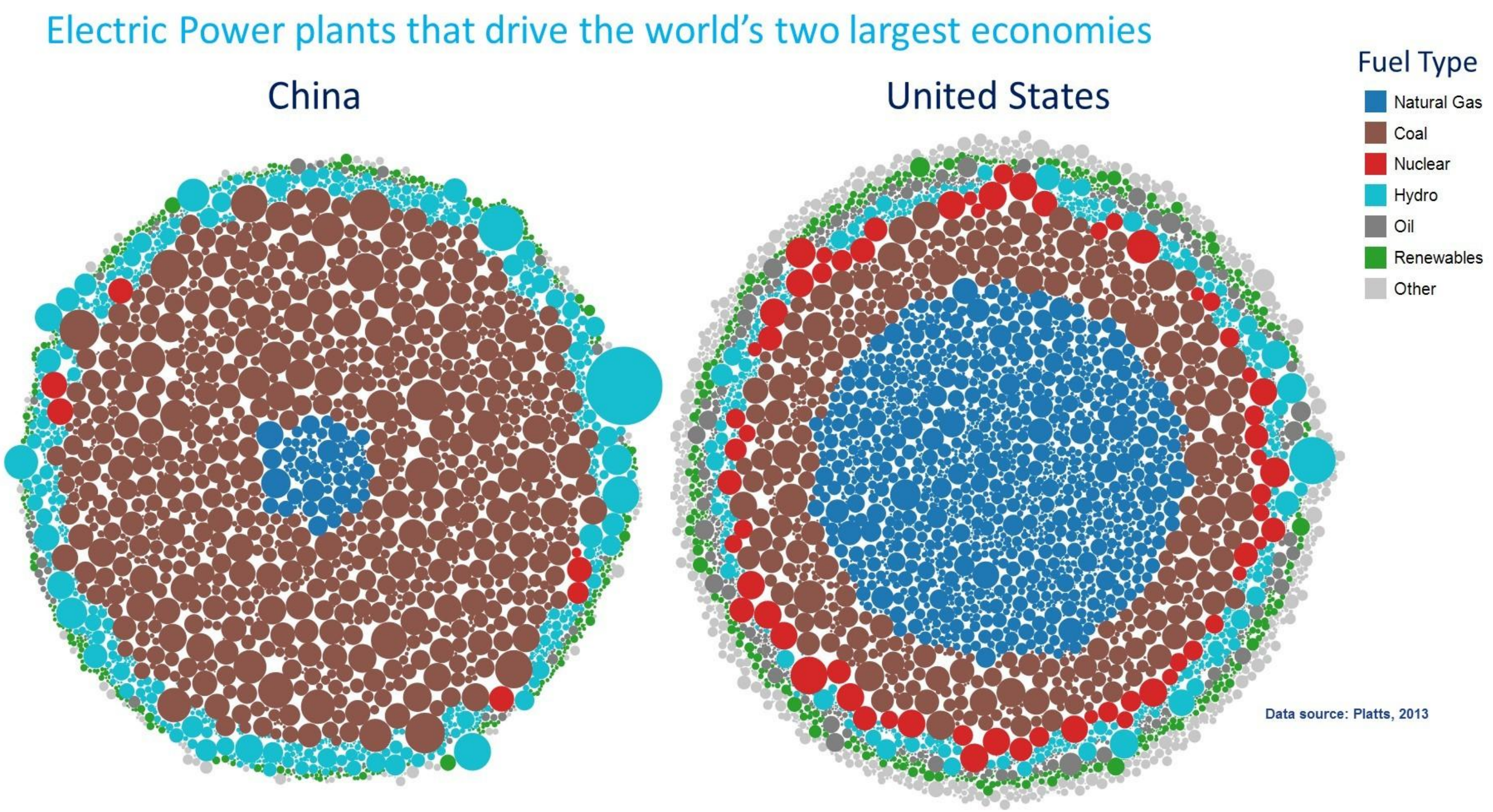
New Vehicle Fuel Economy Standards

30% of total energy consumed is due to transport
90% of the energy for transport uses fossil fuels

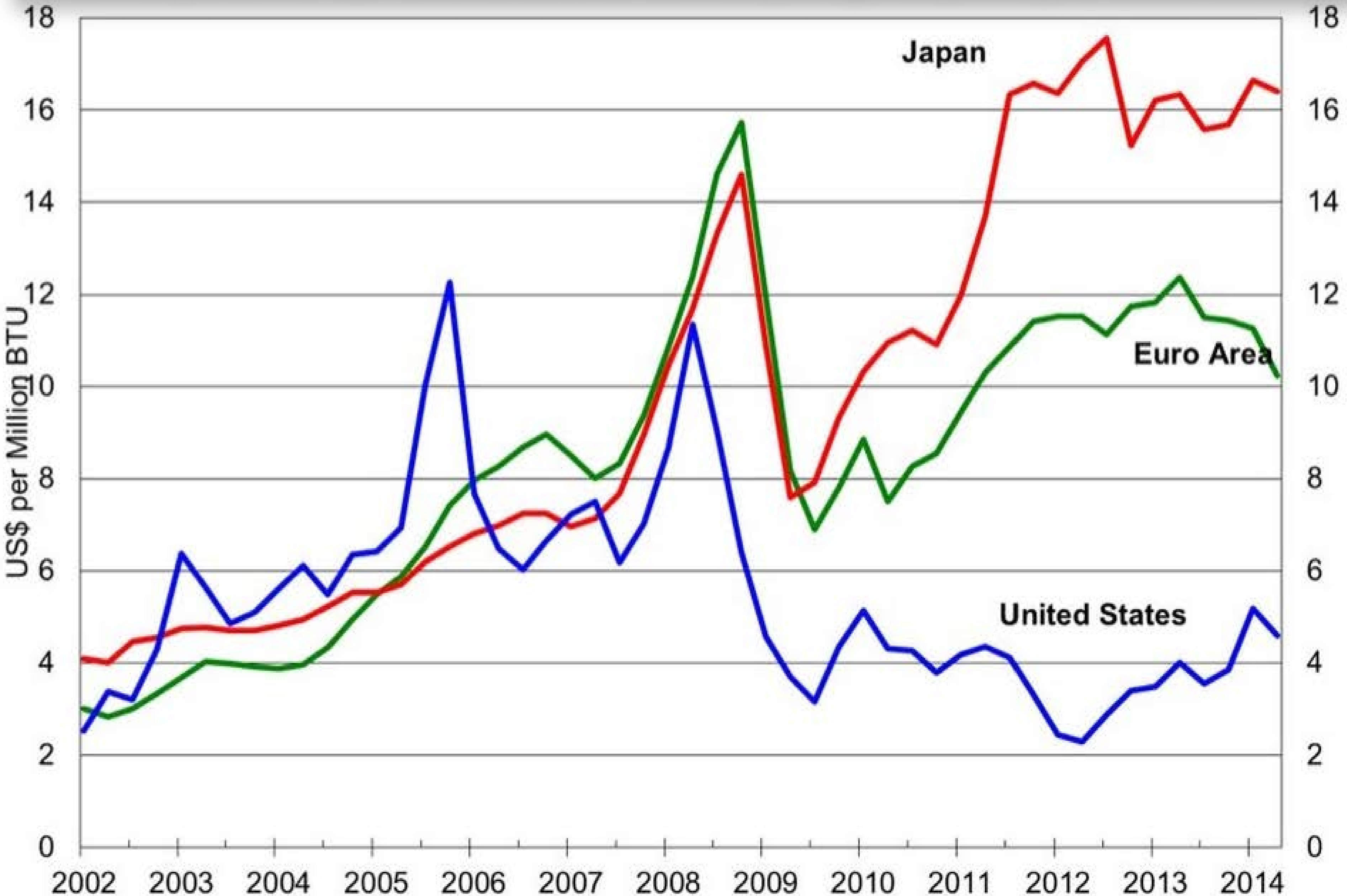


http://needtoknow.nas.edu/energy/energy-use/transportation/

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

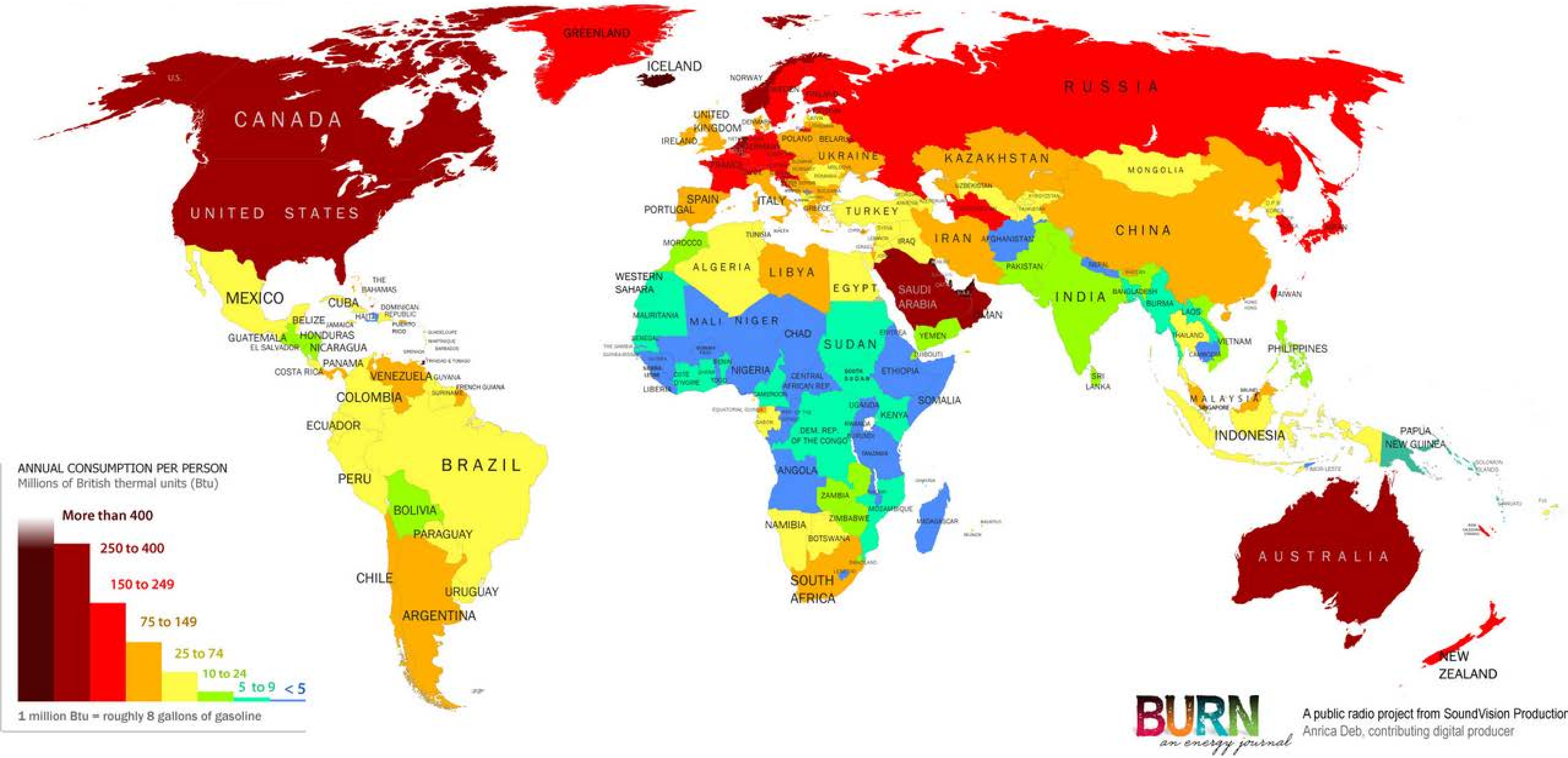


Reality Check ☑ Natural Gas Prices by Region (USD per million BTU)



The World Bank

ENERGY CONSUMPTION BY COUNTRY (2010)

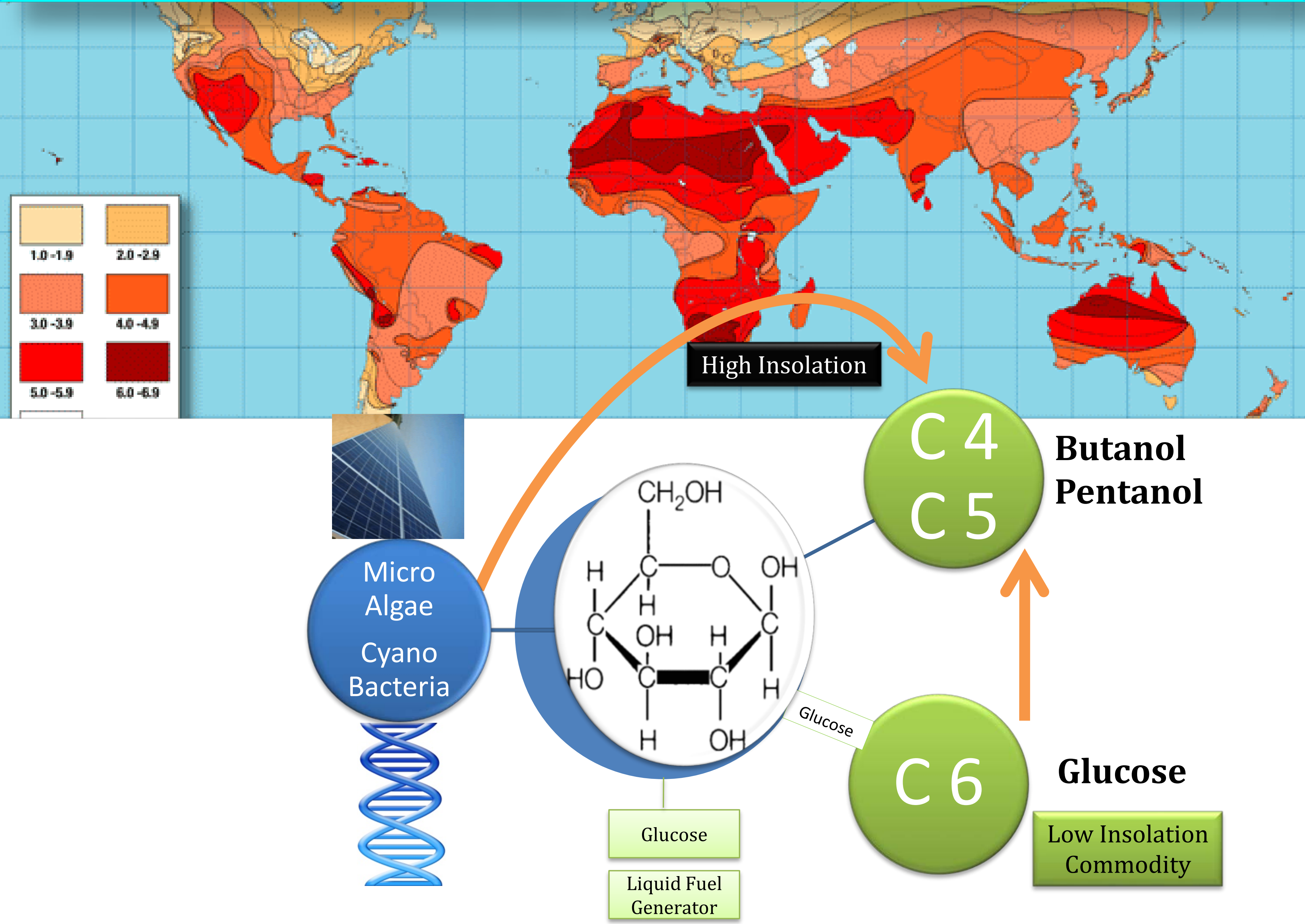


http://burnanenergyjournal.com/wp-content/uploads/2013/03/WorldMap_EnergyConsumptionPerCapita2010_v4_BargraphKey.jpg

The Quest for Carbon-Neutrality

The Hydrogen Economy ?

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



Pushing the Bar on Low-Cost Solar Technology: The Advanced Research Projects Agency – Energy (ARPA-E)'s Micro-scale Optimized Solar-cell Arrays with Integrated Concentration (MOSAIC) Program is announcing $24 million for 11 projects in seven states across the country to develop innovative solar technologies to double the amount of energy each solar panel can produce from the sun, while reducing costs and the space required to generate solar energy. http://bit.ly/ARPA-E-MOSAIC http://bit.ly/MOSAIC-PROJECTS

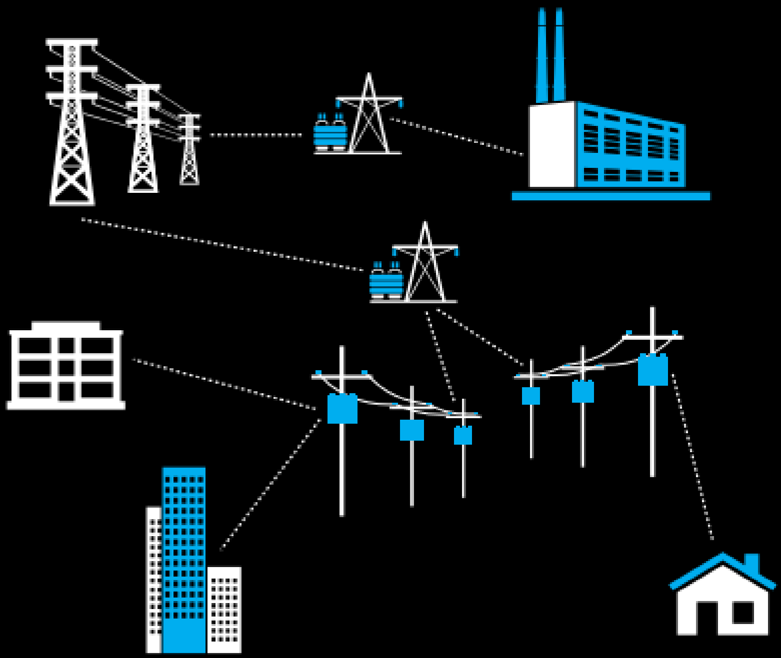
- **California Institute of Technology** (Pasadena, CA) **-** *Micro-Optical Tandem Luminescent Solar Concentrator*
- **Glint Photonics, Inc.** (Burlingame, CA) - *Stationary Wide-Angle Concentrator PV System*
- **Palo Alto Research Center** (Palo Alto, CA) - *Micro-Chiplet Printer for MOSAIC*
- **Massachusetts Institute of Technology** (Cambridge, MA) - *Integrated Micro-Optical Concentrator Photovoltaics with Lateral Multijunction Cells*
- **Massachusetts Institute of Technology** (Cambridge, MA) **-** *Wafer-Level Integrated Concentrating Photovoltaics*
- **Panasonic Boston Laboratory (**Newton, MA) **-** *Low Profile CPV Panel with Sun Tracking for Rooftop Installation*
- **University of Rochester (**Rochester, NY) **-** *Planar Light Guide Concentrated Photovoltaics*
- **Semprius, Inc. (**Durham, NC) **-** *Micro-Scale Ultra-High Efficiency CPV/Diffuse Hybrid Arrays Using Transfer Printing*
- **The Pennsylvania State University** (University Park, PA) **-** *Wide-Angle Planar Microtracking Microcell CPV*
- **Texas A&M University Engineering Experiment Station** (College Station, TX) **-** *Waveguiding Solar Concentrator*
- **Sharp Laboratories of America** (Camas, WA) - *A High-Efficiency Flat Plate PV with Integrated Micro-PV atop a 1-Sun Panel*

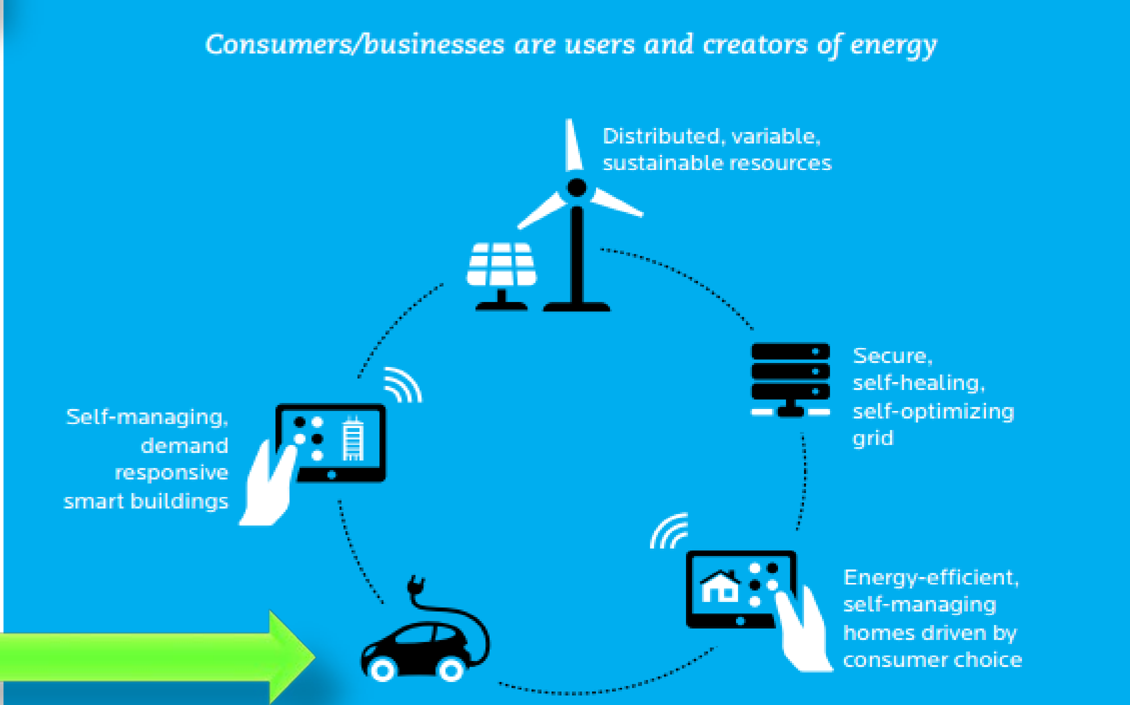
Renewed Vigor for Renewable Energy

Change is in the wind

HYPER MOBILE MICRO GRIDS?

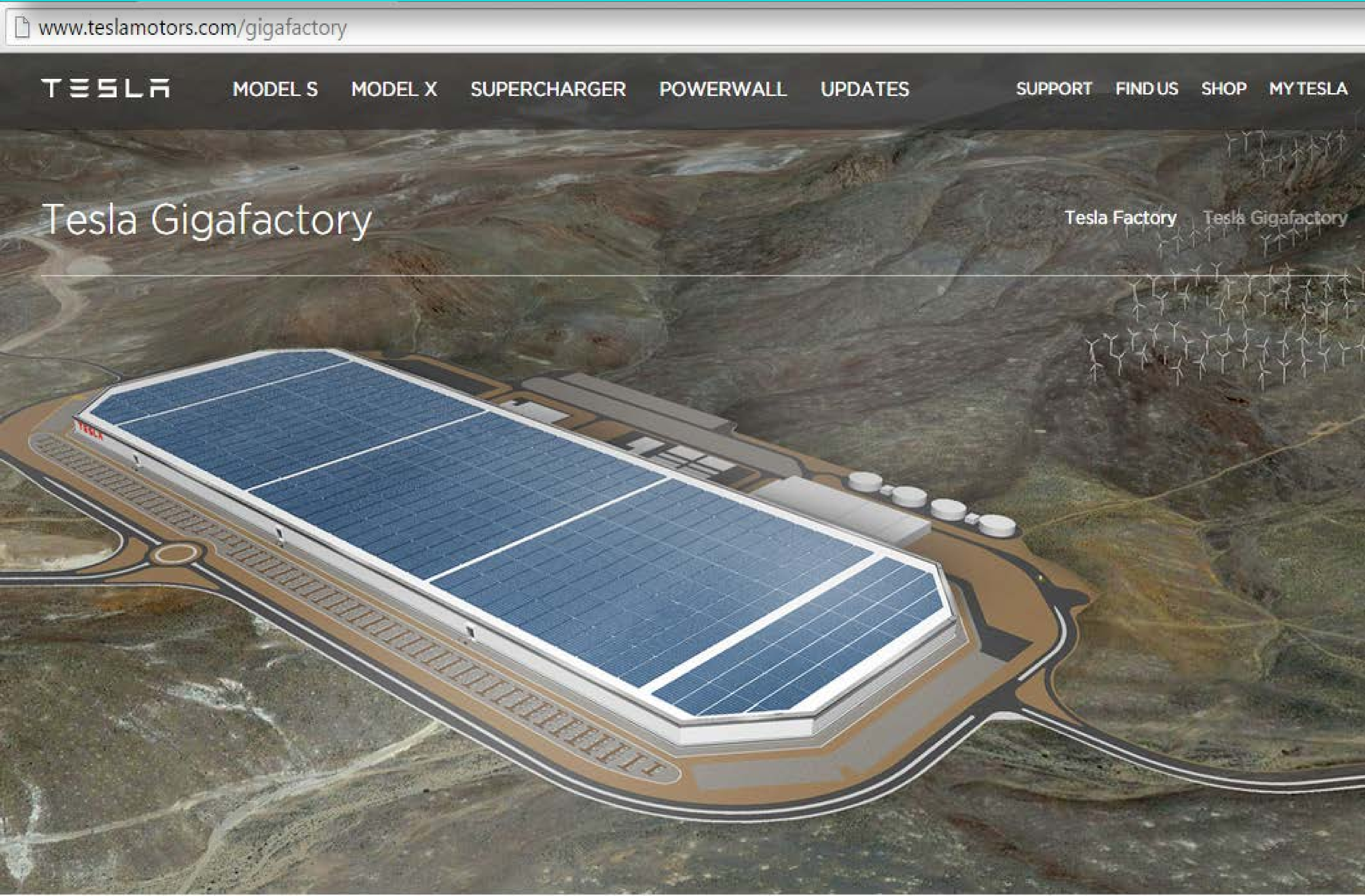
DISRUPTOR ?



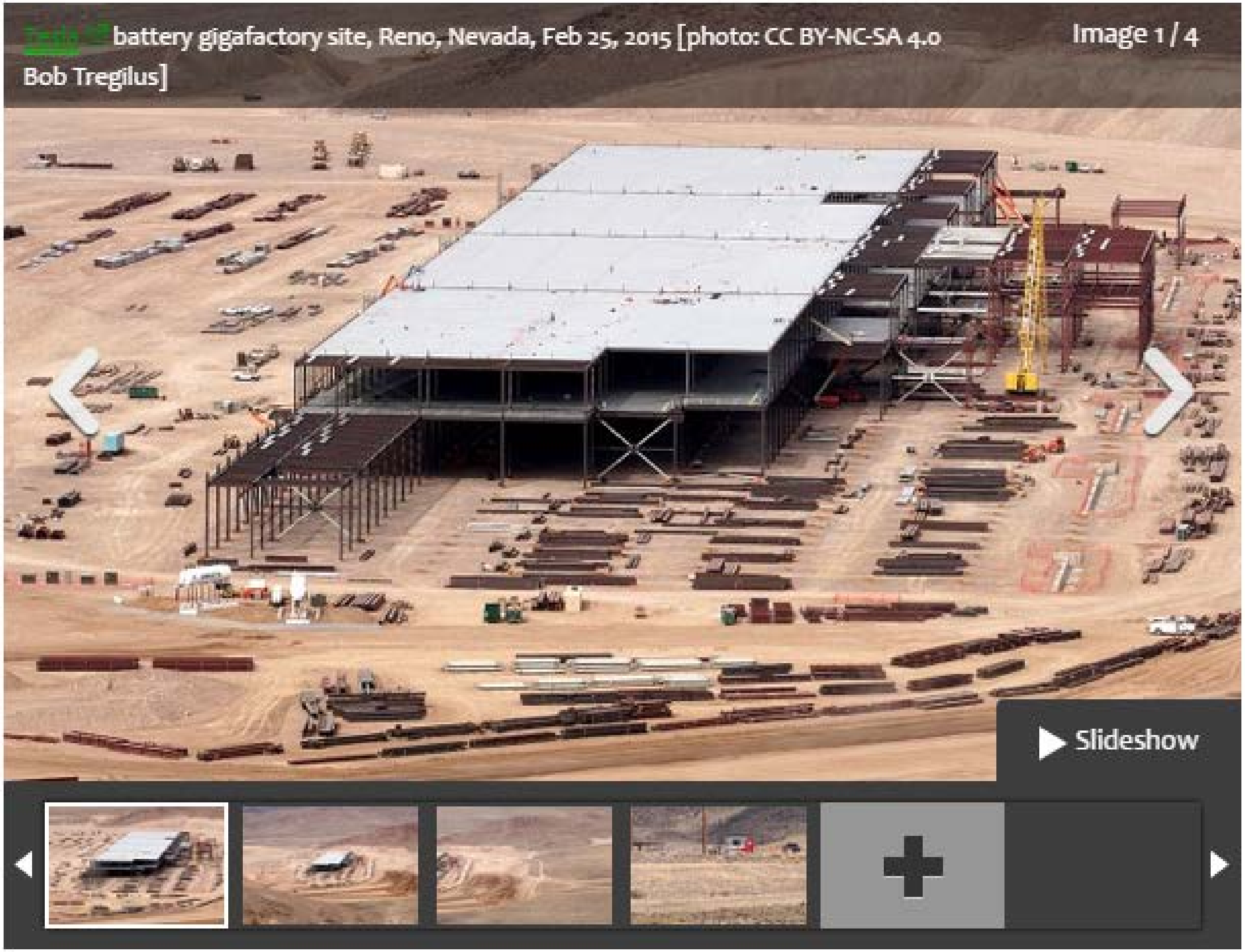

Consumers/businesses are users and creators of energy
Distributed, variable, sustainable resources
Secure, self-healing, self-optimizing grid
Energy-efficient, self-managing homes driven by consumer choice
Self-managing, demand responsive smart buildings

Mobile Renewable On-Demand Grid-Free Energy ?

Mobile ● Renewable ● On-Demand ● Grid-Free ● Energy



TESLA GIGAFACTORY … work in progress (Nevada, US)



IVANPAH SOLAR CONCENTRATOR, (NIPTON, CALIFORNIA) 392MW EST CAPACITY

www.greentechmedia.com/articles/read/ivanpah-solar-plant-falling-short-of-expected-electricity-production

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Home » Energy Secretary Moniz Dedicates World's Largest Concentrating Solar Power Project

Energy Secretary Moniz Dedicates World's Largest Concentrating Solar Power Project

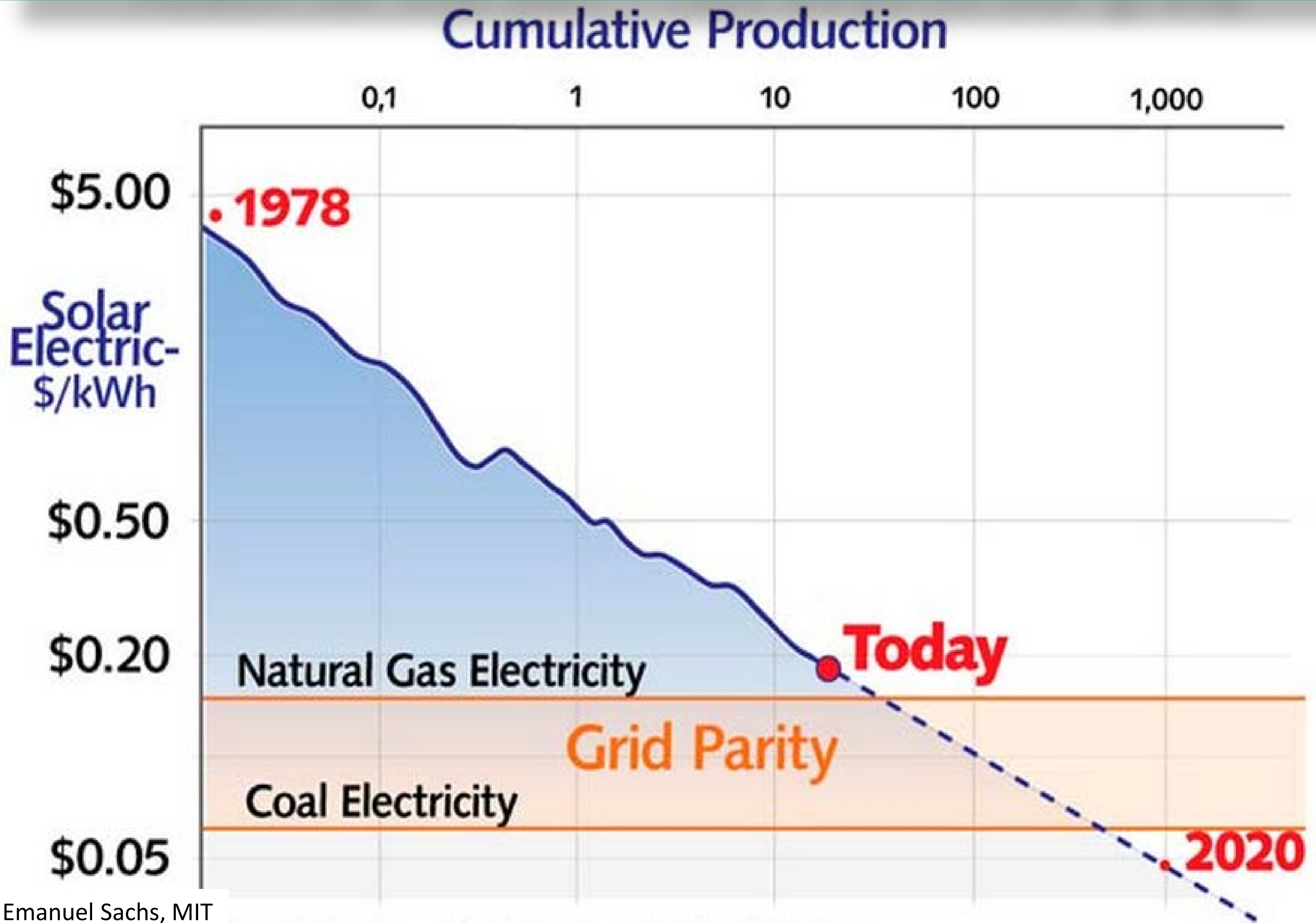
February 13, 2014 - 5:00am


MIT E19 EI (Mar 13, 2009)

India reveals world's first 100% solar-powered airport

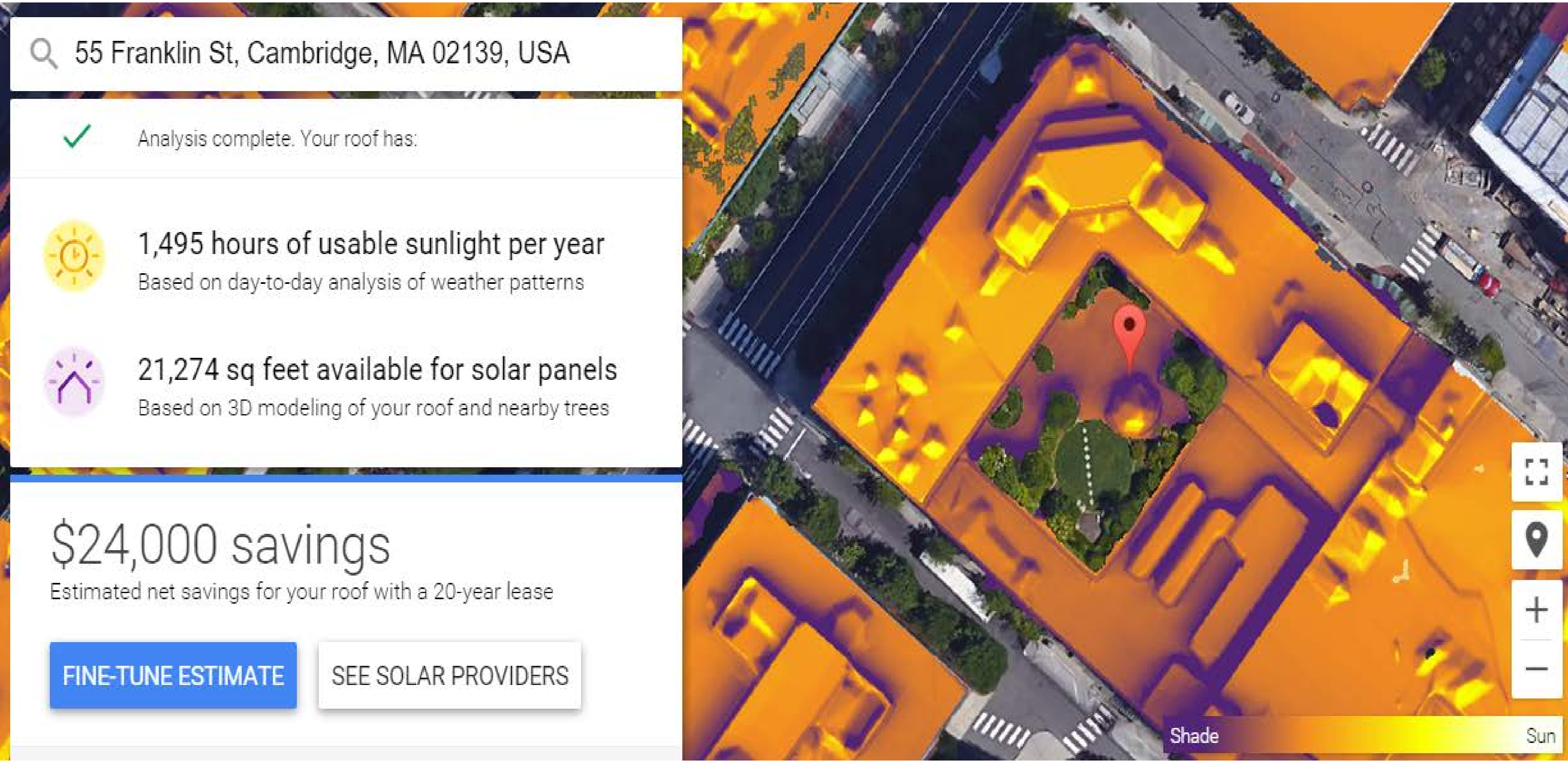
By Ariha Setalvad on August 19, 2015

Reach for the Sun – Not beyond our grasp

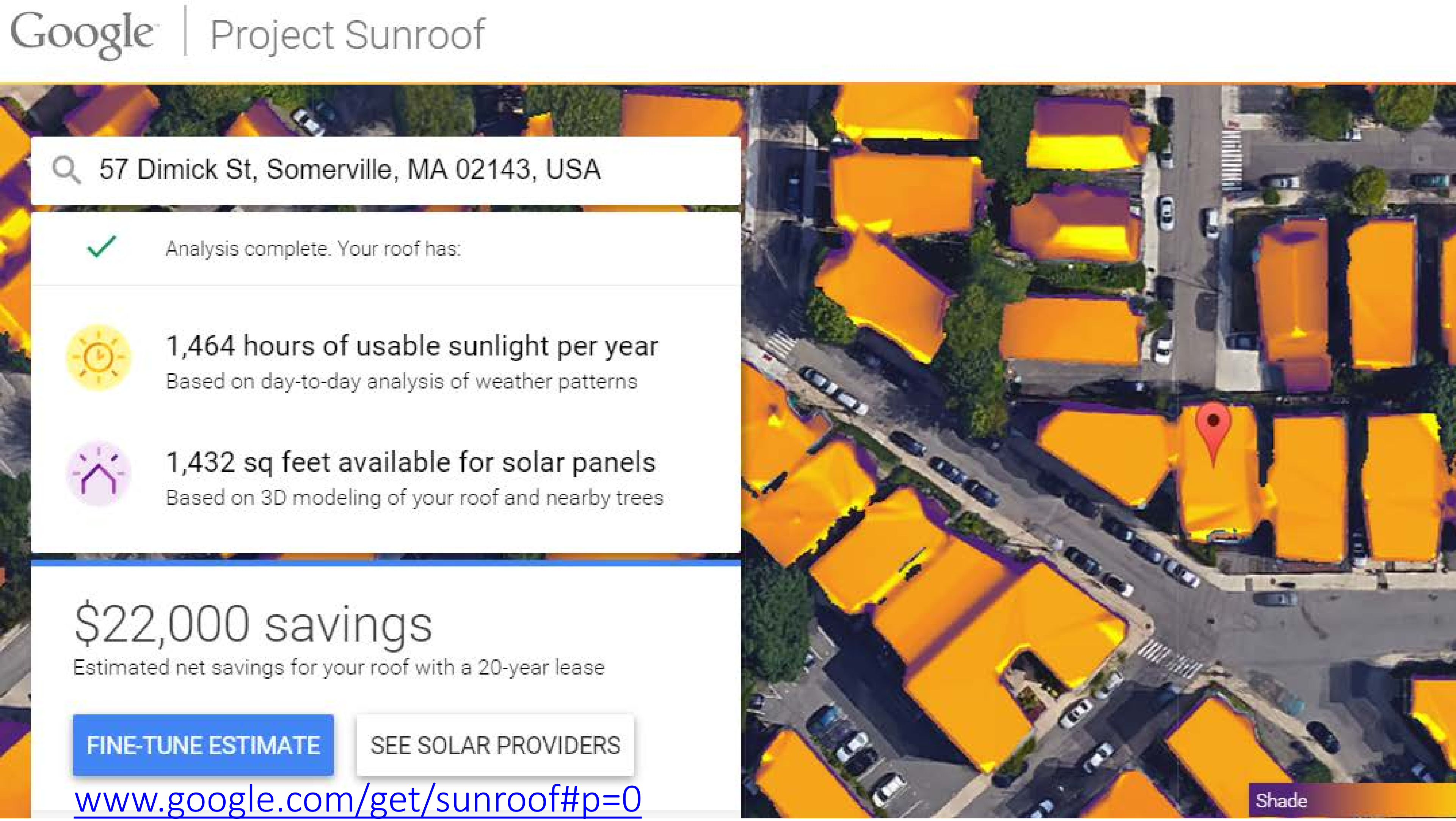


Emanuel Sachs, MIT

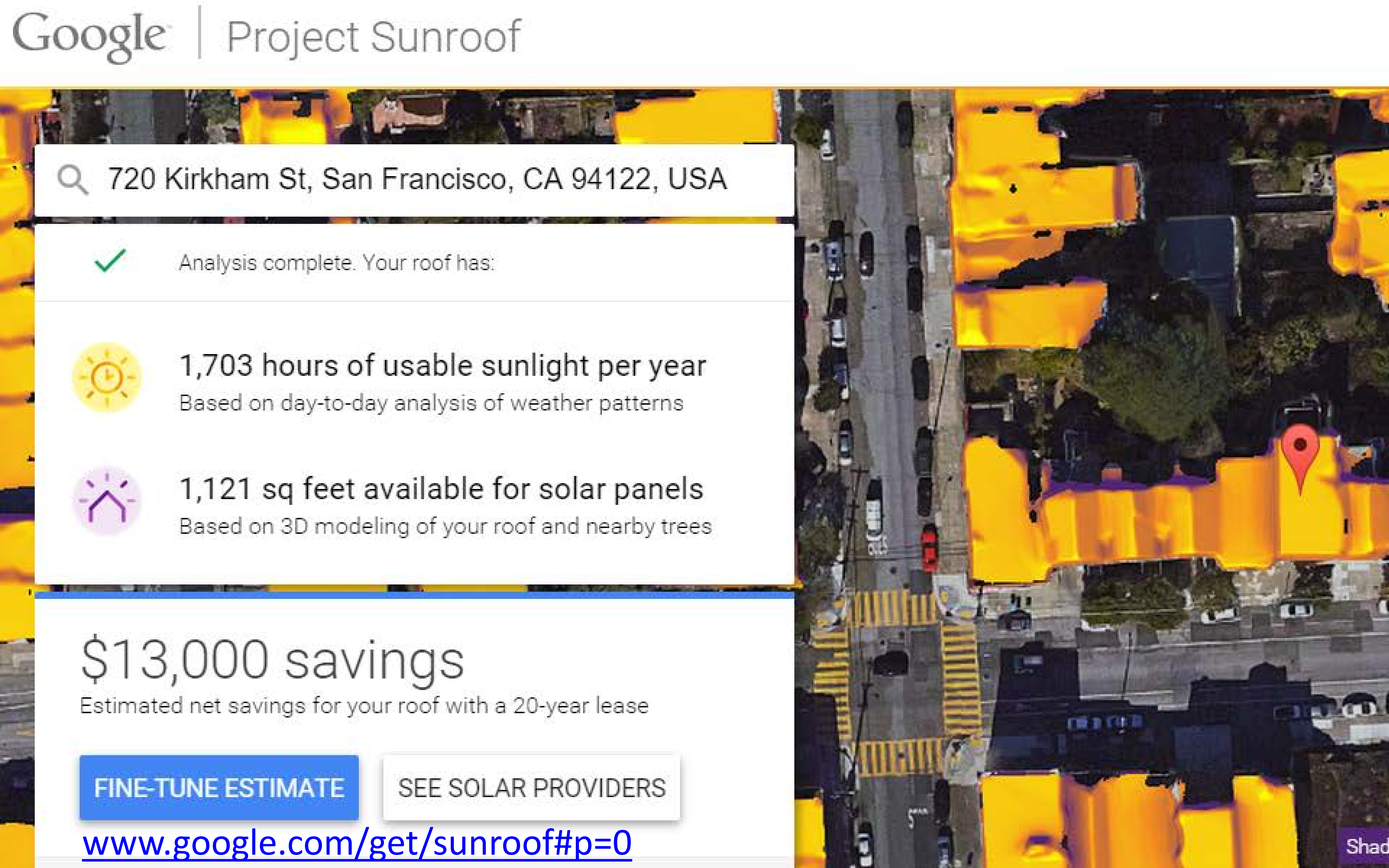
Google will now help you get solar on your roof



http://fortune.com/2015/08/17/google-solar-site/



www.google.com/get/sunroof#p=0



www.google.com/get/sunroof#p=0

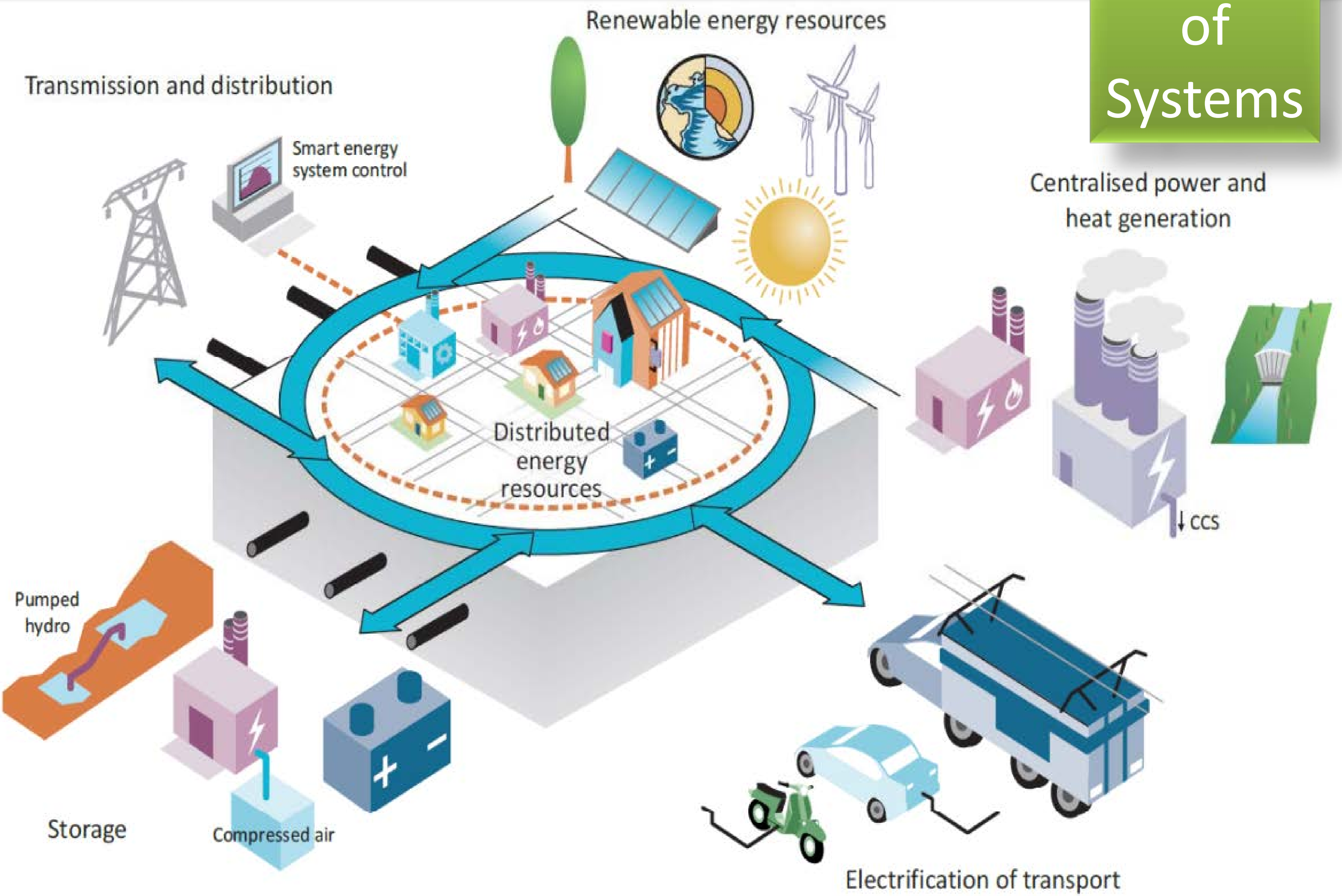

I NOTICE DESMOND HAS BECOME A SOLAR BEAR
Lynch

Internet of Things (IoT) and Internet of Systems (IoS)

Energy Efficiency Optimization

IoS - keeping the dream alive

Internet of Systems



But, we may leave that discussion for another time and focus on

TRANSPORTATION

Robotics catalyzed Autonomous Transportation

Potential for Disruption

Why Autonomy

Autonomous cars are coming and coming fast. Every major car company has autonomous cars under development. By 2035, it's expected there will be more than 54 million autonomous cars on the road, and this will change everything.

Saved Lives: There are 1.2 million people killed every year in car accidents. Autonomous cars don't drive drunk, don't text, don't have Alzheimer's, and don't fall asleep at the wheel.

Reclaiming Land: You can fit eight times more autonomous cars on our roads, making their land use more efficient. In Los Angeles, it's estimated that more than half of the land in the city belongs to the cars in the form of garages, driveways, roads, and parking lots.

Saved Energy: Today, we give close to 25 percent of all of our energy to personal transportation, and 25 percent of our greenhouse gases are going to the car.

Saved Money: Get rid of needing to own a car, paying for insurance and parking, trade out 4,000-lb. cars for lighter electric cars that don't crash, and you can expect to save 90% on your local automotive transportation bill.

Best of all, you can call any kind of car you need, when you need it. Need a nap? Order a car with a bed. Want to party? Order one with a fully-stocked bar. Need a business meeting? Up drives a conference room on wheels.

In the US it was ignited by the US DoD DARPA GRAND CHALLENGE 2004-2007

2004 Grand Challenge [edit]

Main article: DARPA Grand Challenge (2004)

The first competition of the DARPA Grand Challenge was held on March 13, 2004 in the Mojave Desert region of the United States, along a 150-mile (240 km) route that follows along the path of Interstate 15 from just before Barstow, California to just past the California–Nevada border in Primm. None of the robot vehicles finished the route. Carnegie Mellon University's Red Team and car Sandstorm (a converted Humvee) traveled the farthest distance, completing 11.78 km (7.32 mi) of the course before getting hung up on a rock after making a switchback turn. No winner was declared, and the cash prize was not given. Therefore, a second DARPA Grand Challenge event was scheduled for 2005.

2005 Grand Challenge [edit]

Main article: DARPA Grand Challenge (2005)

The second competition of the DARPA Grand Challenge began at 6:40am on October 8, 2005. All but one of the 23 finalists in the 2005 race surpassed the 11.78 km (7.32 mi) distance completed by the best vehicle in the 2004 race. Five vehicles successfully completed the course:

Vehicle	Team Name	Team Home	Time Taken (h:m)	Result
Stanley	Stanford Racing Team	Stanford University, Palo Alto, California	6:54	First place
Sandstorm	Red Team	Carnegie Mellon University, Pittsburgh, Pennsylvania	7:05	Second place
H1ghlander	Red Team		7:14	Third place
Kat-5	Team Gray	The Gray Insurance Company, Metairie, Louisiana	7:30	Fourth place
TerraMax	Team TerraMax	Oshkosh Truck Corporation, Oshkosh, Wisconsin	12:51	Over 10 hour limit, fifth place

Is this the commencement of autonomy? 3rd DARPA GRAND CHALLENGE 2007

Team Name	ID#	Vehicle	Type	Team Location	Time Taken (h:m:s)	Result
Tartan Racing	19	Boss	2007 Chevrolet Tahoe	Carnegie Mellon University, Pittsburgh, Pennsylvania	4:10:20	1st Place; averaged approximately 14 miles per hour throughout the course [14][15]
Stanford Racing	03	Junior	2006 Volkswagen Passat Wagon	Stanford University, Palo Alto, California	4:29:28	2nd Place; averaged about 13.7 miles per hour (22.0 km/h) throughout the course[14][16]
VictorTango	32[17]	Odin	2005 Ford Hybrid Escape	Virginia Tech, Blacksburg, Virginia	4:36:38	3rd Place; averaged slightly less than 13 miles per hour (21 km/h) throughout the course[14]
MIT	79	Talos	Land Rover LR3 (2004–08)	MIT, Cambridge, Massachusetts	Approx. 6 hours	4th Place.[18]
The Ben Franklin Racing Team	74	Little Ben	2006 Toyota Prius	University of Pennsylvania, Lehigh University, Philadelphia, Pennsylvania	Over 6 hour limit	One of 6 teams to finish course
Cornell	26	Skynet	2007 Chevrolet Tahoe	Cornell University, Ithaca, New York	Over 6 hour limit	One of 6 teams to finish course

Sebastian Thrun … profile in public

Researcher Sebastian Thrun helped build Google's amazing driverless car, which he says will not only revolutionize how we get around, but also save lives.

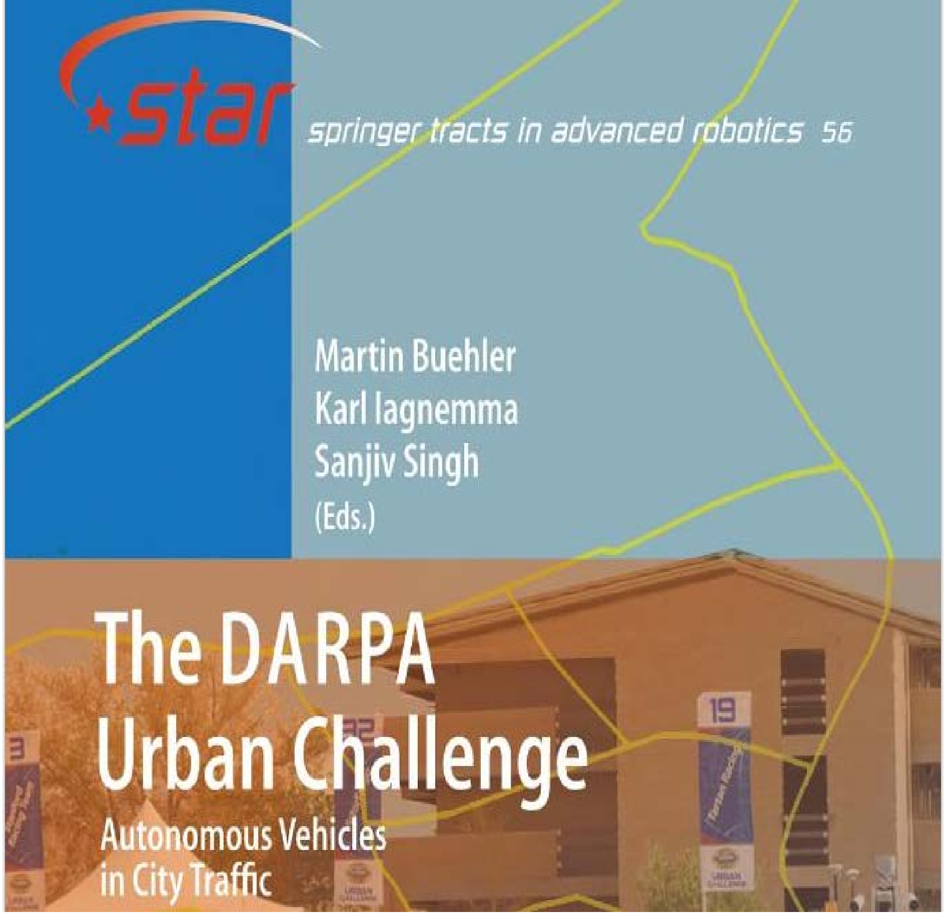
About Sebastian Thrun

Sebastian Thrun is a research professor at Stanford University, a Google Fellow, and co-founder of Udacity. His research focuses on robotics and artificial intelligence. He led the development of the robotic vehicle called Stanley which won the 2005 DARPA Grand Challenge, and is exhibited in the Smithsonian.

Sebastian Thrun … roots in context

Thrun was born May 14, 1967 in Solingen, Germany. He completed his *Vordiplom* (intermediate examination) in computer science, economics, and medicine at the University of Hildesheim in 1988. At the University of Bonn, he completed a *Diplom* (first degree) in 1993 and a PhD (summa cum laude in 1995 & joined Computer Science Department at Carnegie Mellon University (CMU).

In 1998 he became an assistant professor and co-director of Robot Learning Laboratory at CMU. At CMU, he co-founded the Master's Program in Automated Learning and Discovery, which later would become a Ph.D. program in the broad area of Machine Learning and Scientific Discovery. In 2001 Thrun spent a sabbatical year at Stanford University. He returned to CMU as an Associate Professor of Computer Science and Robotics. Thrun left CMU in July 2003 to become an associate professor at Stanford University and was appointed as the director of SAIL in January 2004. From 2007–2011, Thrun was a full professor of computer science and electrical engineering at Stanford. He is also a Google VP and Fellow, and has worked on development of the Google driverless car system. On April 1, 2011, Thrun relinquished his tenure at Stanford to join Google as a Google Fellow. On Jan 23, 2012, Thrun cofounded an online private education company Udacity.



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Springer Tracts in Advanced Robotics ISSN 1610-7438

1st Place – Carnegie Mellon University DARPA GRAND CHALLENGE – 2007

Autonomous Driving in Urban Environments: Boss and the Urban Challenge

Chris Urmson[1,*], Joshua Anhalt[1], Drew Bagnell[1], Christopher Baker[1], Robert Bittner[1], M.N. Clark[1], John Dolan[1], Dave Duggins[1], Tugrul Galatali[1], Chris Geyer[1], Michele Gittleman[1], Sam Harbaugh[1], Martial Hebert[1], Thomas M. Howard[1], Sascha Kolski[1], Alonzo Kelly[1], Maxim Likhachev[1], Matt McNaughton[1], Nick Miller[1], Kevin Peterson[1], Brian Pilnick[1], Raj Rajkumar[1], Paul Rybski[1], Bryan Salesky[1], Young-Woo Seo[1], Sanjiv Singh[1], Jarrod Snider[1], Anthony Stentz[1], William "Red" Whittaker[1], Ziv Wolkowicki[1], Jason Ziglar[1], Hong Bae[2], Thomas Brown[2], Daniel Demitrish[2], Bakhtiar Litkouhi[2], Jim Nickolaou[2], Varsha Sadekar[2], Wende Zhang[2], Joshua Struble[3], Michael Taylor[3], Michael Darms[4], and Dave Ferguson[5]

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Google Self-Driving Car Project
Monthly Report
July 2015

This month, we took a couple of our Lexus self-driving cars to Austin to begin testing in a few square miles of town north and northeast of downtown. We want to get more experience testing our cars in new locations that have different driving environments, traffic patterns and road conditions, and in Austin, we'll have to be ready for anything from pedicabs to pickup trucks! It's also important that we learn how different communities perceive and interact with self-driving vehicles, and we know we can count on Austinites for some great feedback.

Activity Summary (all metrics are as of July 31, 2015)

Vehicles

- 23 Lexus RX450h SUVs – currently self-driving on public streets in Mountain View, CA, and Austin, TX
- 25 prototypes – 5 are currently self-driving on public streets, mainly Mountain View, CA

Miles driven since start of project in 2009

"Autonomous mode" means the software is driving the vehicle, and safety drivers are not touching the manual controls. "Manual mode" means the safety drivers are driving the car.

- Autonomous mode: 1,101,171 miles
- Manual mode: 842,101 miles
- We're currently averaging ~10,000 autonomous miles per week on public streets

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Distracted Driving

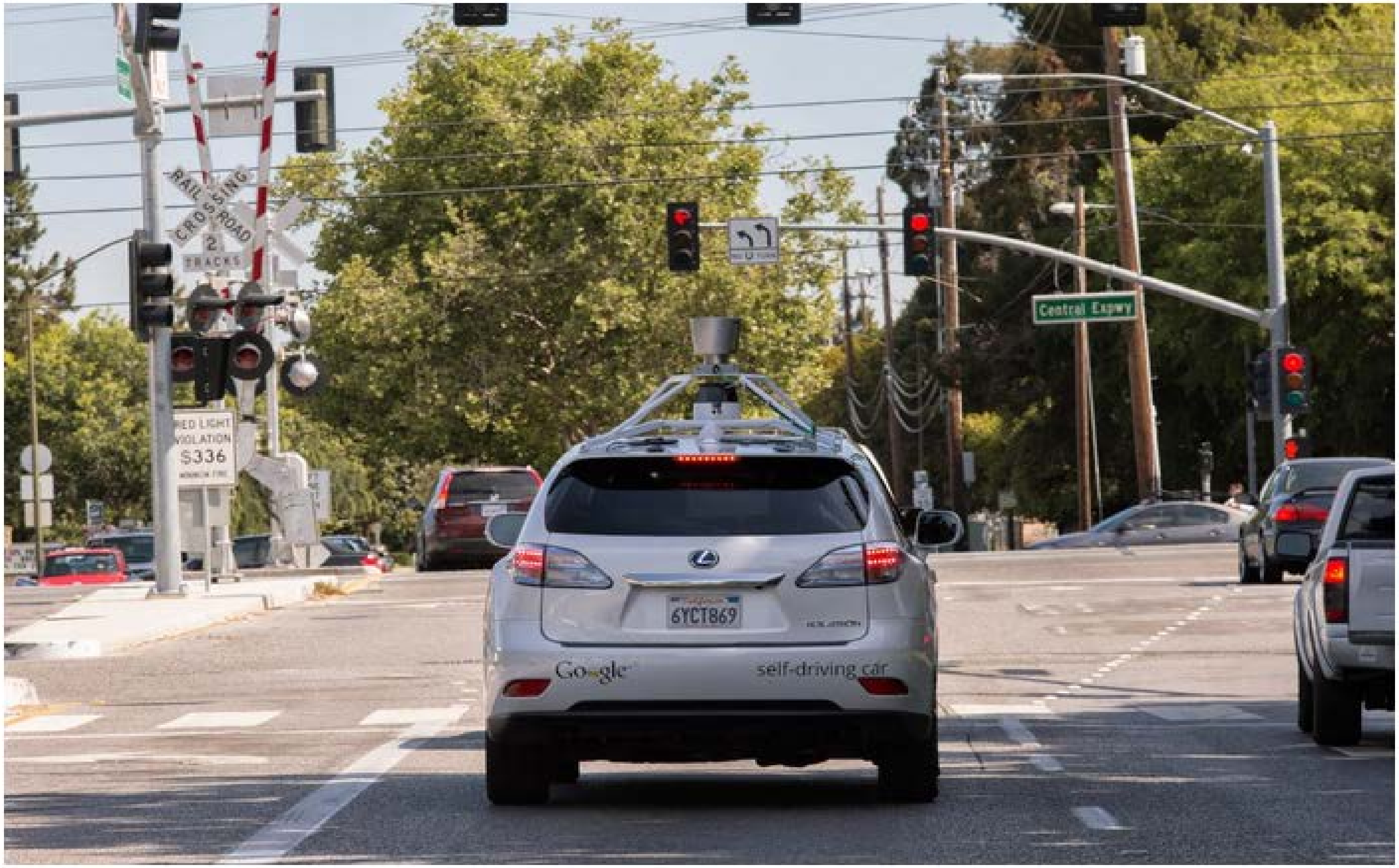
Earlier this month, project director Chris Urmson posted a blog with an important observation – that we seem to be getting hit by a lot of drivers who are distracted and not paying attention to the road. Although the AAA Foundation for Traffic Safety says that summer is the "100 Deadliest Days" for teenage drivers, what we're seeing goes well beyond an age group or specific time of year.

Driving is actually really complex – a driver driving at 30 mph sees an average of 1320 pieces of information every minute. Yet most of us think it's pretty mundane and that we're above average drivers, giving us the confidence to multitask and take our eyes off the road. Cell phones are the most common distractors, with ~660,000 drivers using cell phones or other devices while driving at any given daylight moment across America. These folks are unfortunately 23 times more likely to be involved in a crash or near crash event – see for yourself with AT&T's texting while driving simulator.

Check out Chris's blog for more on why this is motivating us to work toward building a fully self-driving car.

http://bit.ly/GOOGLE-SELF-DRIVING-CAR-JULY-2015

Chris Urmson
Jul 16 · 4 min read



The View from the Front Seat of the Google Self-Driving Car, Chapter 2

Chris Urmson

Roboticist

+GoogleSelfDrivingCars

Chris Umson is the Director of Self-Driving Cars at Google[x].

Why you should listen

Since 2009, Chris Urmson has headed up Google's self-driving car program. So far, the team's vehicles have driven over three quarters of a million miles. While early models included a driverless Prius that TEDsters got to test- ... um, -not-drive in 2011, more and more the team is building vehicles from the ground up, custom-made to go driverless.

Prior to joining Google, Umson was on the faculty of the Robotics Institute at Carnegie Mellon University, where his research focused on motion planning and perception for robotic vehicles. During his time at Carnegie Mellon, he served as Director of Technology

1st Place – Carnegie Mellon University DARPA GRAND CHALLENGE – 2007

Autonomous Driving in Urban Environments: Boss and the Urban Challenge

Chris Urmson[1,*], Joshua Anhalt[1], Drew Bagnell[1], Christopher Baker[1], Robert Bittner[1], M.N. Clark[1], John Dolan[1], Dave Duggins[1], Tugrul Galatali[1], Chris Geyer[1], Michele Gittleman[1], Sam Harbaugh[1], Martial Hebert[1], Thomas M. Howard[1], Sascha Kolski[1], Alonzo Kelly[1], Maxim Likhachev[1], Matt McNaughton[1], Nick Miller[1], Kevin Peterson[1], Brian Pilnick[1], Raj Rajkumar[1], Paul Rybski[1], Bryan Salesky[1], Young-Woo Seo[1], Sanjiv Singh[1], Jarrod Snider[1], Anthony Stentz[1], William "Red" Whittaker[1], Ziv Wolkowicki[1], Jason Ziglar[1], Hong Bae[2], Thomas Brown[2], Daniel Demitrish[2], Bakhtiar Litkouhi[2], Jim Nickolaou[2], Varsha Sadekar[2], Wende Zhang[2], Joshua Struble[3], Michael Taylor[3], Michael Darms[4], and Dave Ferguson[5]

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curmson@ri.cmu.edu

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Warren, Michigan

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Peoria, Illinois 61656

[4] Continental AG
Auburn Hills, Michigan 48326

[5] Intel Research
Pittsburgh, Pennsylvania 15213

Boss Wins!

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

http://bit.ly/WASHINGTON-DC

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

http://bit.ly/SCHUSTER-AUTONOMOUS http://bit.ly/RAJKUMAR-CMU

http://bit.ly/AUDI-CONCEPT-7

http://bit.ly/MB-AutoTruck

Mercedes-Benz Future Truck 2025 | Autonomous driving

Daimler AG

DAIMLER

Subscribed

38,508

Add to Share More 111 5

Published on Jul 8, 2014

Mercedes-Benz Future Truck 2025: Autonomous driving in long-distance truck operations with the "Highway Pilot".

AUTONOMOUS TRANSPORTATION

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

CARNEGIE MELLON SPINOFF OTTOMATIKA ACQUIRED BY DELPHI

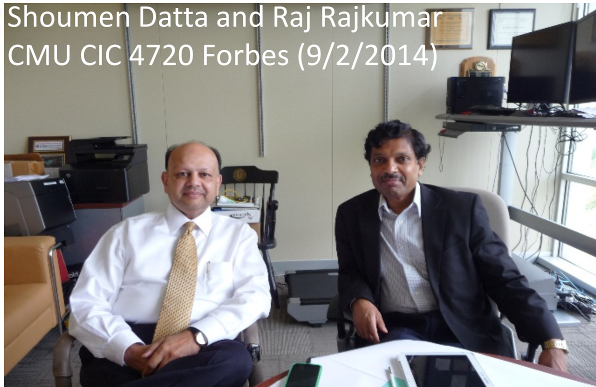
Company Builds on University Strengths in Pioneering Autonomous Vehicle

Tuesday 4th August 2015 www.cmu.edu/news/stories/archives/2015/august/spinoff-acquired.html

Professor Raj Rajkumar poses between CMU's latest self-driving car, a Cadillac SRX, and the university's first autonomous vehicle 30 years ago.

Ottomatika Inc., a Carnegie Mellon University spinoff company that provides software and systems development for self-driving vehicles, has been acquired by the global vehicle technology company Delphi Automotive PLC.

Led by Electrical and Computer Engineering Professor Raj Rajkumar, Ottomatika spun off from Carnegie Mellon in 2013 and received an investment from Delphi in November 2014.



Social integration of autonomous vehicles with public road traffic?

2033-2035

Author's suggestion

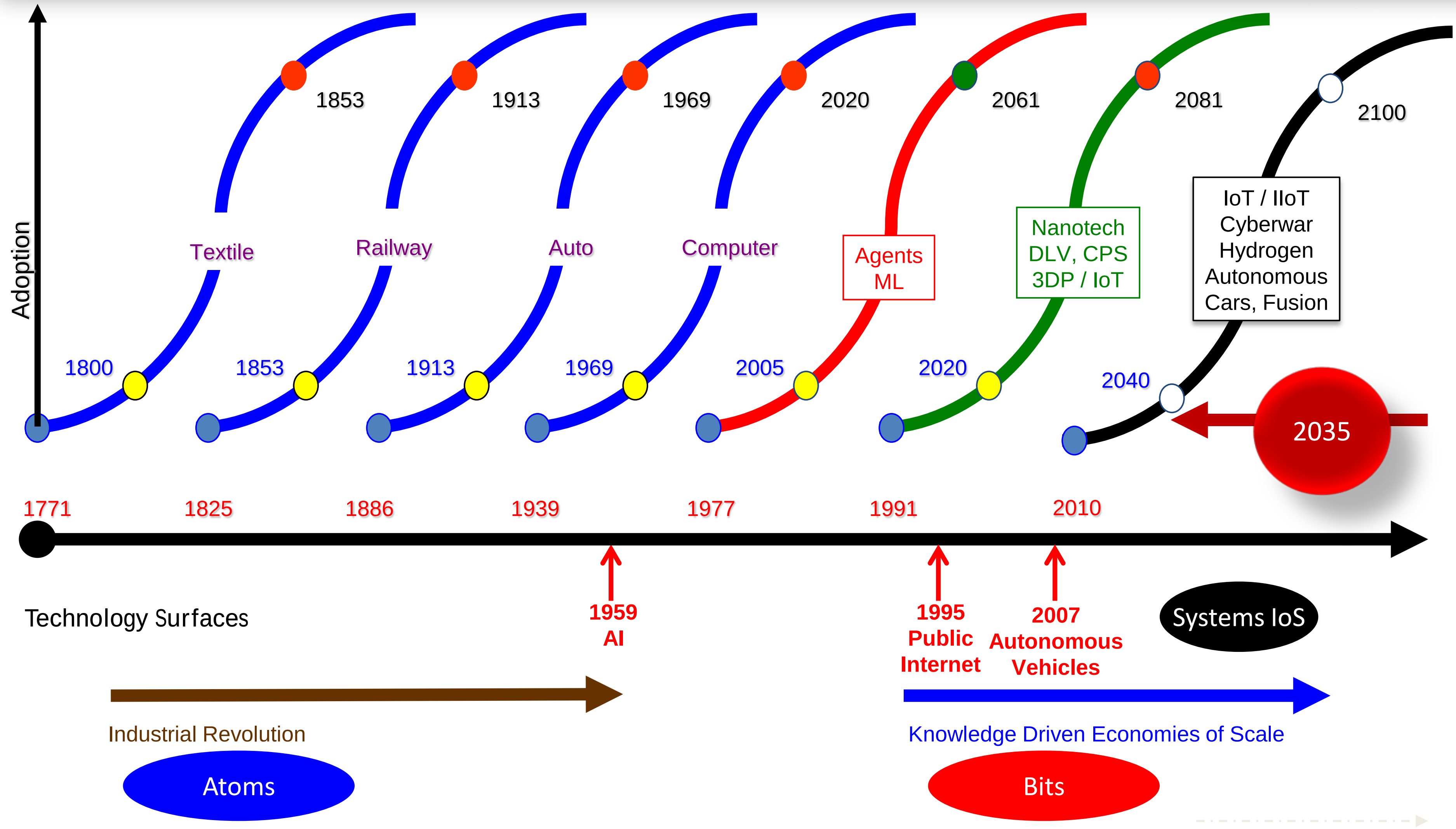
WHY ?

2033-2035

2nd DARPA Challenge 2005 – 3rd DARPA Challenge 2007

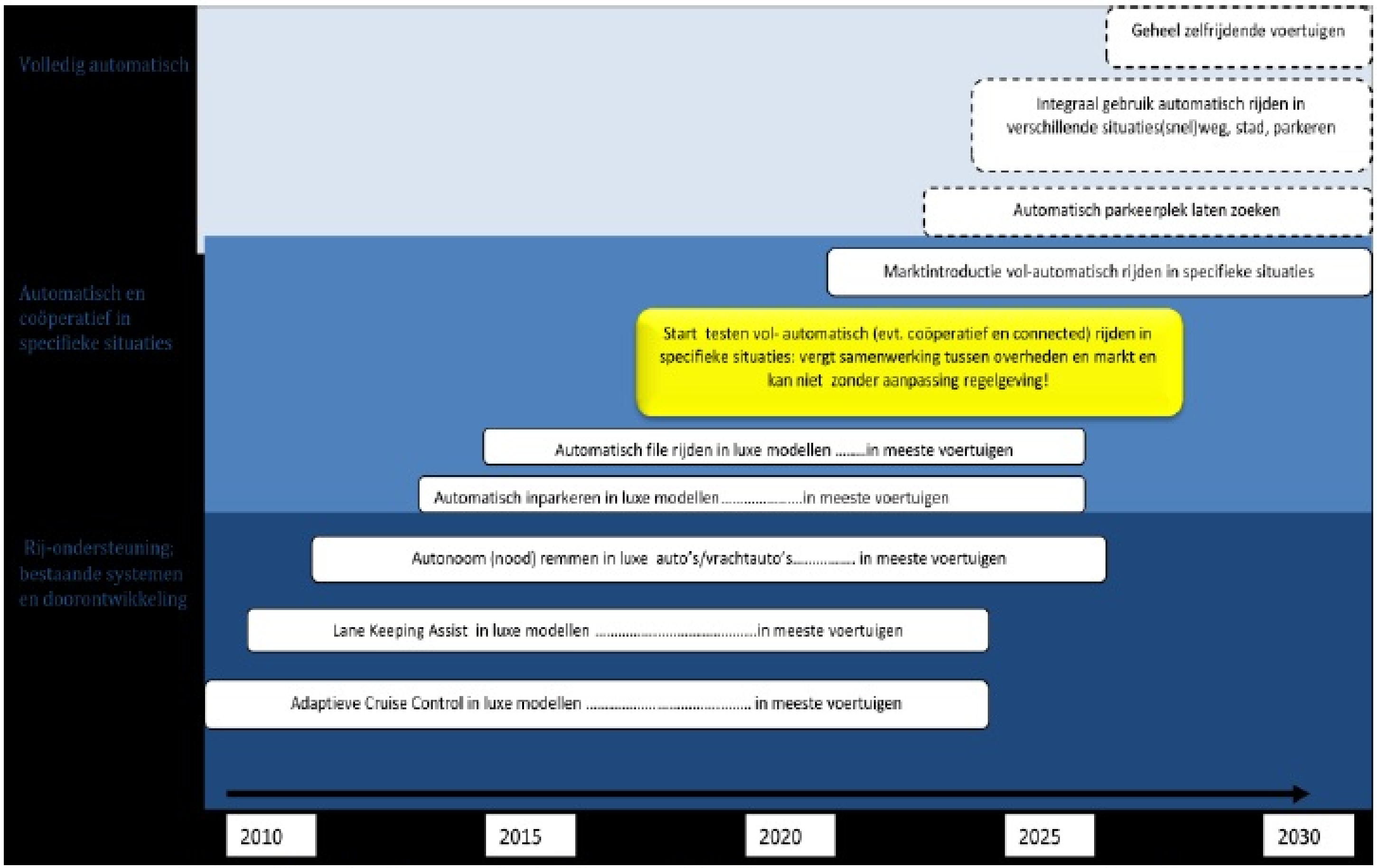
The Wealth of Nations ● Nature of the Firm (Transaction Cost Economics)

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. Expect exponential growth of IoS ~ 2025-2026.

Go Dutch – Autonomous Vehicles by 2030 ?



Figuur 1 Globaal beeld (mogelijke) ontwikkelingen van automatische functies

Go BMW – Gesture Controlled Vehicles in 2016

THE 2016 BMW 7 SERIES IS THE FIRST PRODUCTION CAR WITH GESTURE CONTROL. HERE'S HOW IT WORKS

By **Andrew Hard** — August 31, 2015

THE 2016 BMW 7 SERIES IS THE FIRST PRODUCTION CAR WITH GESTURE CONTROL. HERE'S HOW IT WORKS

By **Andrew Hard** — August 31, 2015

THE 2016 BMW 7 SERIES IS THE FIRST PRODUCTION CAR WITH GESTURE CONTROL. HERE'S HOW IT WORKS

By **Andrew Hard** — August 31, 2015

Subject to further disruption?

Germany to digitise autobahn, ready for self-driving car tests

The German Ministry of Transport is paving the way for autonomous cars to hit one freeway with both dedicated and mixed lanes.

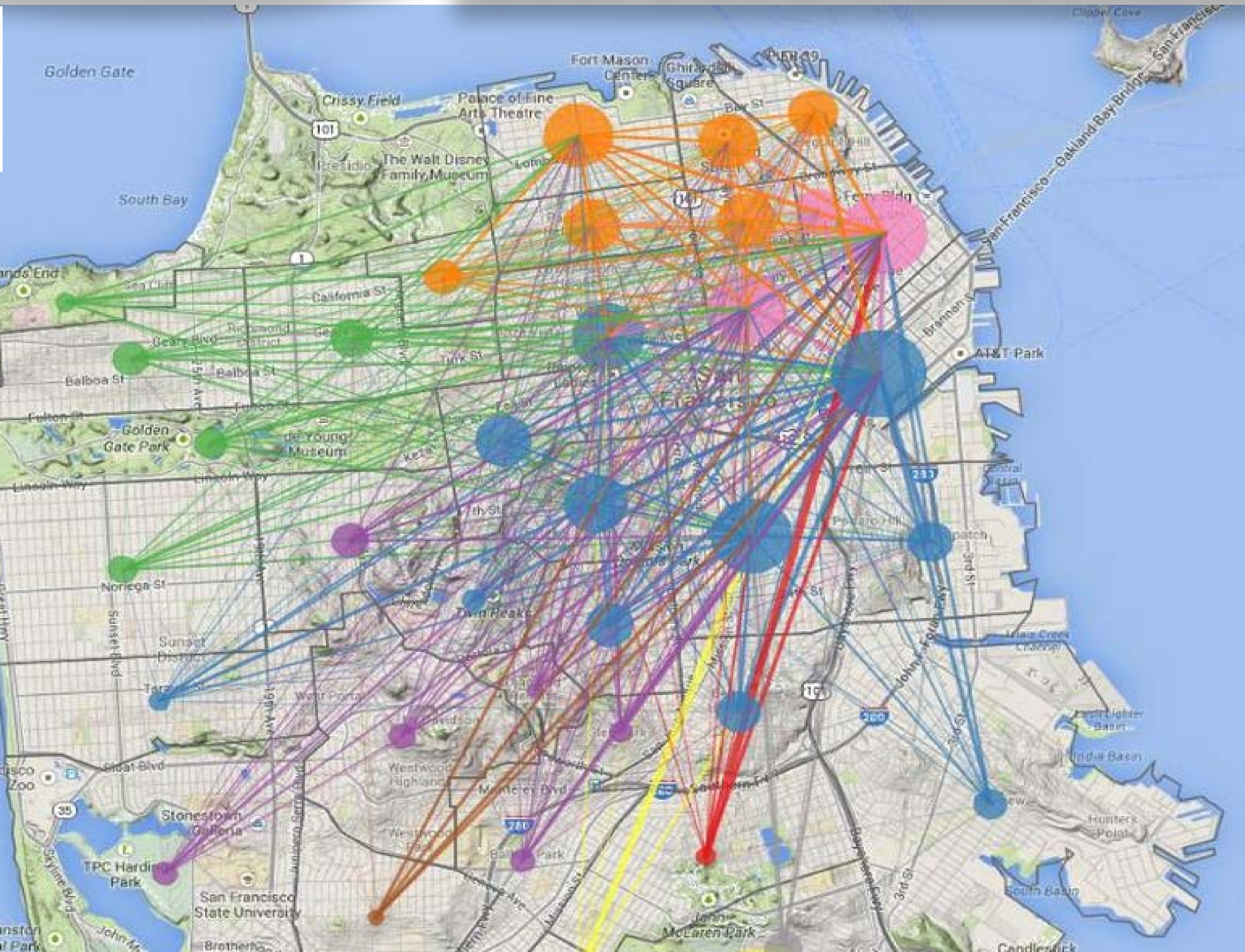
By Sara Zaske for The German View | February 2, 2015 -- 13:00 GMT (05:00 PST) | Topic: Mobility

The self-driving Mercedes-Benz F015.

A section of the A9 autobahn in Bavaria will soon be opened up for tests of self-driving vehicles, according to the German Ministry of Transport.

Mobile IoS Economy

Uber's Information Flow



How Uber's Autonomous Cars Will Destroy 10 Million Jobs and Reshape the Economy by 2025

Zack Kanter

Intelligent people are full of doubts, while the stupid ones are full of confidence - Heinrich Karl Bukowski

Uber Turns from Google, Teams Up with Carnegie Mellon on Self-Driving Cars

By Evan Ackerman

Posted 3 Feb 2015 | 22:00 GMT

UBER'S SELF-DRIVING CAR PROJECT GETS INTO GEAR, VEHICLE SPOTTED ON PITTSBURGH STREETS

By Trevor Mogg — May 22, 2015


Ambrozinio / Shutterstock

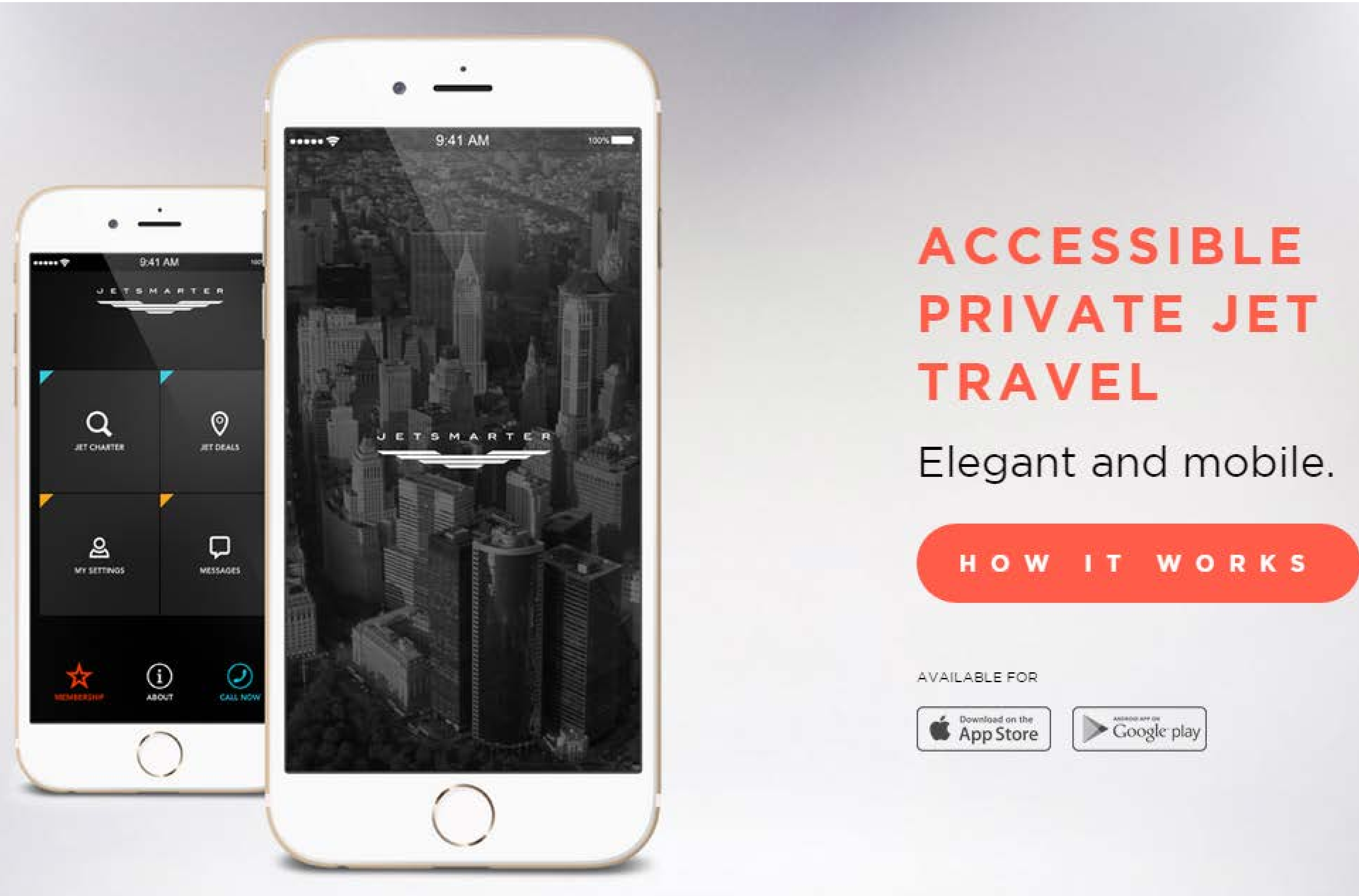
Carnegie Mellon Reels After Uber Lures Away Researchers

Uber staffs new tech center with researchers poached from its collaborator on self-driving technology

Wall Street Journal - May 31, 2015

Uber for Trucks

Uber for Jets



Uber for Drones

WIRED

NEED EYES IN THE SKY? THIS 'UBER FOR DRONES' WILL SEND YOU A PILOT

www.wired.com/2014/11/uber-for-drones/

Uber for Bikes

Uber announces UberRUSH, a bicycle courier service, launching first in Manhattan

- 8 Apr '14,

Uber for Baby Strollers

sign in | register | your account | checkout

Uber KIDS

說中國的超級

The Chinese Acceptance

China's top taxi app startup, Didi Kuaidi (the new name for the merger between Didi Dache and Kuaidi Dache), revealed today that it has raised a record-breaking US$2 billion in funding. The money came from Capital International Private Equity Fund and Ping An Ventures, as well as "several other globally renowned investors" that went unnamed. Existing investors like Alibaba, Tencent, and Temasek also contributed to this bumper new investment.

This is the biggest ever funding round for a private company, beating Uber's US$1.2 billion series D and series E rounds, as well as US$1.5 billion private equity rounds for Airbnb and Facebook.

www.techinasia.com/didi-kuaidi-confirms-2-billion-bucks-funding/

10 July 2015

The French Resistance

French anti-Uber protests turn violent

AFP

By Joshua Melvin and Simon Valmary
June 25, 2015 5:43 PM

Paris (AFP) - Protests against ride-booking app Uber turned violent in France on Thursday as taxi drivers set fire to vehicles and blocked major roads.

Will Apple Add Fuel To The Fire?

Autonomous Apple ?

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?

Documents confirm Apple is building self-driving car

Exclusive: Correspondence obtained by the Guardian shows Project Titan is further along than many suspected and company is scouting for test locations

Apple has been rumoured to be working on a self-driving electric car, codenamed Project Titan, but this is the first time its existence has been documented. Photograph: Zero Creatives/Getty Images

Apple is building a self-driving car in Silicon Valley, and is scouting for secure locations in the San Francisco Bay area to test it, the Guardian has learned. Documents show the oft-rumoured Apple car project appears to be further along than many suspected.

TOYOTA FINALLY GETS SERIOUS ABOUT SELF-DRIVING CARS

Guess who's running the program at Toyota

Last year, Toyota showed off a car that can stay in its lane and a safe distance from other cars on the highway. Now it's talking about more advance research. TOYOTA

TOYOTA HAS JOINED the race to build a self-driving car.

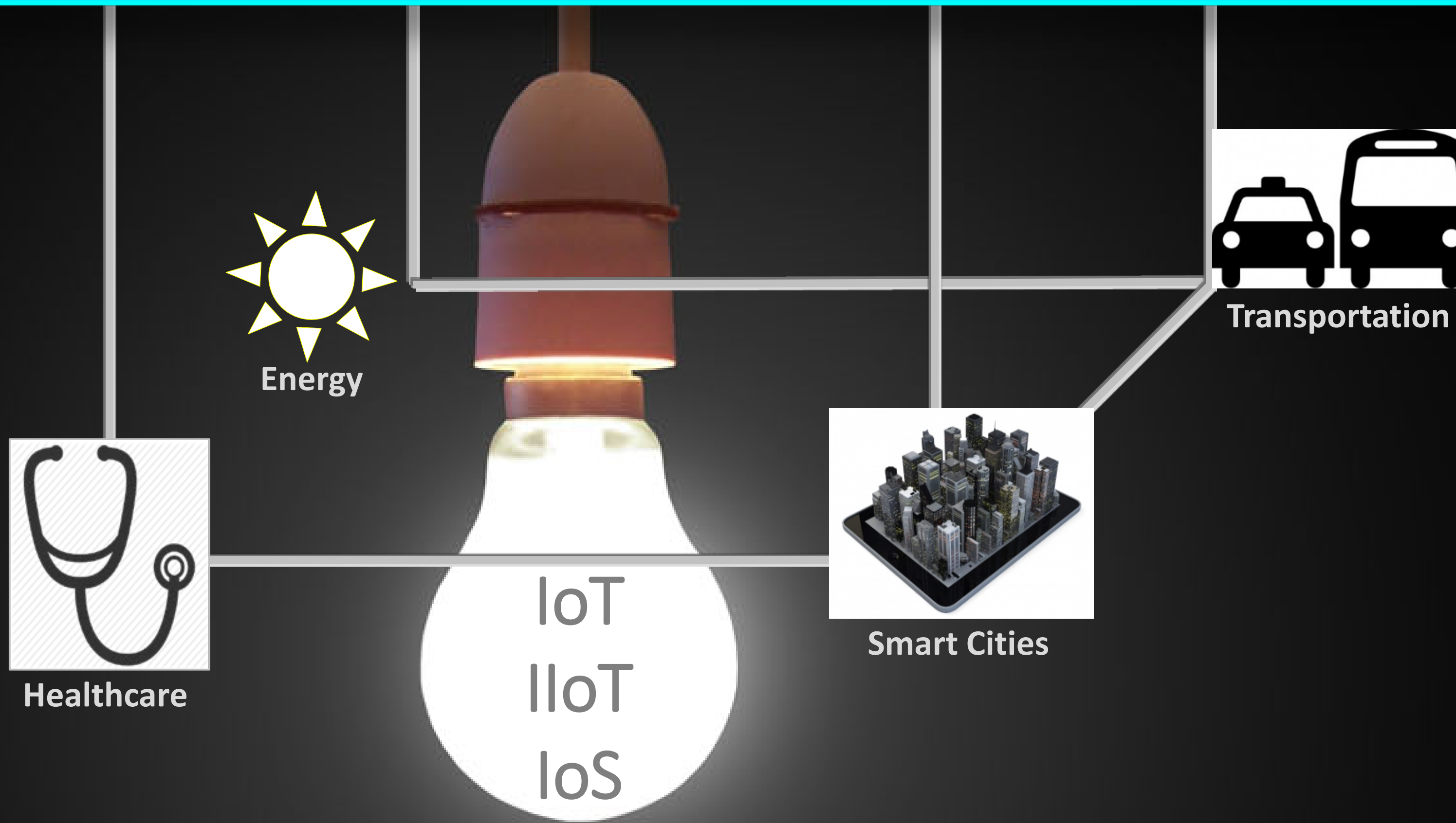
The Japanese automaker announced it's dropping $50 million in the next five years to establish research centers with both Stanford and MIT, to work on artificial intelligence and autonomous driving technology.

4 SEP 2015

www.wired.com/2015/09/toyota-enters-self-driving-car-race

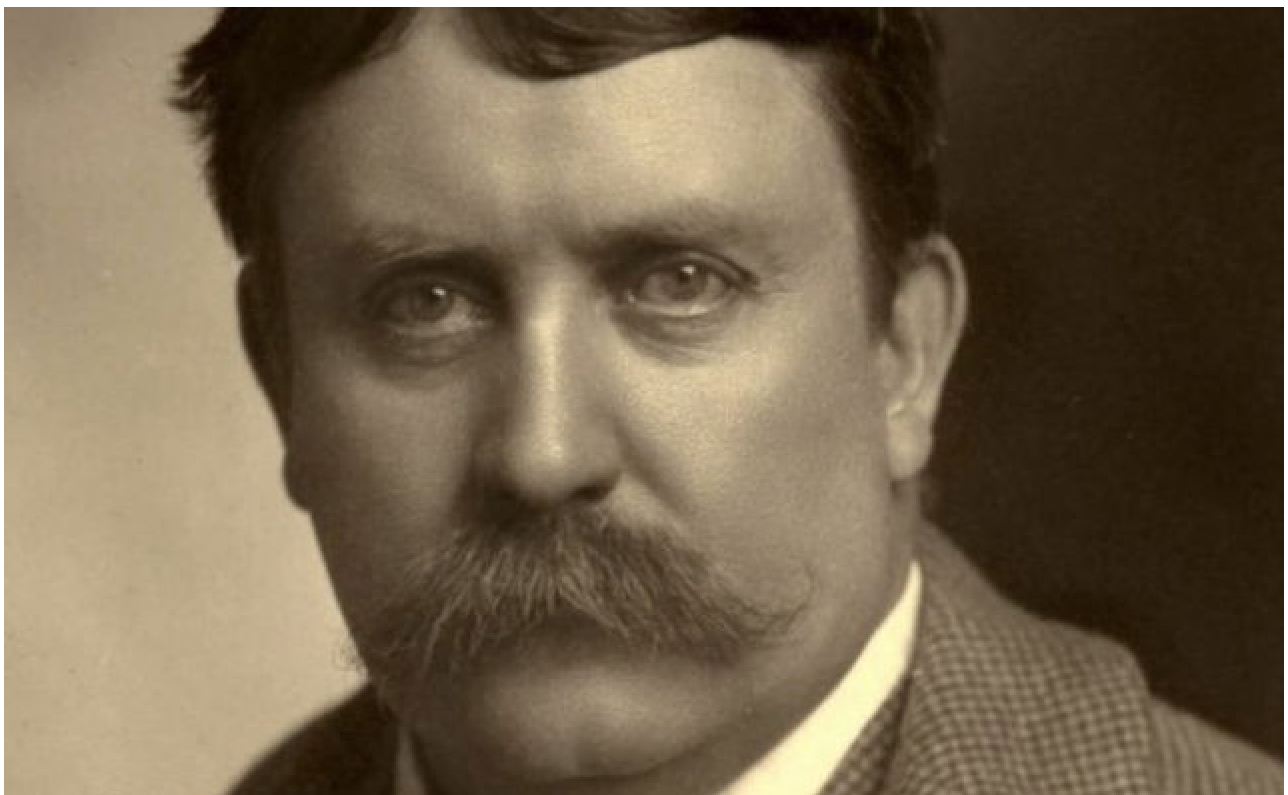
The Supply Chain Evolution in the Near Future?

System of Systems • Transdisciplinarity



Grand Challenges

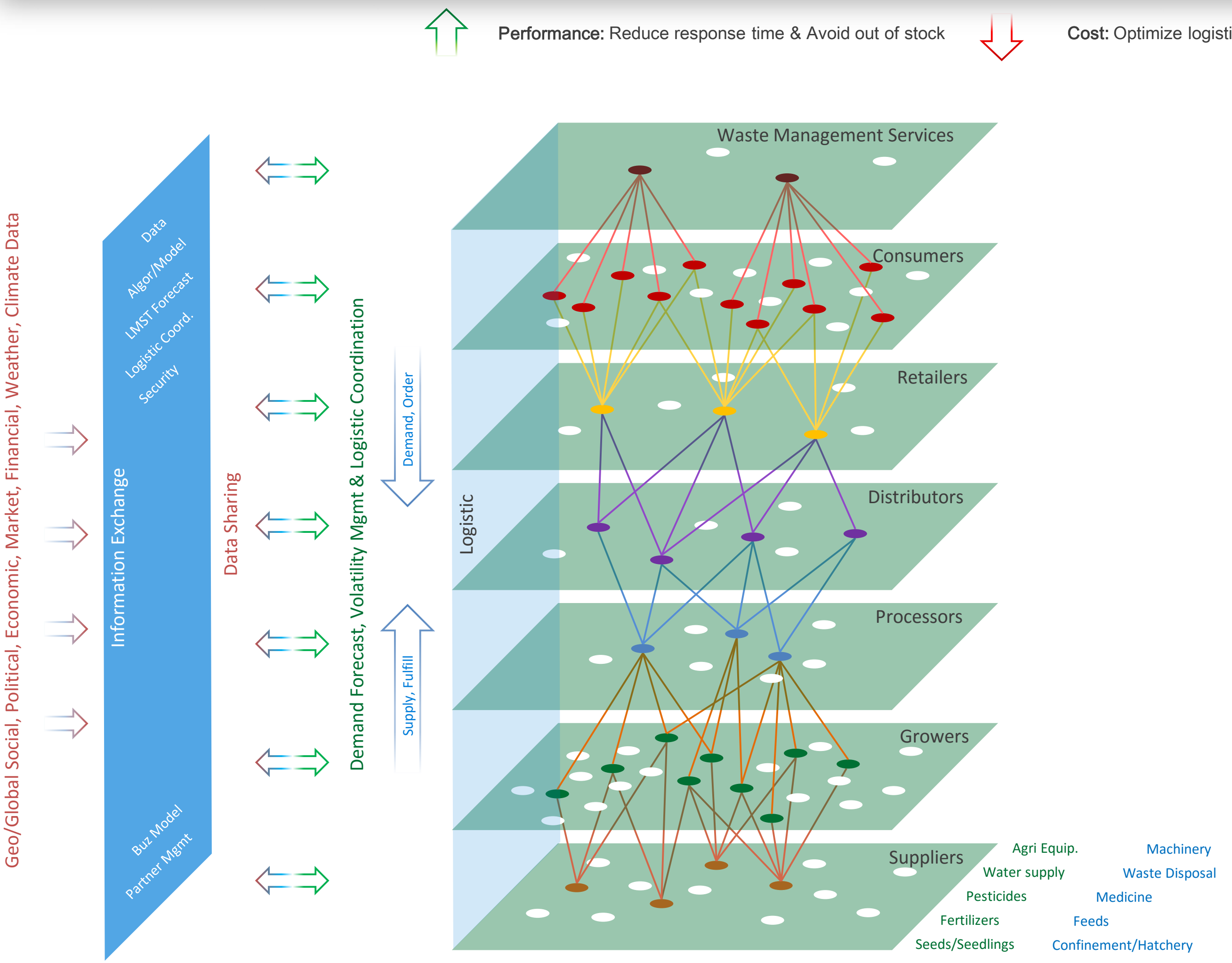
Make no little plans; they have no magic to stir men's blood and probably themselves will not be realized. Make big plans; aim high in hope and work.



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

IIC started discussing potential grand challenges and Transportation Grand Challenge was approved as a test bed by IIC Steering Committee (03/2014).

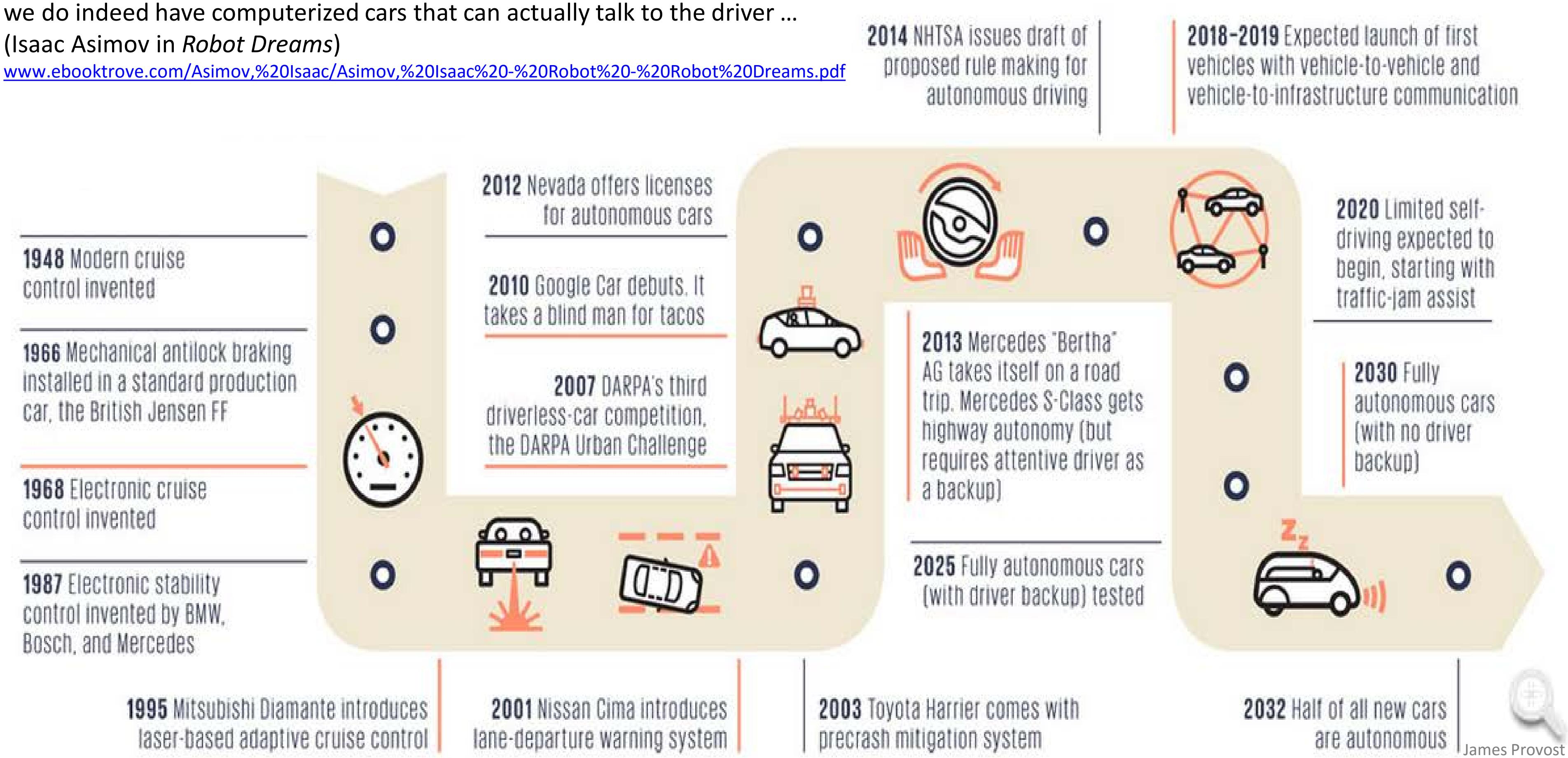
These were the initial IIC test bed ideas proposed by Intel



Dr Shi-Wan Lin, Intel

Can we deploy semi-autonomous freight transportation ?

… in my story "Sally," published in 1953, I described computerized cars that had almost reached the stage of having lives of their own. And, in the last few years, we do indeed have computerized cars that can actually talk to the driver …
(Isaac Asimov in *Robot Dreams*)
www.ebooktrove.com/Asimov,%20Isaac/Asimov,%20Isaac%20-%20Robot%20-%20Robot%20Dreams.pdf



In 2002, transportation-related goods & services accounted for more than ten percent (over $1 trillion) of US GDP [www.rita.dot.gov/bts/programs/freight_transportation/html/transportation.html]

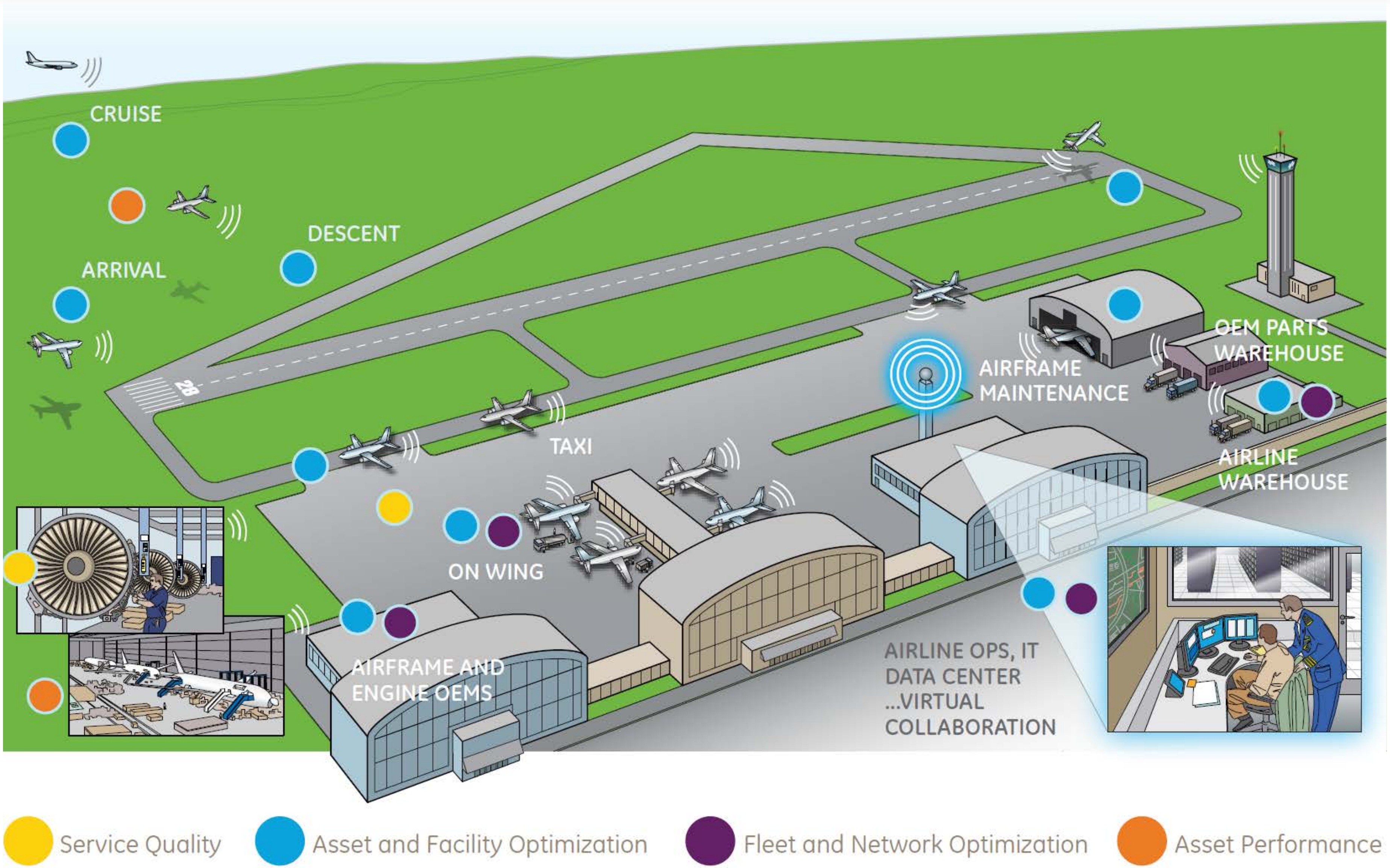
Semi-Autonomous Transportation – connecting atoms (cargo and goods via land, sea and air) with bits (data)

- Highly granular micro-localization of goods movement between various nodes and modes
- Intra-container visibility and tamper-proofing / tamper-evidence (data via 5G network devices)
- Sequential check of bill of lading and tracking (compliant with SOX-409 / DHS CBP e-manifests)

Autonomous Transportation – connect to freight and global container track and trace (goods transparency)

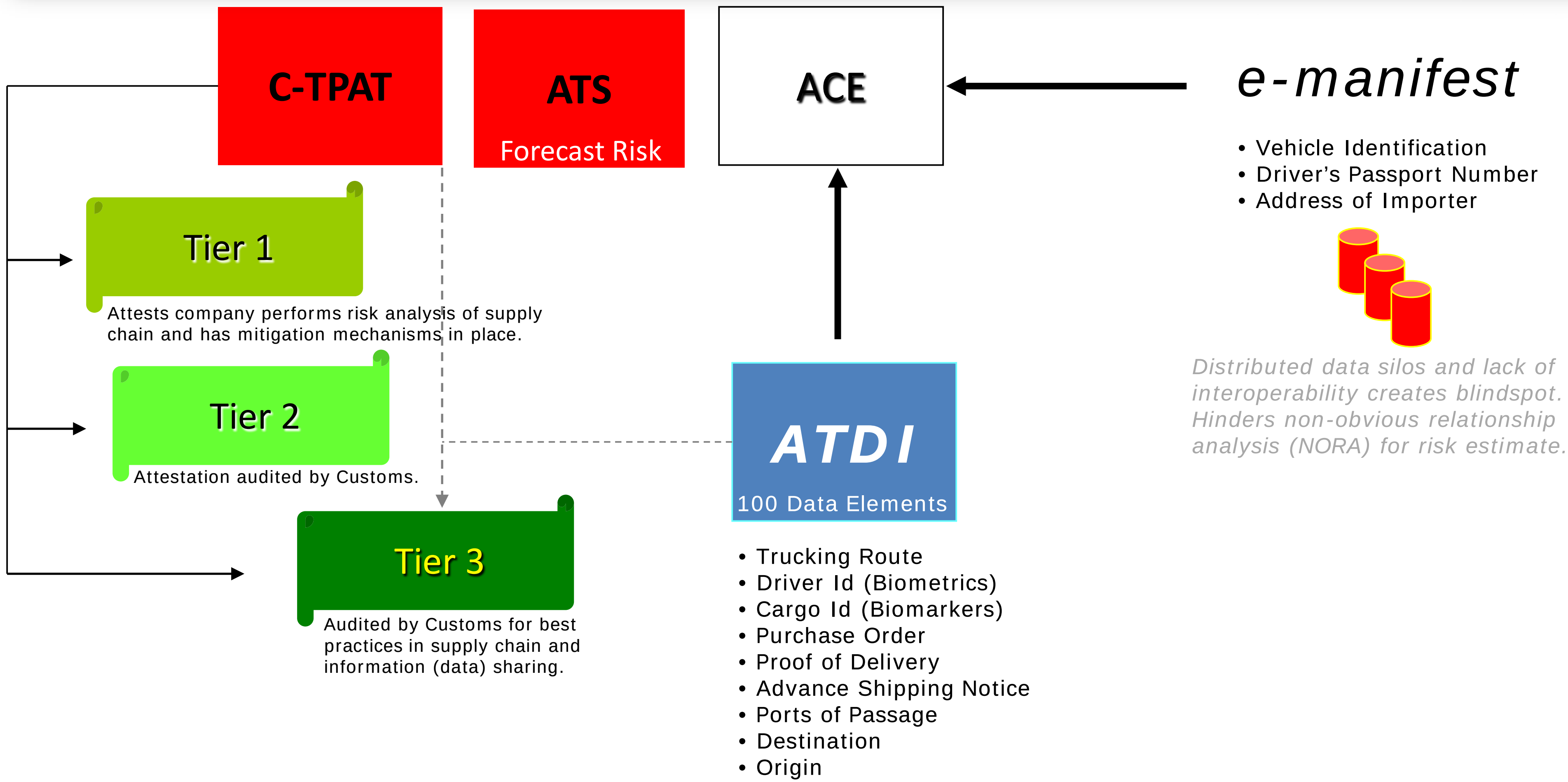
Autonomous Transportation – Air Freight Forwarding

Asset optimization, security enhancement and supply chain visibility



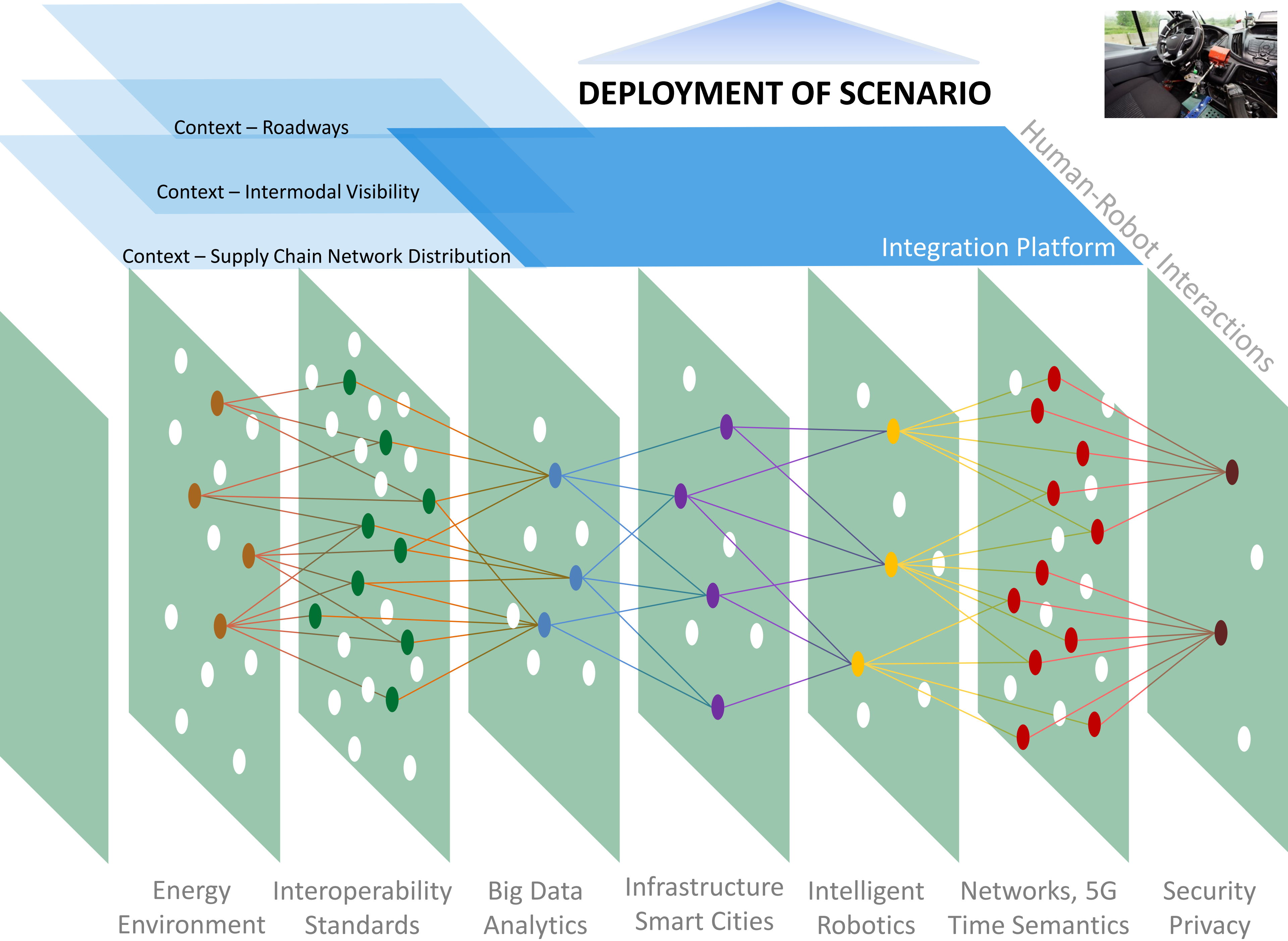
Dr Peter Closson Evans (GE Global Strategy and Analytics, 2013)

Autonomous Transportation ● 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)

Outline of the framework suggested by IIC as a part of the Transportation Grand Challenge umbrella of ideas



DEPLOYMENT OF SCENARIO
Context – Roadways
Context – Intermodal Visibility
Context – Supply Chain Network Distribution
Integration Platform
Human-Robot Interactions
Energy Environment
Interoperability Standards
Big Data Analytics
Infrastructure Smart Cities
Intelligent Robotics
Networks, 5G Time Semantics
Security Privacy

IIC discussions were gradually focused on deployment and it evolved as the semi autonomous freight transport initiative (abbreviated hereafter SAFTI)

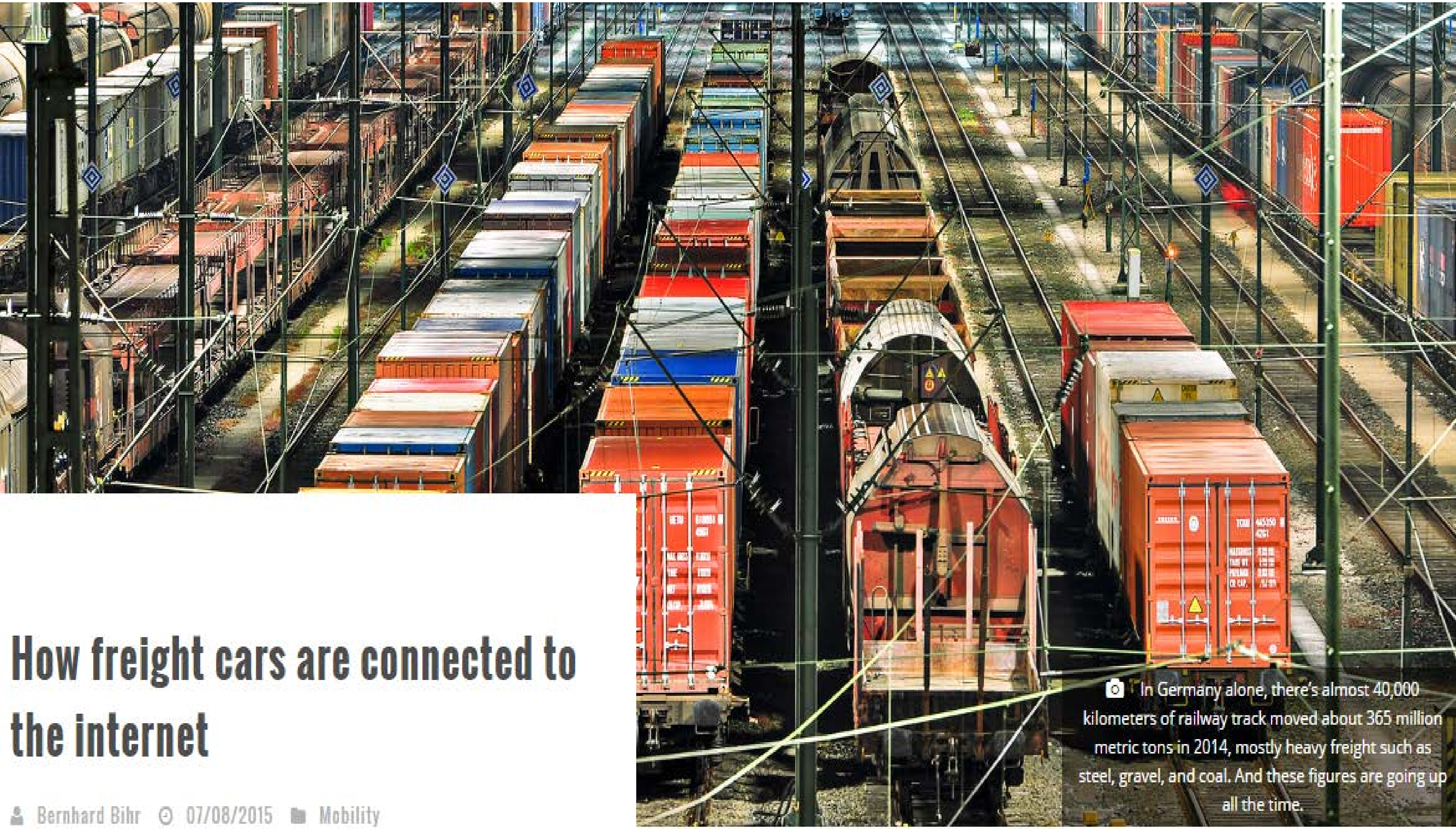
IIC Transportation Grand Challenge (2014) forged a partnership with Professor Raj Rajkumar at CMU (IIC member). Autonomous transportation has deep roots in the Robotics Institute (Google, Uber, Ottomatika, Delphi).

Why focus on freight ?

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

This is not one of the reasons to focus on freight

Freight



How freight cars are connected to the internet

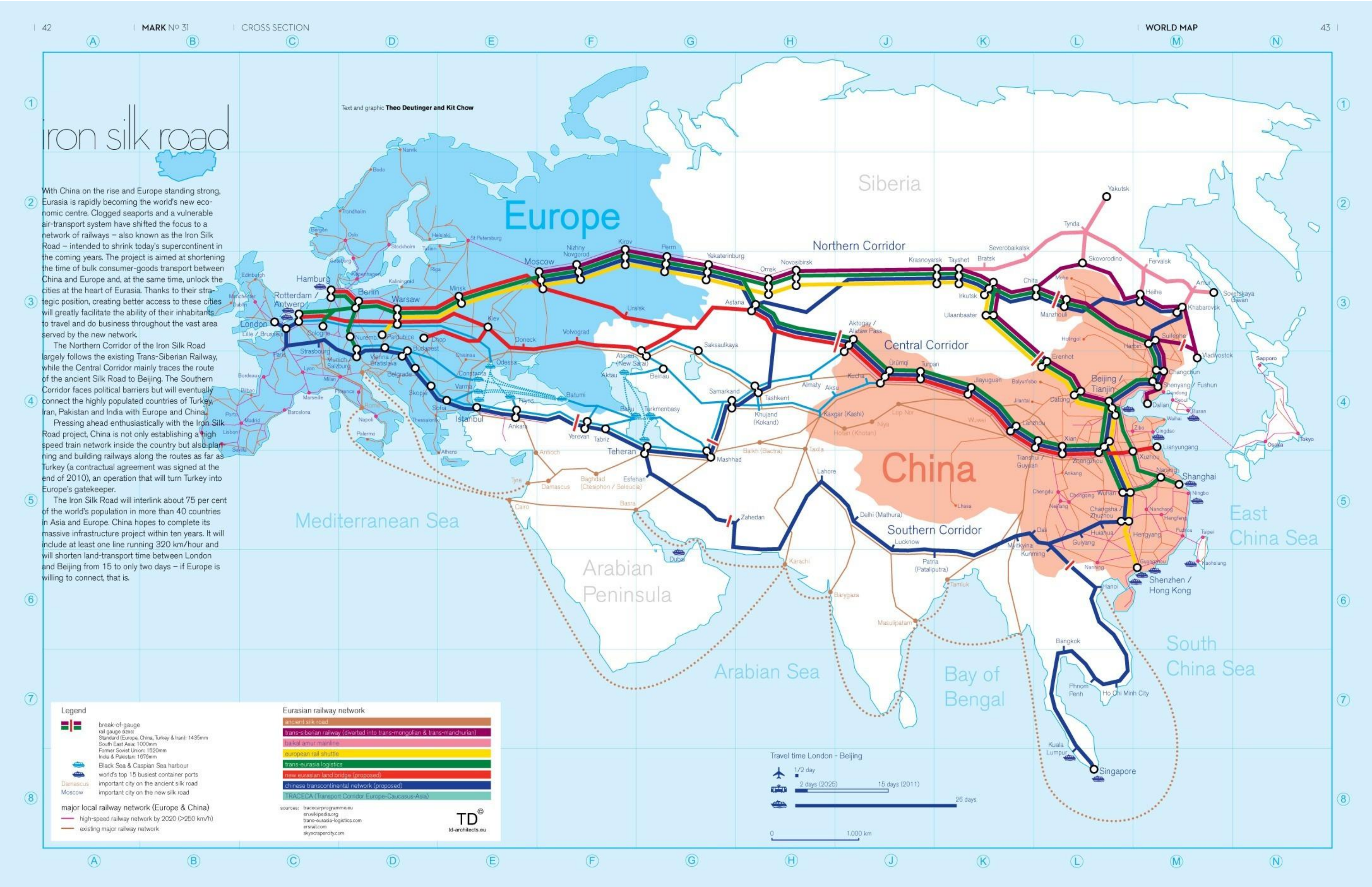
Bernhard Bihr 07/08/2015 Mobility

In Germany alone, there's almost 40,000 kilometers of railway track moved about 365 million metric tons in 2014, mostly heavy freight such as steel, gravel, and coal. And these figures are going up all the time.

Intelligent Freight?

With the new condition monitoring system, a freight train becomes a digital and intelligent mode of transportation. New functions are now possible: precisely locating the railcar, gathering information about the freight's conditions during transport, recognizing vibrations during shunting, and recording how many kilometers a railcar travels for distance- and condition-based maintenance.

Adapt or Die – The Iron Silk Road ahead



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

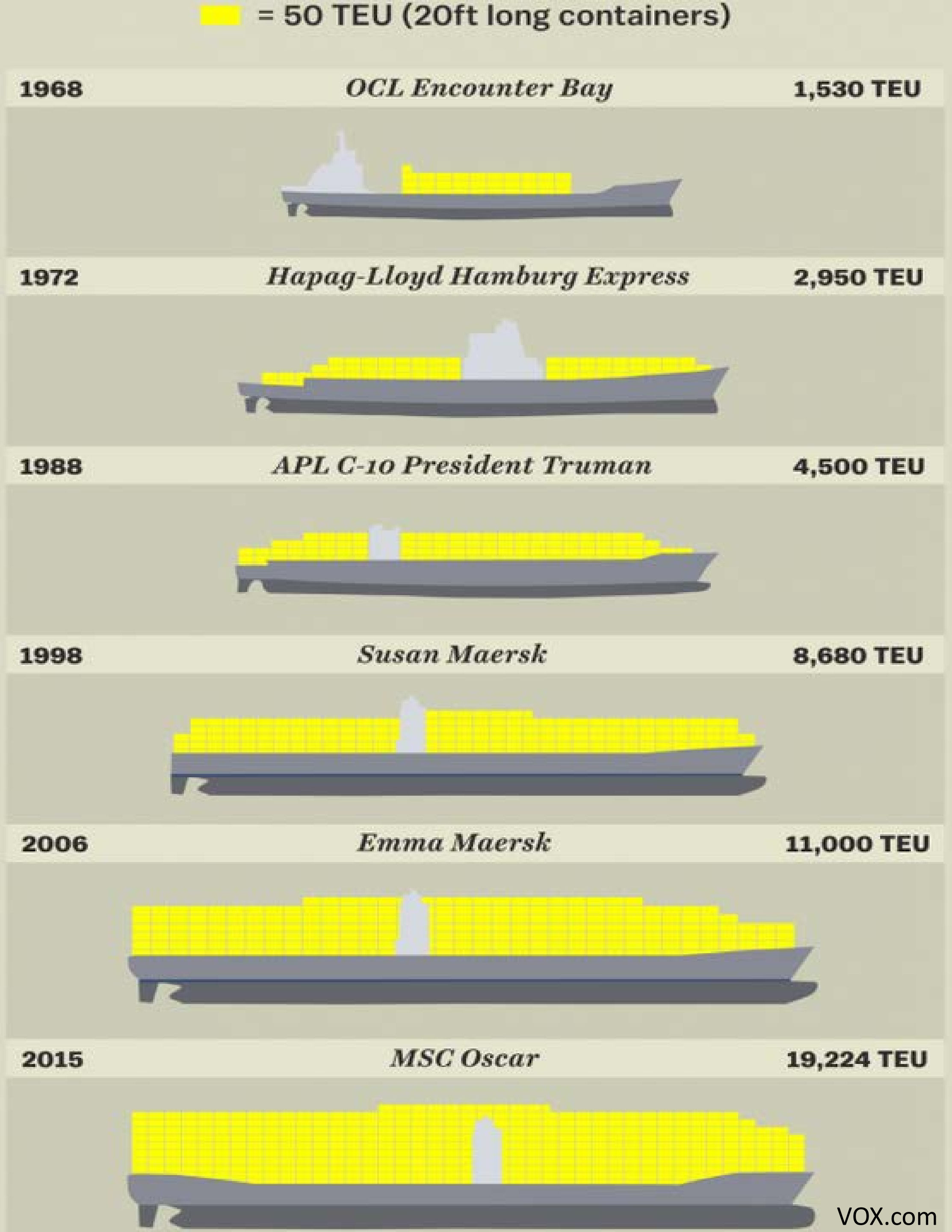
http://dspace.mit.edu/bitstream/handle/1721.1/41897/WiFi%20Meet%20FuFi%20_%20MIT%20ESD%20WP.pdf?sequence=1

Focus on freight

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

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

Shipping


= 50 TEU (20ft long containers)
1968
OCL Encounter Bay
1,530 TEU
1972
Hapag-Lloyd Hamburg Express
2,950 TEU
1988
APL C-10 President Truman
4,500 TEU
1998
Susan Maersk
8,680 TEU
2006
Emma Maersk
11,000 TEU
2015
MSC Oscar
19,224 TEU
VOX.com

FedEx Hub in Memphis, TN

Business of Disruptive Convergence ?

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

Daimler unveils autonomous truck at Hoover Dam event

Freightliner Inspiration Truck

Daimler Trucks launched its newly developed autonomous transport truck, the Freightliner Inspiration, at an event that turned the Hoover Dam into a large projection screen. The Level 3 autonomous truck uses Highway Pilot sensors and hardware with cameras and radar to safely operate under a range of highway conditions, and has been granted a license to operate in Nevada.

Traffic congestion drains the U.S. economy of $87.2 billion every year with 4.2 billion hours and 2.8 billion gallons of fuel spent sitting in traffic, according to US DOT ITS JPO

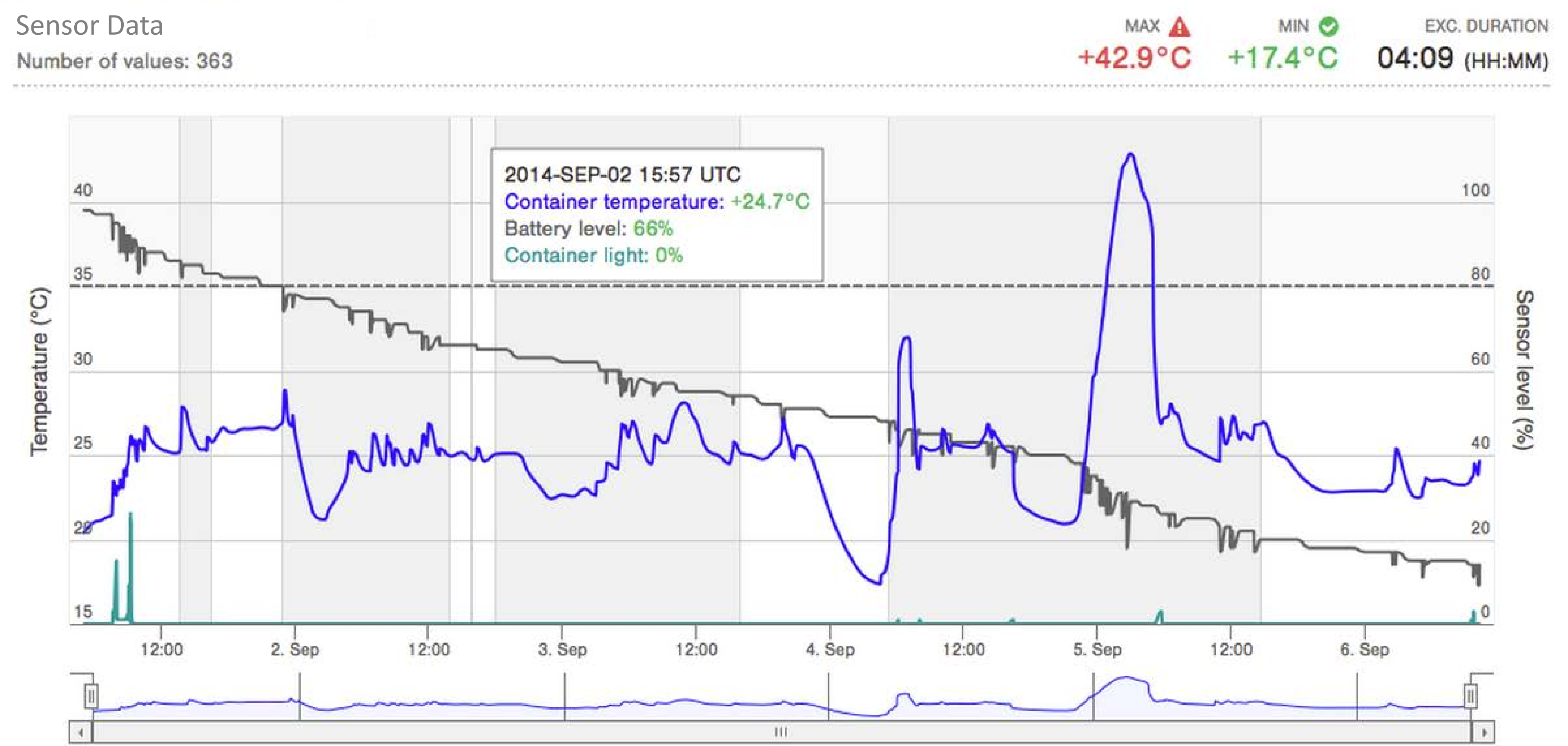
Autonomous Trucks with a Cab ?

Autonomous Trucks of the Future?

Illustration by Sarah Dellea, IIC

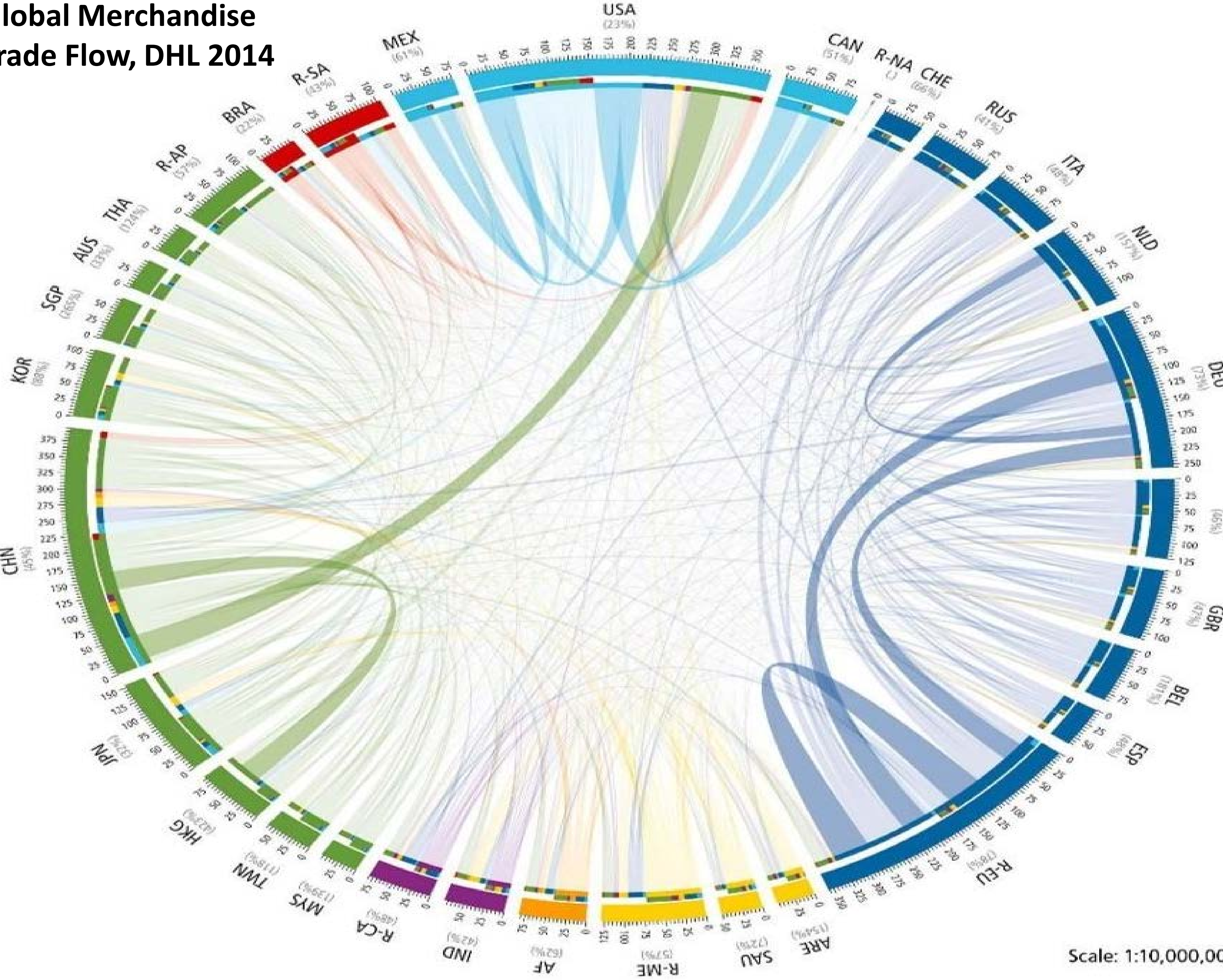
Even more reasons to focus on freight

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



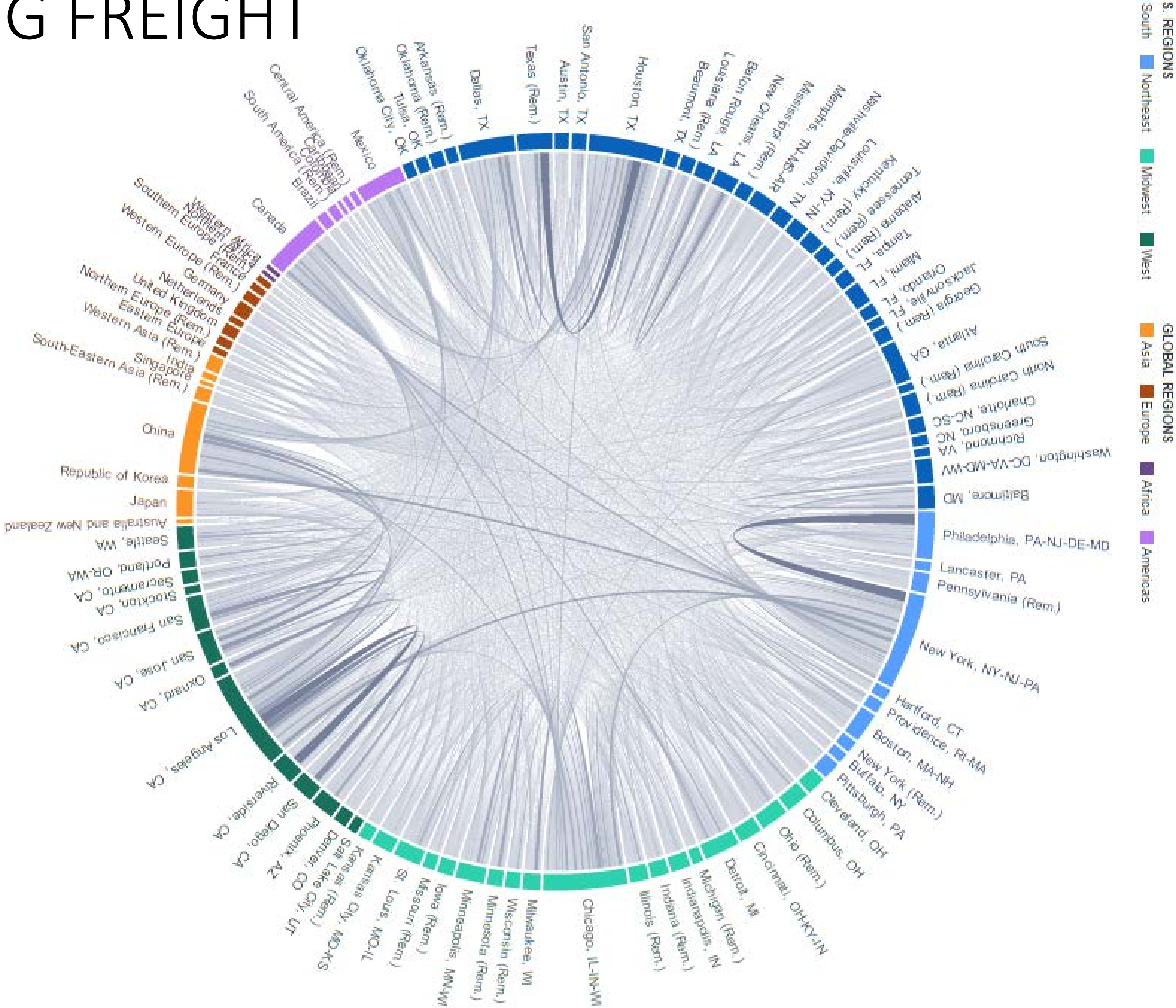
www.starbright.se/growth-in-refrigerated-transports/

Global Merchandise Trade Flow, DHL 2014



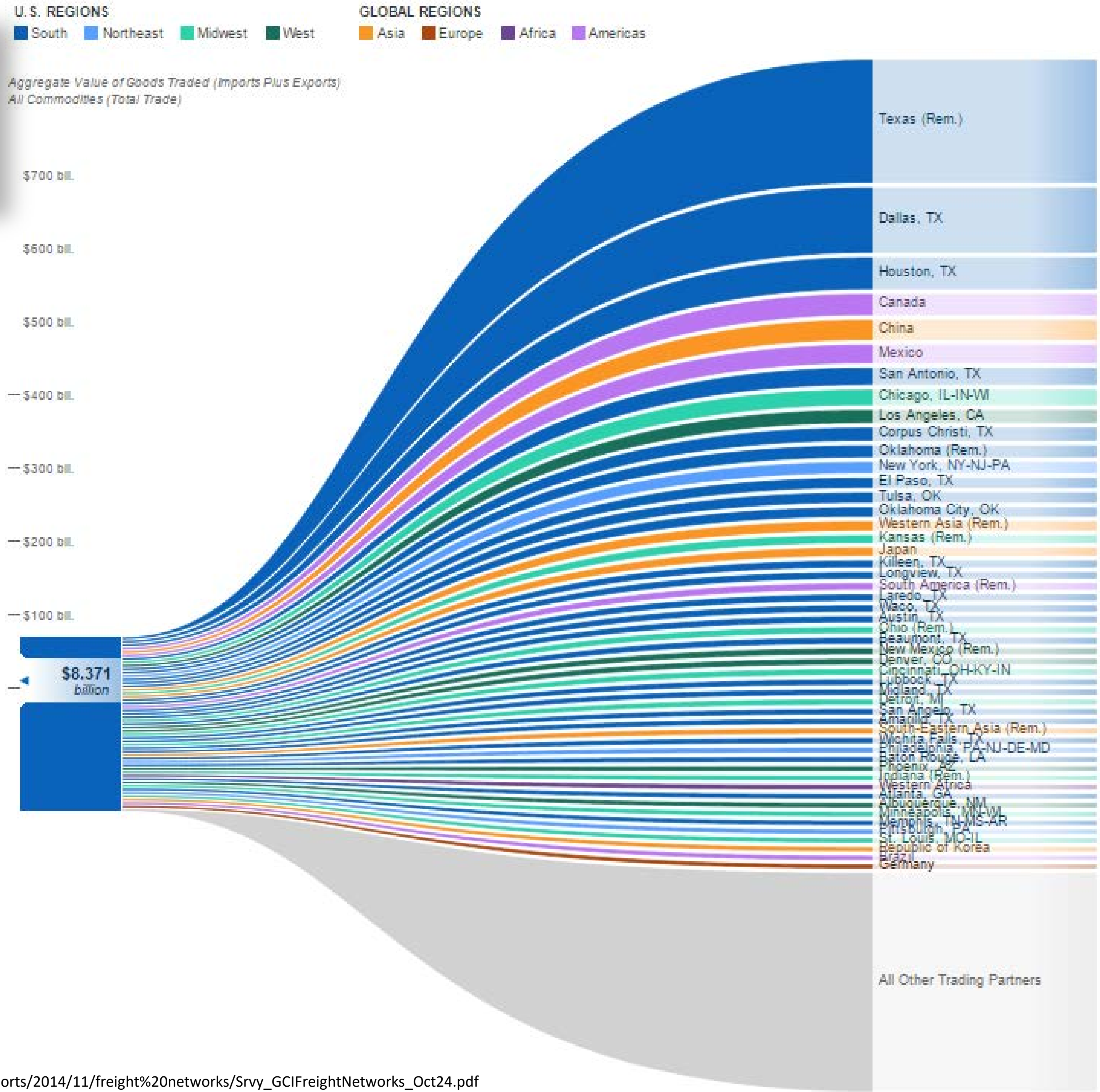
www.dhl.com/content/dam/Campaigns/gci2014/downloads/dhl_gci_2014_study_high.pdf

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

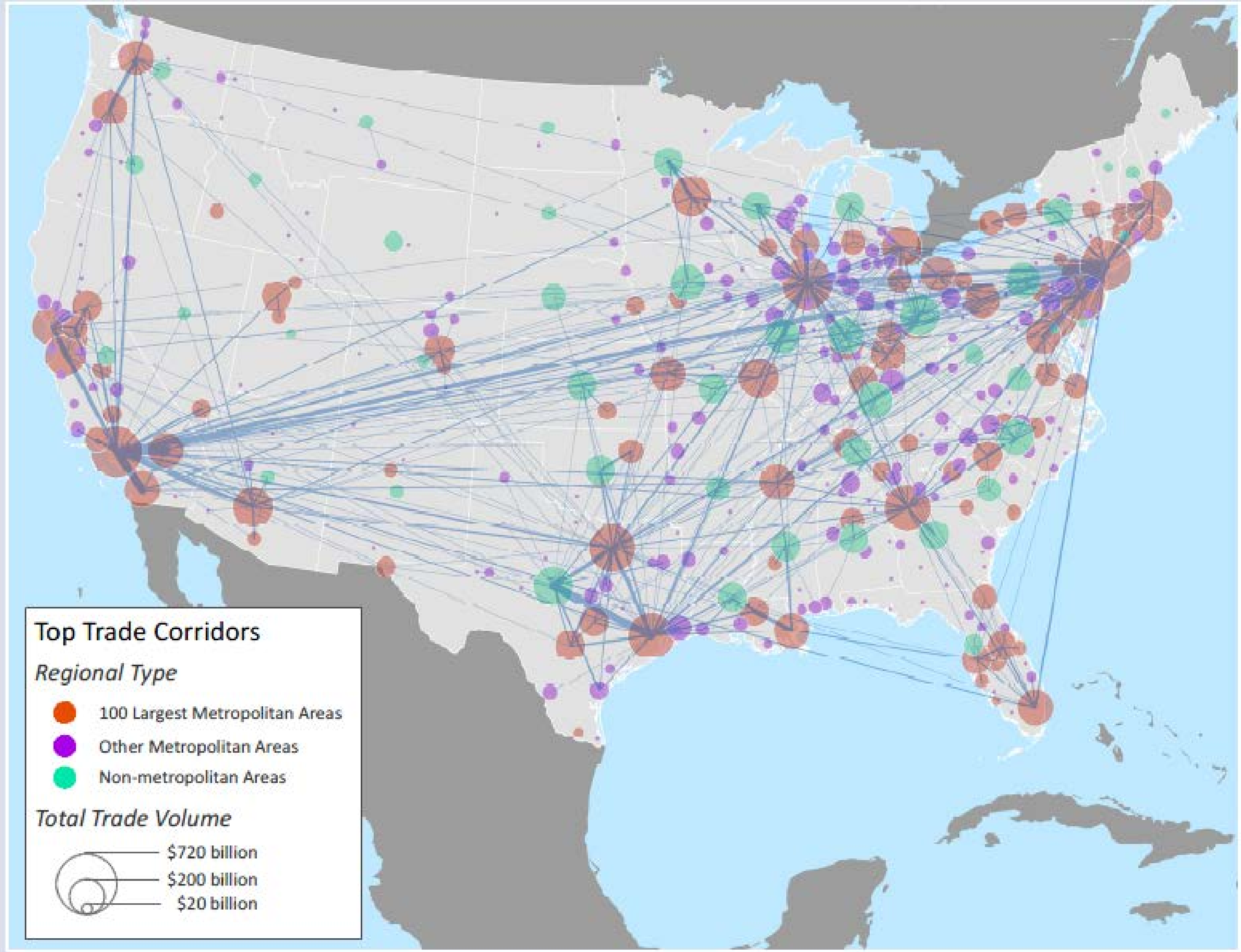
National Goods Trade ($20 trillion) exceeds GDP ($15 trillion)

		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)

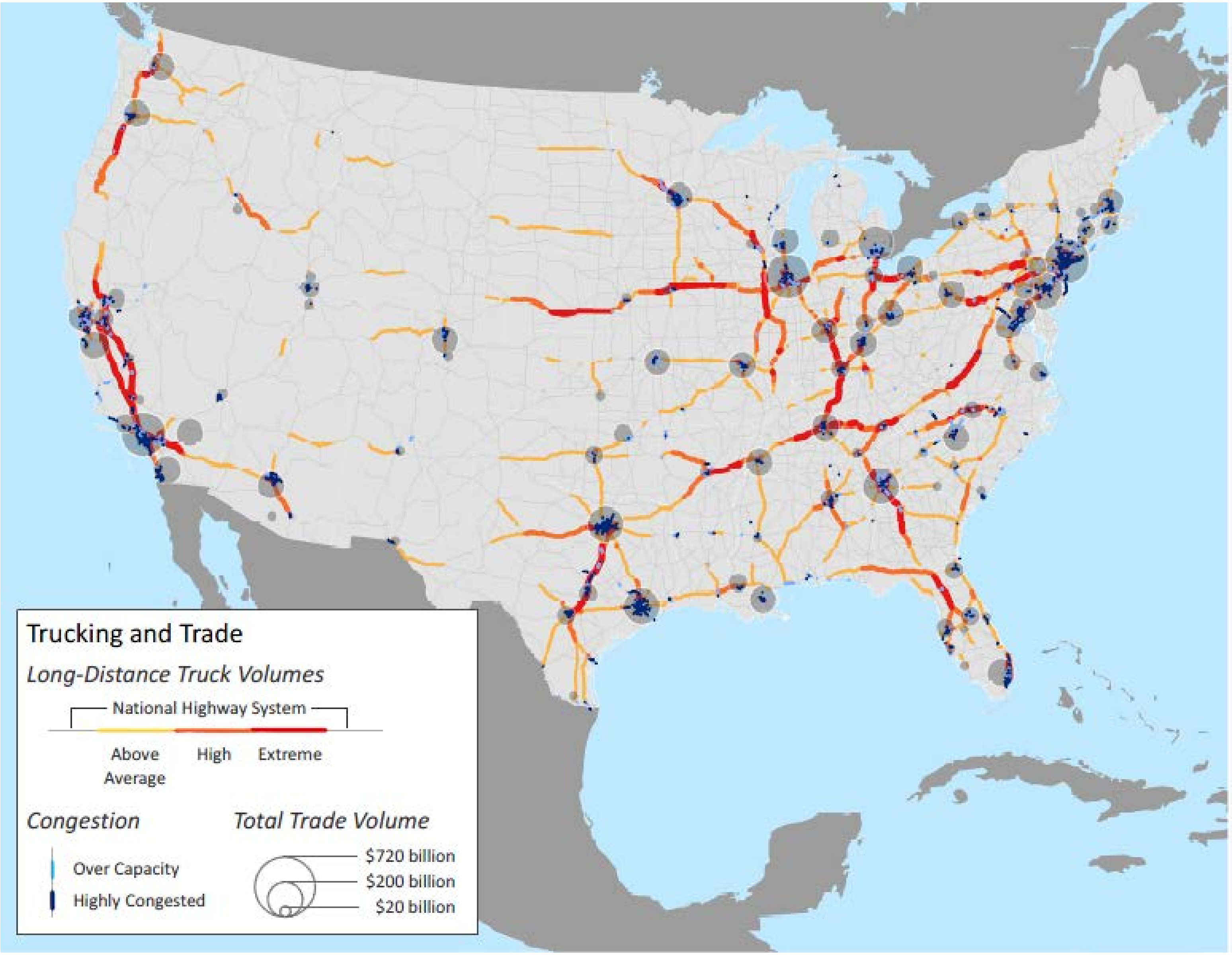
www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

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



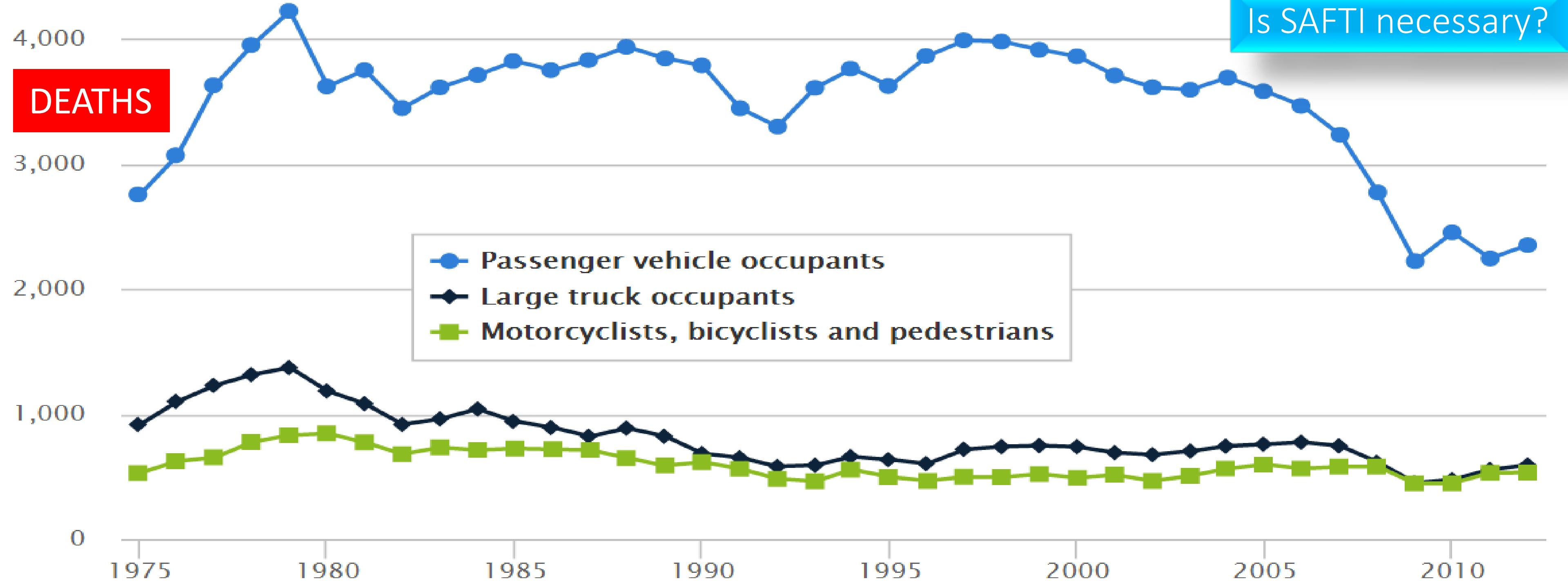
www.brookings.edu/~/media/Research/Files/Reports/2014/11/freight%20networks/Srvy_GCIFreightNetworks_Oct24.pdf

Long Distance Truck Loads and Highway Congestion



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

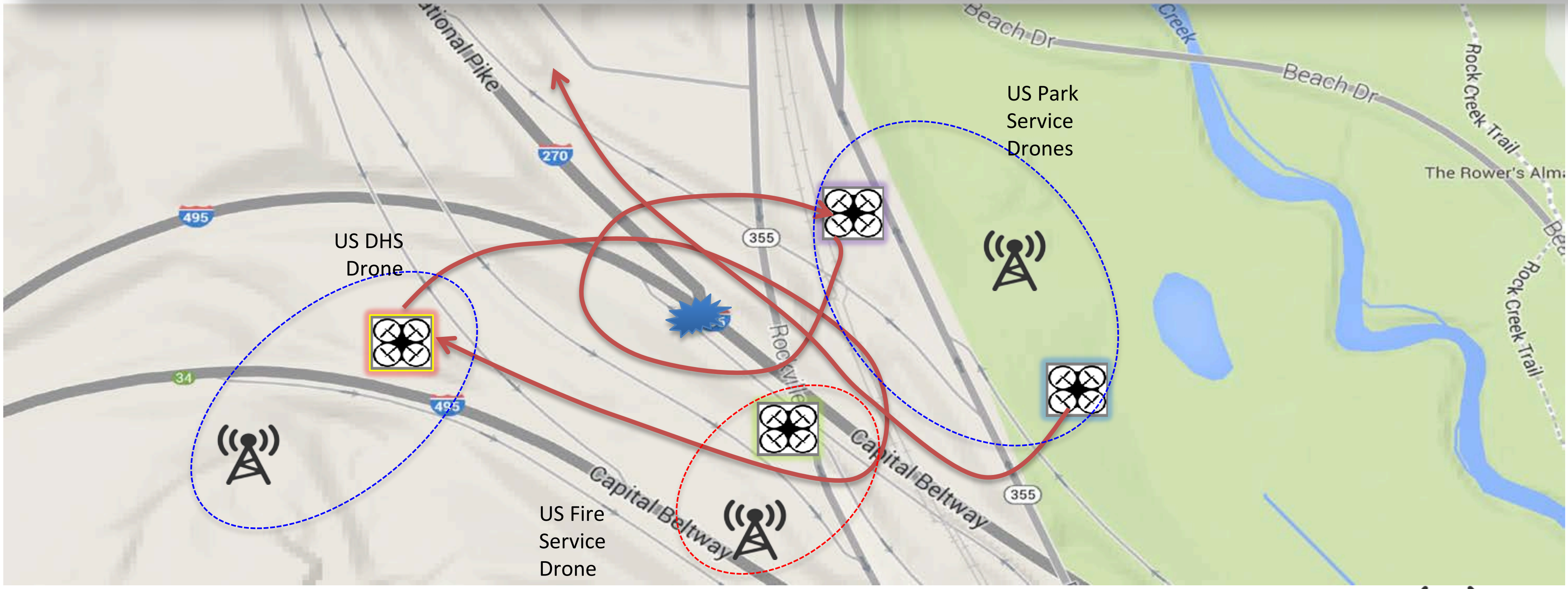
Is SAFTI necessary?

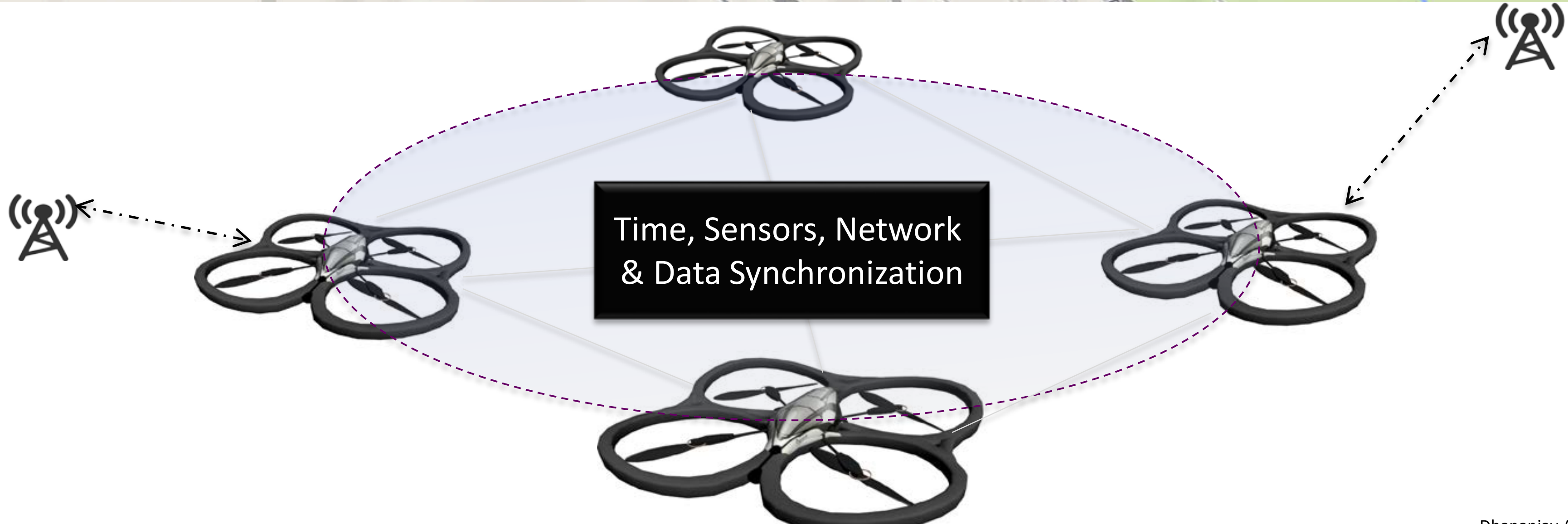


www.iihs.org/iihs/topics/t/large-trucks/fatalityfacts/large-trucks

Transportation Coordination - Emergency “Crash to Care” Response

Transportation of data – key to emergency search and rescue drones





Dhananjay Anand, NIST

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

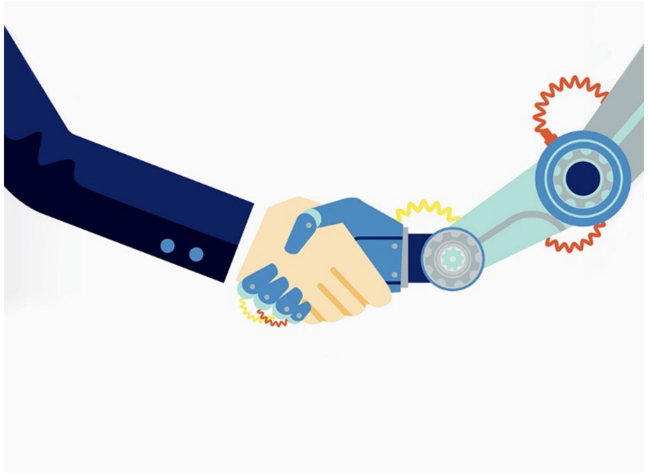
Semi-Autonomous Freight Transportation Initiative

Broad Deployment Packages (BDP)

Dr Shoumen Datta

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

- Can we deploy of Semi-Autonomous Freight Transportation?



SAFTI Semi-Autonomous Freight Transportation Initiative

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 <u>three</u> 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

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 [software defined] vehicles) 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 software defined vehicles) 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 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*

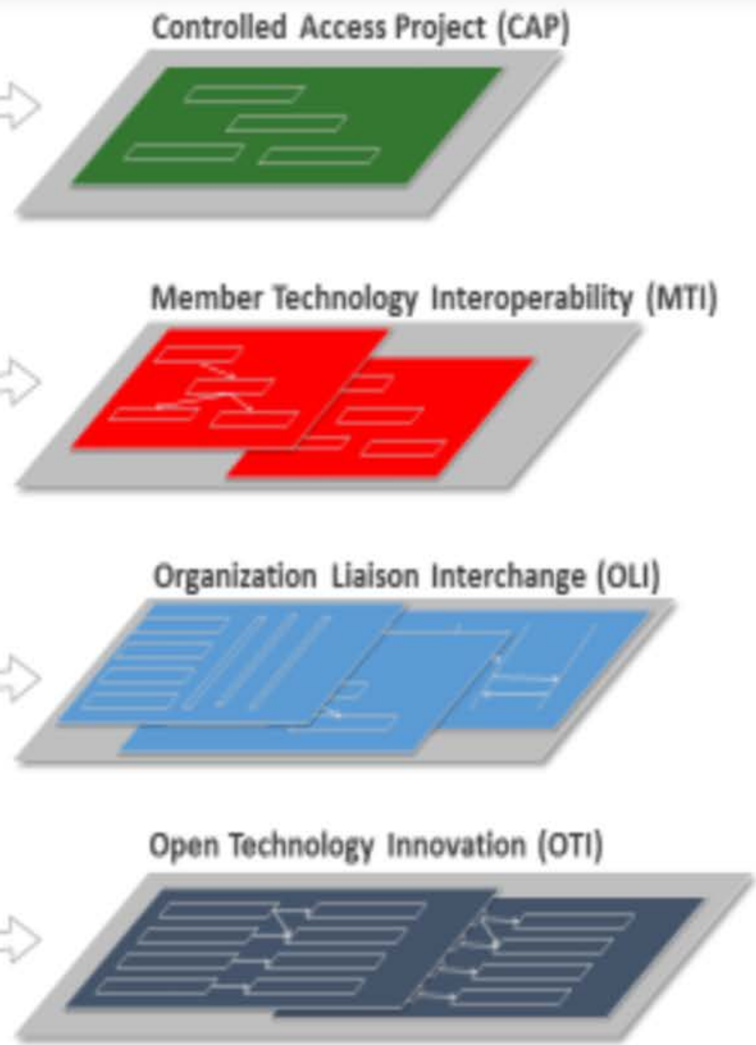
Outline of an idea to address IP rights of contributors and collaborators

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*

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.

Open technology innovation initiative. Explore "Grand Challenges" or IoS here 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

Connected Vehicle Reference Implementation Architecture (CVRIA)

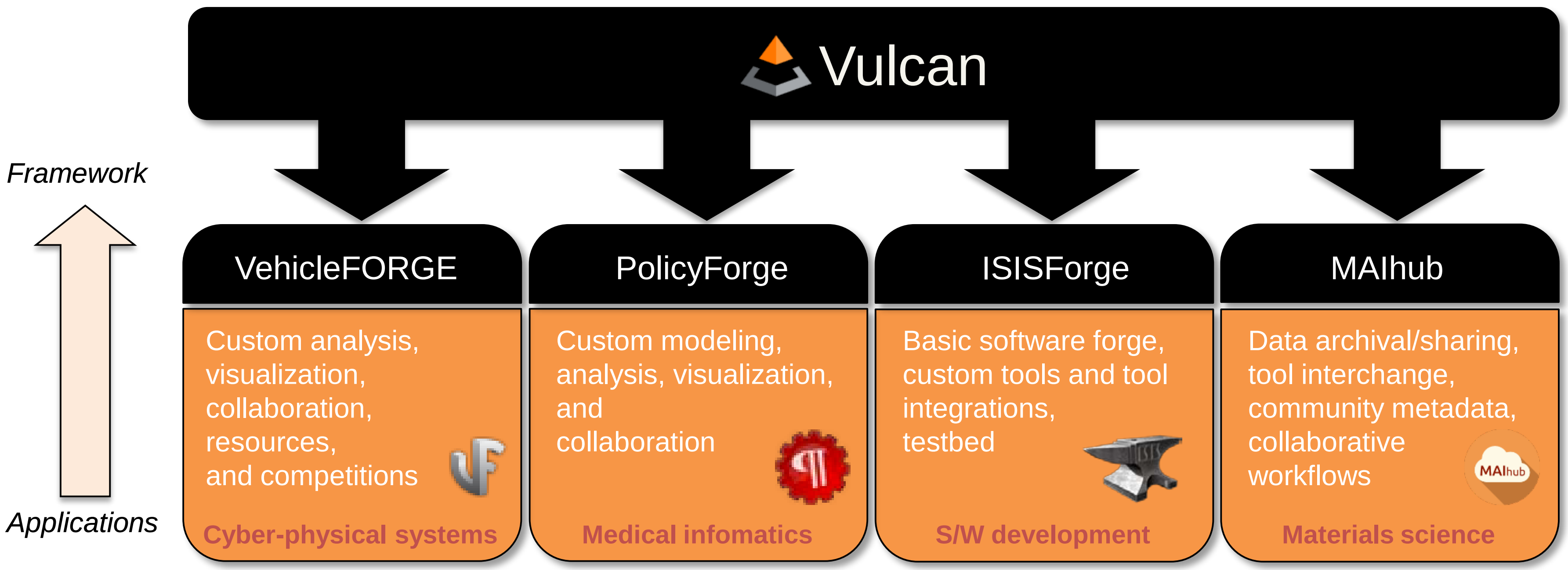
We start the process of further decomposition using the US DoT mandated MS Visio-like tool referred to as the connected vehicle reference implementation architecture.

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.

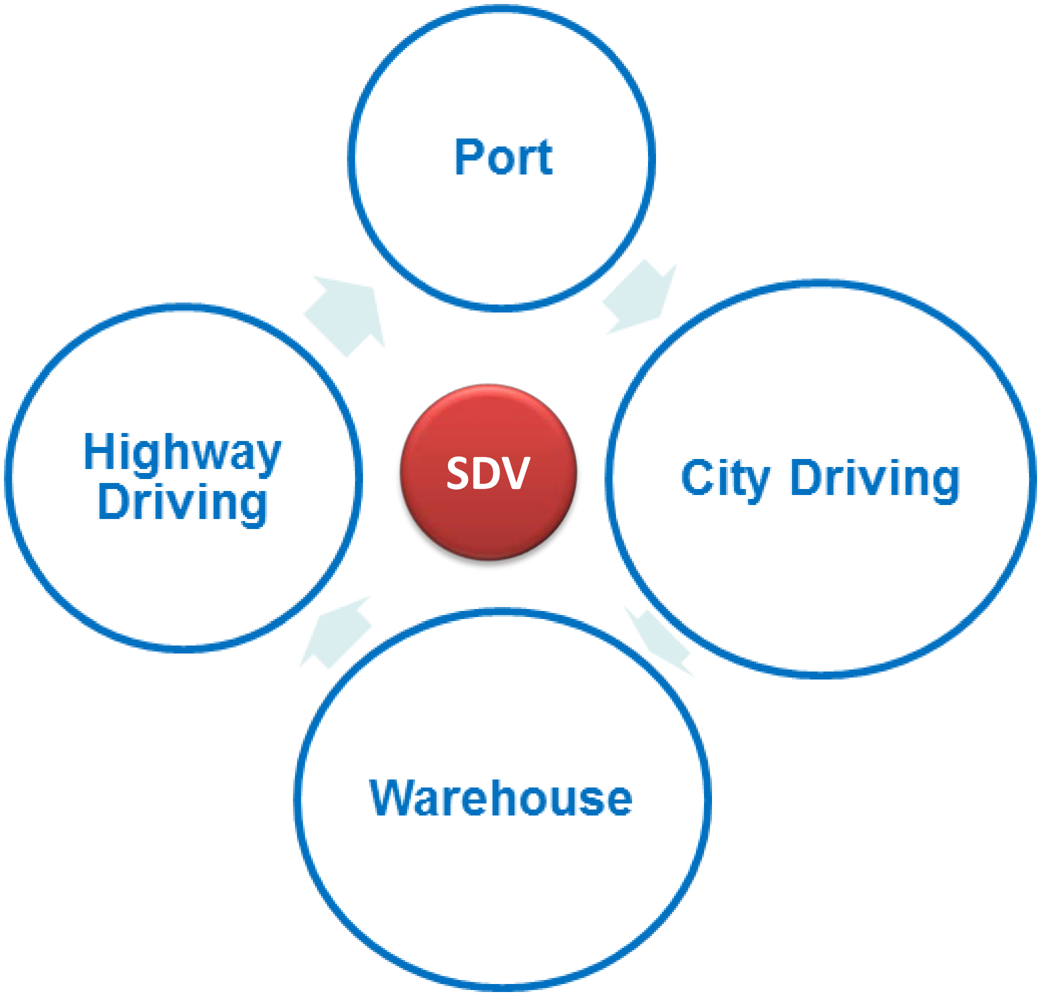
www.iteris.com/cvria/html/resources/cvriatraining.html

Can we evolve CVRIA with Vulcan ?



SAFTI

May comprise of 4 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 (eg Pittsburgh, PA)

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

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

- Eco-driving assist

3. Operation near and at the container port (eg California, South Carolina)

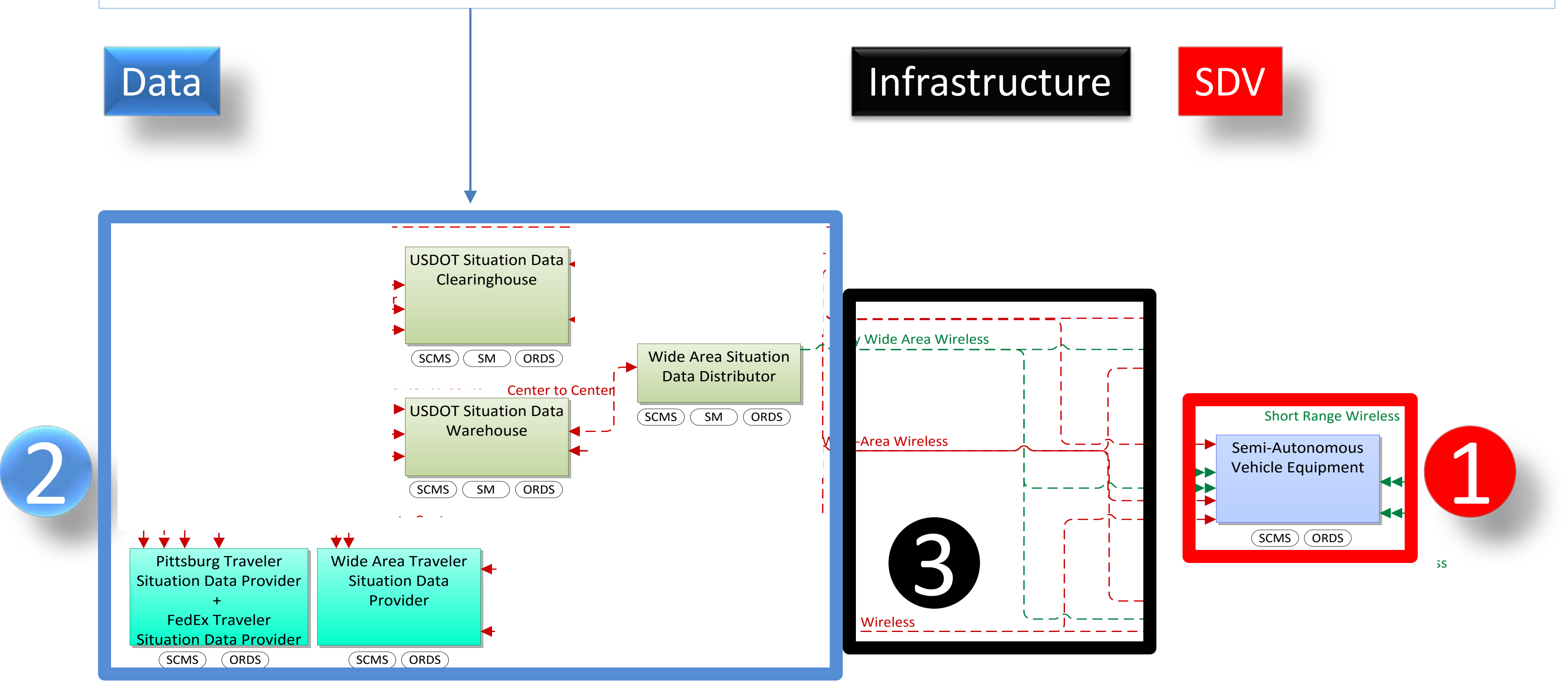
- Semi-Autonomous vehicle operation
- Freight and vehicle logistics management

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)

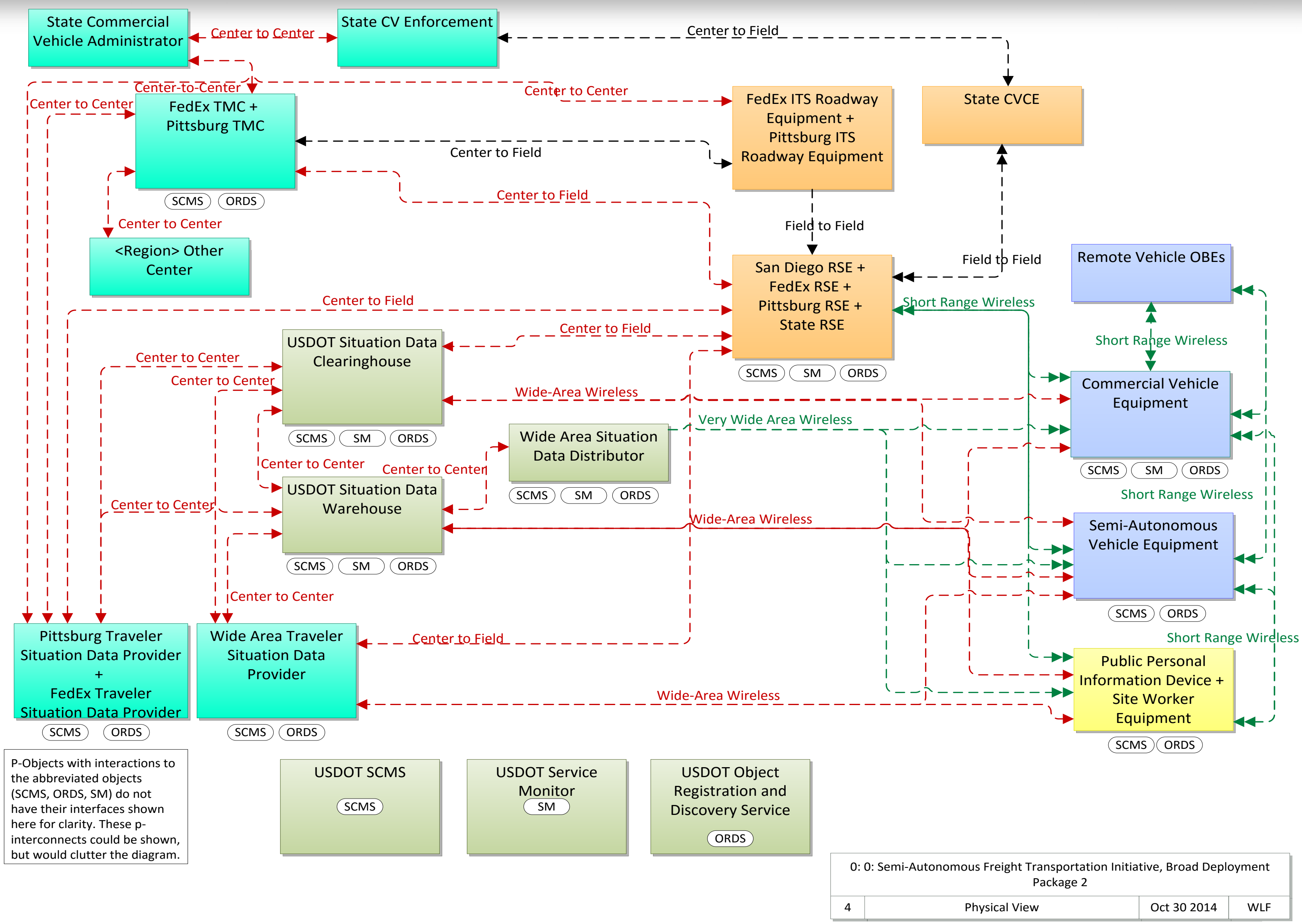
Can we create a secure "God Server" for this data? Question asked by Walton Fehr of US DoT at NIST on 2/12/2015



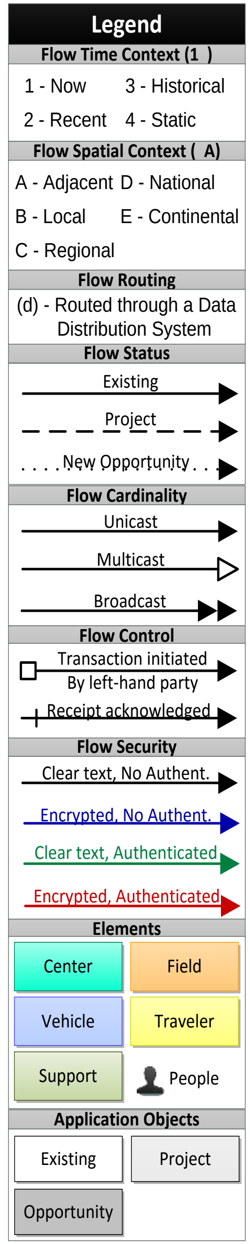
0: 0: Semi-Autonomous Freight Transportation Initiative, Broad Deployment Package			
4	Physical View	Oct 30 2014	WLF

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.

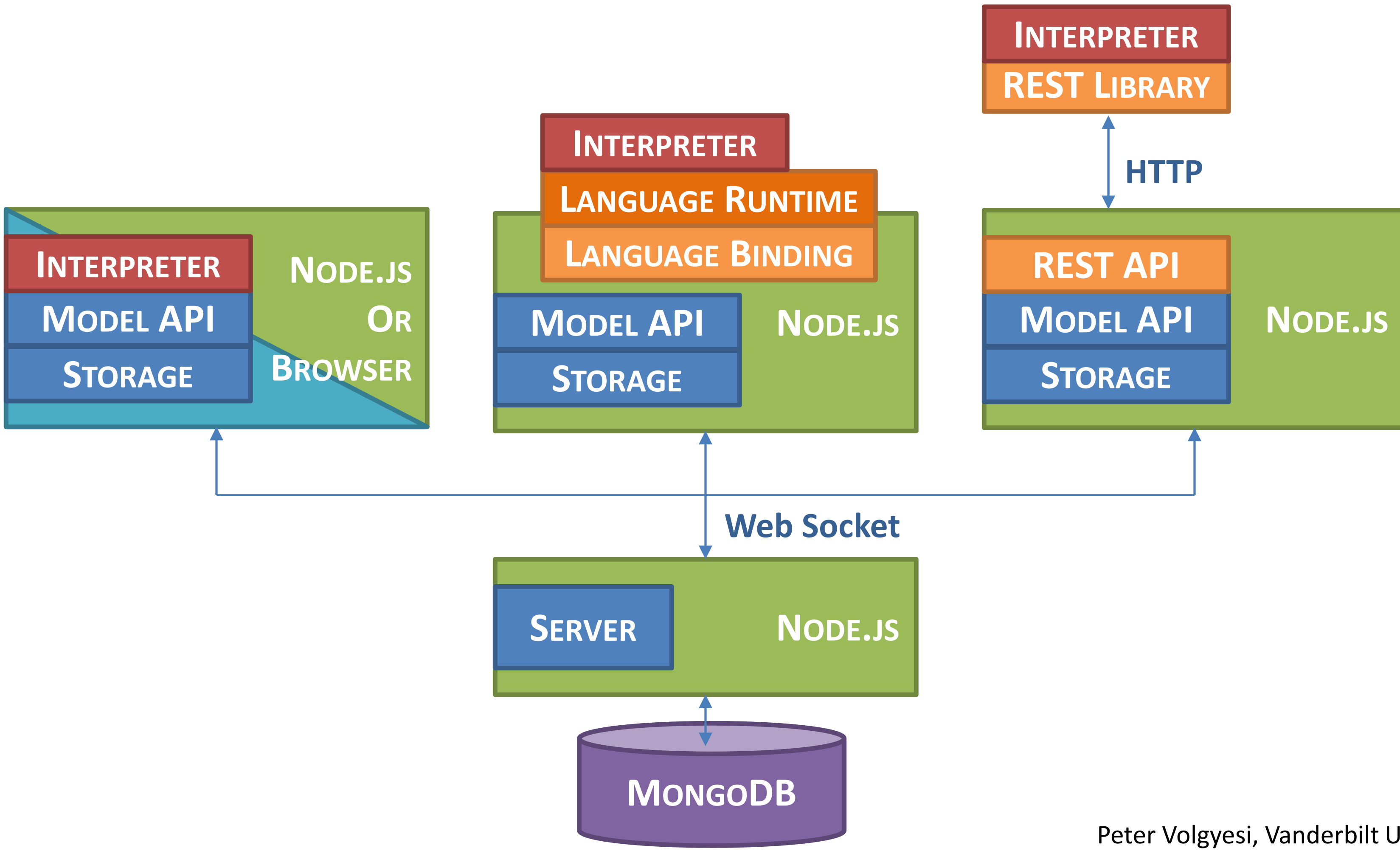
2: Layer 2 Legend			
1	Physical View	Oct 30 2014	WLF

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*

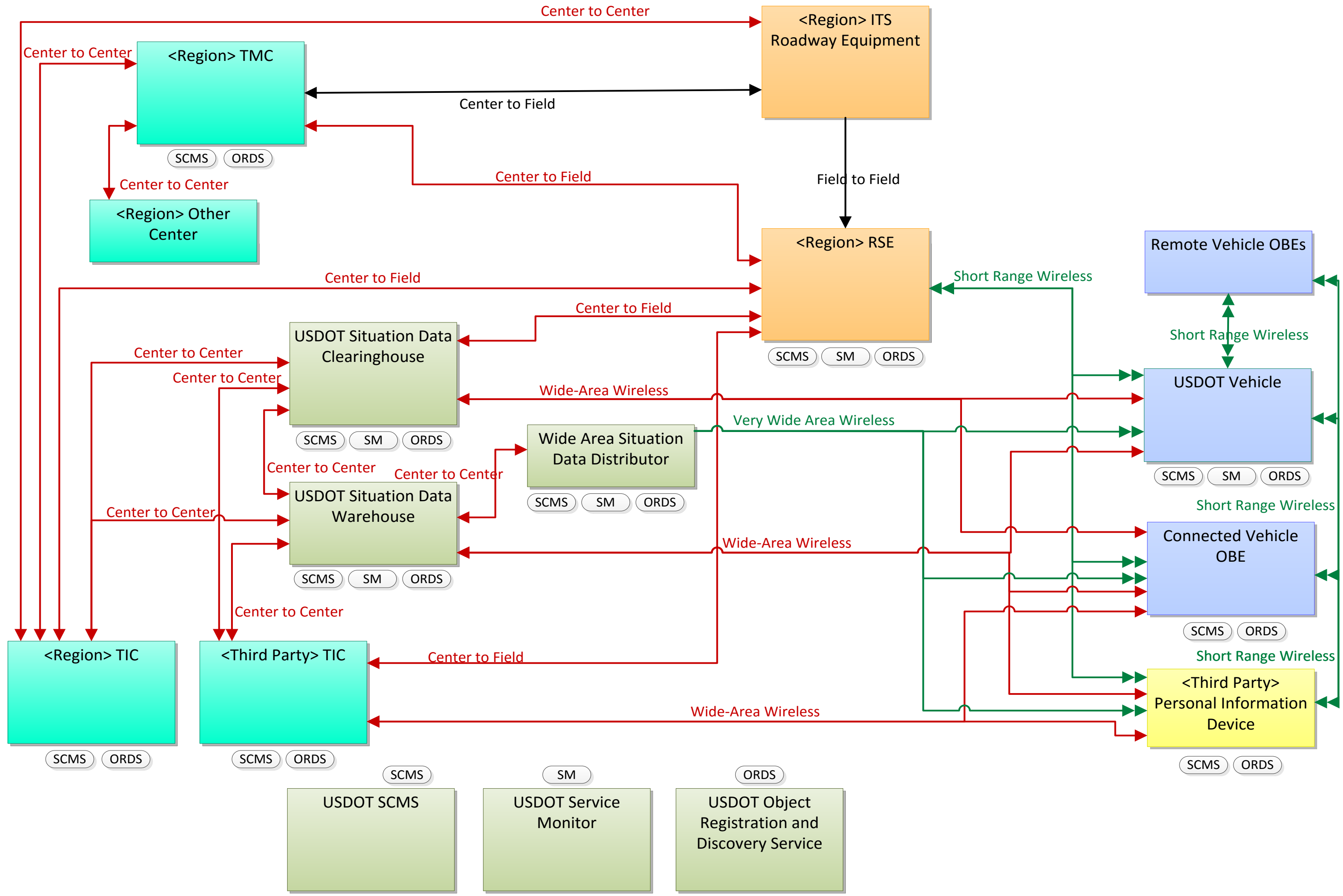


Peter Volgyesi, Vanderbilt University

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)

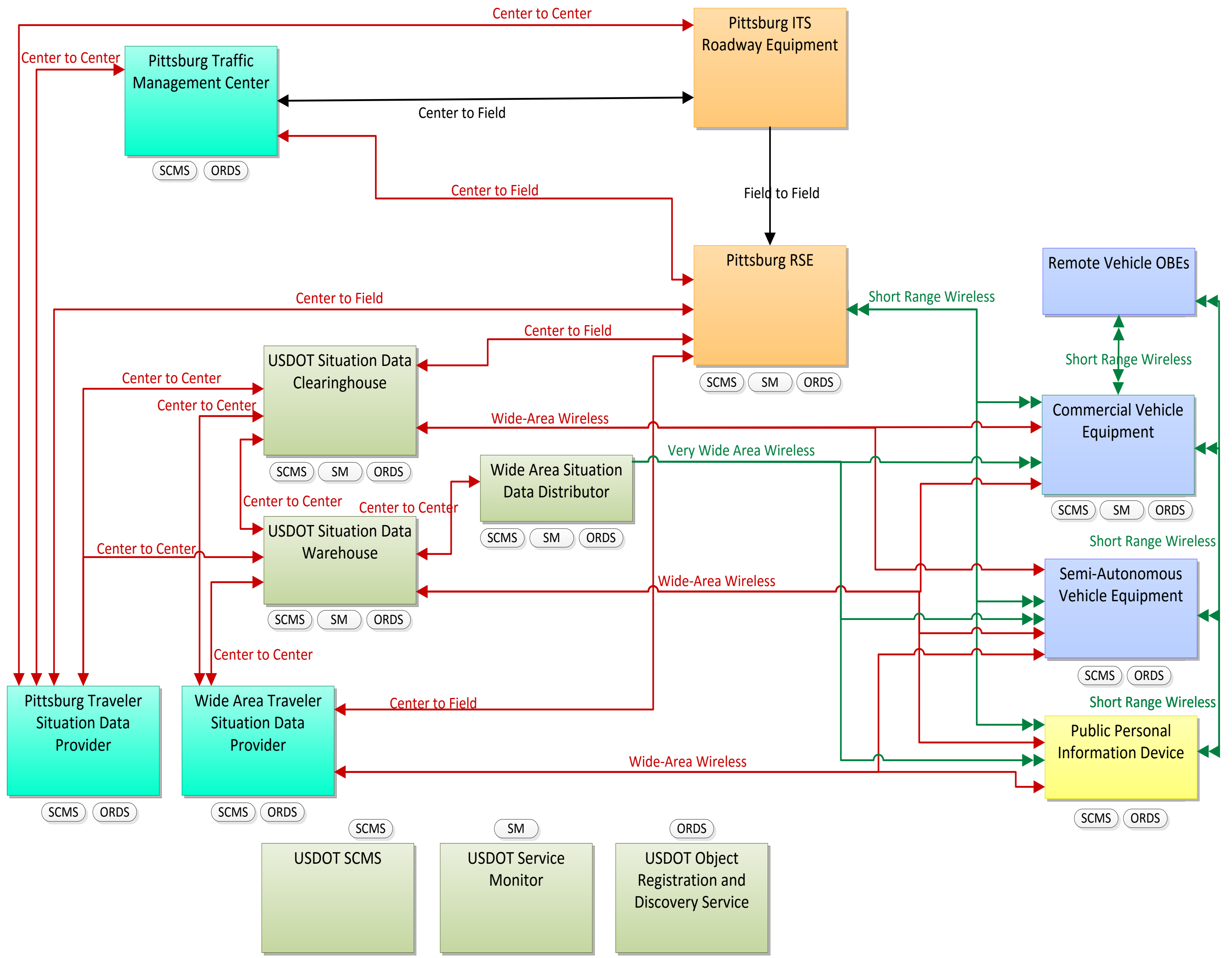
Physical View – Layer 0



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

Approved for OTI

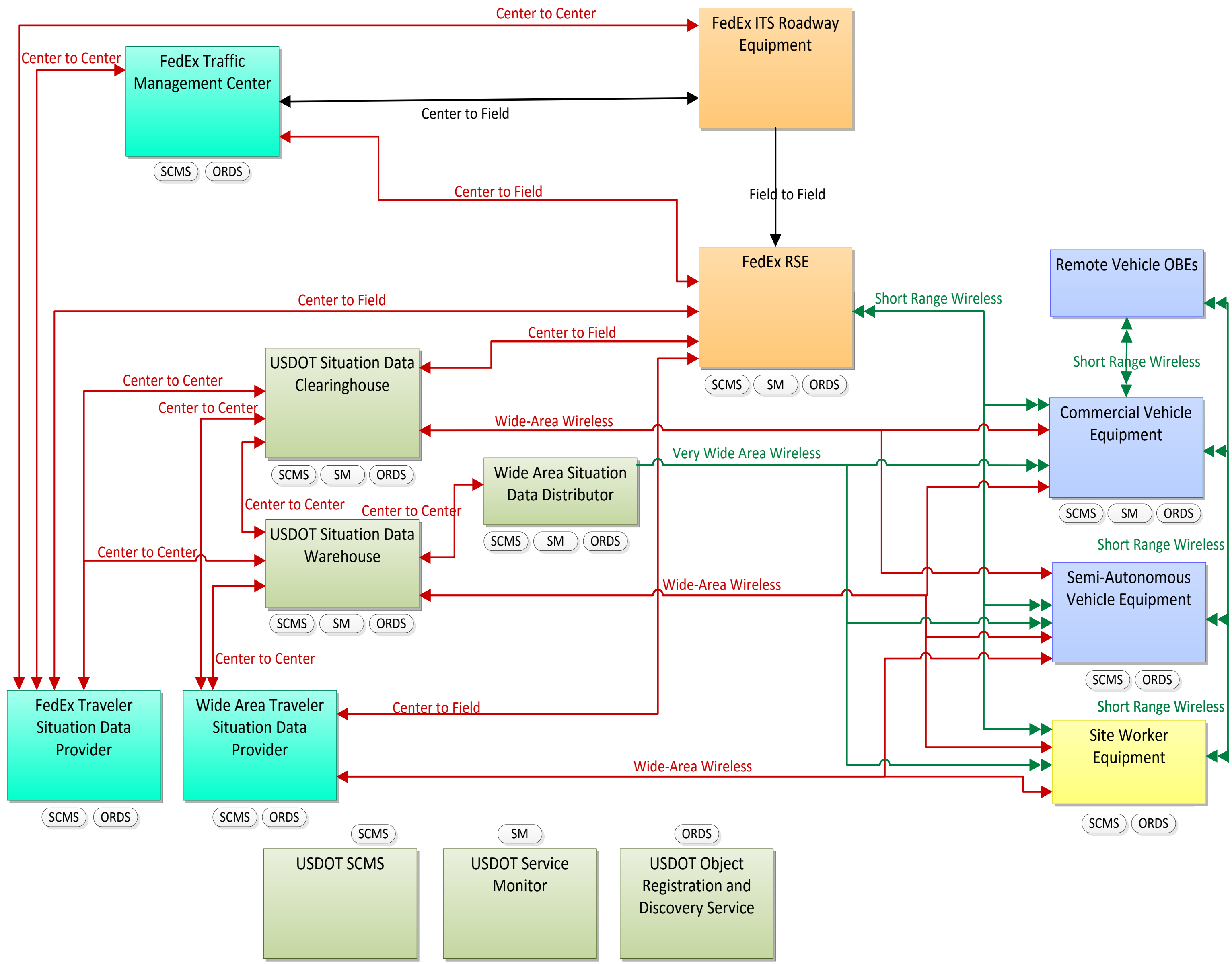
Specific versions of the Physical View - Layer 0 to be created for each of the operating environments of BDP2



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



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

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

3 general purpose information flows 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.

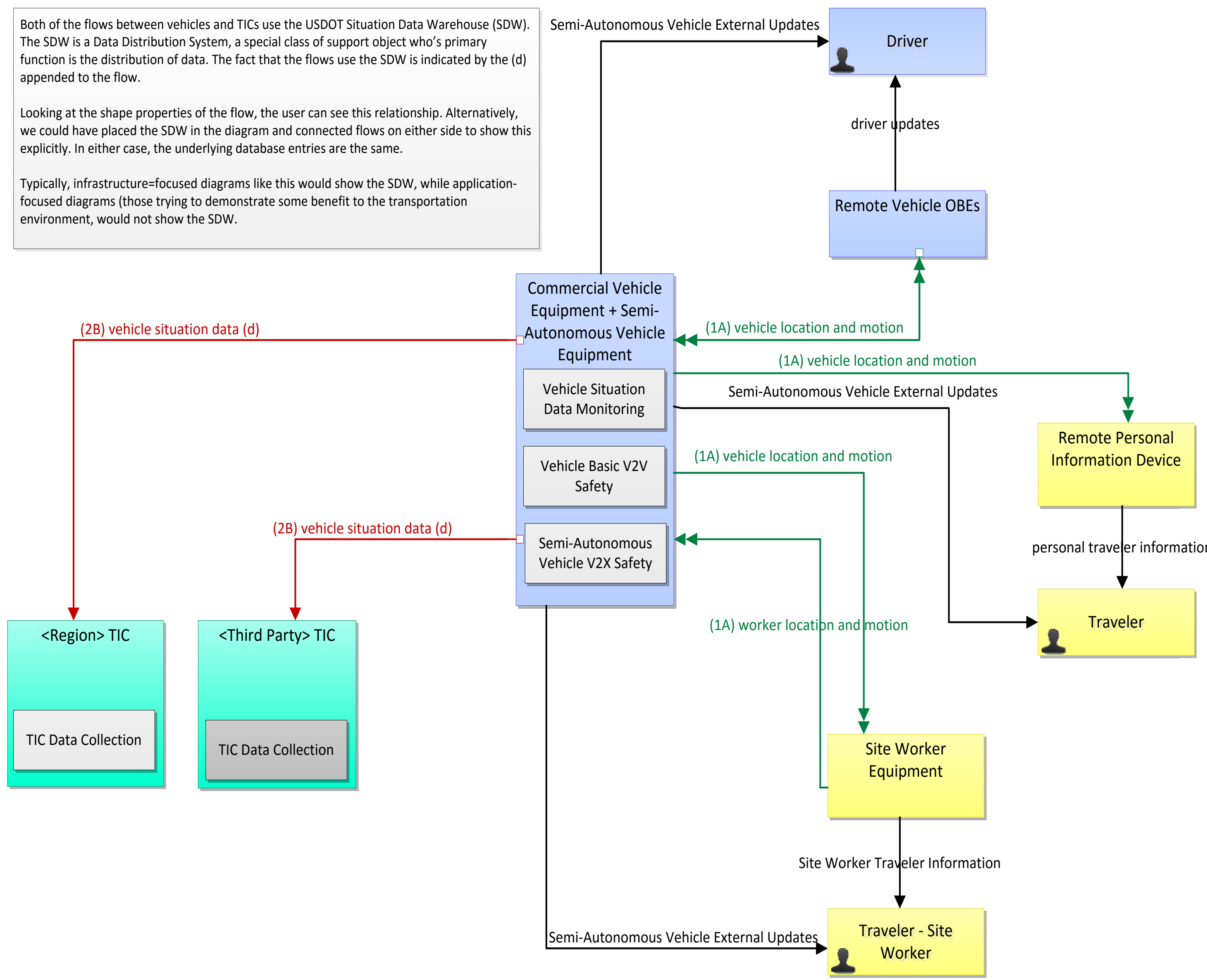
[3] Traveler Situation Data originates at centers and directed toward vehicles & mobile devices.

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.

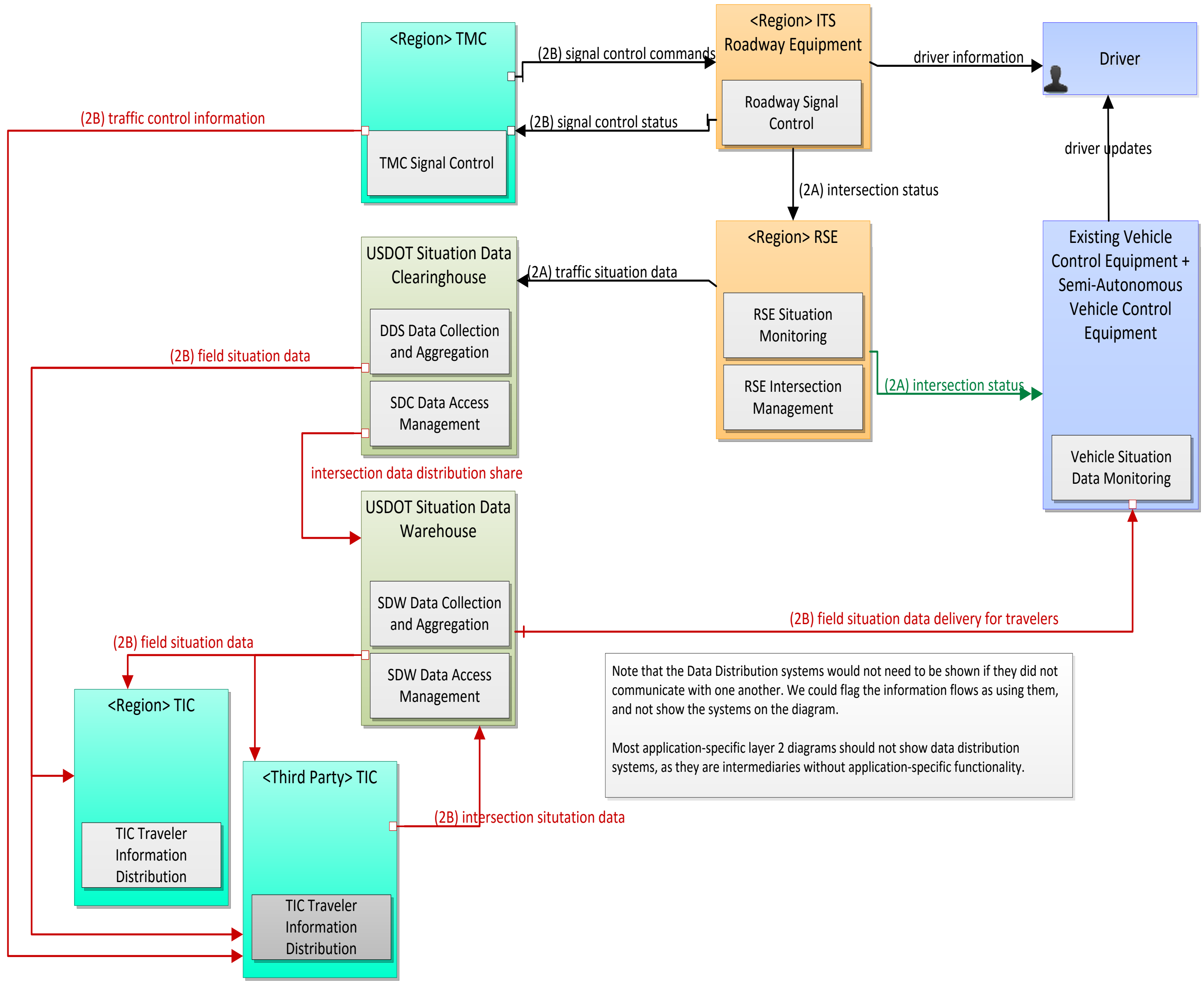
Typically, infrastructure=focused diagrams like this would show the SDW, while application-focused diagrams (those trying to demonstrate some benefit to the transportation environment, would not show the SDW.



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.



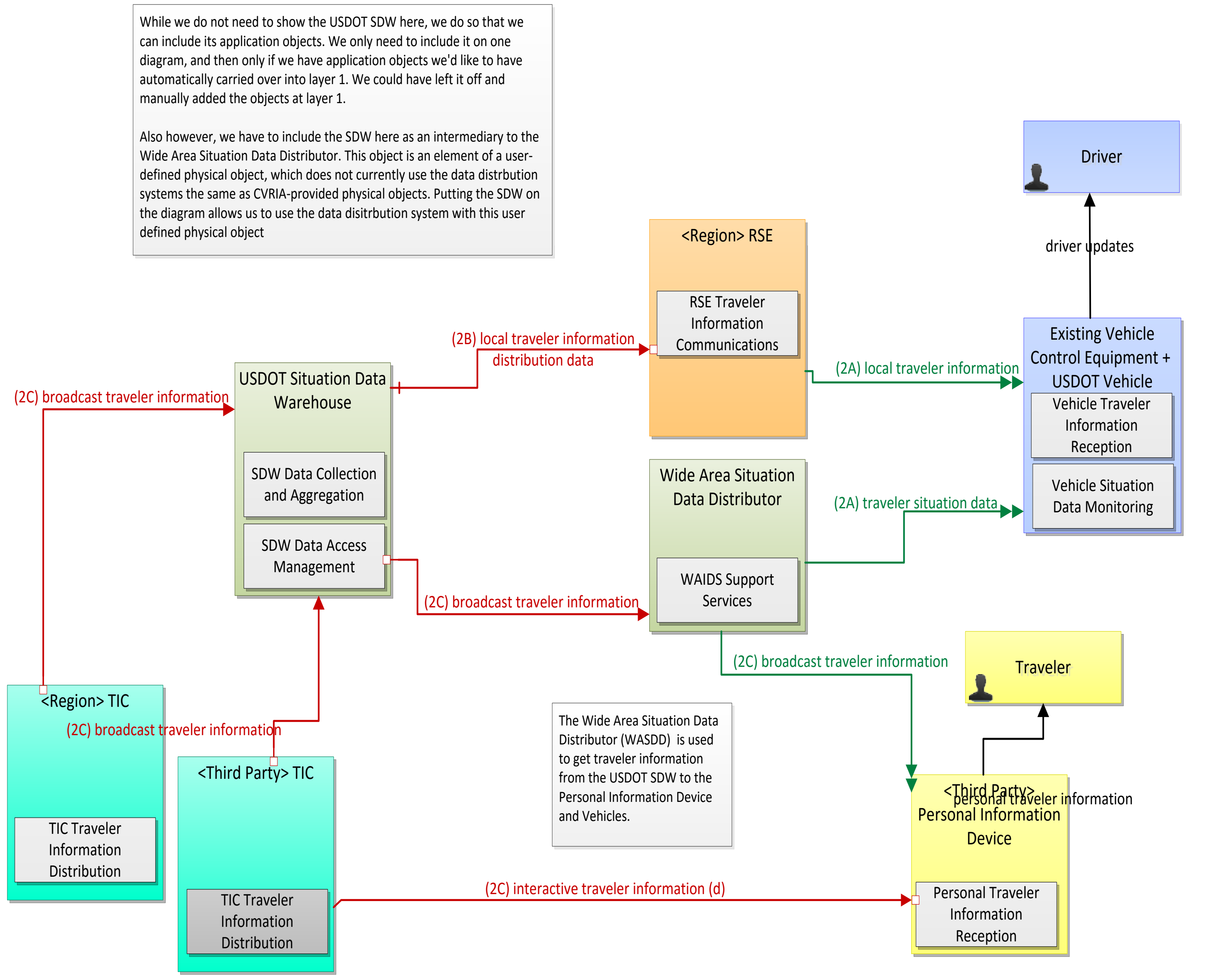
Note that the Data Distribution systems would not need to be shown if they did not communicate with one another. We could flag the information flows as using them, and not show the systems on the diagram.

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.

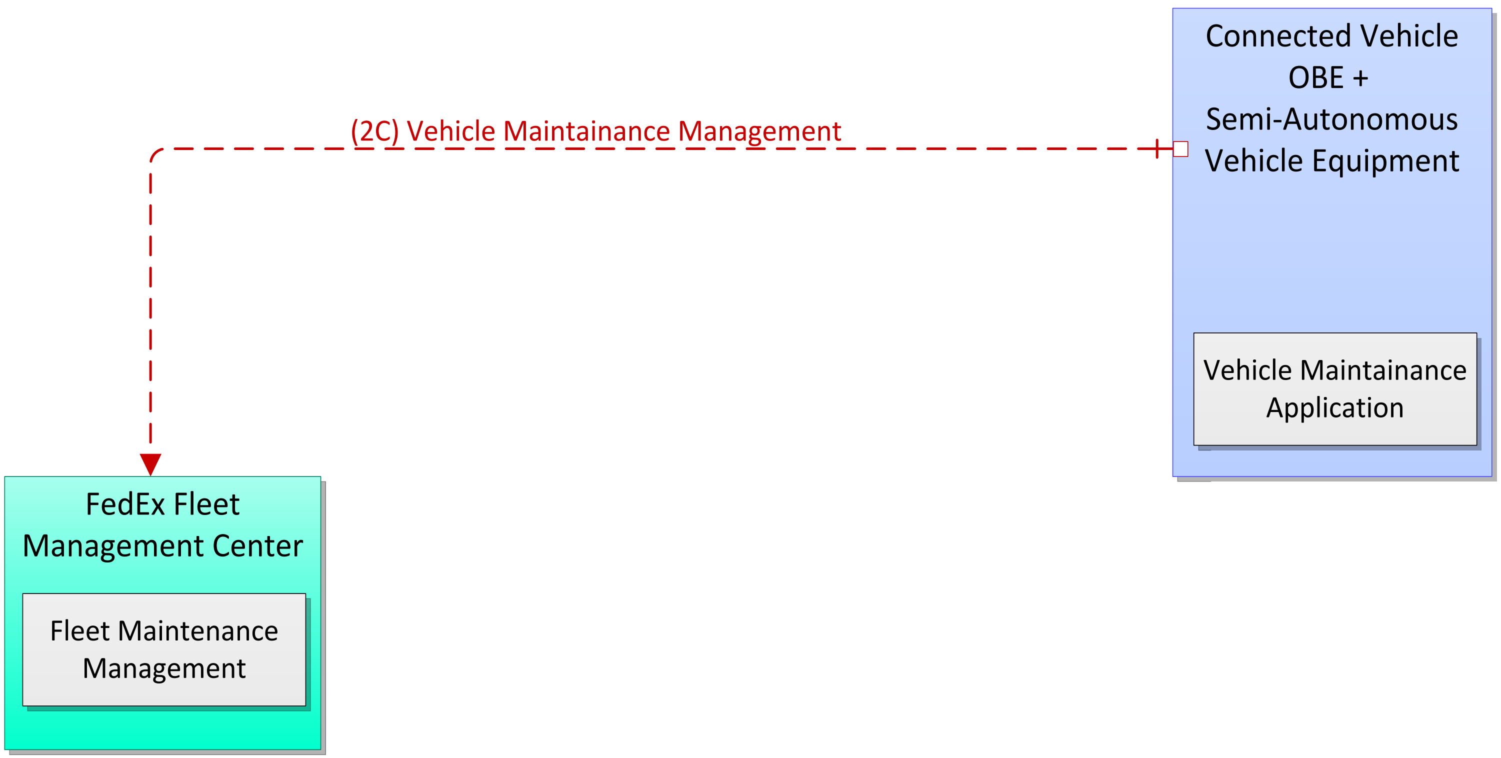


Physical Layer 2
Traveler Situation Data

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)

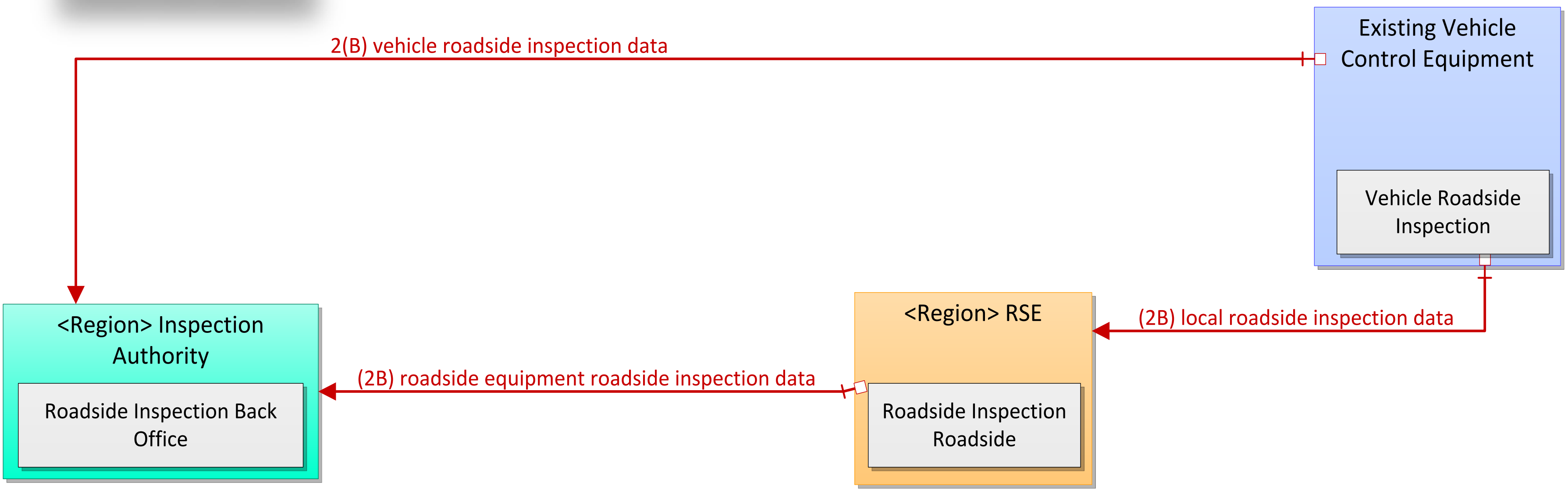
Management



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)

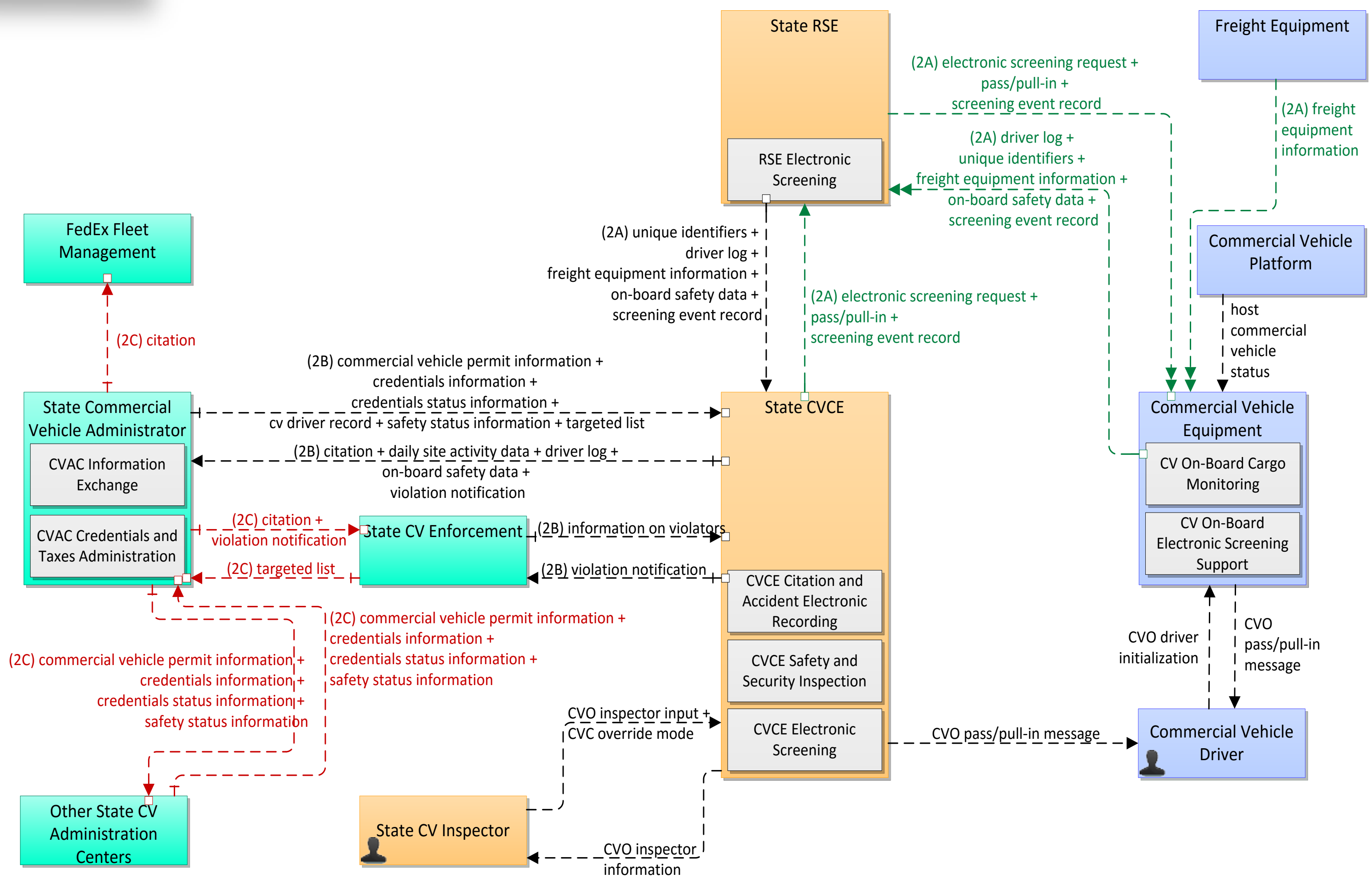
Maintenance



2: Third P2P			
4	Physical View	Oct 26 2014	WLF

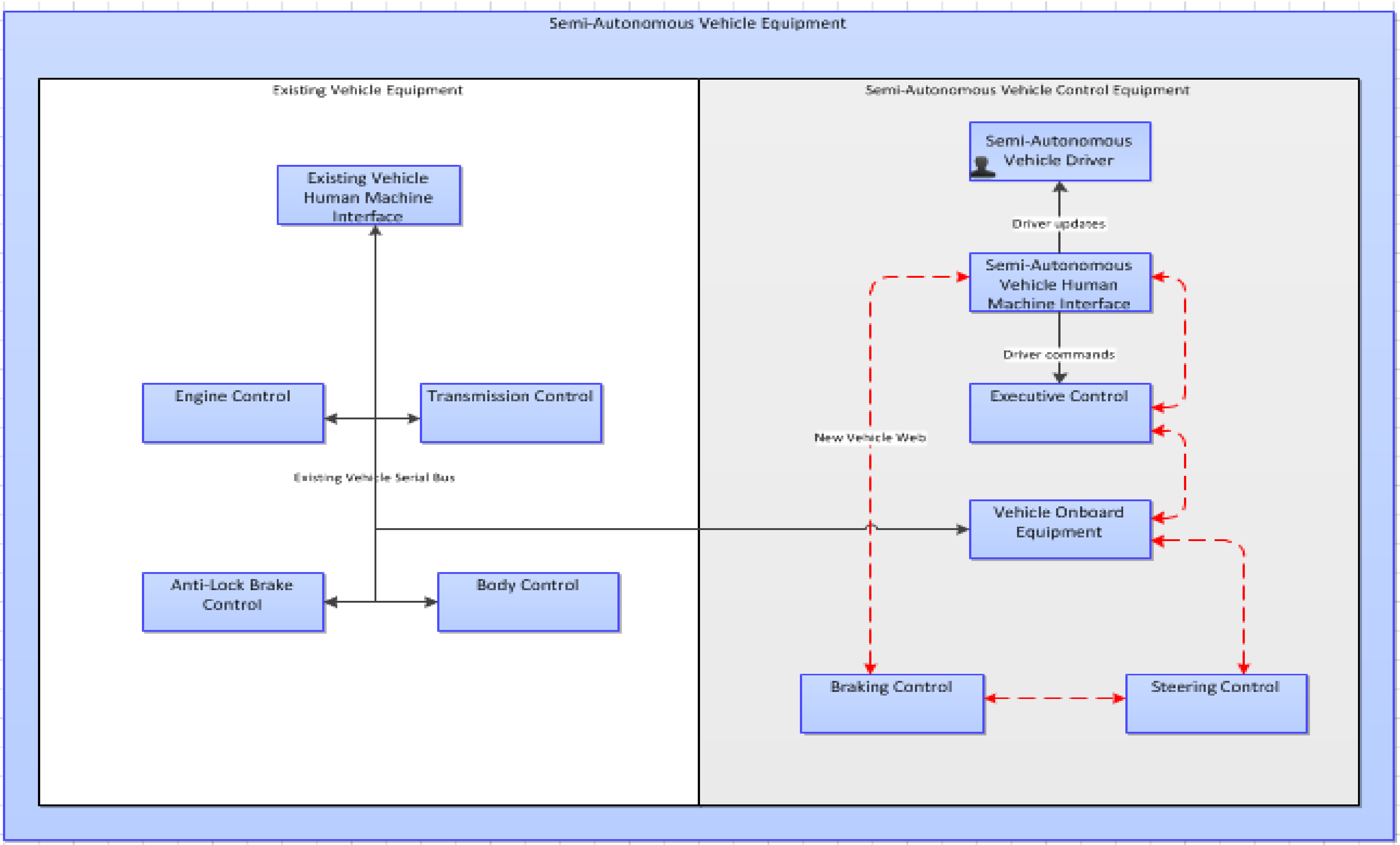
Along with the general purpose information flows will be a number of peer-to-peer data exchange flows to support decision management, maintenance, enforcement and commercial activities related to goods on vehicle (supply chain, inventory, delivery)

Enforcement



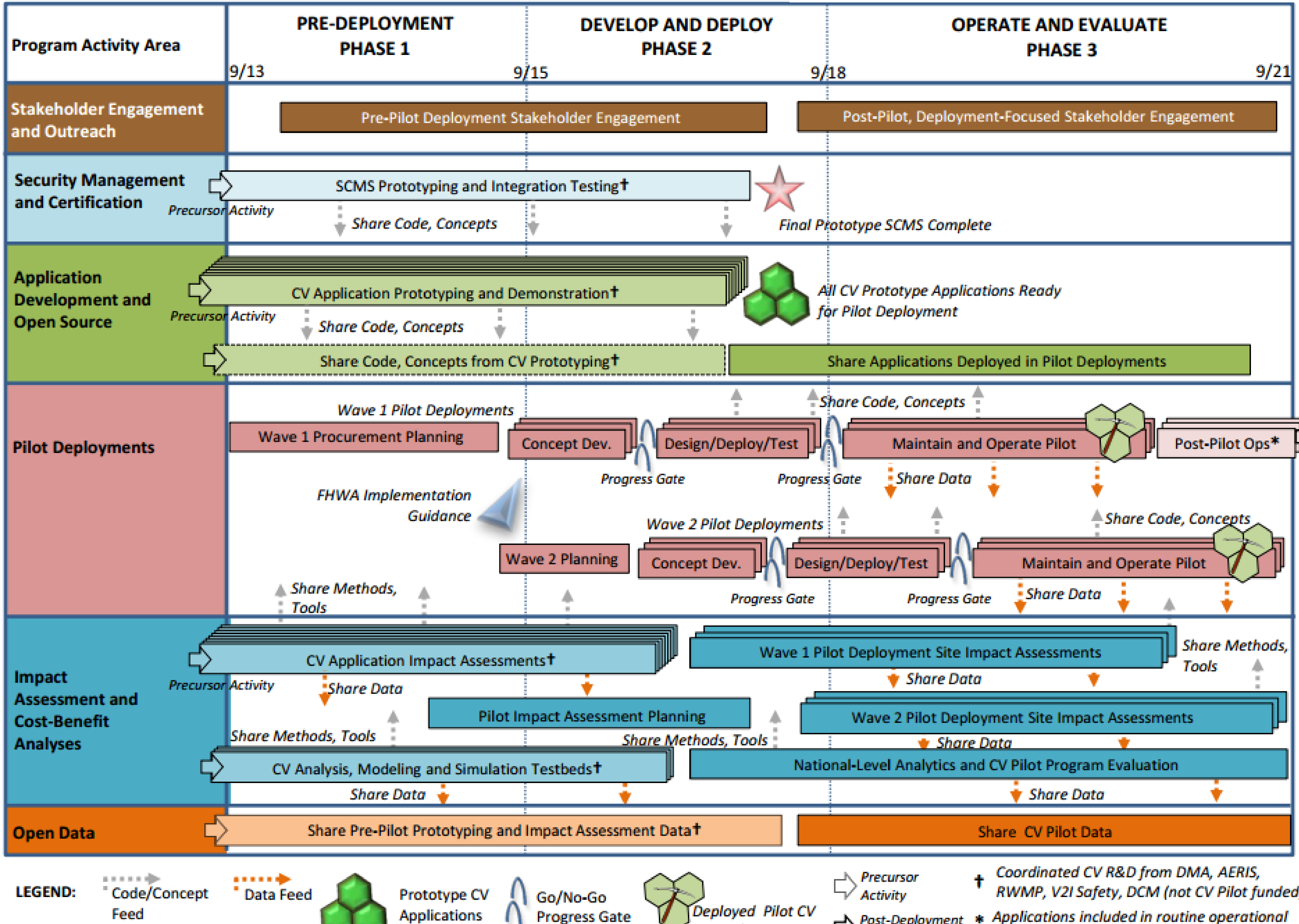
2: Smart Roadside Initiative (Electronic Clearance (Inspection Station)) (Copy 1)			
2	Based on CVRIA diagram r5	Oct 30 2014	WLF

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



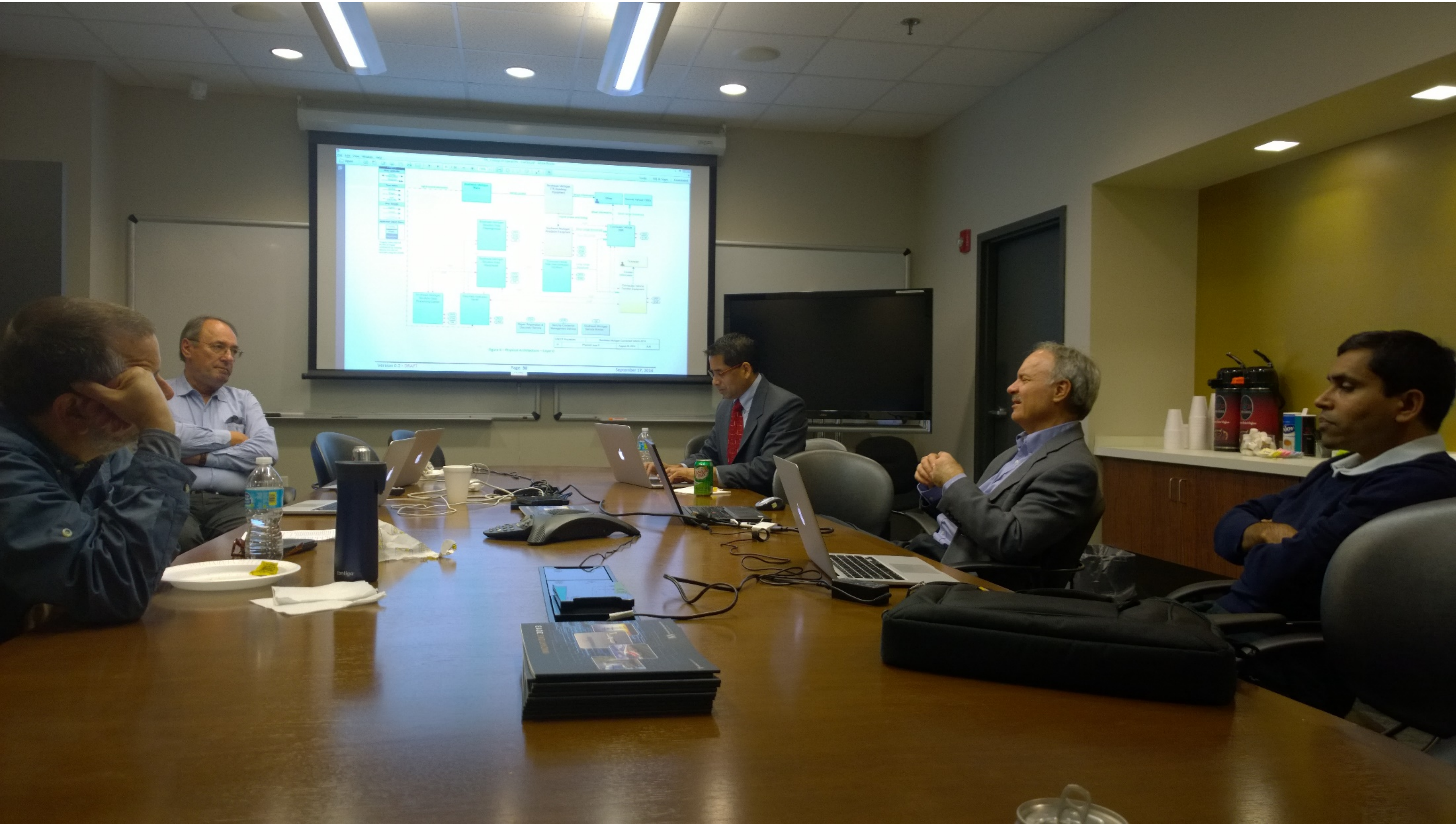
CV Pilots High-Level Roadmap v1.3 (6/23/2014)

Solving Challenges

Takes Ensembles, Not Soloists

IIC Members - SAFTI Planning with Prof Raj Rajkumar at CMU

IIC Members - SAFTI Planning with Prof Janos Sztipanovits, Vanderbilt ISIS



IIC Members - SAFTI Planning at ISIS, Vanderbilt University

IIC Members - SAFTI Planning at The Cohen Group, Washington DC

IIC Members - SAFTI Planning at the US Department of Transportation

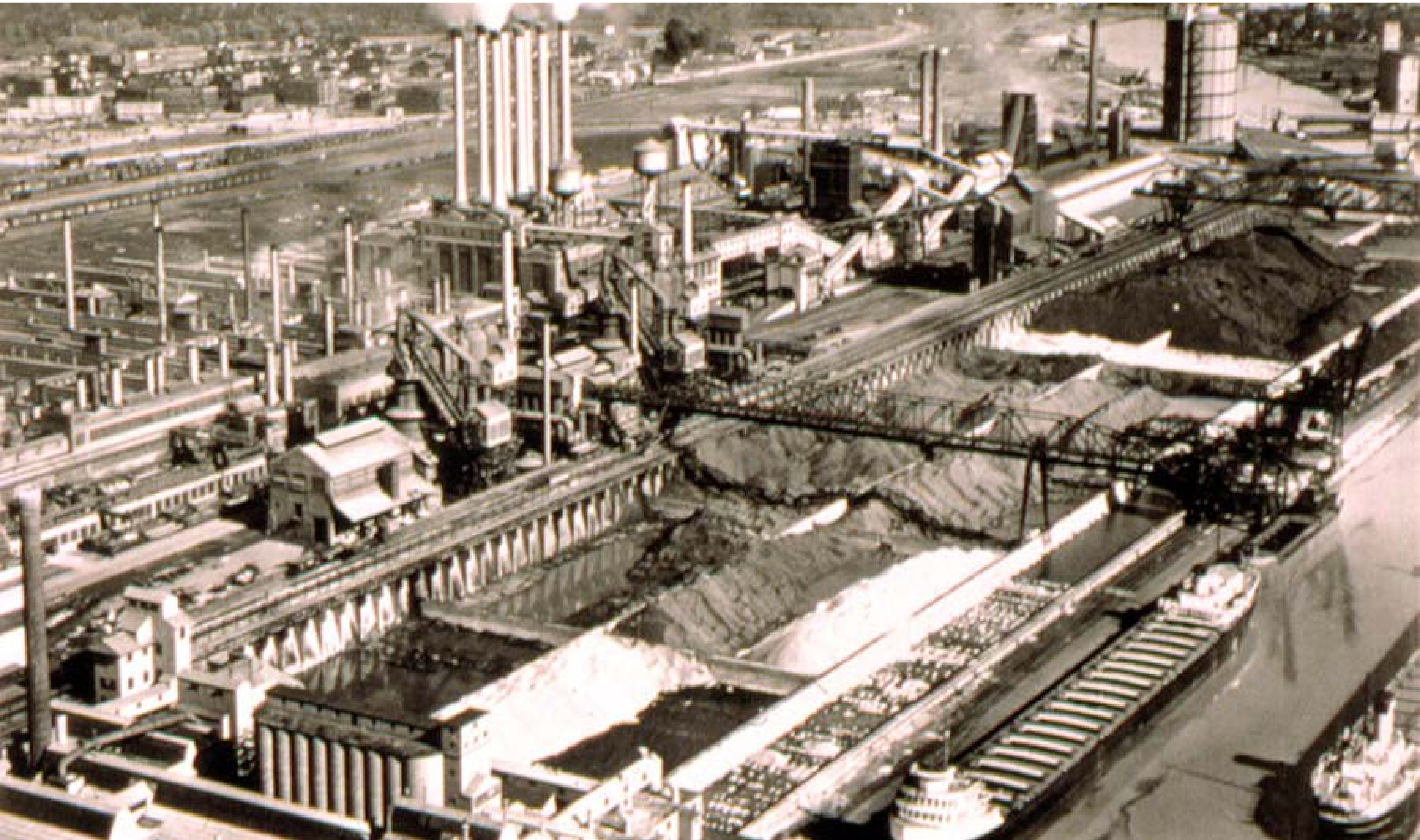
IIC SAFTI vs US DoT and other Realities

- SAFTI proposal had to be modified to fit Intelligent Transport System (ITS) call as issued on Jan 30, 2015.
- We had to exclude deployment of semi-autonomous vehicles to comply with the funding agency guidelines.
- Professor Raj Rajkumar submitted competing proposal for the same US DoT grant but with his team at CMU.

OUTLINE OF THE INDUSTRIAL INTERNET CONSORTIIUM PROPOSAL TO DOT

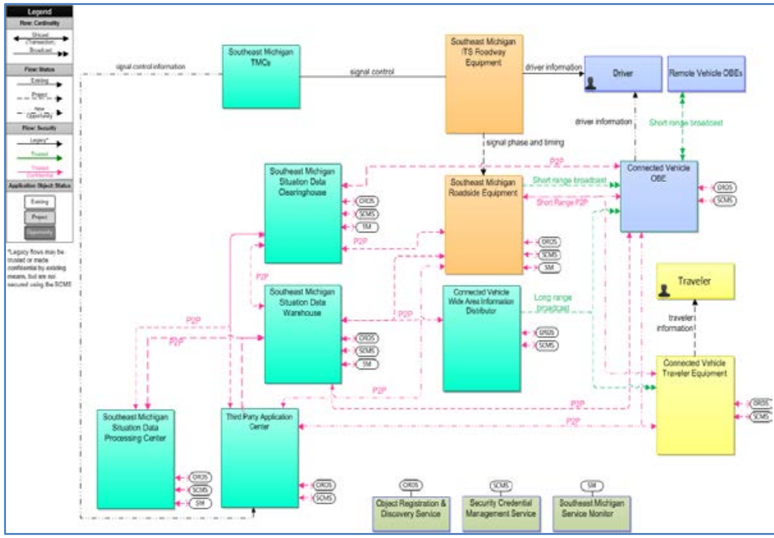
Submitted on March 27, 2015

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)



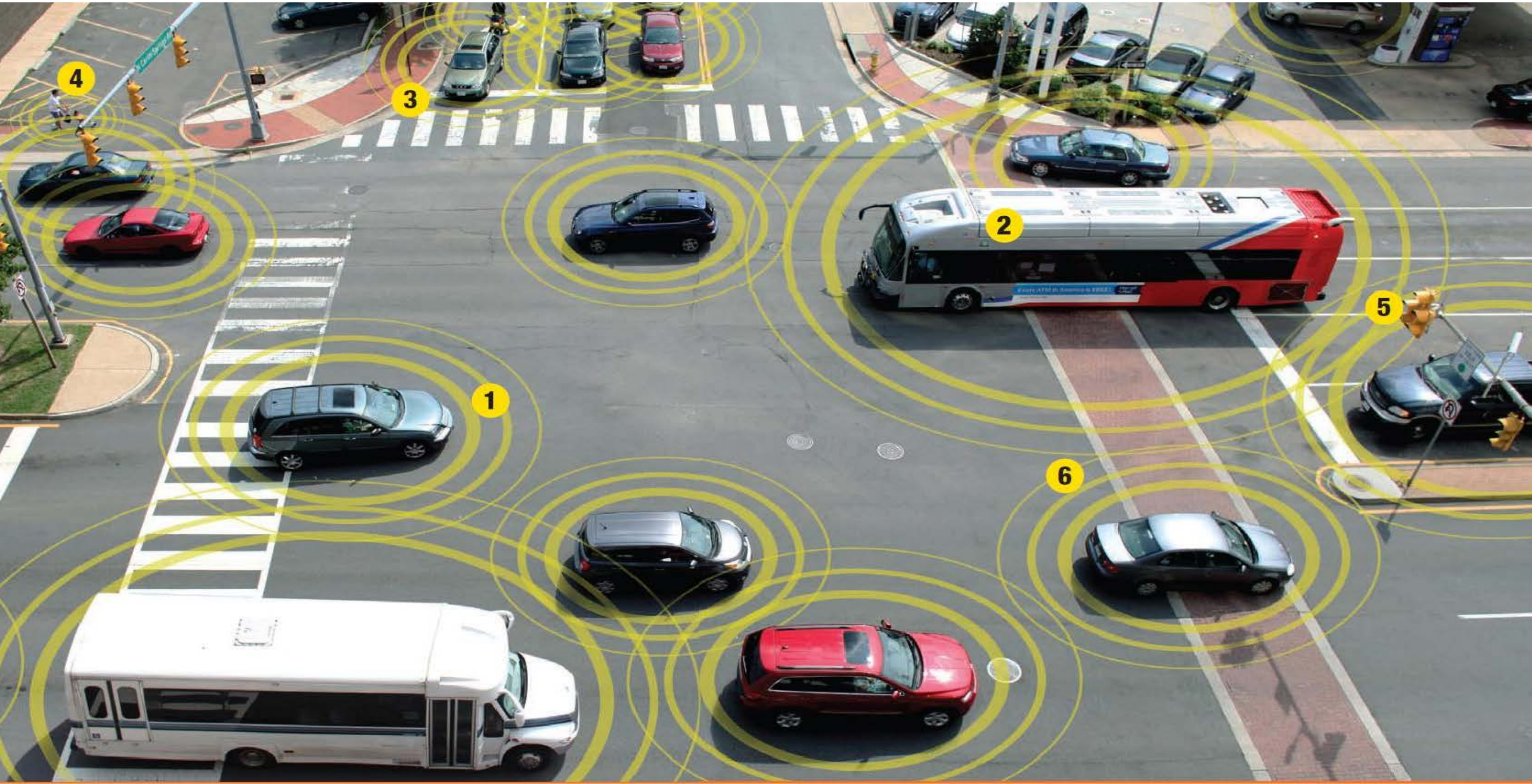
IIC Transportation Proposal Team

- IIC team proposes to develop a scalable, practical, replicable 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 architecture, testing)
  - Enterprise Web (provisioning)
  - MIT (traffic control, autonomy)
  - Tech Mahindra (operations)
  - NI (software, equipment)
  - Cyber Lightning (visualization)
  - Parstream (analytics)
  - SiriusXM (connectivity)

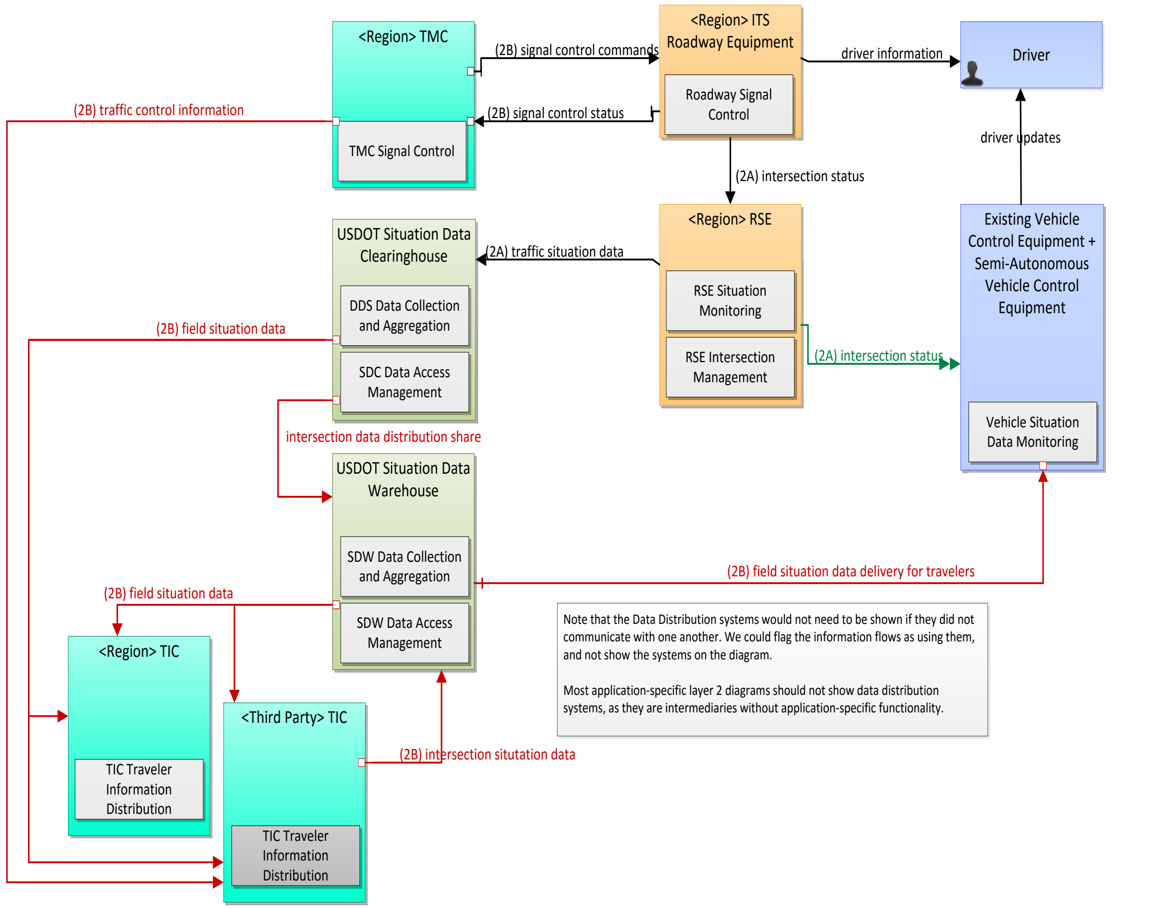


US DoT Connected Vehicle Reference Implementation Architecture (CVRIA)

ITS Infrastructure and Scalable Tools for Automotive Networks



Information Flow – Intelligent Transport System (ITS) Connected Vehicle Reference Implementation Architecture (CVRIA)

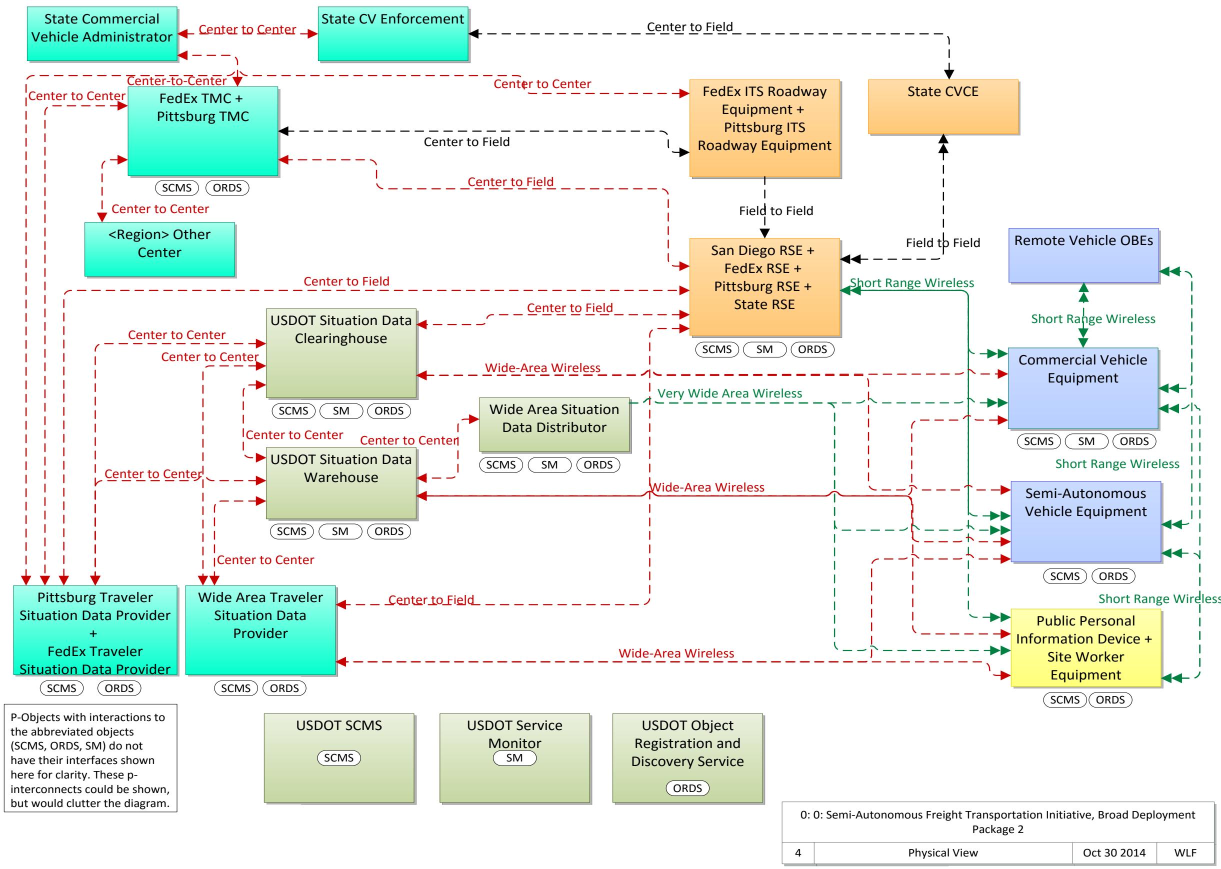


Physical Layer 2

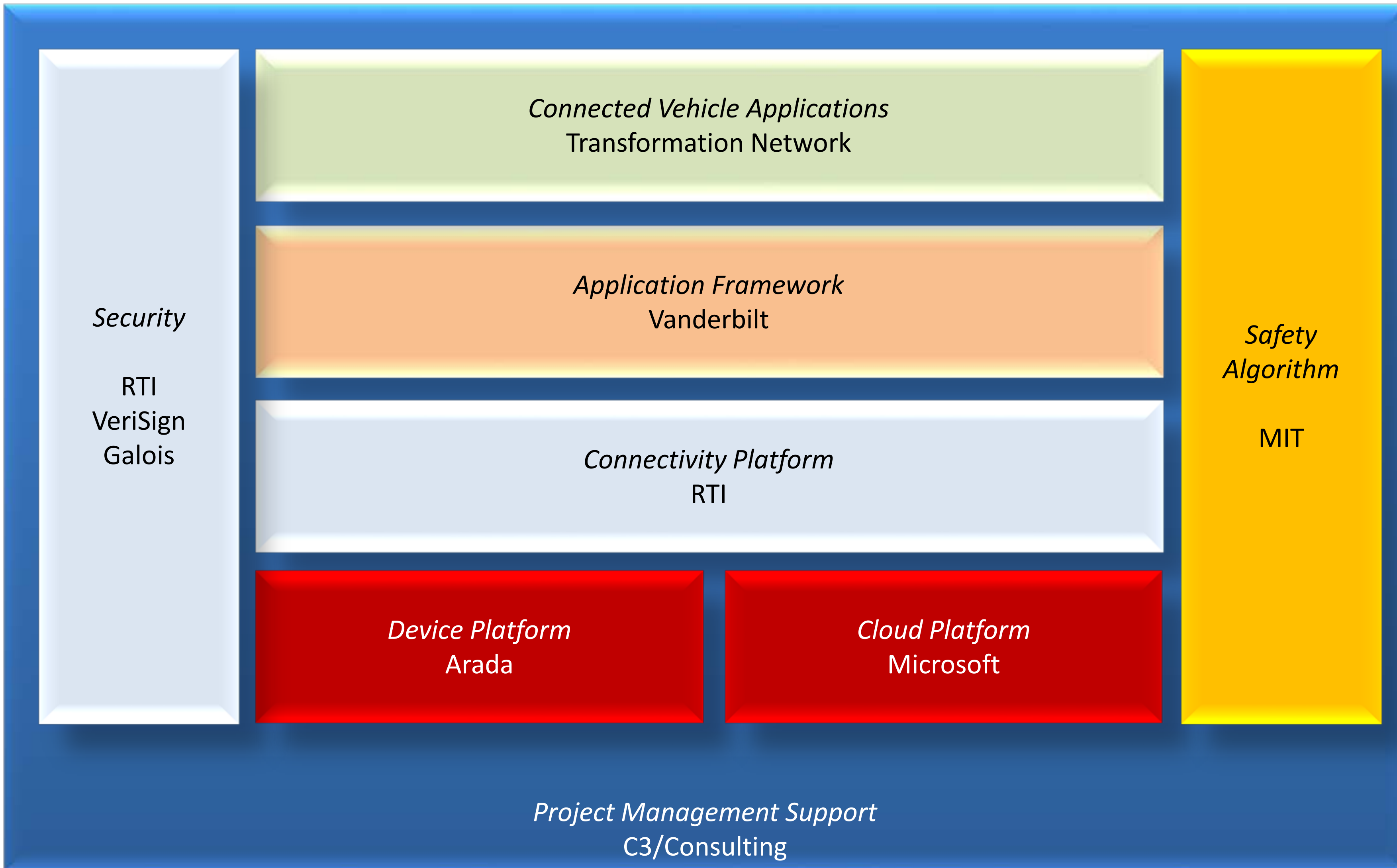
Field Situation Data originates at field devices eg traffic signal controllers

US DoT

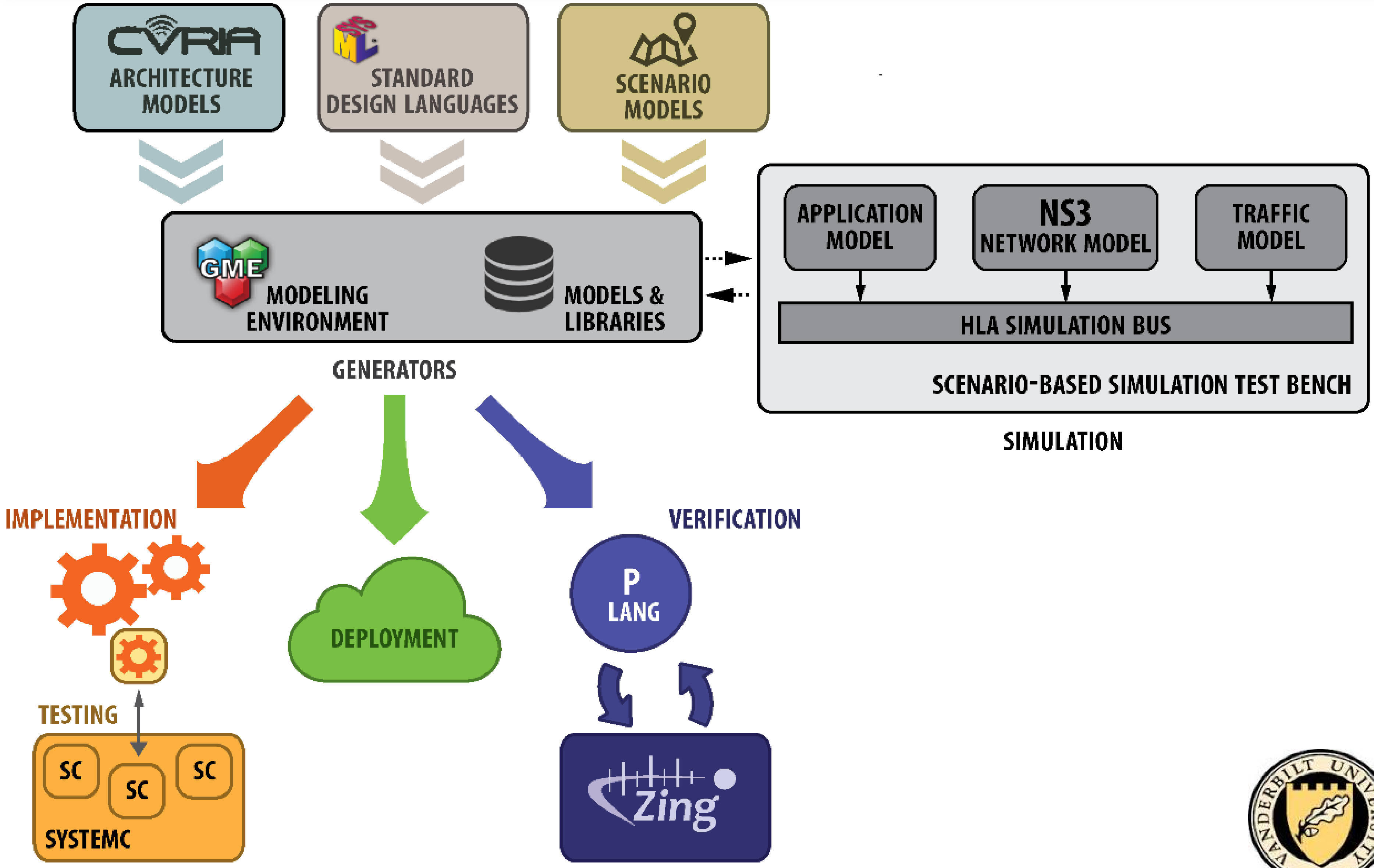
Challenge
Transform US DoT ITS CVRIA from an Idea to Implementation



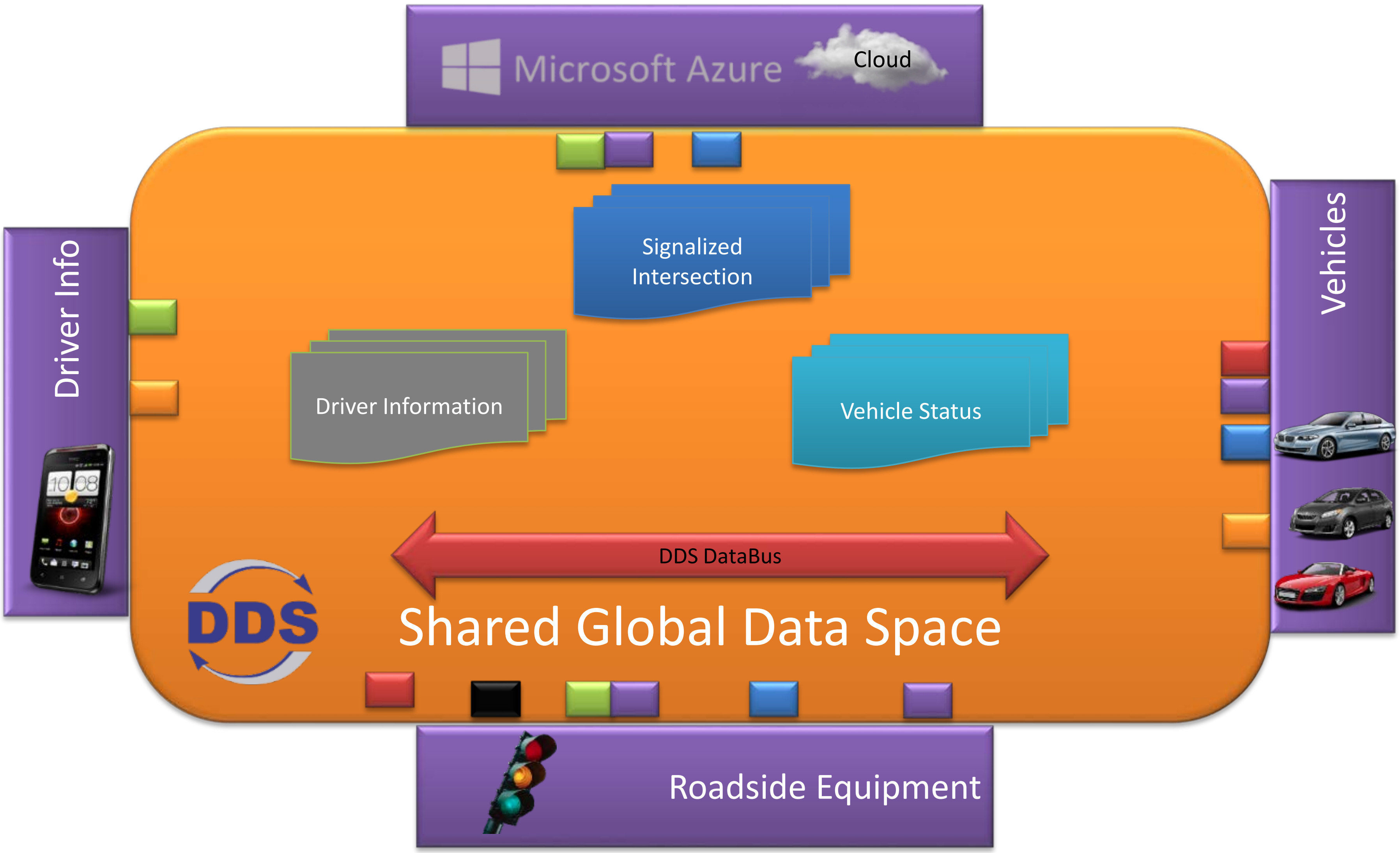
Tier 1 Team Structure by Architectural Emphasis



Domain-Specific Modeling Languages (DSML)

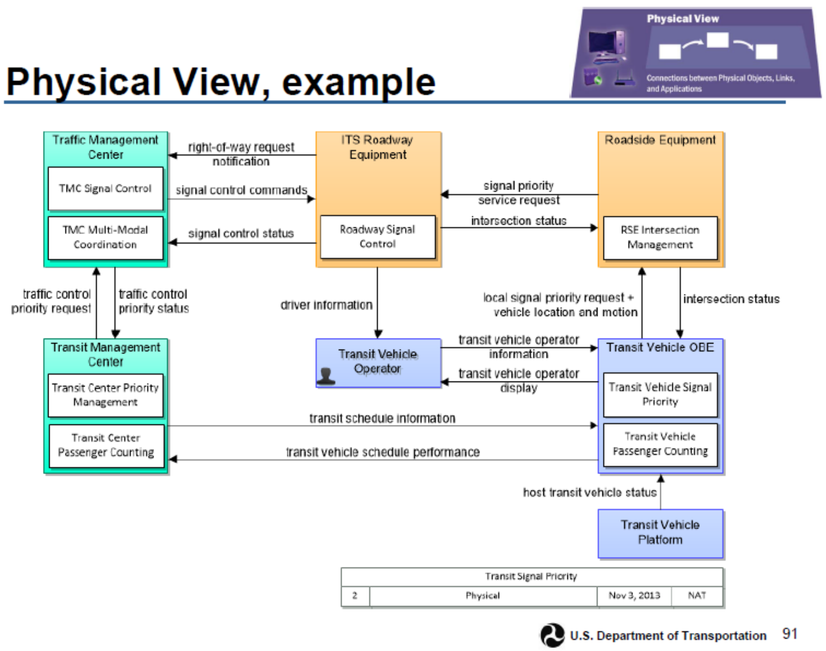


Standard Connectivity Platform



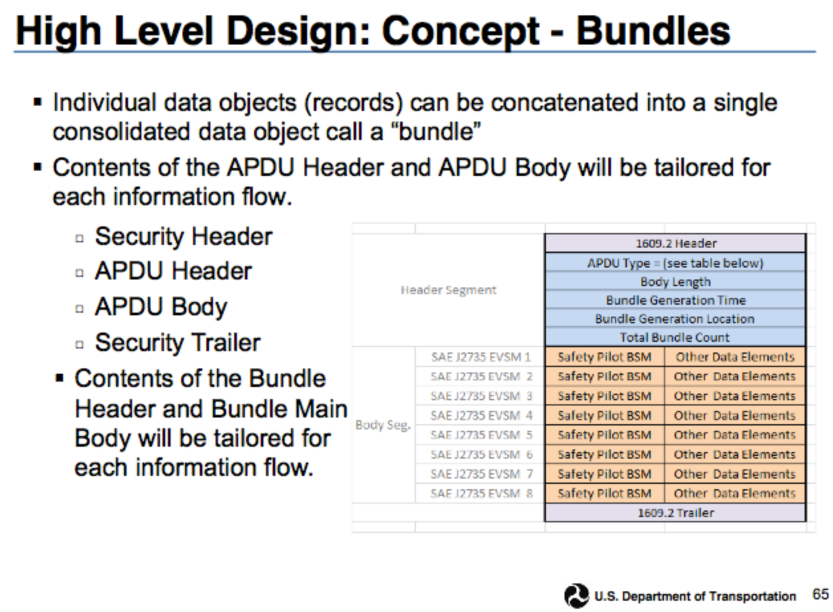
Simplify Applications with Decoupled Data Paths

- Problem: Pre-defined data paths
  - Application code dependency on data sources/sinks
  - Complex server configuration
    - Startup dependencies
    - Difficult redundancy management and single points of failure
- DDS: Decouple data from flow
  - Transparent, redundant sources/sinks/nets
  - Huge scalability
  - No servers



Raise Abstraction Level

- Problem: Low-level comm dependencies
  - Application-level batching
  - Source/destination dependencies
  - Loss of strongly-typed interfaces
  - Language/OS/CPU platform dependencies
- DDS: High-level abstract transports
  - Automatic batching, throttling
  - Latency budgeting
  - Full platform transparency
  - Pluggable transports; supports future evolution



High Level Design: Concept - Bundles

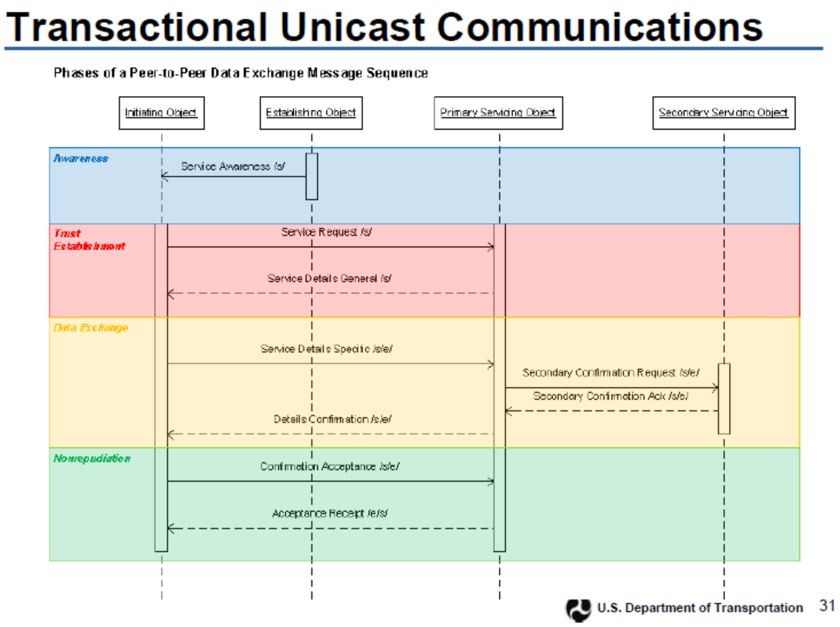
- Individual data objects (records) can be concatenated into a single consolidated data object call a "bundle"
- Contents of the APDU Header and APDU Body will be tailored for each information flow.
  - Security Header
  - APDU Header
  - APDU Body
  - Security Trailer
  - Contents of the Bundle Header and Bundle Main Body will be tailored for each information flow.

Header Segment		1609.2 Header	
		APDU Type = (see table below)	
		Body Length	
		Bundle Generation Time	
		Bundle Generation Location	
		Total Bundle Count	
Body Seg.	SAE J2735 EVSM 1	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 2	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 3	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 4	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 5	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 6	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 7	Safety Pilot BSM	Other Data Elements
	SAE J2735 EVSM 8	Safety Pilot BSM	Other Data Elements
		1609.2 Trailer	

U.S. Department of Transportation 65

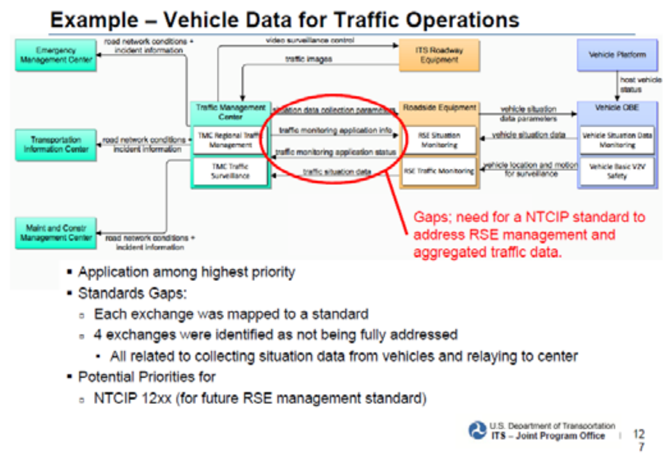
Handle Corner Cases in Middleware

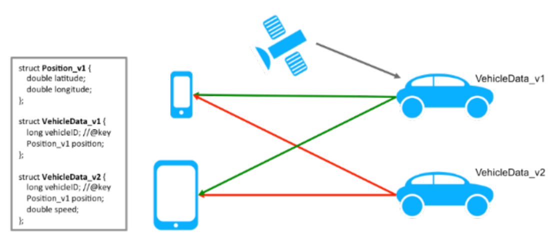
- Problem: DIY protocols
  - "Good case" is 20% of code
  - Protocol evolution is hard
  - Interoperability is tricky
- DDS: Proven Protocol
  - 10+ years of experience
  - 1000+ working applications
  - 100% approved standard
  - 12+ implementations

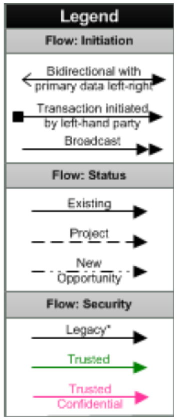


All About the Data

- What data?
  - Directly implement data model
  - Clarify schema for all parties (NTCIP)
- How is data needed?
  - Directly implement QoS
  - Think about how objects need and share data, not message sequences
  - Timing, reliability, liveliness, security, redundancy, filtering
- Plan for evolution
  - Data path changes & new uses
  - Scalability (nodes, data values, teams, QoS, rates, etc.)
  - Schema change!



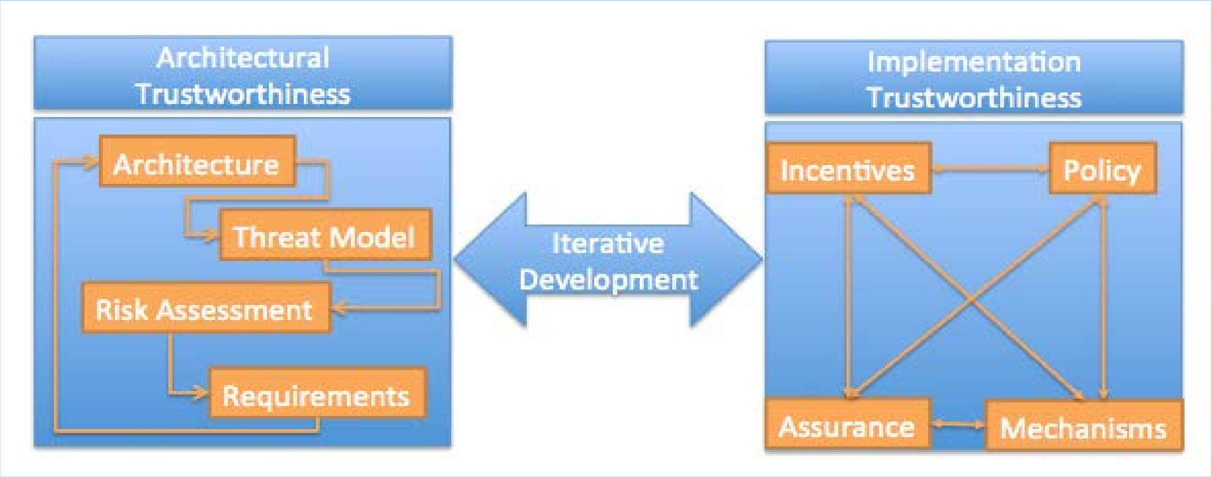




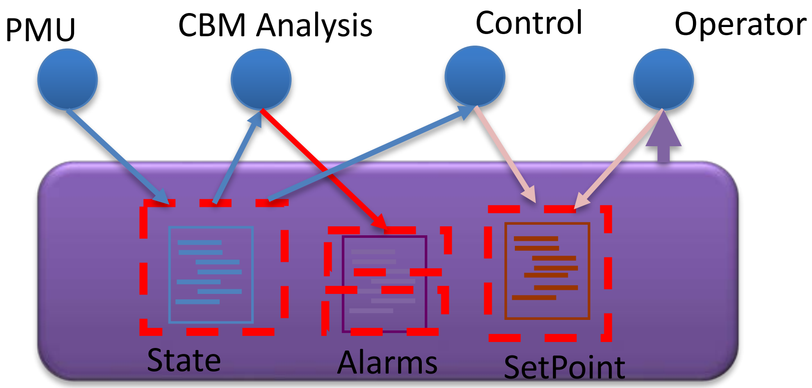
Architectural Recommendations

- Use abstraction to separate concerns
  - Decouple generation from distribution
  - Decouple protocol from data types
  - Decouple QoS control from application code
  - Decouple applications in both time & space
- Plan for scale and evolution
  - Enable data path flexibility
  - Enable bandwidth control and filtering
  - Enable system type and version evolution
- Learn from decades of protocol experience
  - Adopt open standards where possible

Practical Fine-Grain Security



- Per-Topic Security
  - Control r,w access for each function
  - Ensures proper dataflow operation
- Complete Protection
  - Discovery authentication
  - Data-centric access control
  - Cryptography
  - Tagging & logging
  - Non-repudiation
  - Secure multicast
  - 100% standards compliant
- No code changes!
- Plugin architecture for advanced uses



Topic Security model:

- PMU: State(w)
- CBM: State(r); Alarms(w)
- Control: State(r), SetPoint(w)
- Operator: *(r), Setpoint(w)

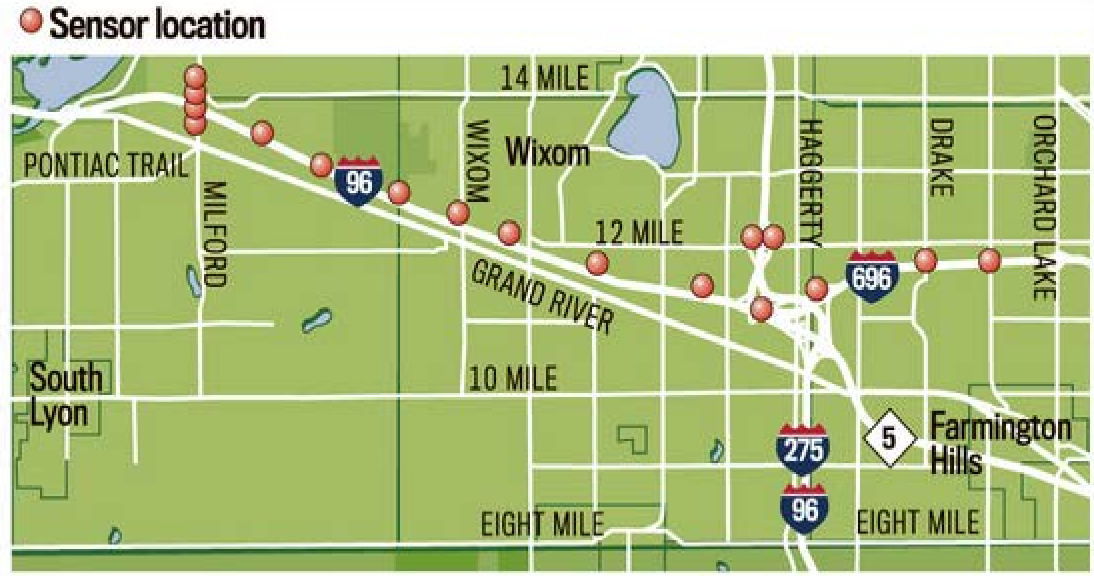
Implementation

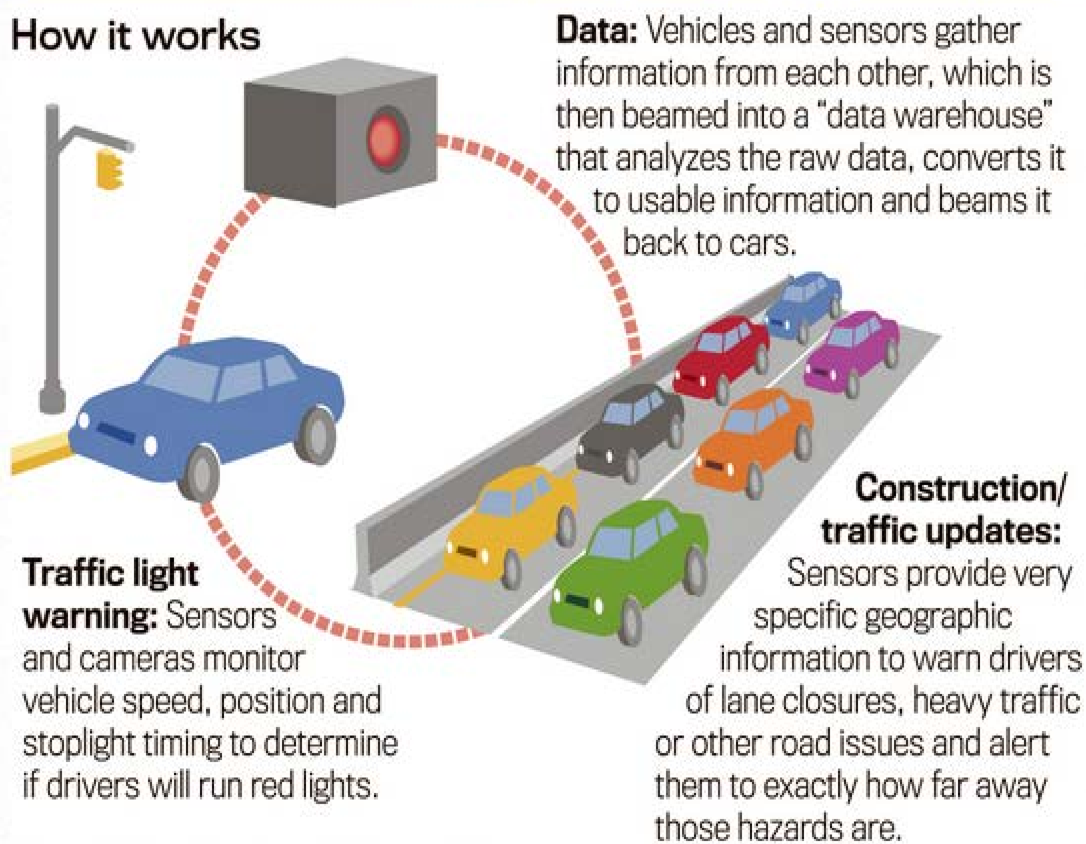
KEY LEAD - DAVE ACTON

- 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, operation.
- First deployment of 5.9GHz DSRC technology
- Founding member of the VII Working Group, which set the direction for V2X systems in the US.

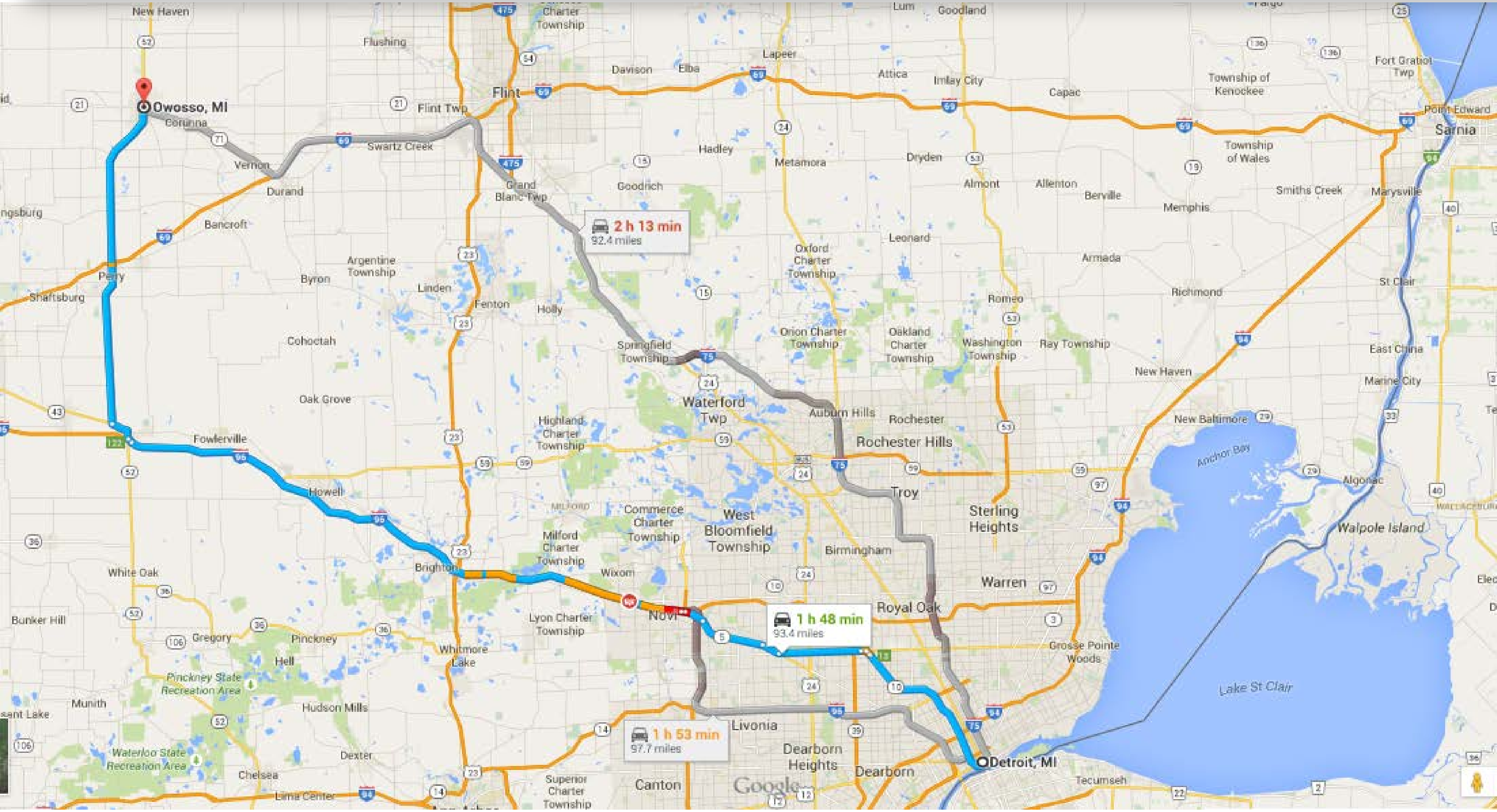
Deployment

"The main idea is to digitize the autobahn to make it possible for cars to communicate with other cars and with the street - with the infrastructure itself," a ministry spokesperson told ZDNet.





Deployment planned in Owosso, MI



- Size: 4000 vehicles
  - Big enough to prove the problem
  - Small enough to manage the city

- Close to ecosystem of US DoT SE Michigan testbed
- Citizen involvement
  - Populace, Mayor, City Council, Public Safety

IIC Proposal Submitted 03/27/2015 ● Decision Expected September 2015

US Department of Transportation, Washington DC (9/18/2014). Standing from left to right: Jessica (Program Assistant), Mr Richard McKinney (CIO, US DoT), Mr Kenneth Leonard (ITS, JPO, US DoT), Dr Thibaut Kleiner (Head, DG CONNECT, EU and European Commission), Dr Shoumen Datta, Mr Gregory Winfree (Assistant Secretary, Department of Transportation, US DoT) & Mr Walton Fehr (Program Manager, Intelligent Transport Systems, US DoT). Photo by Dr Grace Lin, Director, Advanced Research Institute, III (TW)

US DoT Proposal

Award Decision September 2015

Various issues in Transport

Challenges of Autonomy

Leap frog to Autonomous Transport Systems ?

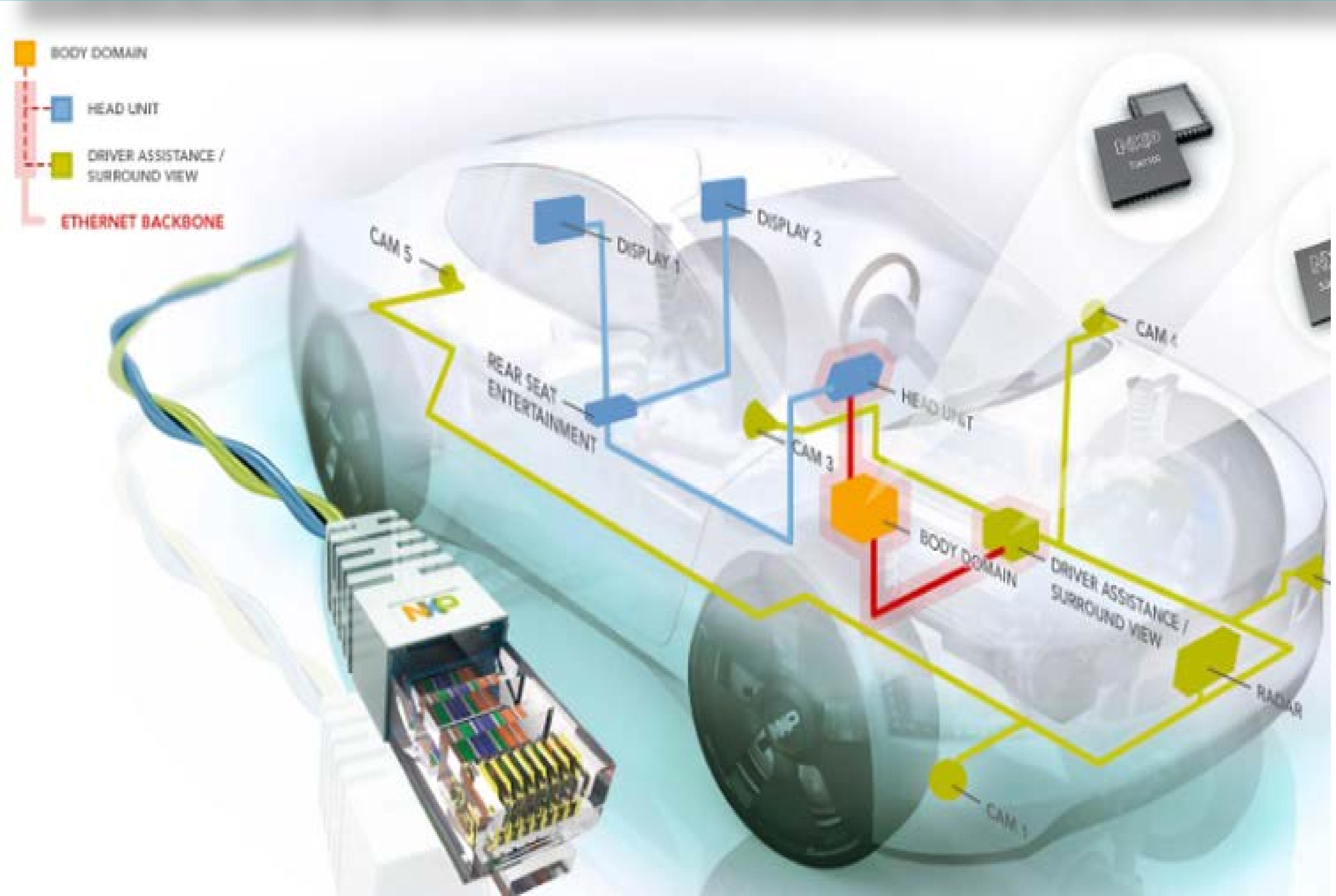
SDV - Software Defined Vehicles - http://bit.ly/MIT-IOT

- ☑ **Migration path to Semi-Autonomous**
- ☑ **Integrate Autonomous Transportation**

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

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

SDV coupled with Mobile Ethernet



The Migration of the Automobile Industry

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.

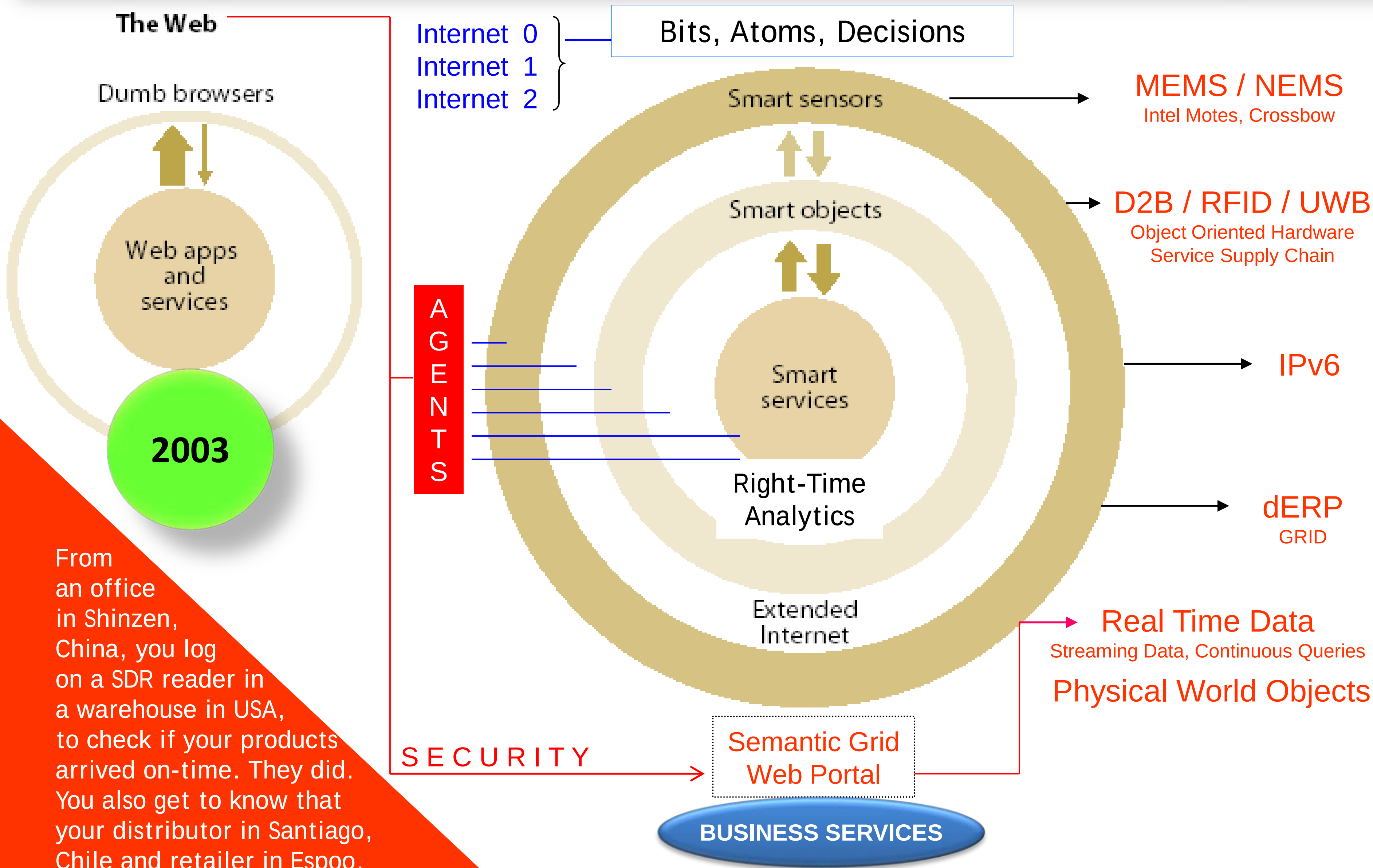
Ecosystem of the Internet of Systems
Data and Analytics for SDV

Pervasive and Ubiquitous

Ambient Intelligence

Autonomy

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



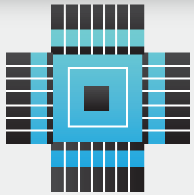
From an office in Shinzen, China, you log on a SDR reader in a warehouse in USA, to check if your products arrived on-time. They did. You also get to know that your distributor in Santiago, Chile and retailer in Espoo, Finland also checked the delivery status, moments before you logged on.

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

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.
COMMMUNICATION 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.

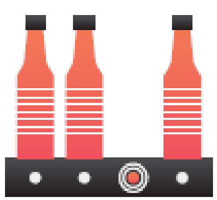
Ambient services

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.

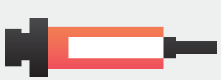
Business use cases[a]

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.

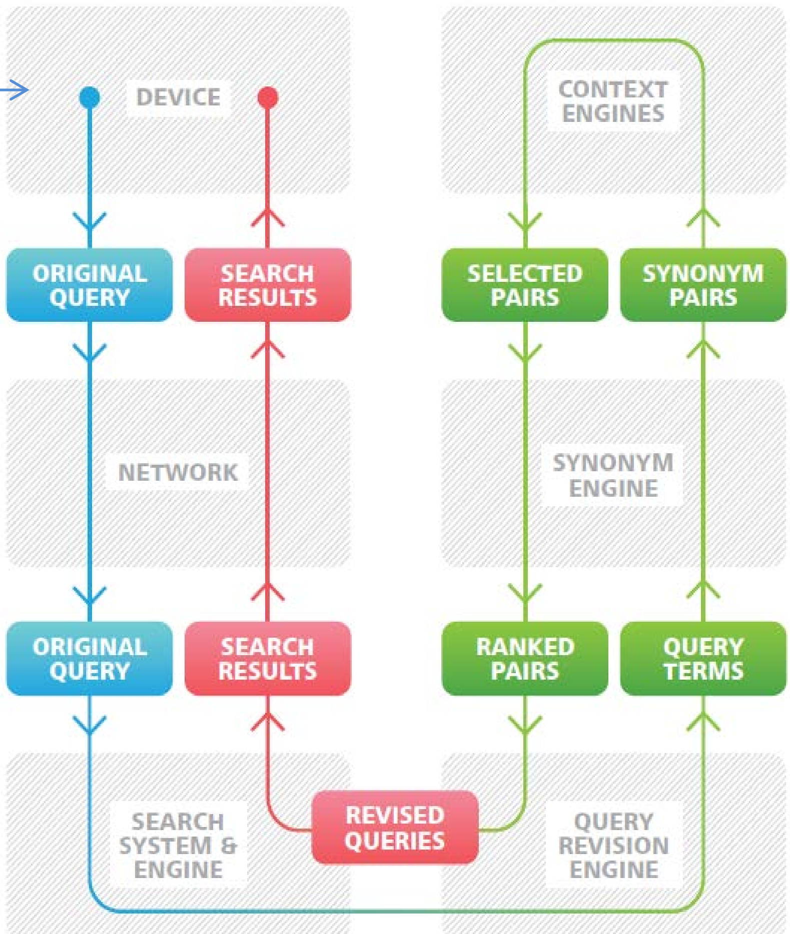
LOGISTICS Inventory and asset management, fleet monitoring, route optimization.



HEALTH & WELLNESS Personalized treatment, remote patient care.

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

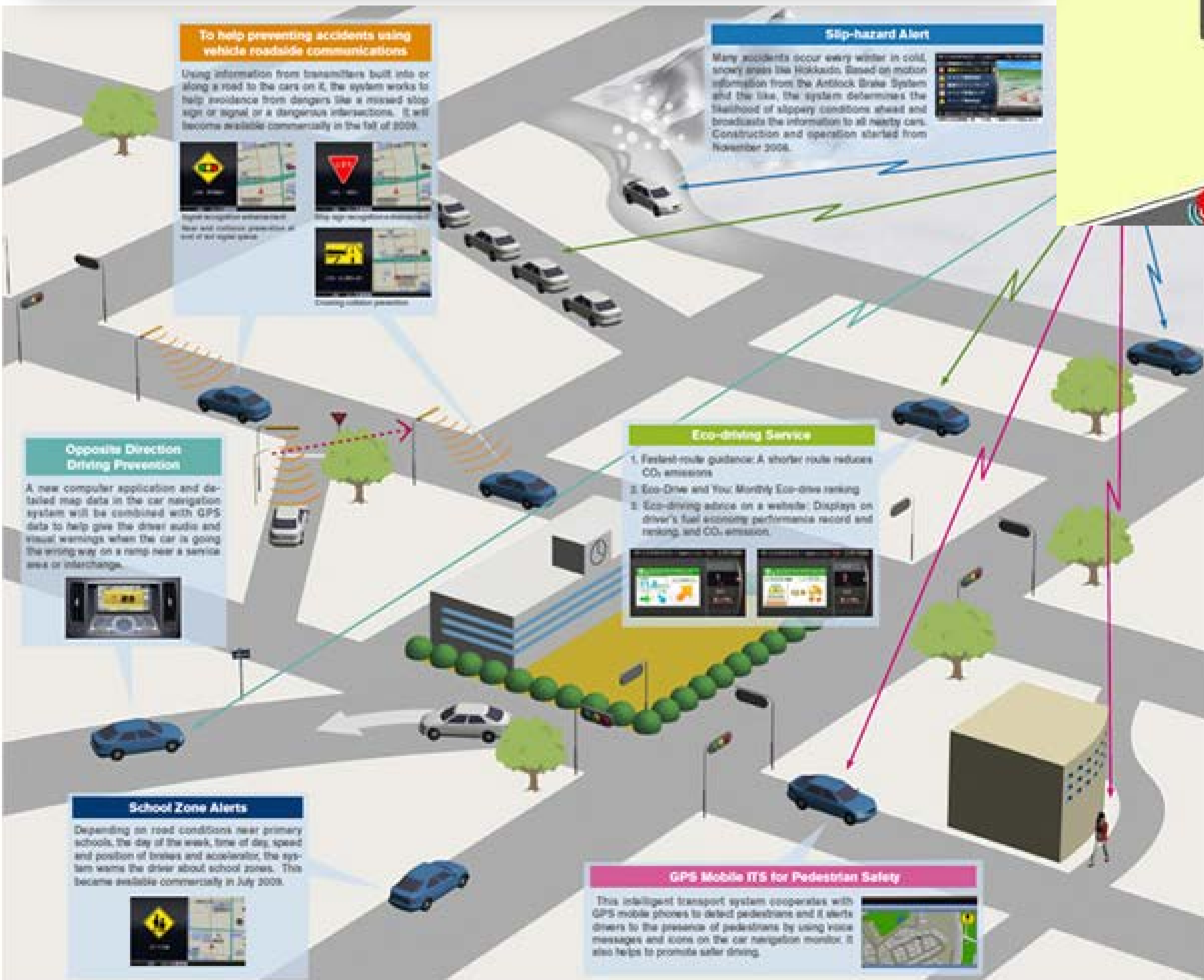
MANUFACTURING Connected machinery, automation.



Deloitte Cartoon

www.google.com/patents/US8538984

Connected Vehicles 101
Transportation of Data



Autonomy
?

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

Agnik Awarded U.S. DOT Phase II Research Contract for Next Generation Insurance Solutions for Connected Cars

After successful Phase I demonstration of smartphone apps and devices with driver analytics, privacy preserving machine learning, and game theoretic social incentives technology

September 01, 2015 09:00 AM Eastern Daylight Time

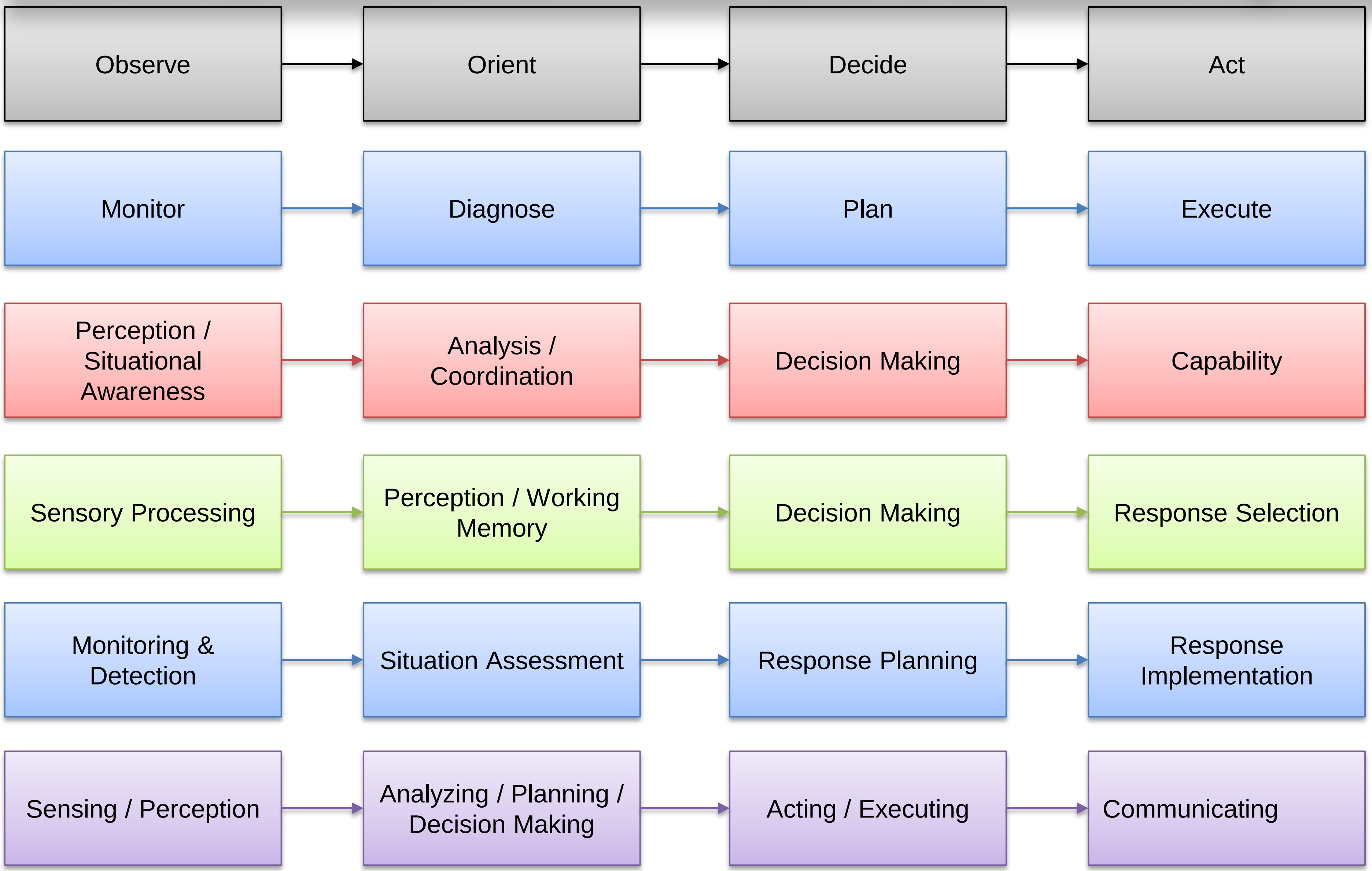
BALTIMORE--(BUSINESS WIRE)--Agnik, the market leading data analytics company for connected cars and life, announced today that it has received a US Department of Transportation Phase II Contract to develop an advanced connected car platform for insurance solutions. This project will advance Agnik's smartphone and device-based connected life platform with advanced driver analytics, privacy-preserving machine learning, game theoretic social incentives, and mechanism design for usage-based insurance.

The project will be supported by numerous leading insurance carriers and several Agnik distribution channels and partners. This integrated platform will power Agnik's unique Connected Insurance Program (CIP). CIP offers a unique, low cost way for insurance carriers to execute the full spectrum of insurance solutions for connected cars. This Phase II project is the result of Agnik's successful demonstration of the core technology during the Phase I project.

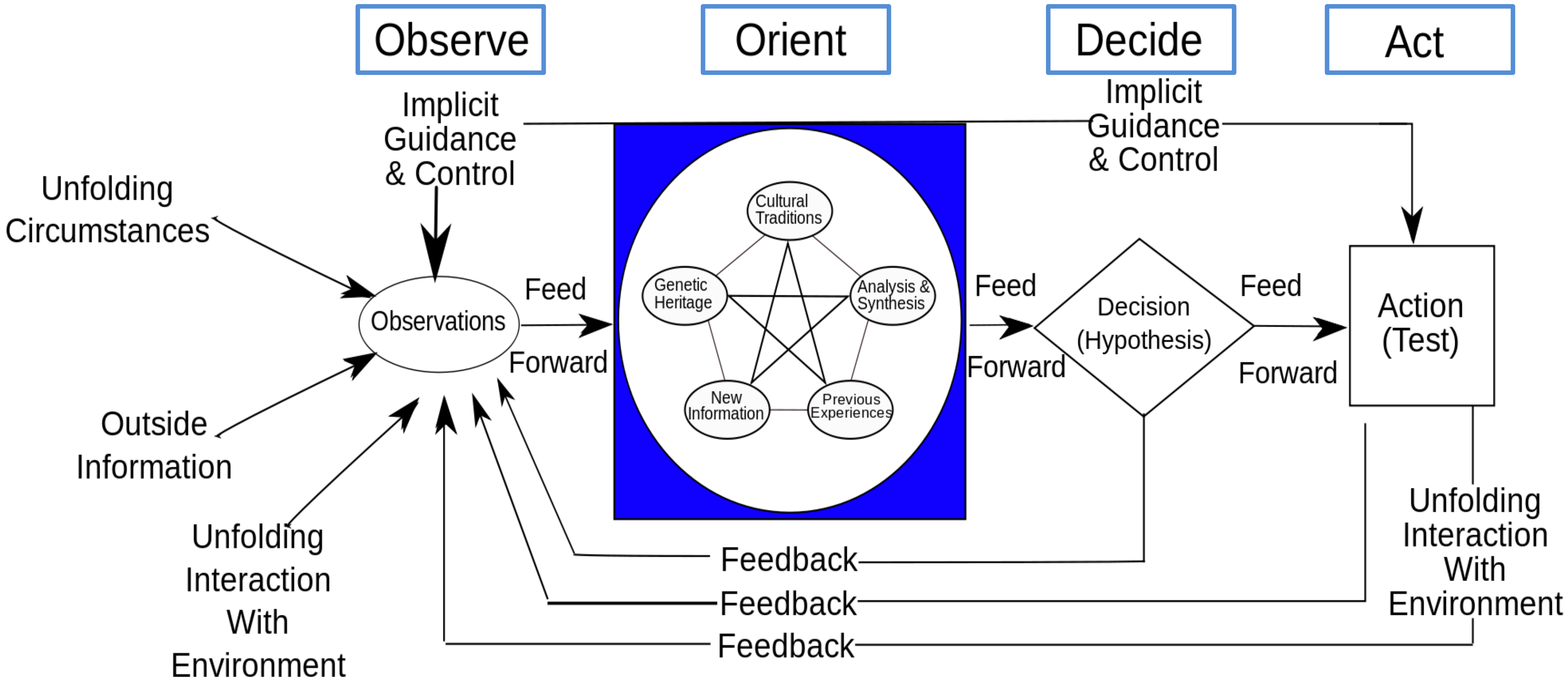
"This will further enhance Agnik's Connected Insurance Program and allow insurance carriers to engage consumers in a broader social context with little telematics infrastructure overhead. We are pleased to receive this contract and work with the team."

Driving a car is a social experience. Blending social experience with connected car applications is creating new opportunities for insurance carriers. Some key considerations include: Privacy protection and making use of smartphone sensors in order to reduce the overhead of the connected car infrastructure.

What level of autonomy ?

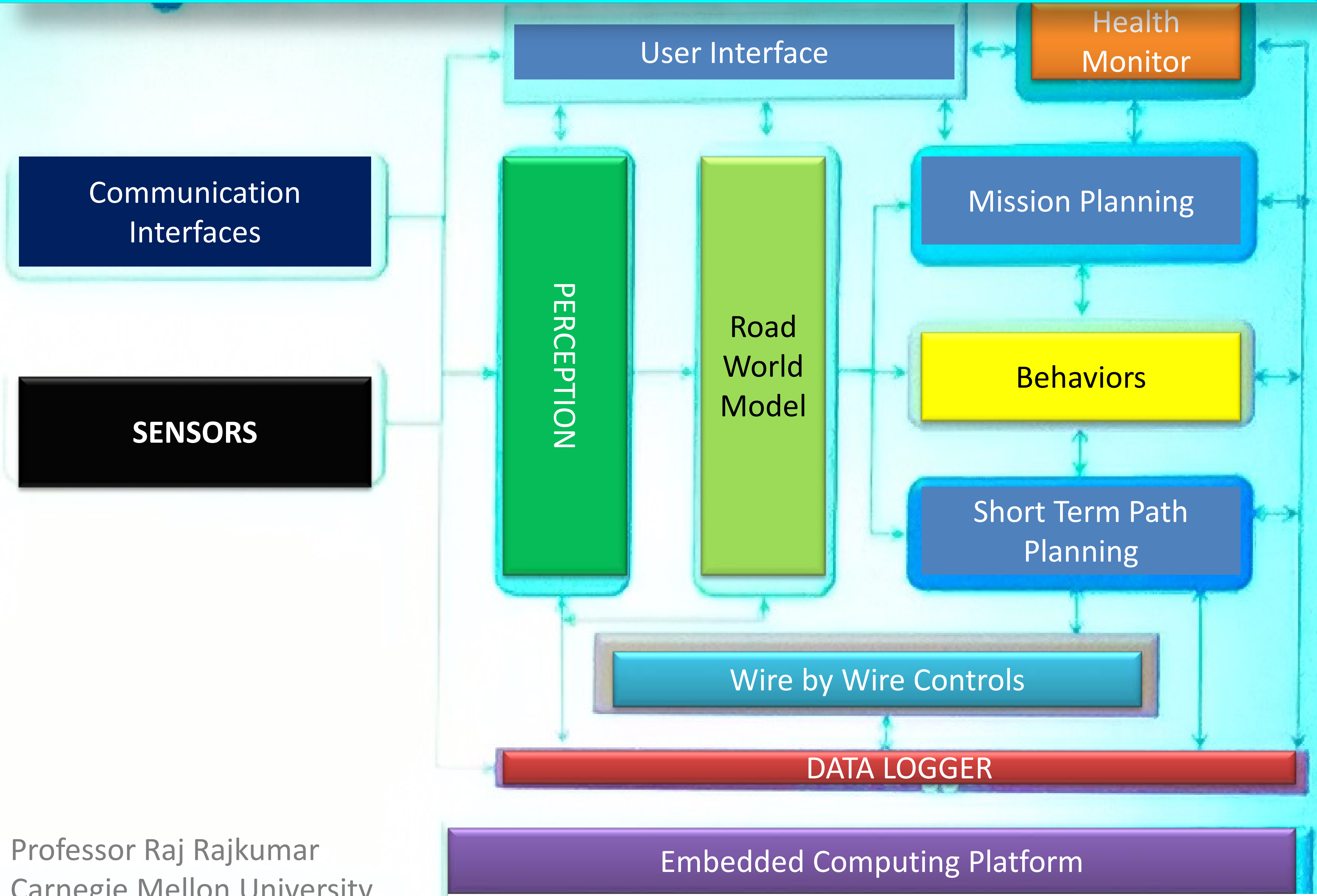


OODA Loop in Autonomous Driving Functions?



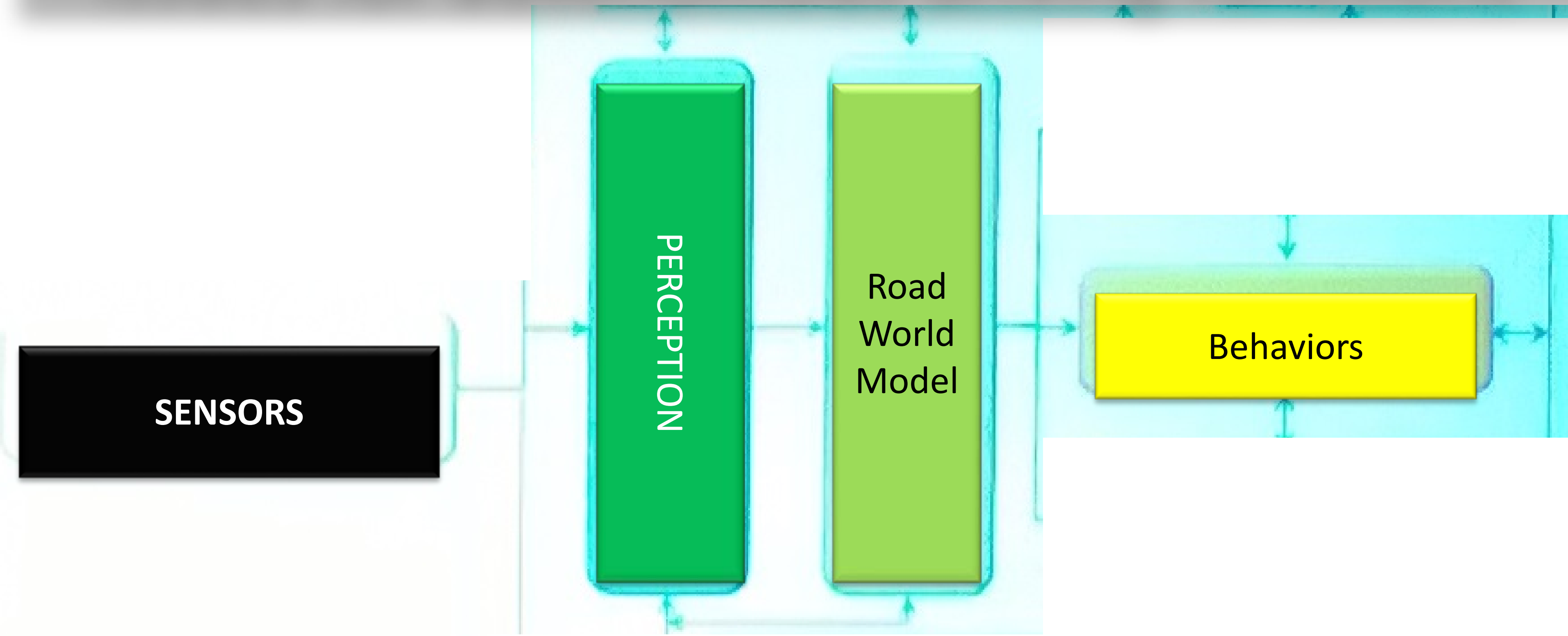
John Boyd

BASIC ARCHITECTURE FOR AUTONOMY



Professor Raj Rajkumar
Carnegie Mellon University

Data analysis problems and algorithmic issues for autonomous driving functions

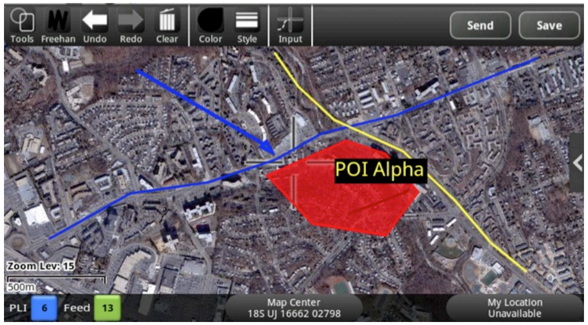


Professor Raj Rajkumar
Carnegie Mellon University

Continuous Real Time Data in Autonomous Driving

Android Mobile Middleware Objects

Situational Awareness

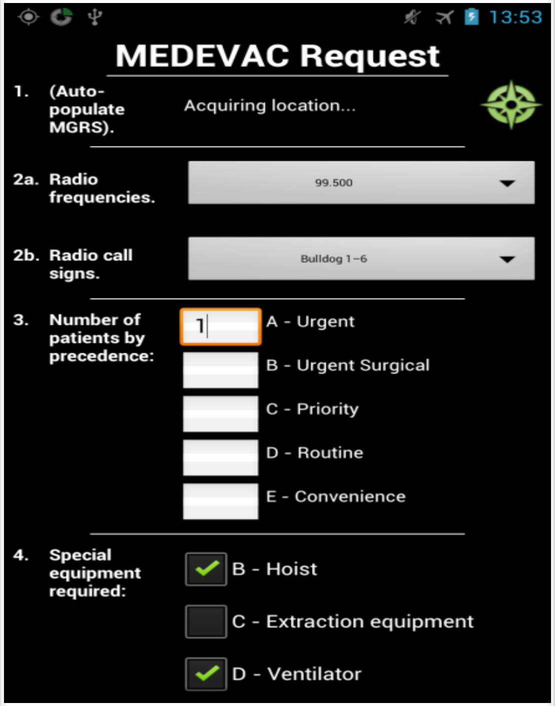


- Monitor/Track
- Mark spots on map
- Share maps with peers

Tactical Chat

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

Medevac Reports



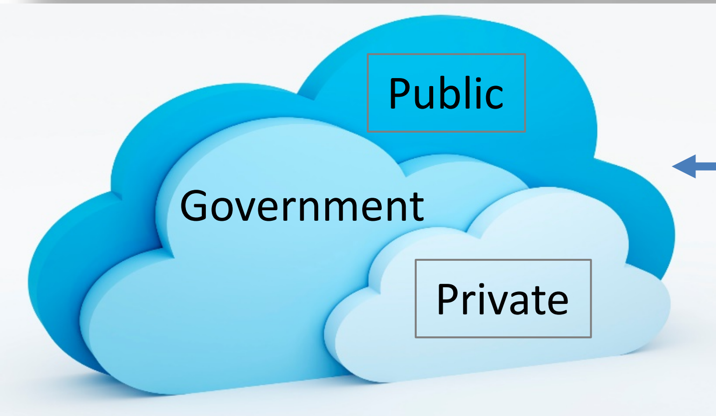
- Injury and location
- Real-time
- Reliable delivery

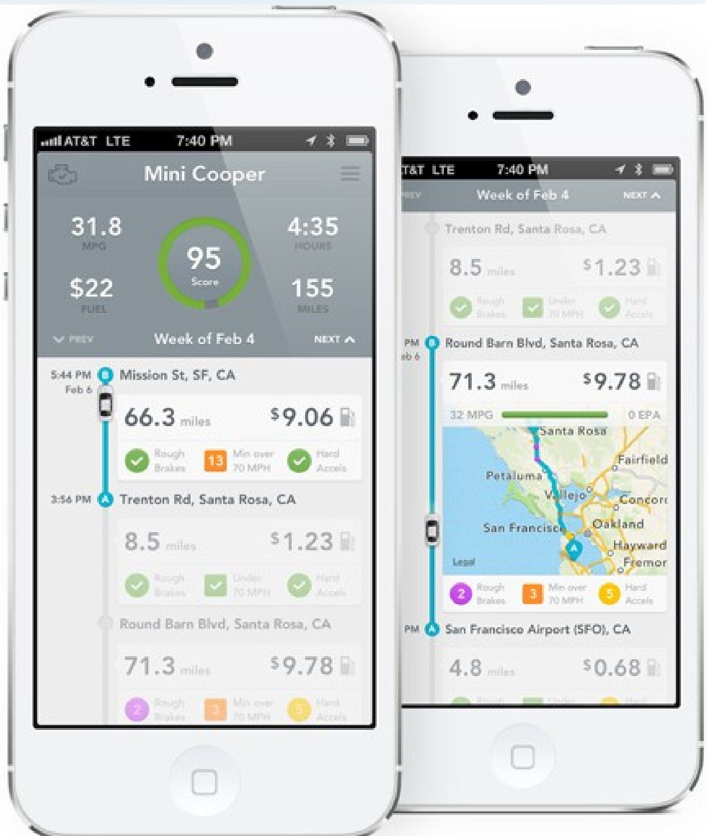
DARPA Transformative Apps – AMMO provides data persistence and communication-networking backbone (Dr Sandeep Neema, Institute for Software Integrated Systems, Vanderbilt University)

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

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

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





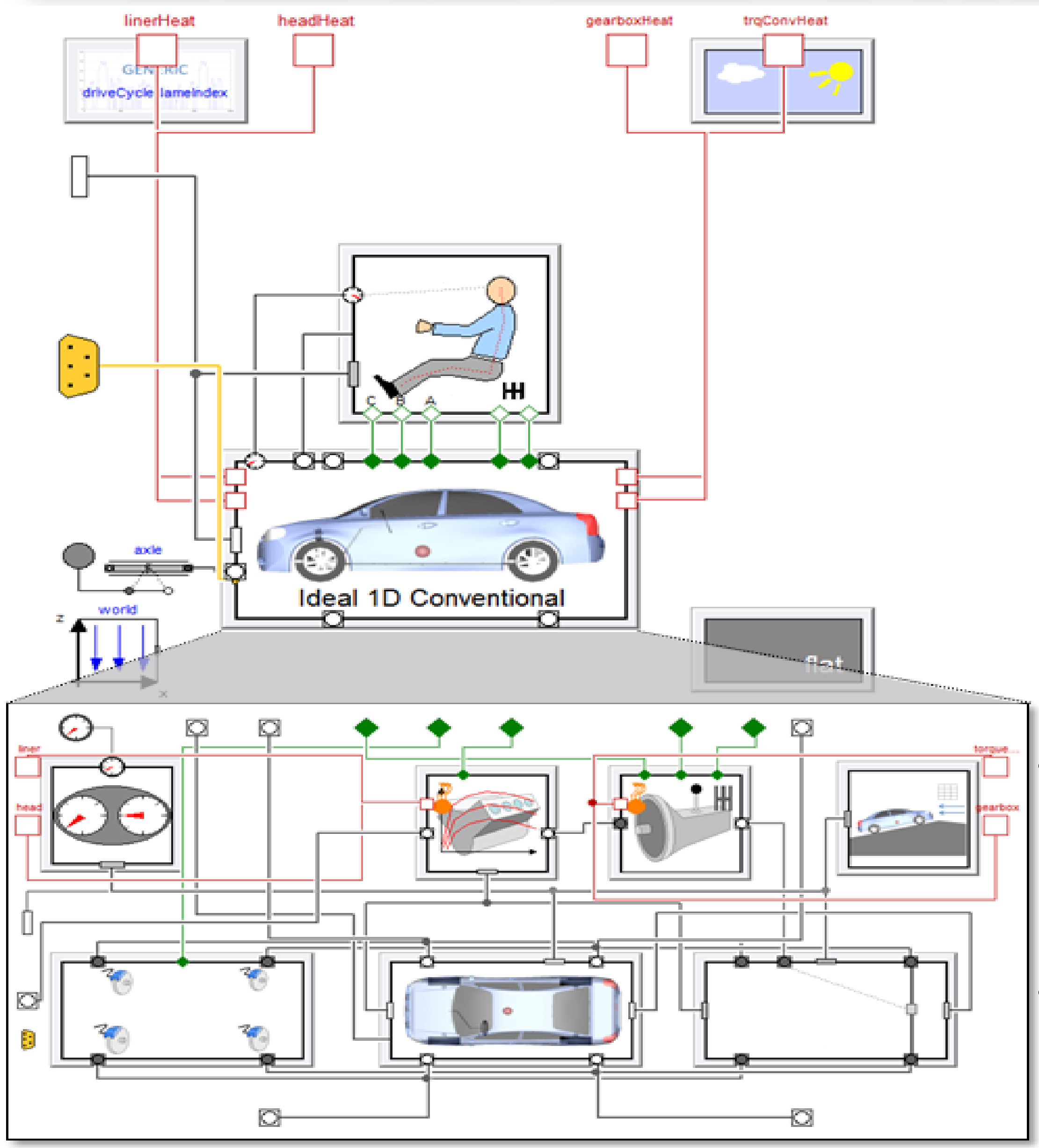
D = Data ▪ I = Infrastructure ▪ P = Platform ▪ S = Software ▪ K = Knowledge

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

Temporal Decomposition of Complex Simulations

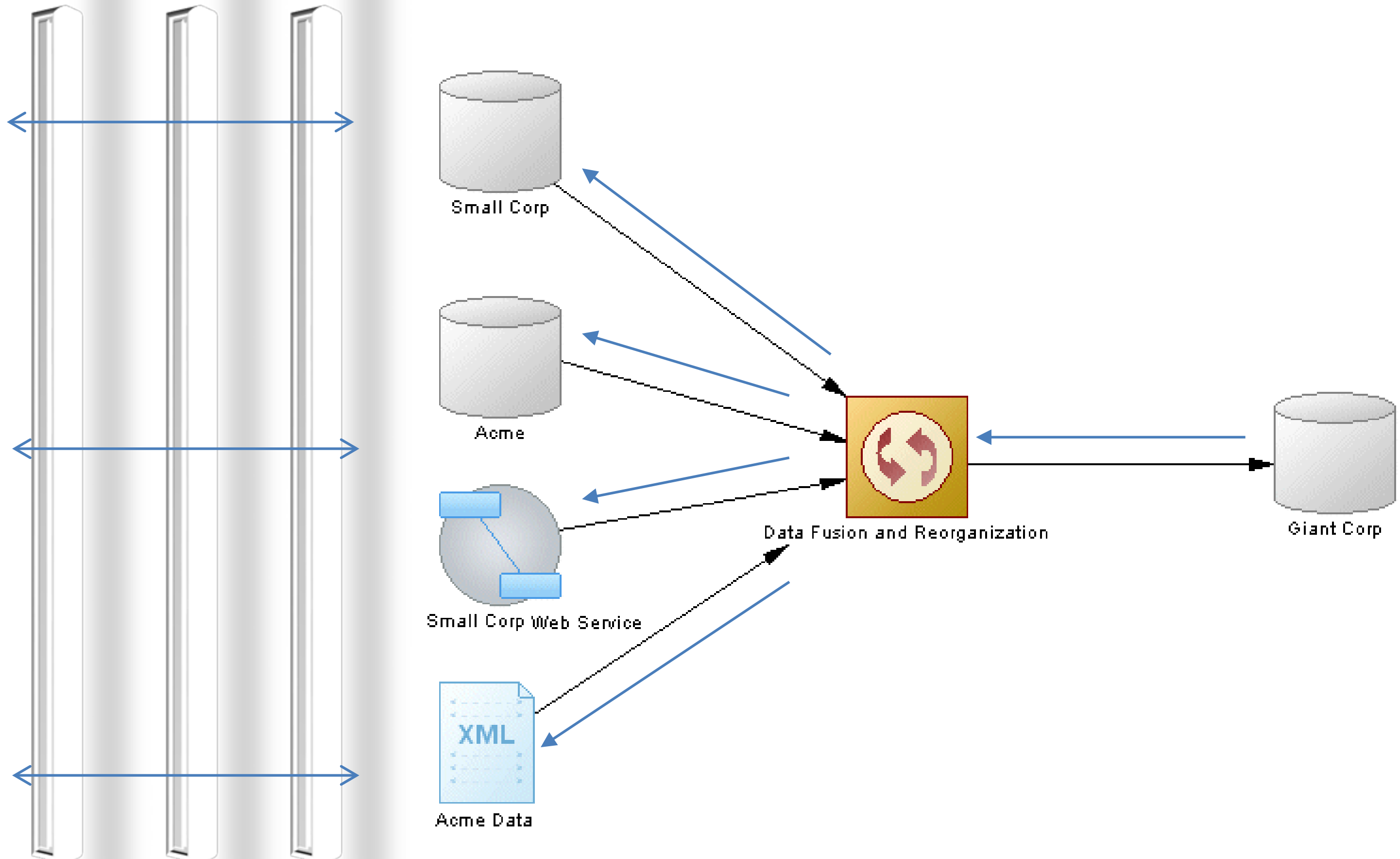
ECU based intruder dectection? Run-time condition monitoring?



- 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

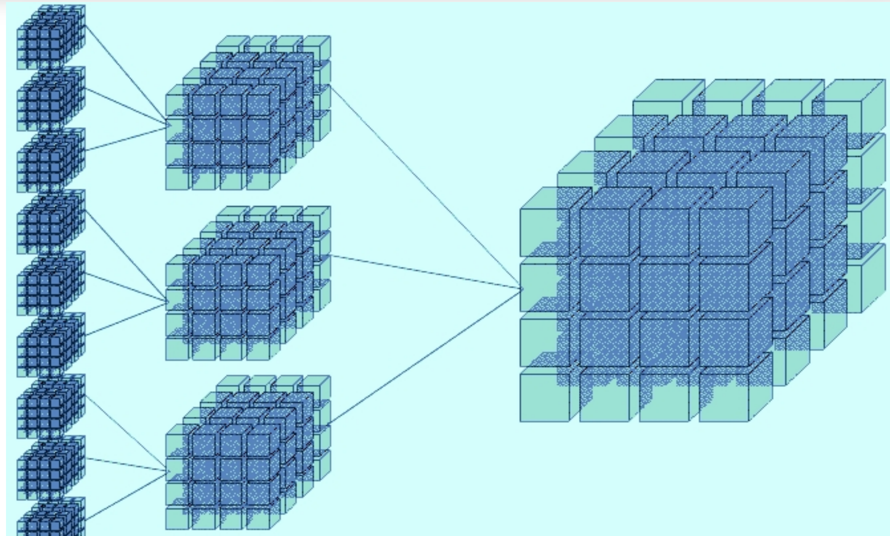
Neema, H., J. Gohl, Z. Lattmann, J. Sztipanovits, G. Karsai, S. Neema, T. Bapty, J. Batteh, H. Tummescheit, and C. Sureshkumar, ***"Model-Based Integration Platform for FMI Co-Simulation and Heterogeneous Simulations of Cyber-Physical Systems"*** *in Proceedings of the 10th International Modelica Conference,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

Response to a complex situation may need real-time data curation, analysis, synthesis & fusion to respond



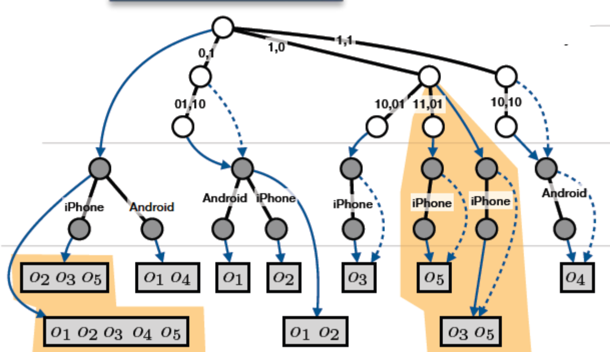
Raw Data (in any silo) is of limited value unless analyzed in conjunction with other data in temporal context of the problem-question to deliver the value the application seeks.

Response may need “past scenario” analytics in real-time

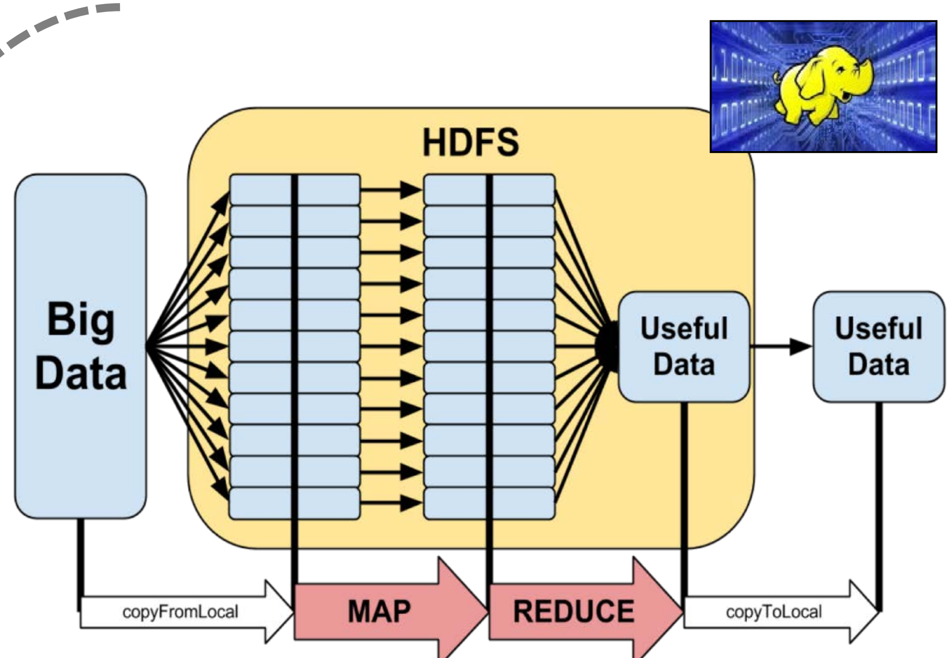


Marvin Minsky “cube on cube” (The Society of Mind, 1959)

nanocubes

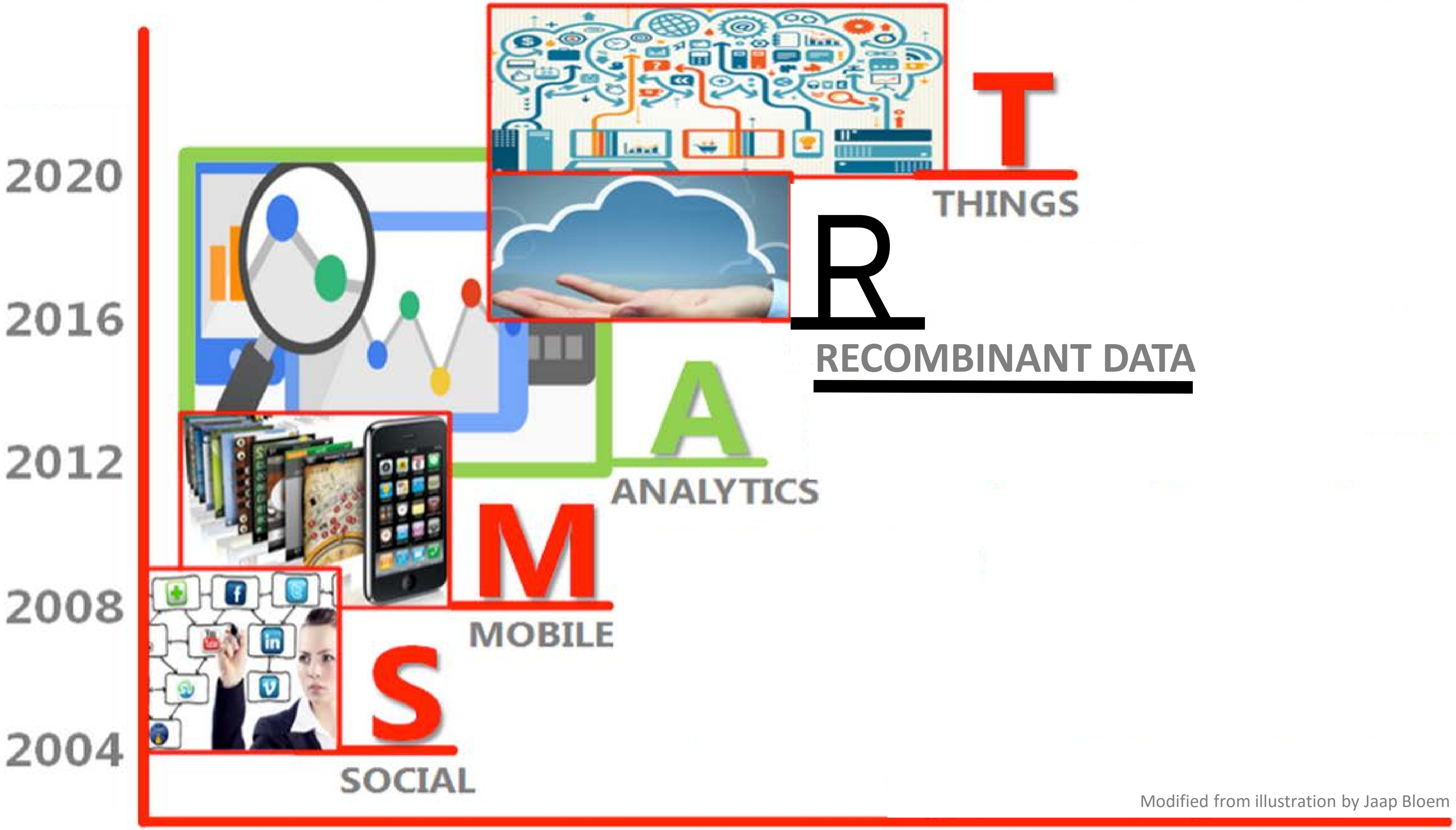


www.nanocubes.net/assets/pdf/nanocubes_paper.pdf



http://bit.ly/GFS-2004

Recombinant Data may lack tools for curation and re-synthesis

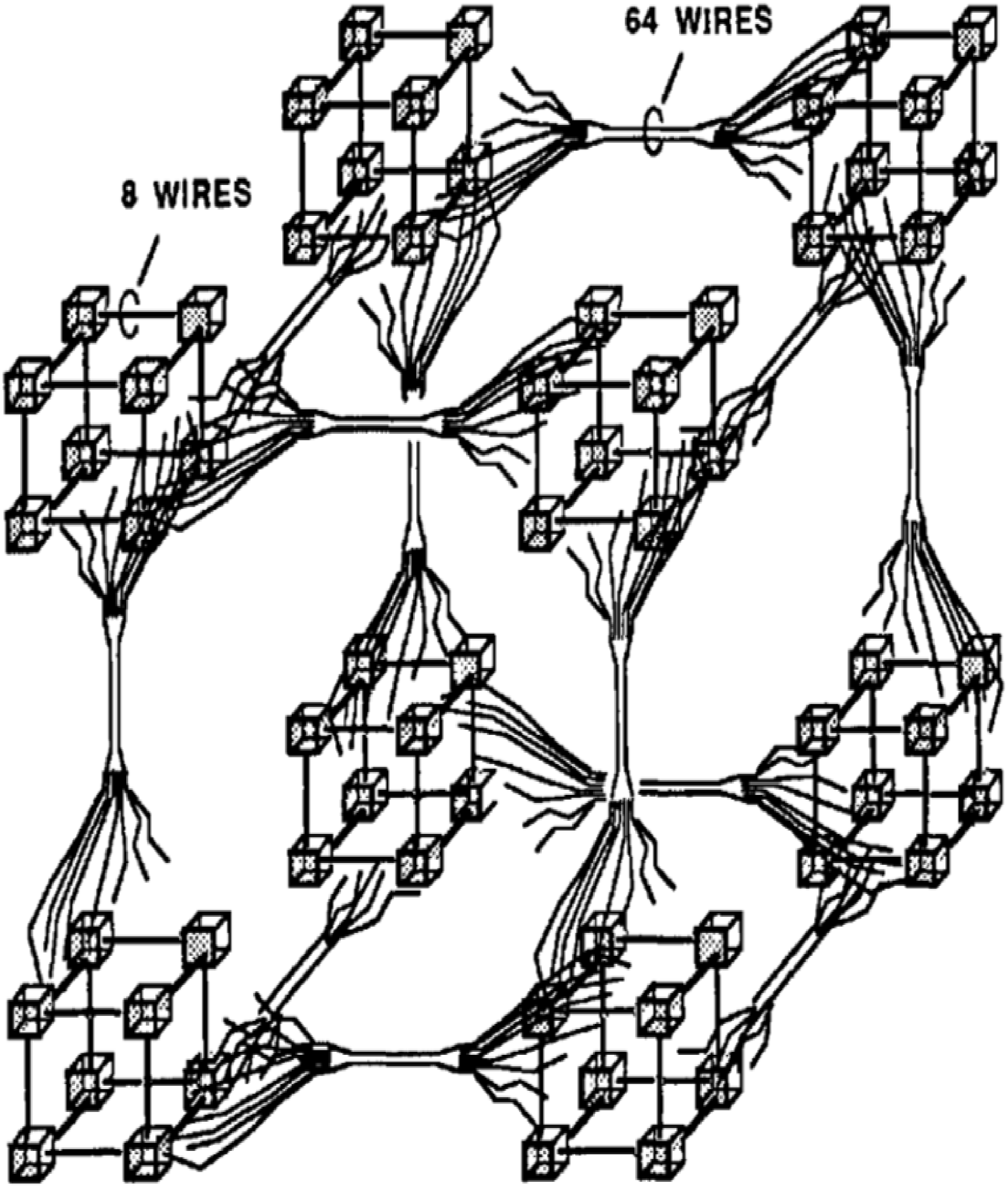


Modified from illustration by Jaap Bloem

Real-time Autonomous Driving
ANALYTICS SUPPORT

Think, Connect and Converge like a Neuron

Interoperability between data domains is key



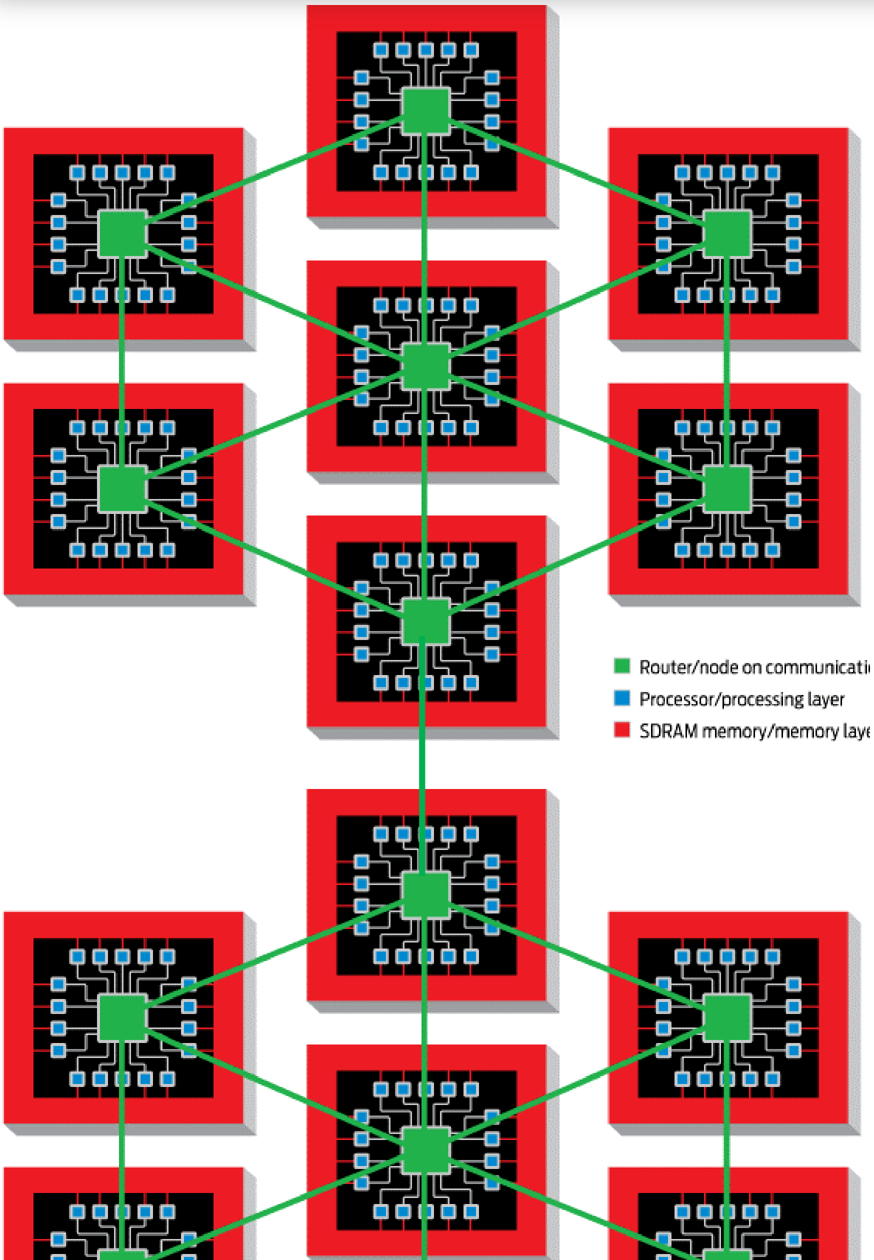
Here, 8 agents make a little cube, and 8 such cubes make a 64-agent supercube.

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.

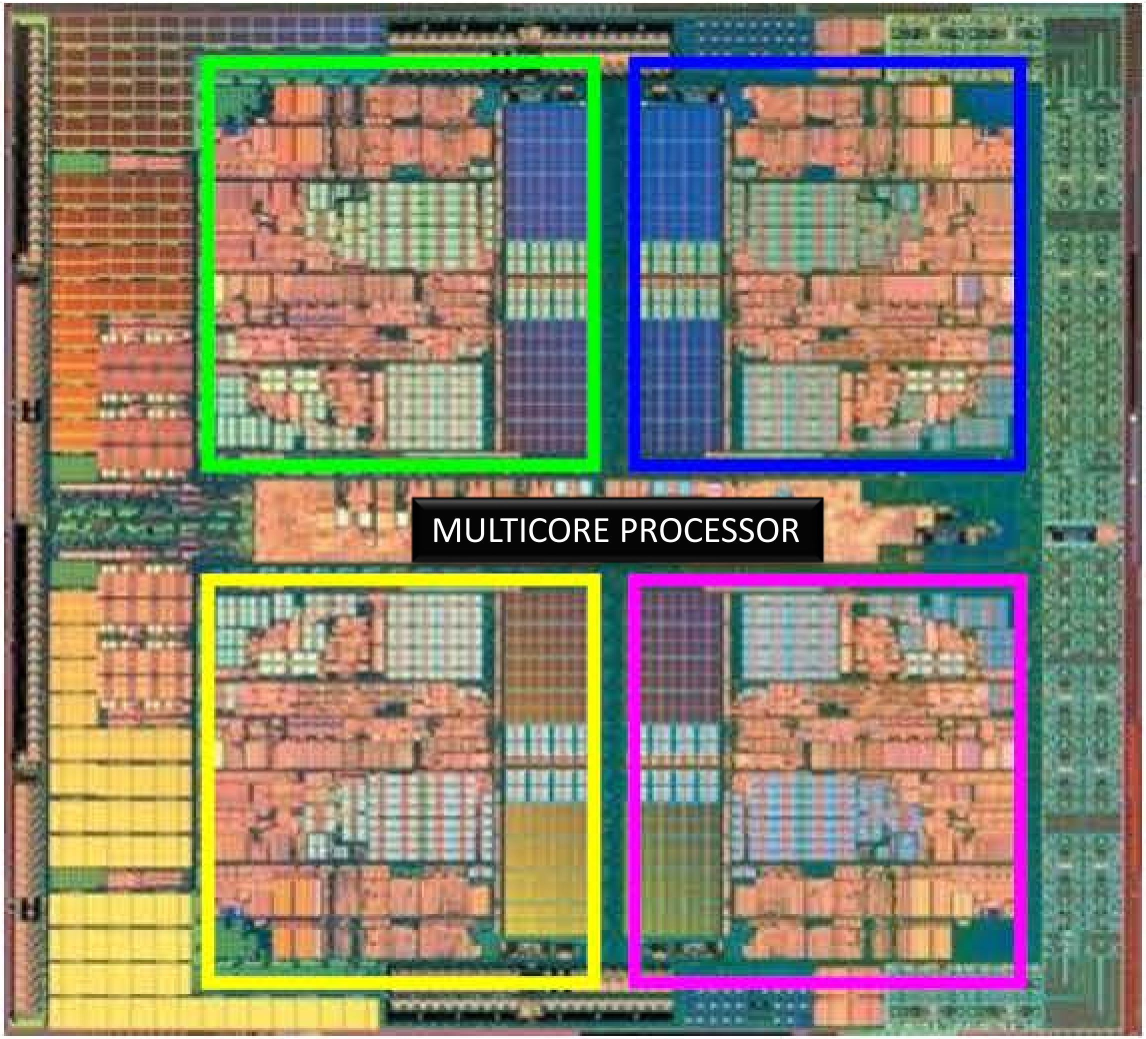
THE SOCIETY OF MIND
Marvin Minsky (1959)

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 Data API ● Core may hold matrix of questions

Simple Problem ?

EXAMPLE

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.

plastic bag

We are talking about image identification

person

cement mixer

person

spotlight

flying boat

American lobster

hunting dog

stealth bomber

The Wolfram Language

Image Identification Project

person

cement mixer

person

spotlight

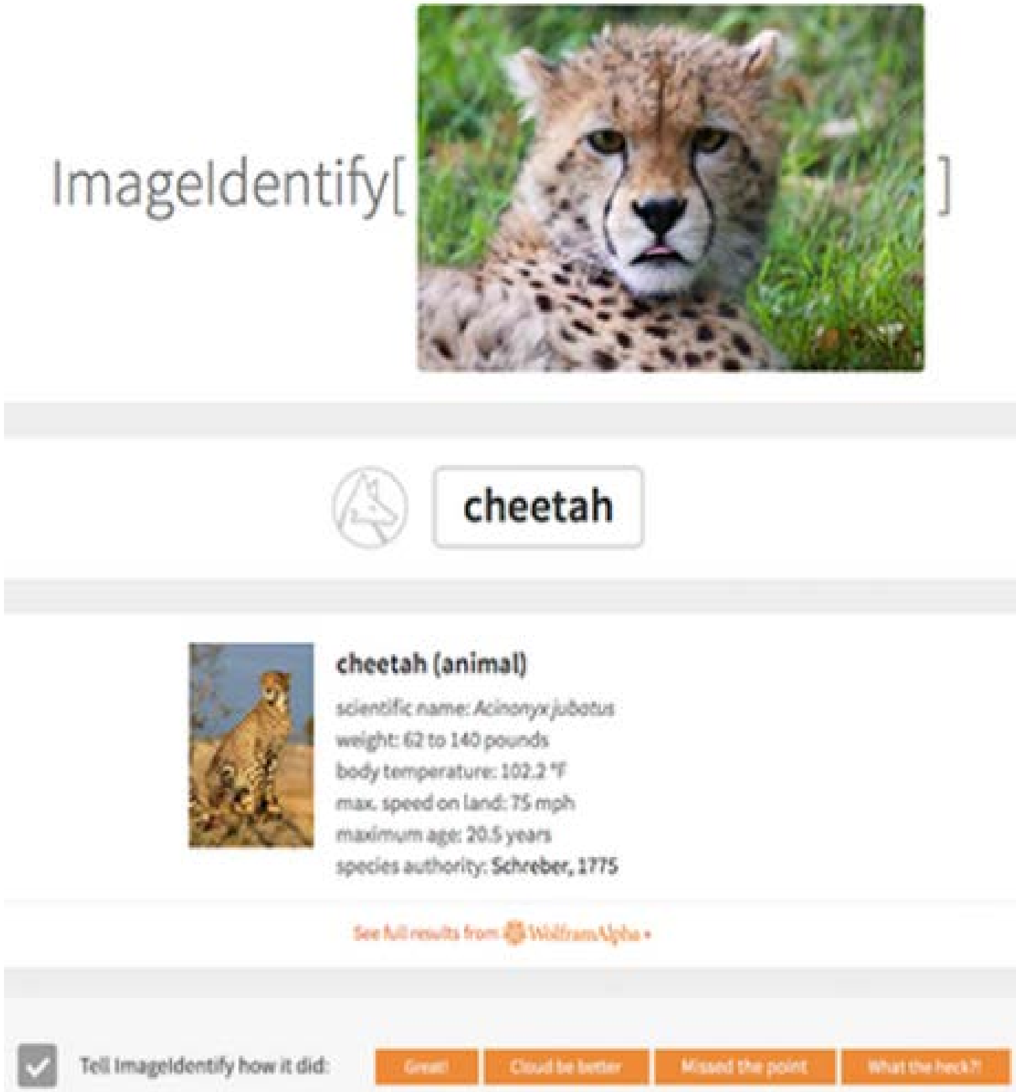
flying boat

American lobster

hunting dog

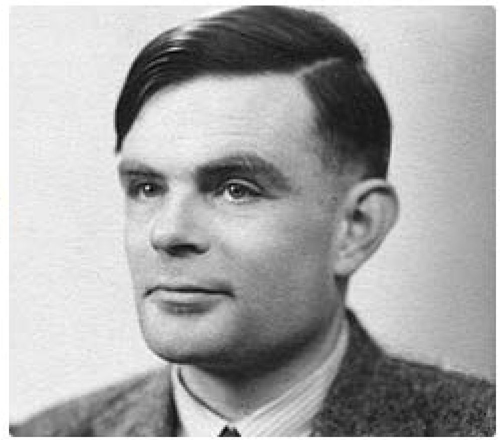
stealth bomber

The Wolfram Language
Image Identification Project



The Wolfram Language

Image Identification Project

ImageIdentify[]

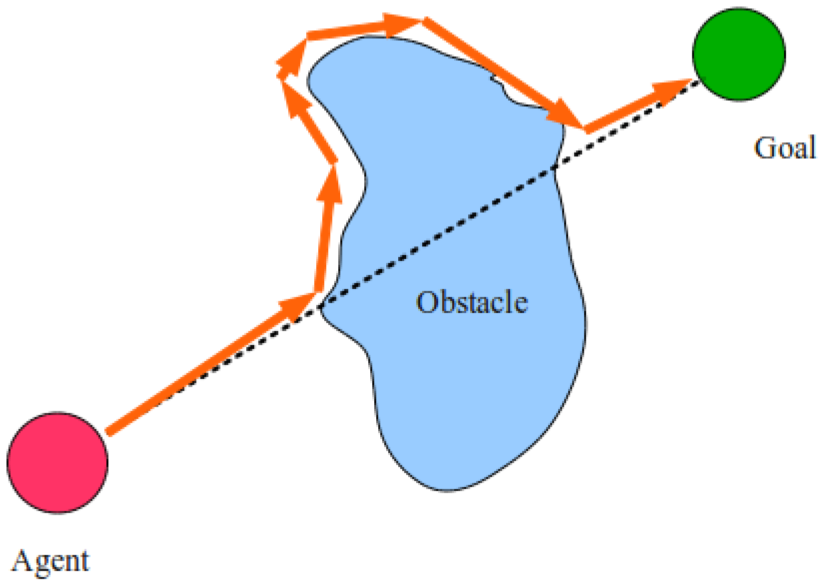
person

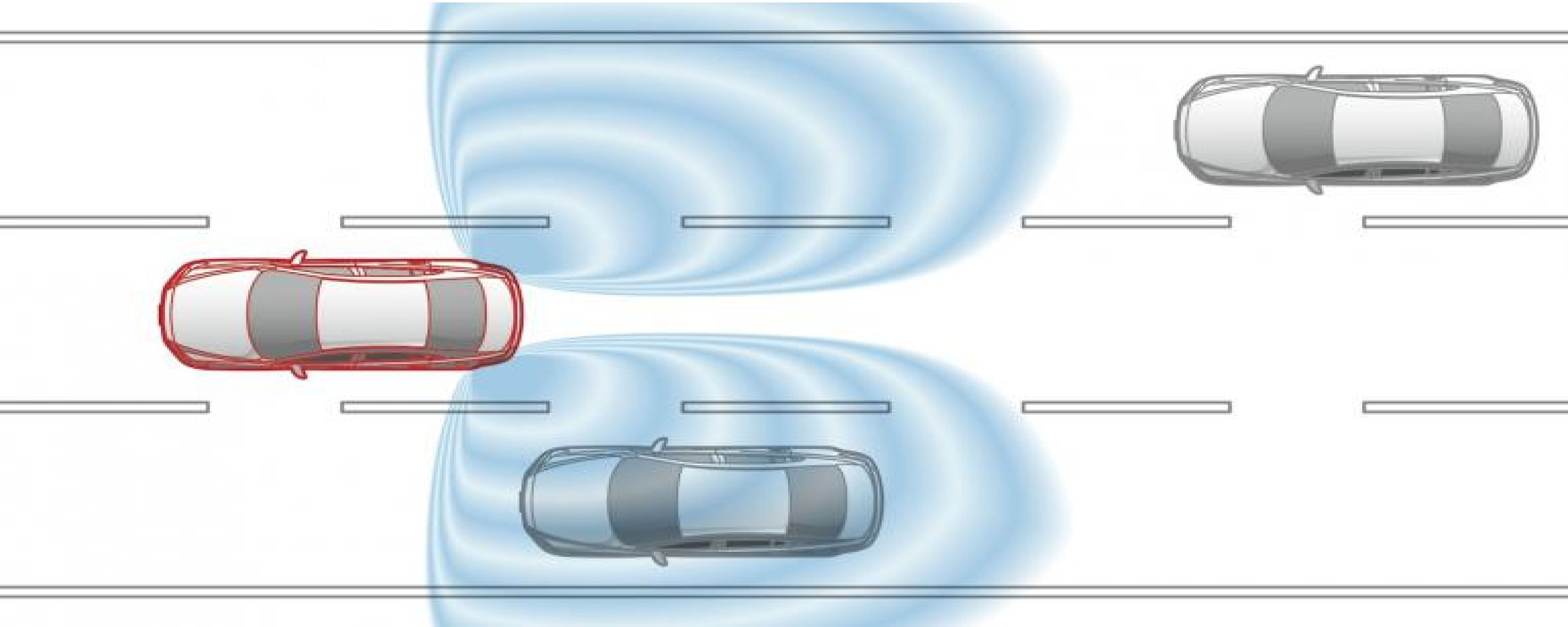
Classify["NotablePerson", ]

Crticial tools for real-time image identification and semantic context of the image for autonomous vehicle

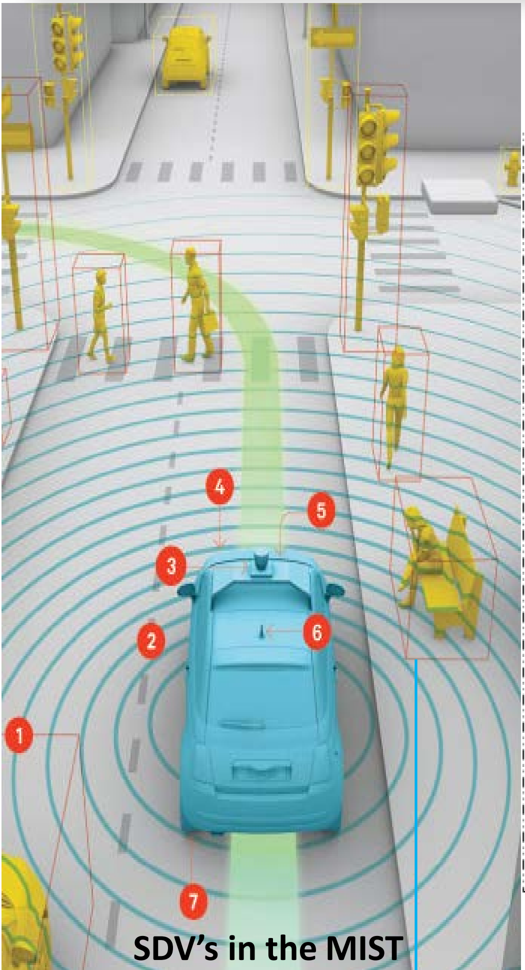
What if this speed limit sign did not communicate with the vehicle? Can the system identify the meaning from the image of the icon?

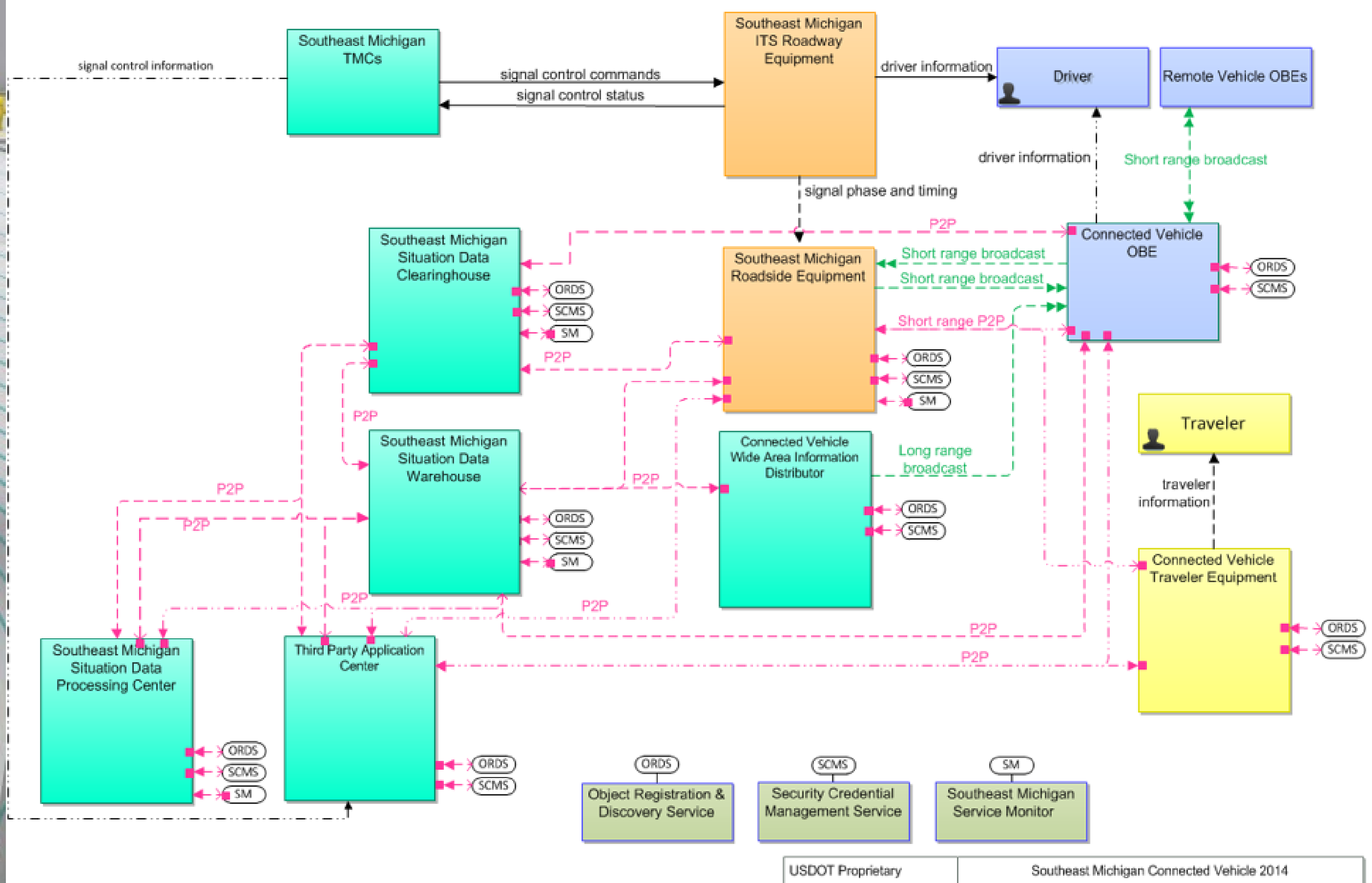
Ford's Intelligent Speed Limiter reads traffic signs, adjusts vehicle speed to comply with speed limits. Just launched in Europe, it's under consideration for Asian and North America.

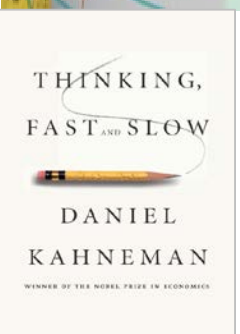

Goal
Obstacle
Agent



Hellabytes of images and other data from road side scenarios for analysis by 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)

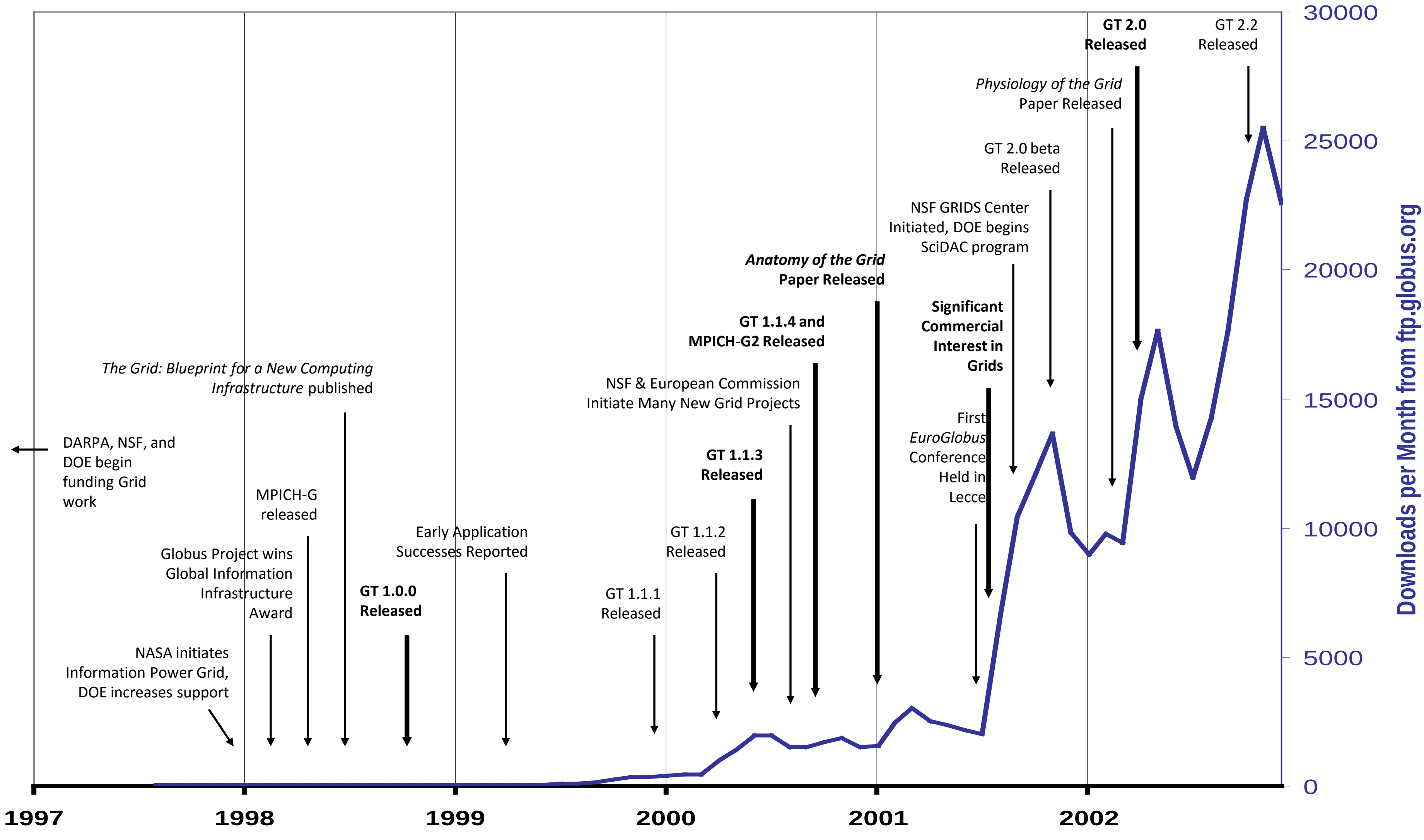
Hellabytes of Data Per Second from Software Defined Vehicles

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

Tools for Composable Mobile Dynamic "Mist" Computing

Evolution of Grid Computing and Globus Toolkit
Composable Near Field "Mist" Computing ??



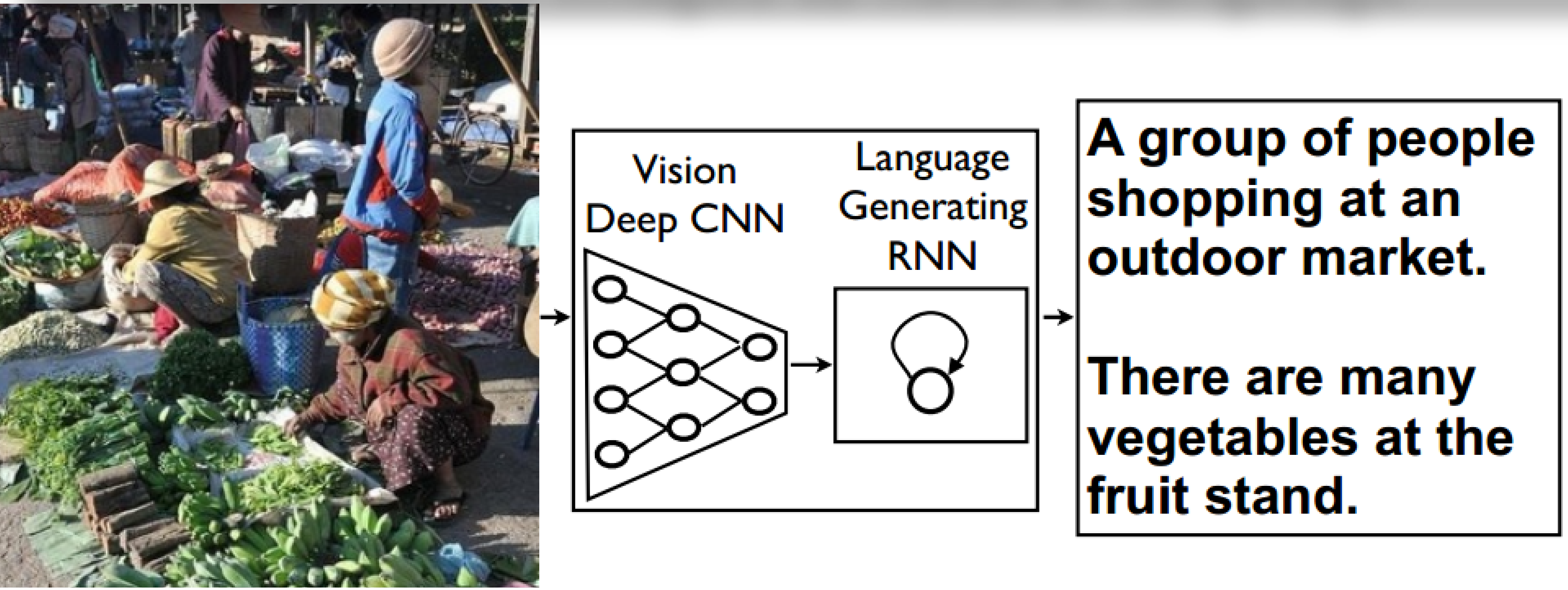
Computing in the mist

“Mist Computing” does not exist. It is a suggestion by the author.

Oh I see a plastic bag

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

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

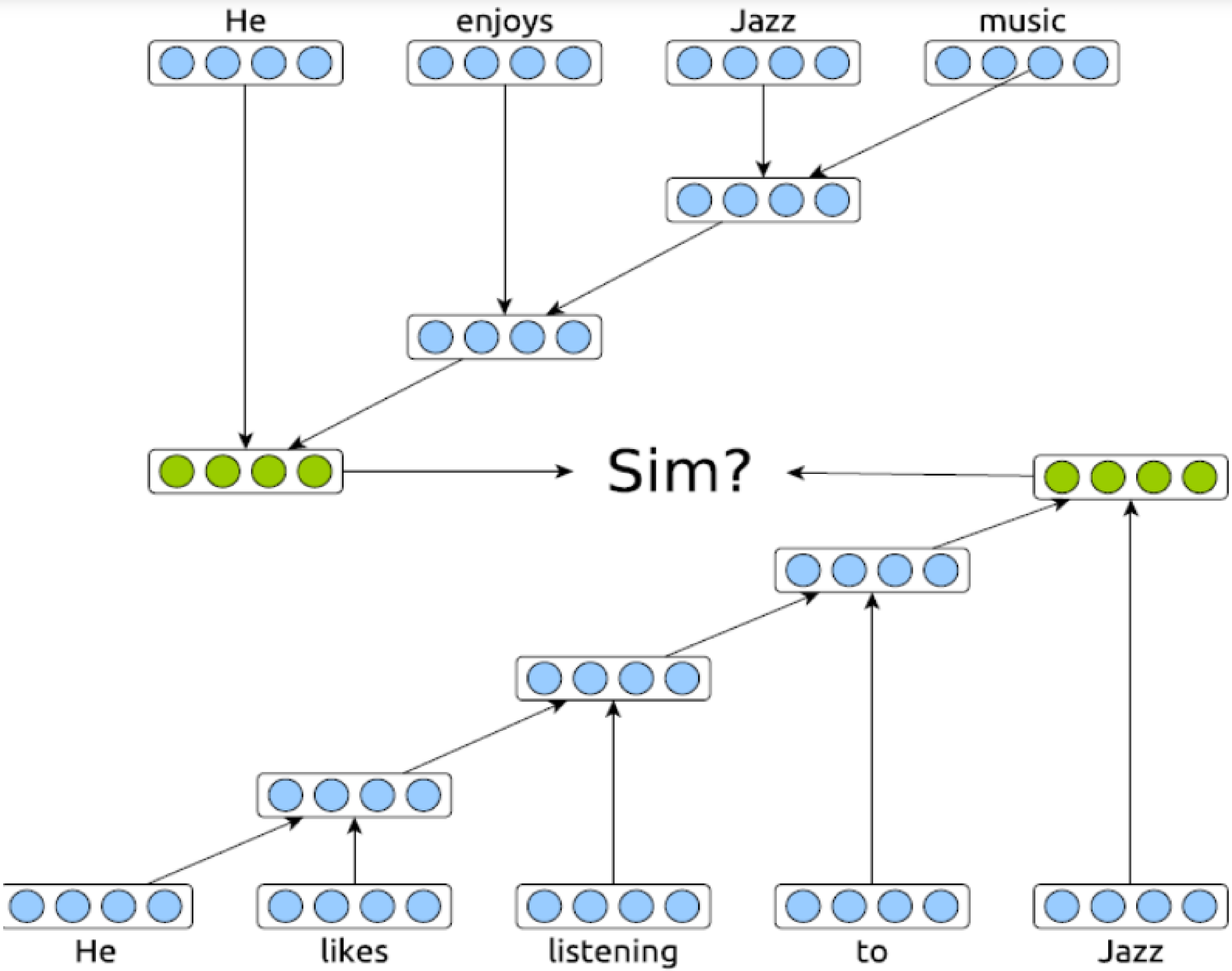


http://arxiv.org/pdf/1411.4555v1.pdf

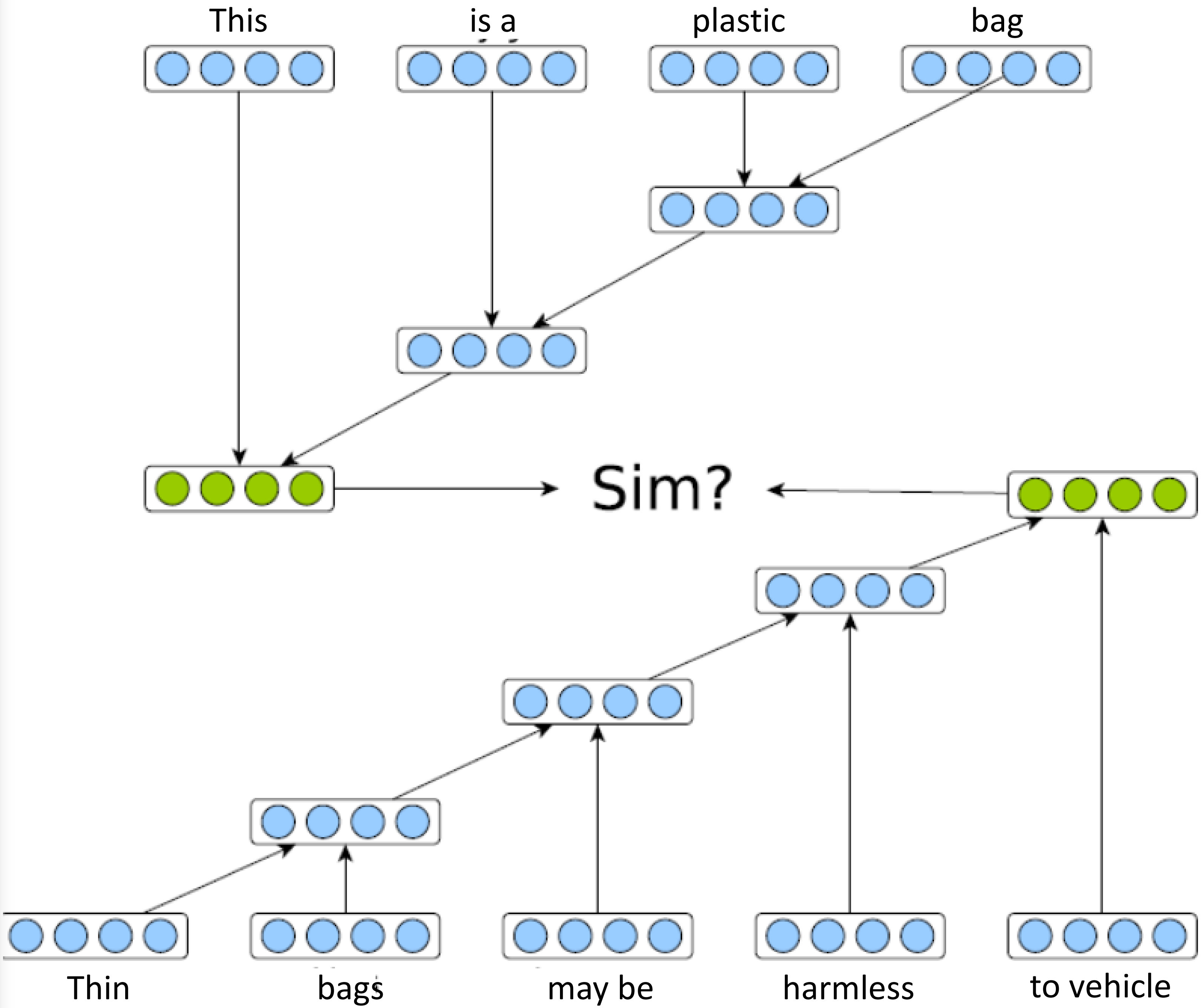
To translate languages, [Recurrent Neural Network]() (RNN) transforms a French sentence into a [vector representation](), and a second RNN uses that vector representation to generate a target sentence in German. Replace first RNN and input words with deep [Convolutional Neural Network]() (CNN) trained 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

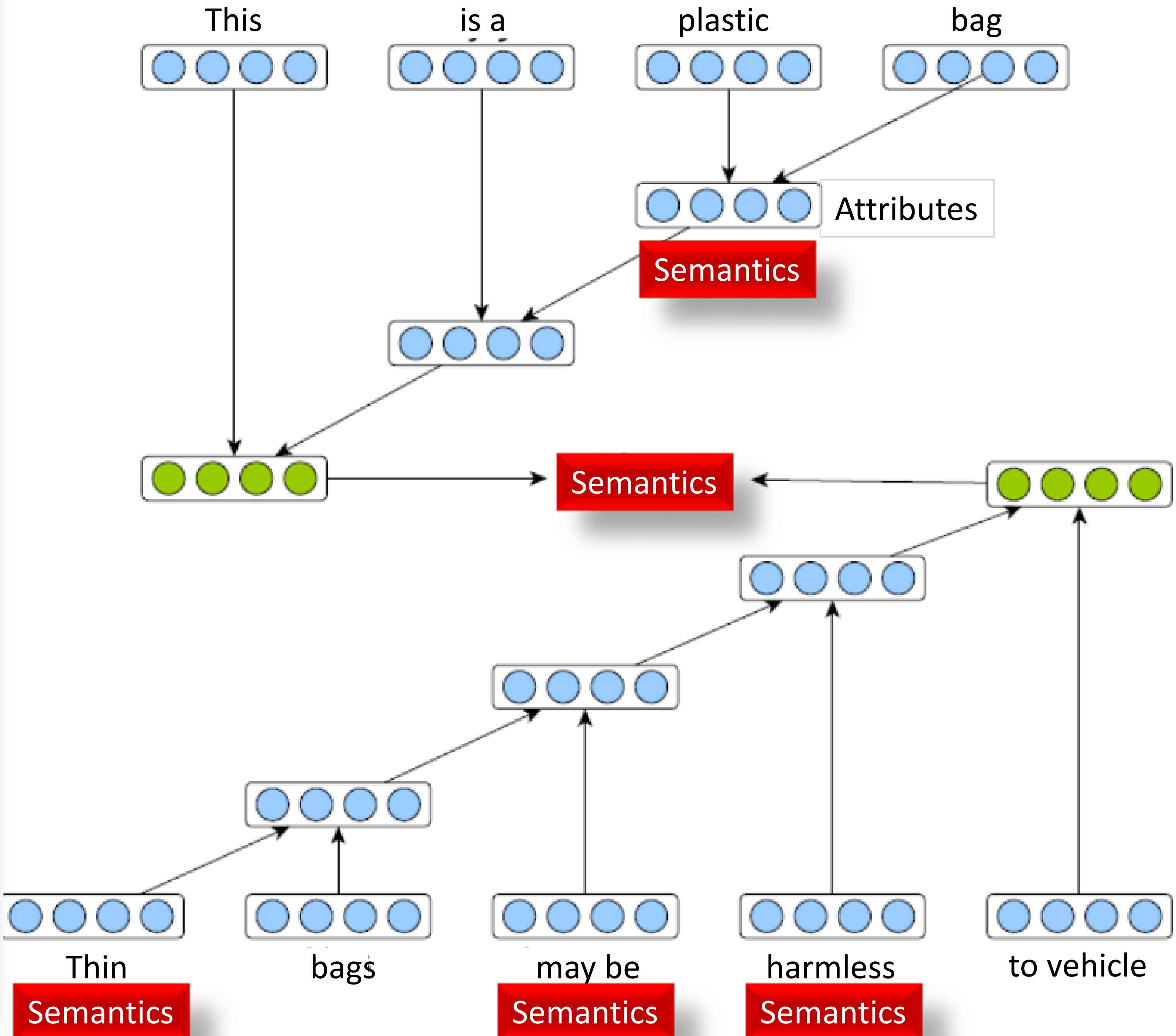
Siamese Networks – Paraphrase Detection



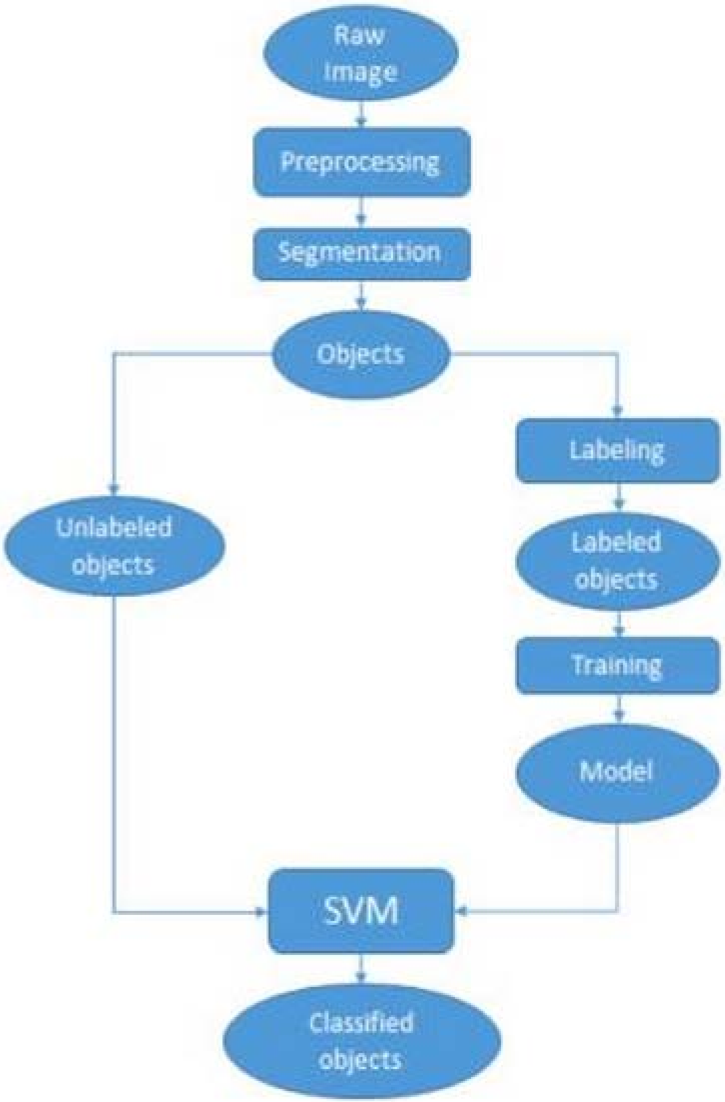
Siamese Networks – Paraphrase Detection

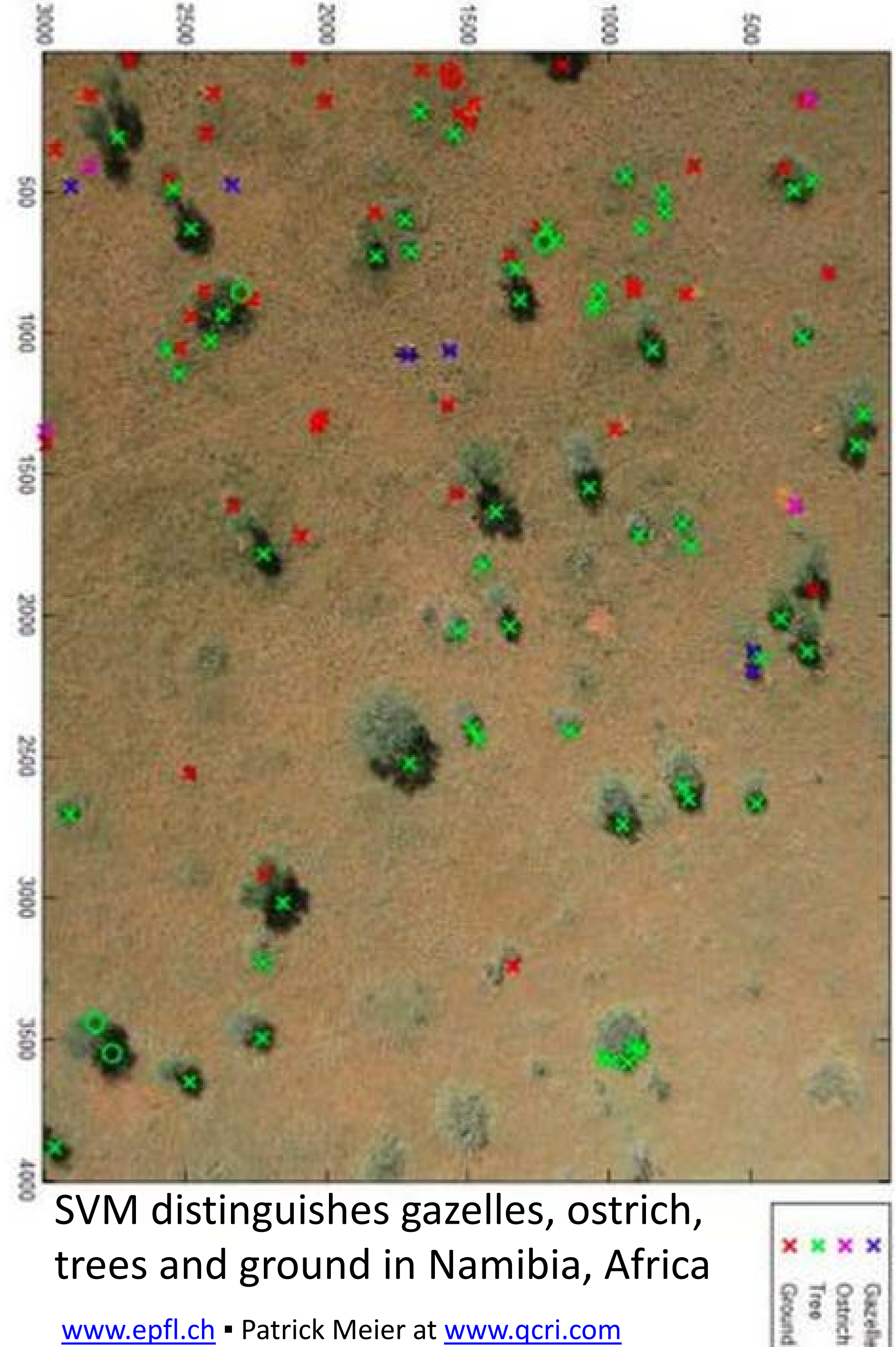


Siamese Networks – Paraphrase Detection



Connected Vehicle
Mist Computing Tool
Support Vector Machine



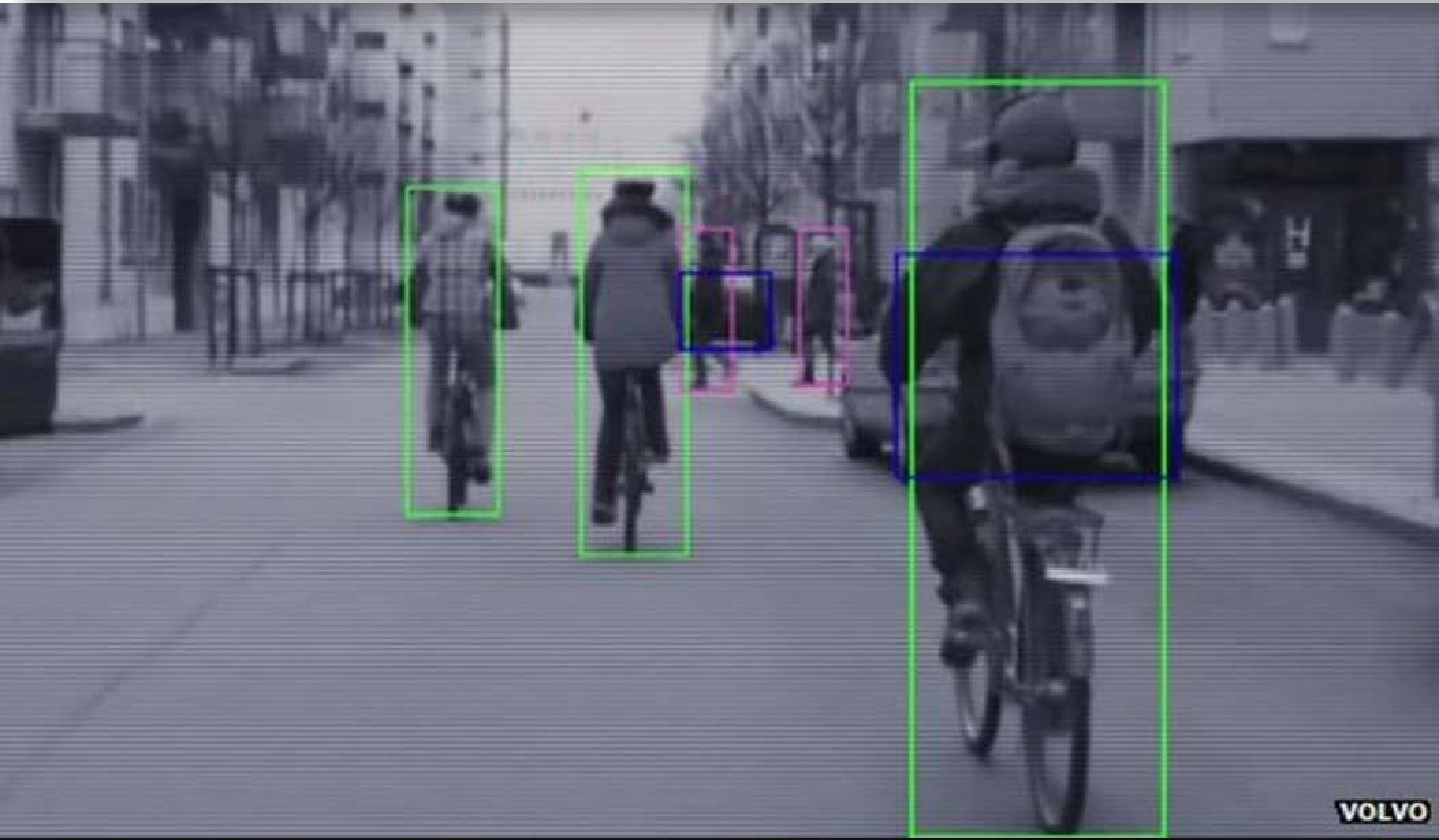


SVM distinguishes gazelles, ostrich, trees and ground in Namibia, Africa

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

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

Support Vector Machines for ITS in China



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

Google Autonomous Vehicle *"baffled by a man" on a bike*

Google's self-driving cars are very careful.

When Google released its first accident reports in June, the company revealed that in the combined 1.8 million miles its cars had been on the road, they had been involved in 12 minor accidents, none of which were their fault.

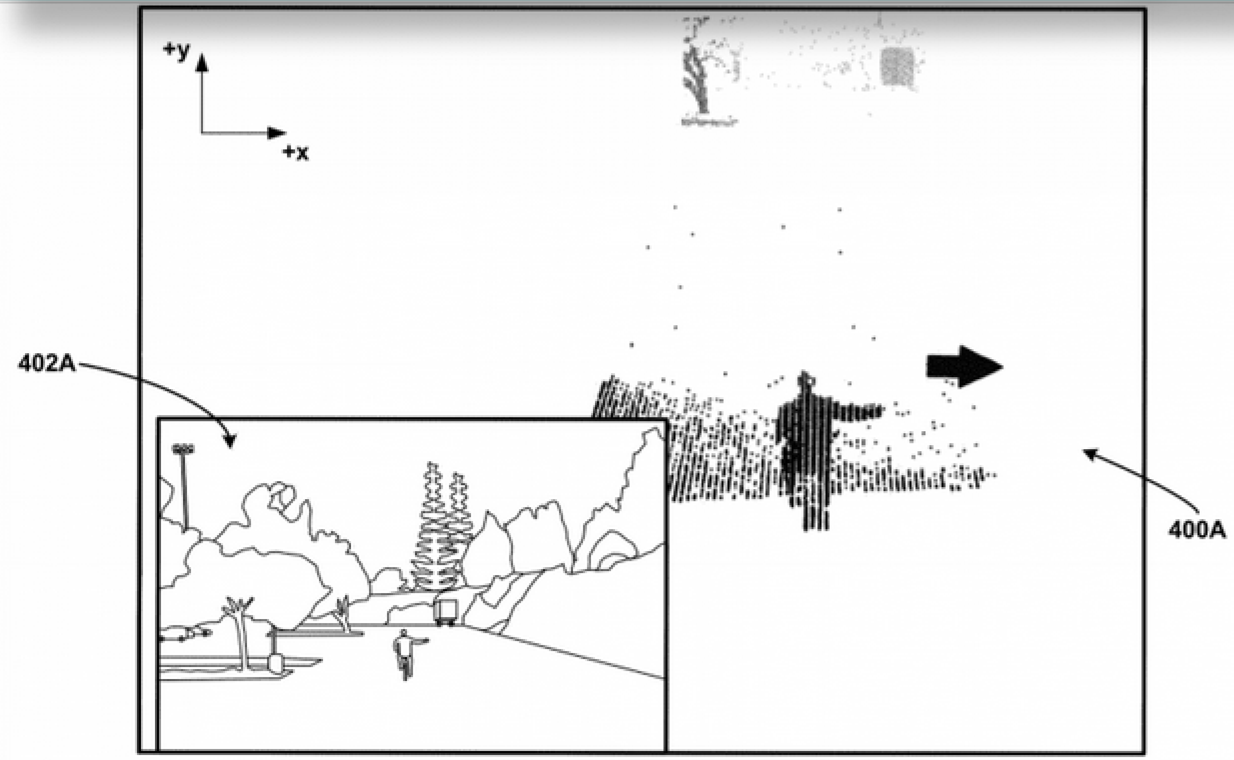
But this default to caution can cause strange incidents when Google cars run into humans engaging in nonstandard behavior.

One of Google's self-driving cars.

One such incident reportedly occurred earlier this month in Austin, when a robot car was baffled by a man riding a fixed-gear bike — aka a fixie, a favorite of so-called hipsters around the world — The Washington Post reports.

http://bit.ly/GOOGLE-PATENT-CYCLISTS

Autonomous Vehicles - interpreting hand signals of cyclists



Here we see how the driverless car's sensors identify the cyclist and his intent to turn right. (U.S. Patent and Trademark Office)

A year ago, Google made an impressive announcement. Its self-driving cars were capable of interpreting the hand signals of cyclists.

Google didn't offer much detail then on how this system worked, but a patent issued to the tech giant in April gives a window into how it plans to use machine learning to make self-driving cars a reality on city streets.

Google granted patent for interpreting hand signals of cyclists

United States Patent **9,014,905**
Kretzschmar , et al. **April 21, 2015**

Cyclist hand signal detection by an autonomous vehicle

Abstract

Methods and systems for detecting hand signals of a cyclist by an autonomous vehicle are described. An example method may involve a computing device receiving a plurality of data points corresponding to an environment of an autonomous vehicle. The computing device may then determine one or more subsets of data points from the plurality of data points indicative of at least a body region of a cyclist. Further, based on an output of a comparison of the one or more subsets with one or more predetermined sets of cycling signals, the computing device may determine an expected adjustment of one or more of a speed of the cyclist and a direction of movement of the cyclist. Still further, based on the expected adjustment, the computing device may provide instructions to adjust one or more of a speed of the autonomous vehicle and a direction of movement of the autonomous vehicle.

Inventors: **Kretzschmar; Henrik** (Freiburg, **DE**), **Zhu; Jiajun** (Palo Alto, CA)

Applicant:

Name	City	State	Country	Type
Google Inc.	Mountain View	CA	US	

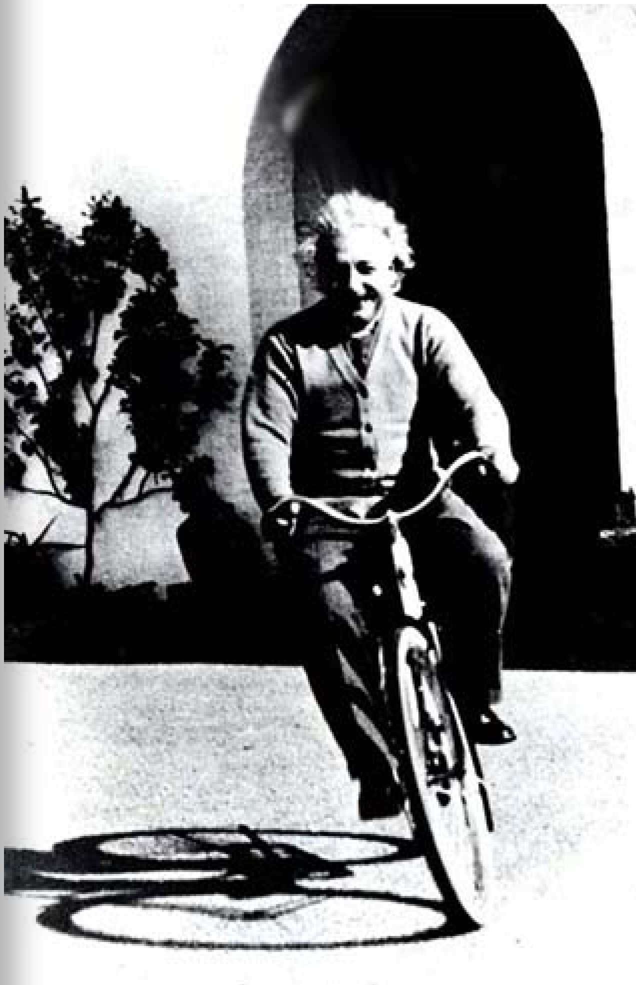
Assignee: **Google Inc.** (Mountain View, CA)
Family ID: **52822648**
Appl. No.: **14/166,502**
Filed: **January 28, 2014**

Can machine learning analytics distinguish between scenarios?

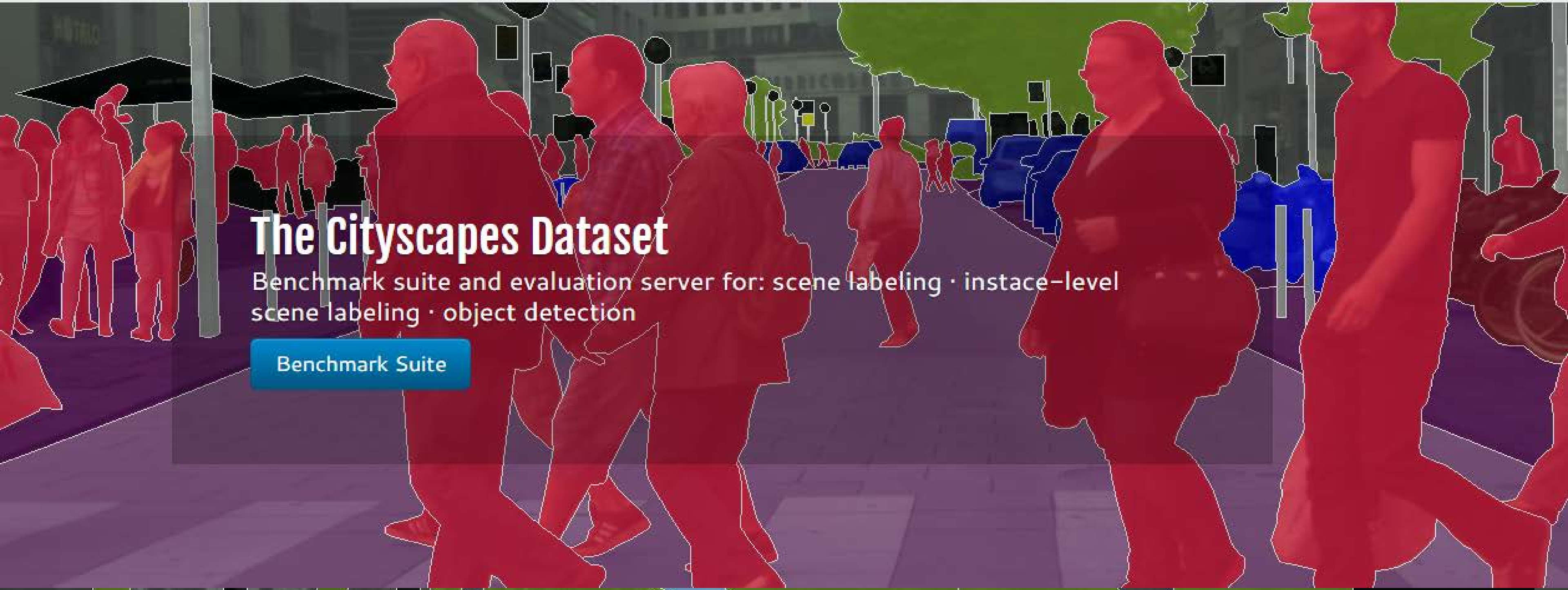

PREFECTURE DE POLICE


gettyimages
Thomas Grass
87987647

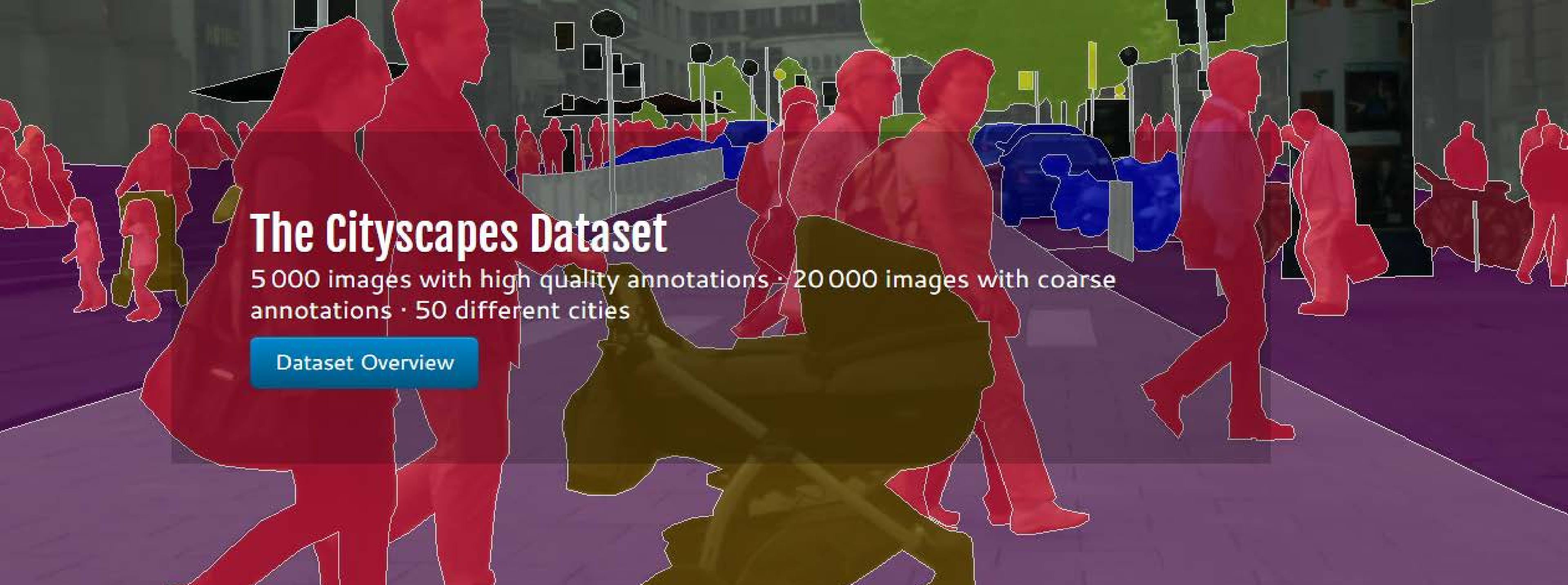
Viktor Weisskopf, Maria Göppert, Max Born
Göttingen (1920)

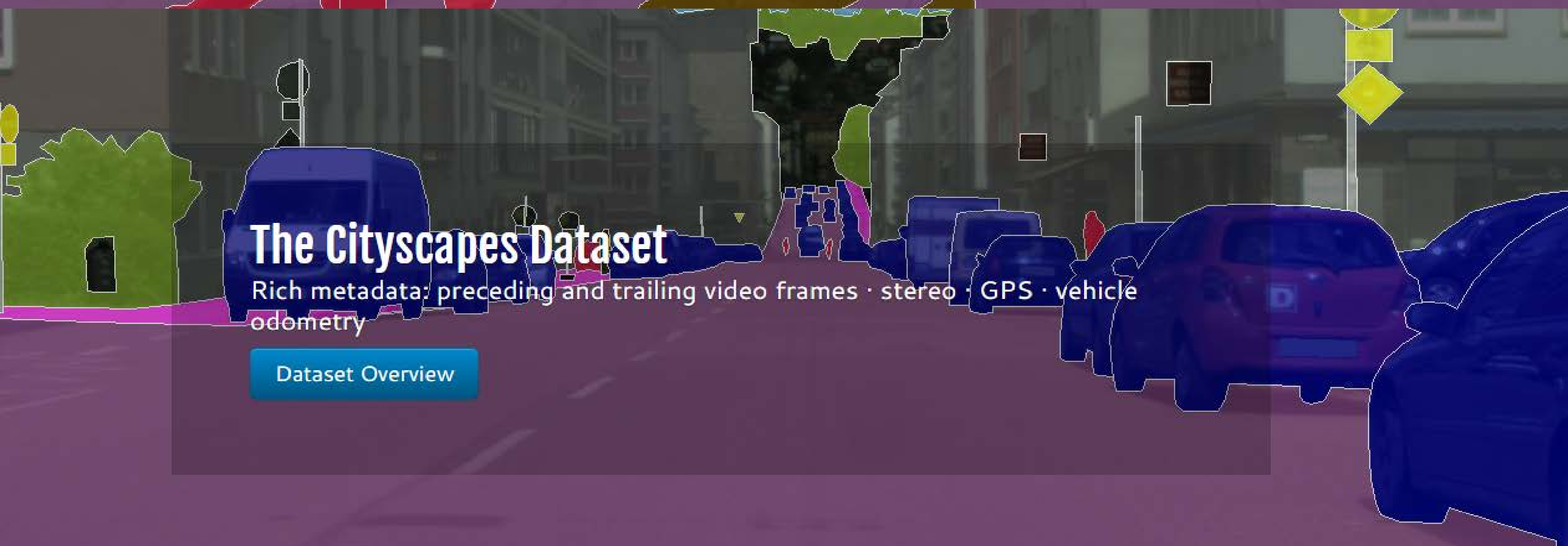


The crucial importance of scenario semantics for autonomous vehicles



www.cityscapes-dataset.net





www.cityscapes-dataset.net

Do we have to compute “bike” scenario for 1000 most common situations for every type of city?

may be not

The original image the team fed the algorithm this image of houses to be 'reimagined' in the style of different artists

+10

A Neural Algorithm of Artistic Style

Leon A. Gatys,[1,2,3*] Alexander S. Ecker,[1,2,4,5] Matthias Bethge[1,2,4]

[1]Werner Reichardt Centre for Integrative Neuroscience
and Institute of Theoretical Physics, University of Tübingen, Germany
[2]Bernstein Center for Computational Neuroscience, Tübingen, Germany
[3]Graduate School for Neural Information Processing, Tübingen, Germany
[4]Max Planck Institute for Biological Cybernetics, Tübingen, Germany
[5]Department of Neuroscience, Baylor College of Medicine, Houston, TX, USA
[*]To whom correspondence should be addressed; E-mail: leon.gatys@bethgelab.org

In fine art, especially painting, humans have mastered the skill to create unique visual experiences through composing a complex interplay between the content and style of an image. Thus far the algorithmic basis of this process is unknown and there exists no artificial system with similar capabilities. However, in other key areas of visual perception such as object and face recognition near-human performance was recently demonstrated by a class of biologically inspired vision models called Deep Neural Networks.[1,2] Here we introduce an artificial system based on a Deep Neural Network that creates artistic images of high perceptual quality. The system uses neural representations to separate and recombine content and style of arbitrary images, providing a neural algorithm for the creation of artistic images. Moreover, in light of the striking similarities between performance-optimised artificial neural networks and biological vision,[3–7] our work offers a path forward to an algorithmic understanding of how humans create and perceive artistic imagery.

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[2]Bernstein Center for Computational Neuroscience, Tübingen, Germany
[3]Graduate School for Neural Information Processing, Tübingen, Germany
[4]Max Planck Institute for Biological Cybernetics, Tübingen, Germany
[5]Department of Neuroscience, Baylor College of Medicine, Houston, TX, USA
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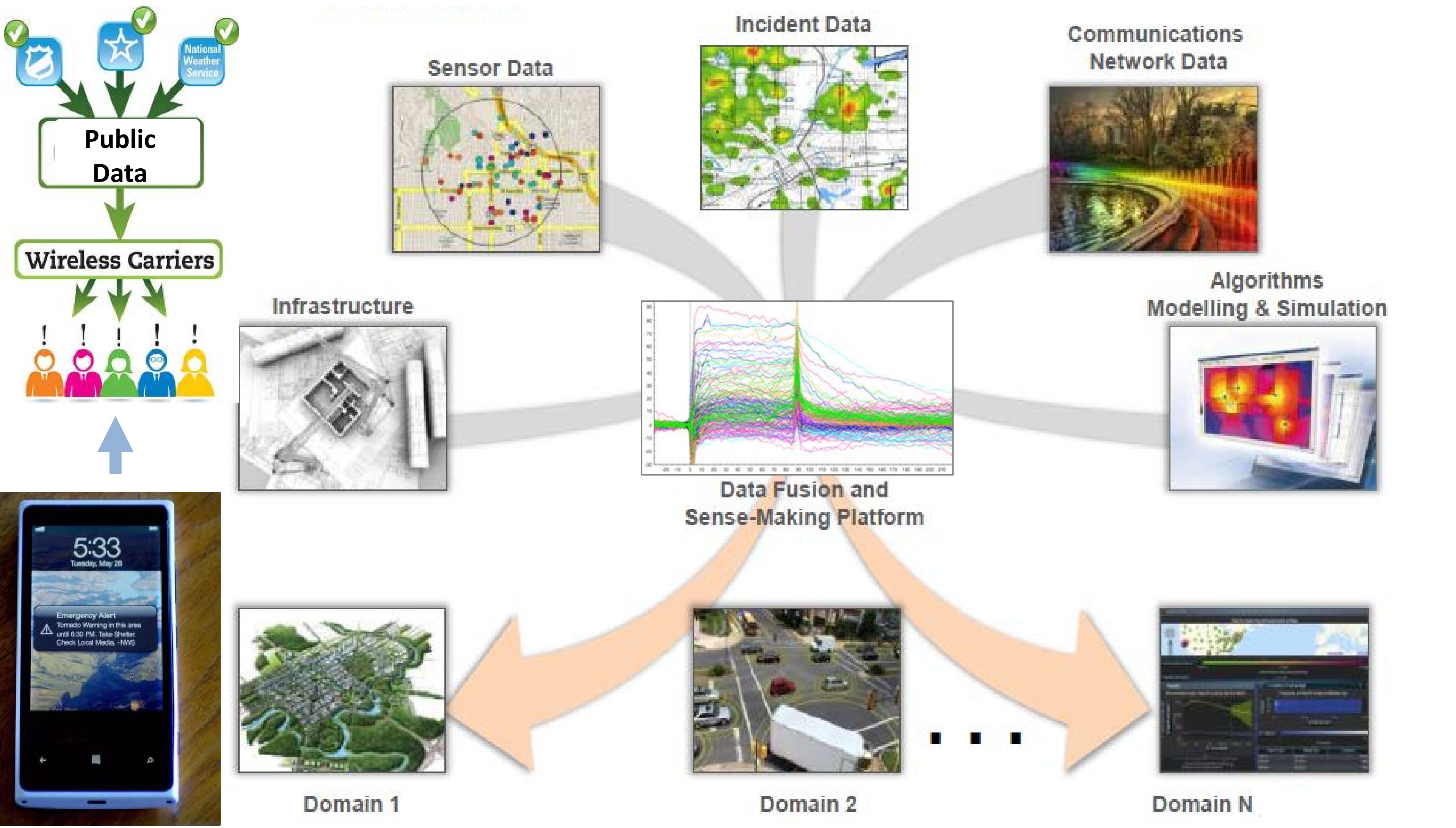
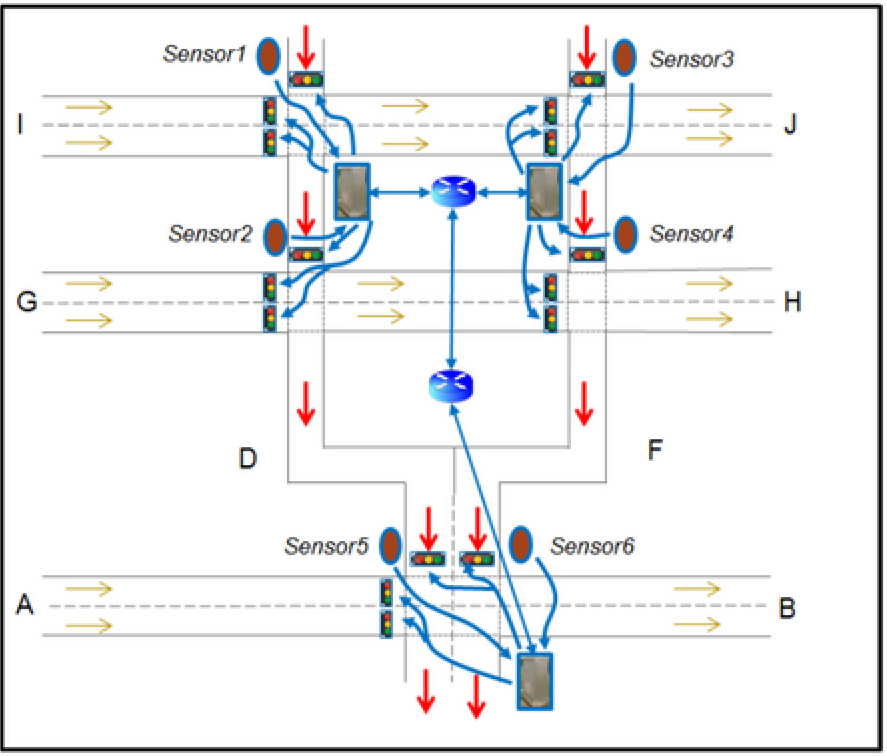
This and many more decisions must be synthesized in real-time to support autonomous driving

DATA and ANALYTICS for AUTONOMOUS VEHICLE MANAGEMENT

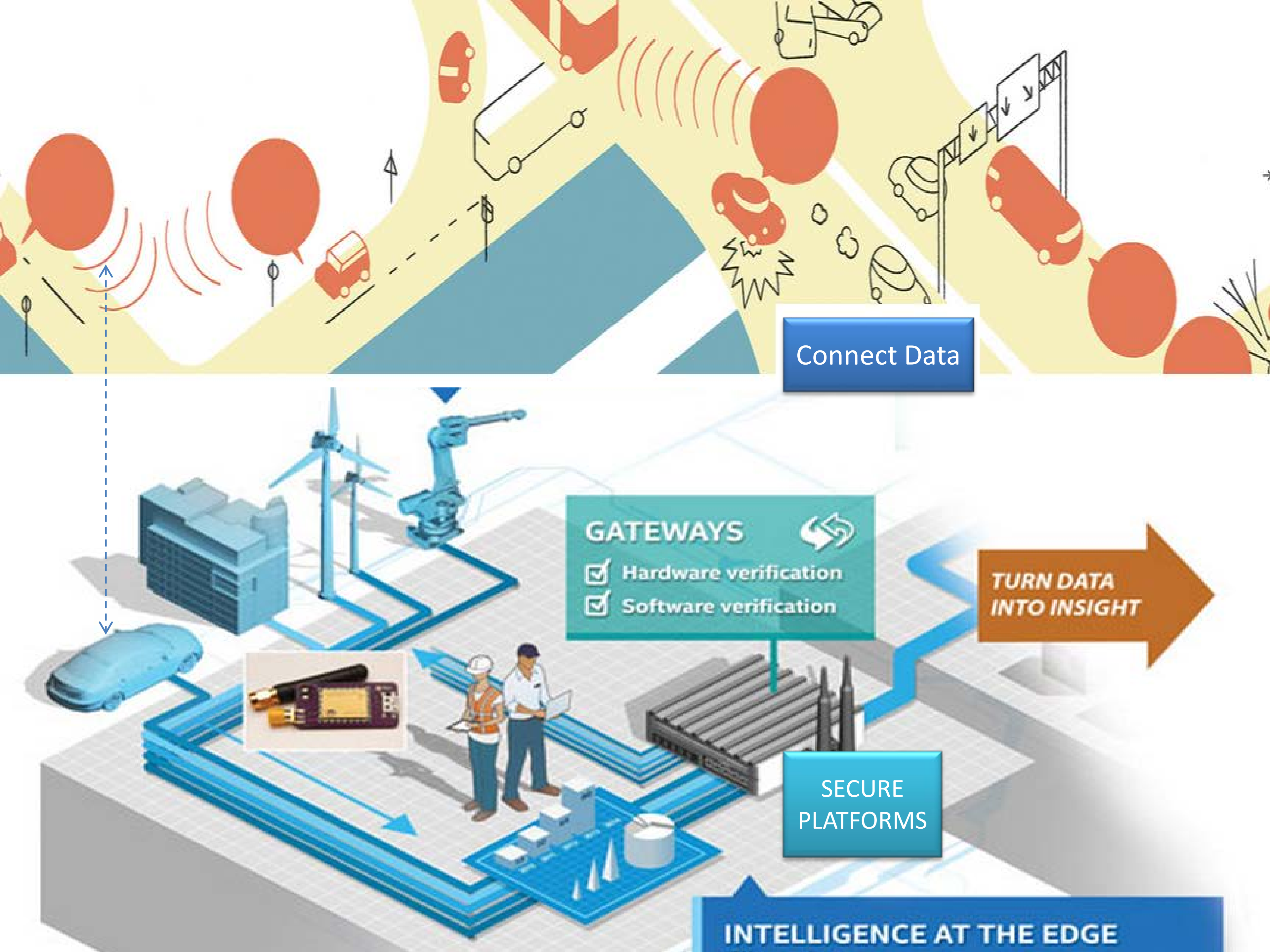


Data, Message, Alert Dashboard for Communities and Commuters

CONNECT DATA and ANALYTICS for EMERGENCY MANAGEMENT

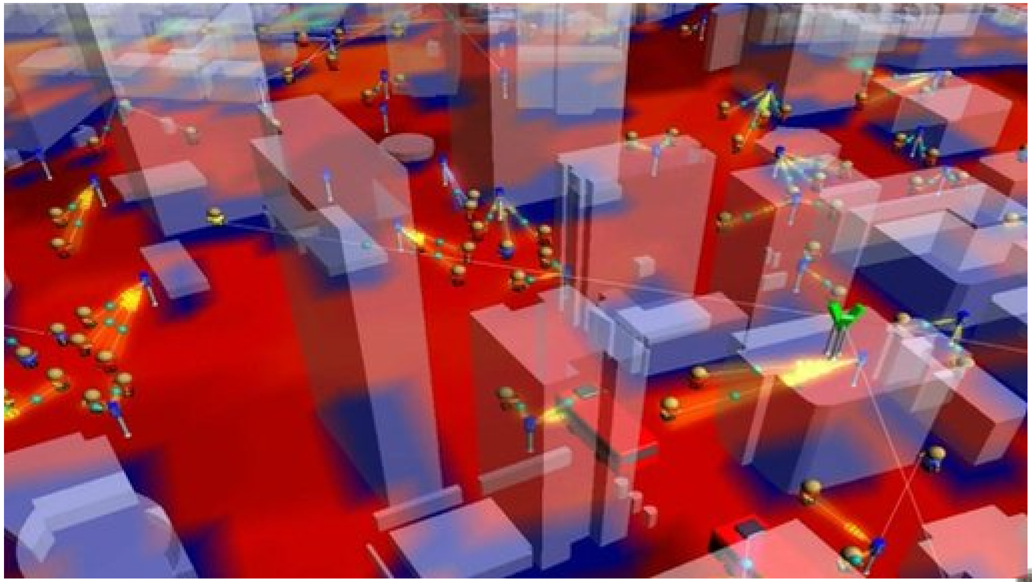


- Emergency vehicles need to get through (North-South)
- Significant traffic across (East-West)
- Each intersection is controlled by traffic lights
- Sensors are deployed on vertical streets
- Arbitrary number of controllers can be added, assigning them to sensors and lights and providing control algorithm.
- 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


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

More hurdles

Quintessential for Autonomy



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

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

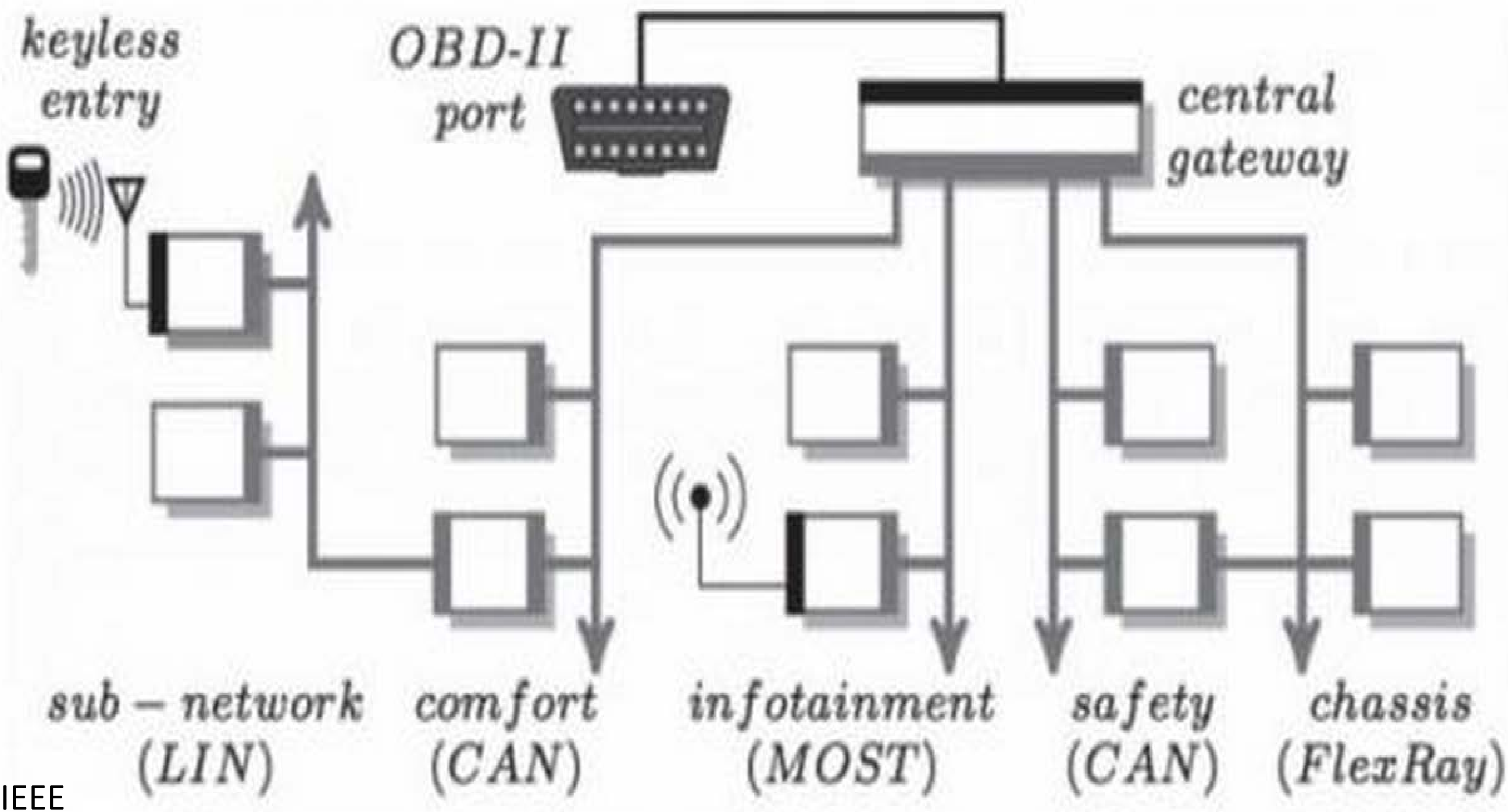
5G will be helpful when available

Ericsson's 5G Phone-on-Cart (2015) outperforms 4G phones in the market

Sara Mazur
VP, Ericsson

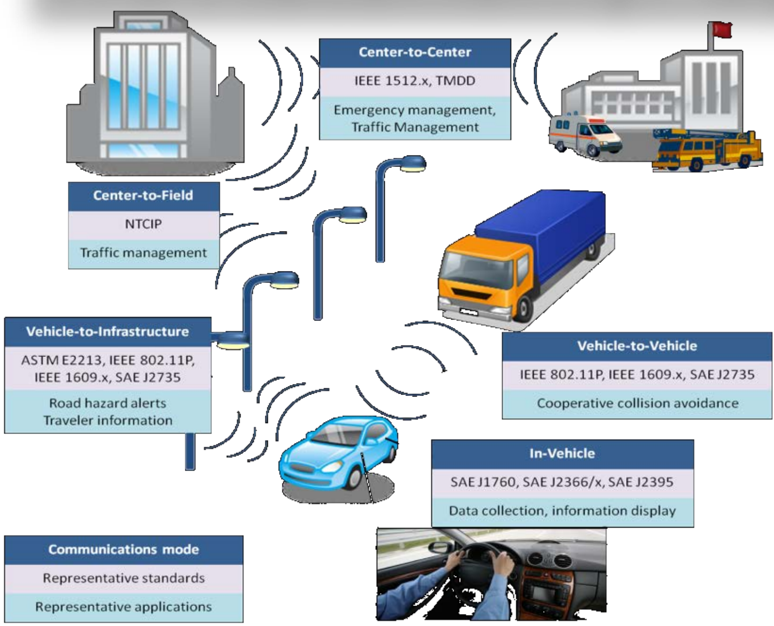
CURRENT SAFETY & SECURITY CONCERNS

in-vehicle mobile ethernet network

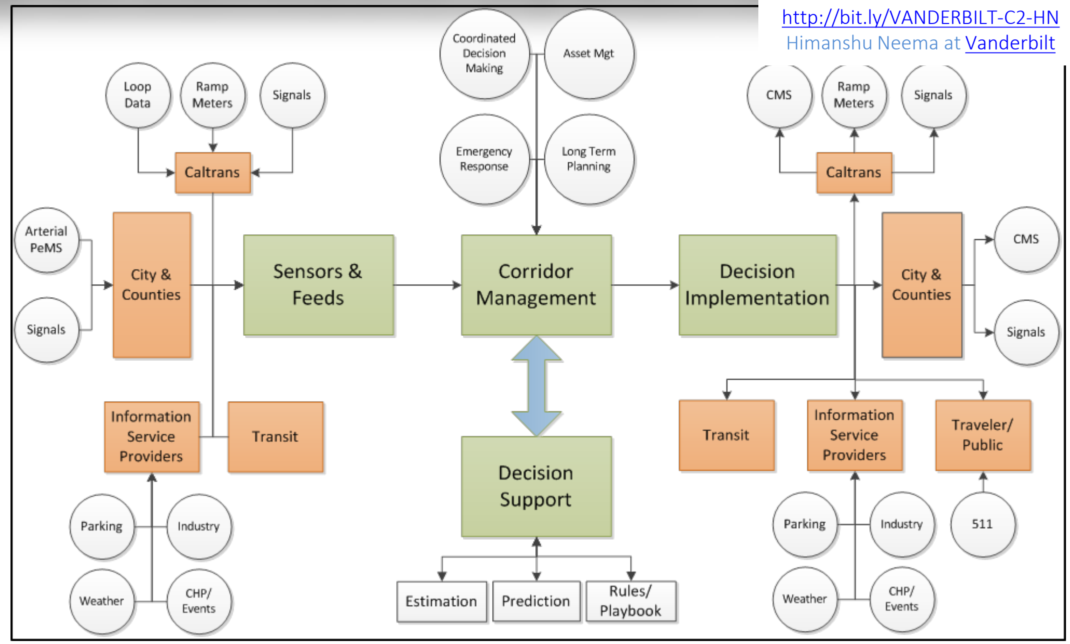


IEEE

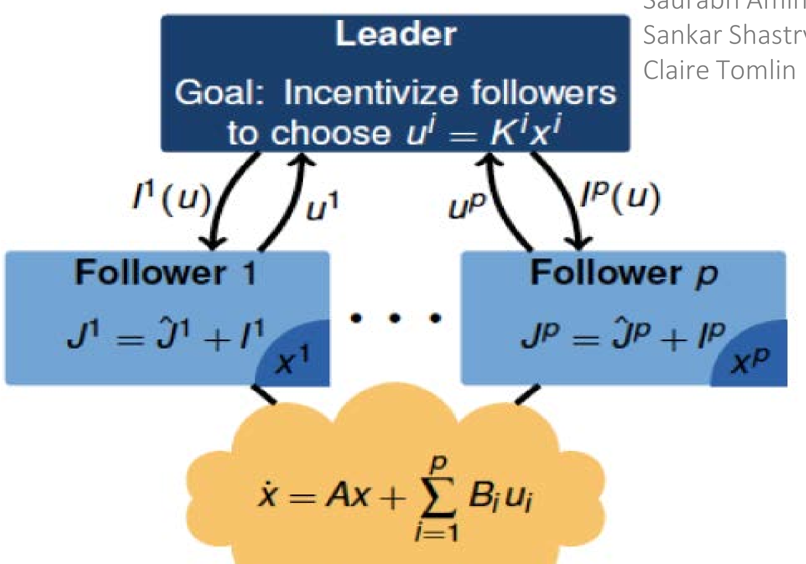
ITS Autonomy: Opportunistic cyber attacks?



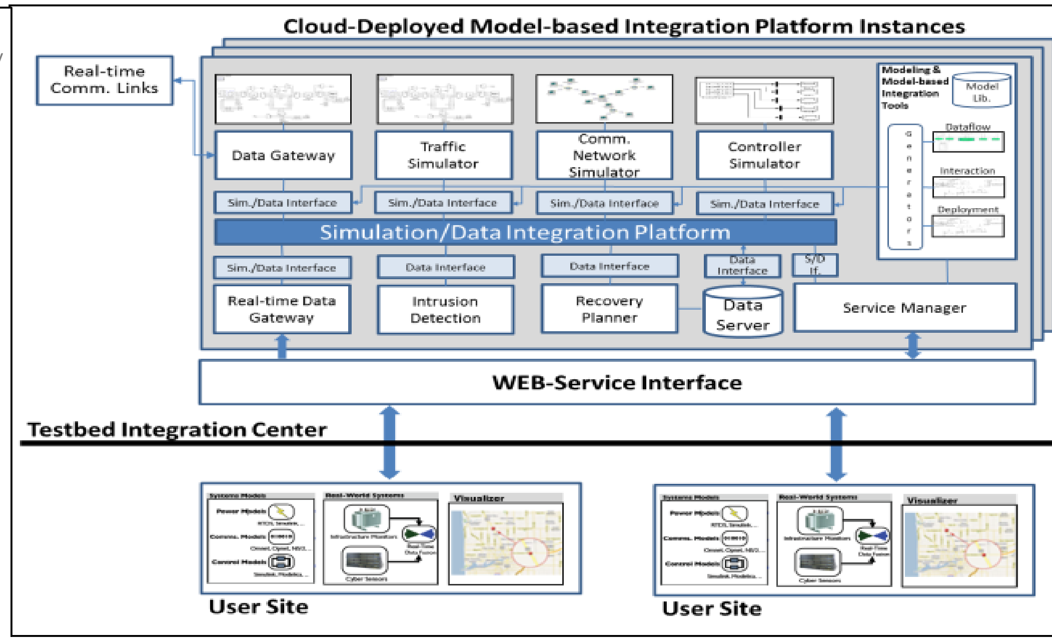
http://bit.ly/VANDERBILT-C2-HN
Himanshu Neema at Vanderbilt



Saurabh Amin
Sankar Shastry
Claire Tomlin



Game Theory in resilient control design - Stackelberg games

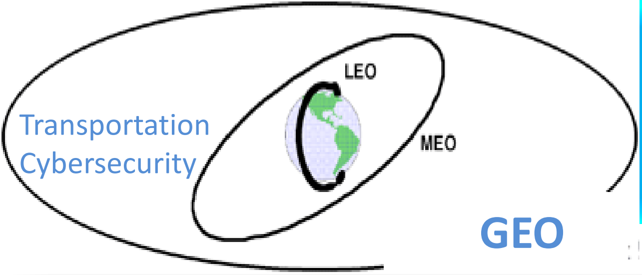


F6 Information Architecture

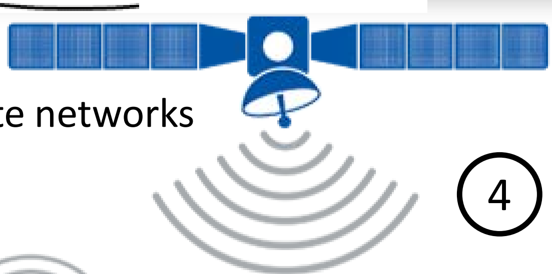
Abstraction applicable to intelligent transport?

GABOR KARSAI, Institute for Software Integrated Systems, Vanderbilt University

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



What happens if the network is disrupted?

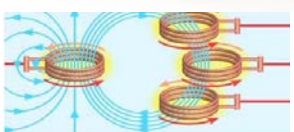


nano-satellite networks

3

4

2



1

5

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

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

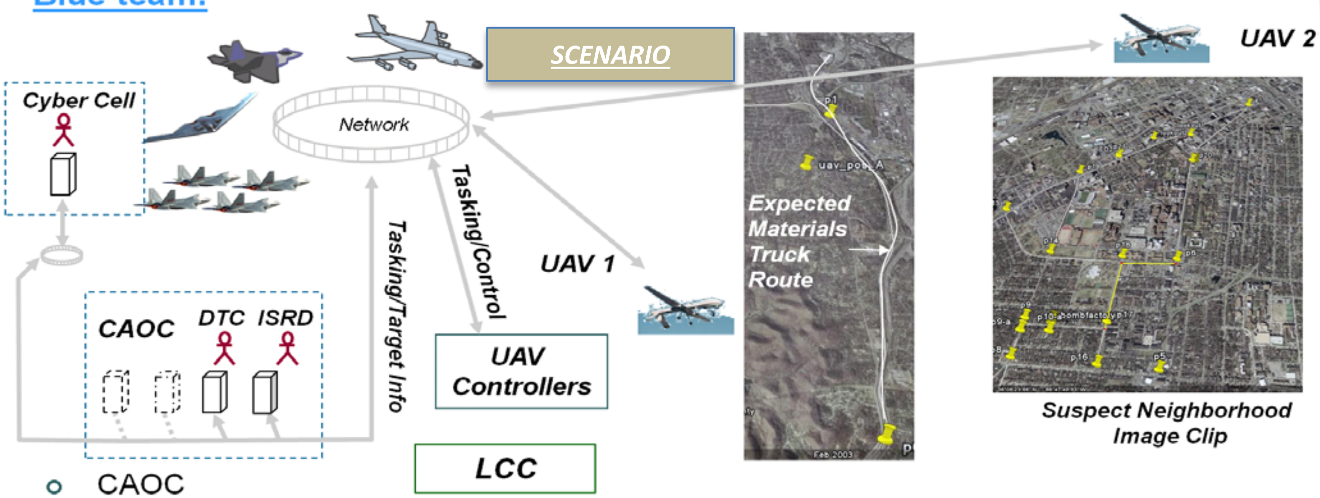
Truck installed Micro-Droneport

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:

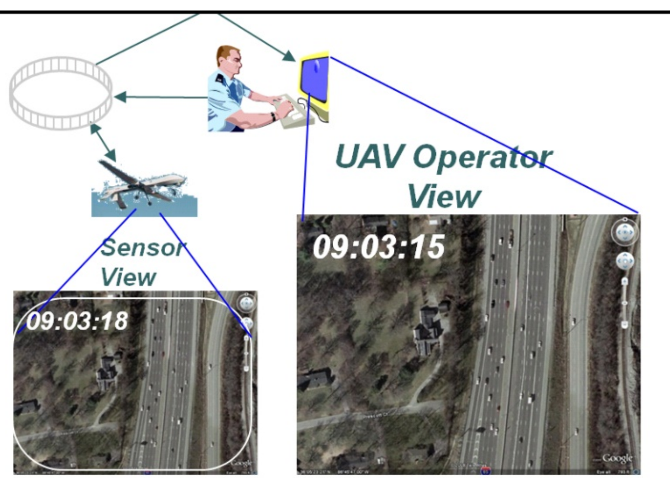


- CAOC
  - Commander
  - Dynamic Targeting Cell (DTC)
  - ISR Division (ISRD)
- Cyber Cell

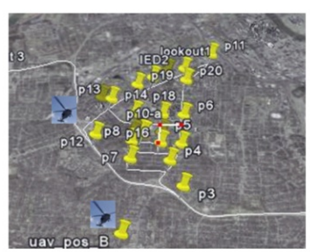
- **SIGINT**
- **UAV Operators/Controllers**
- **Land Component (LCC)**

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



Ground Truth

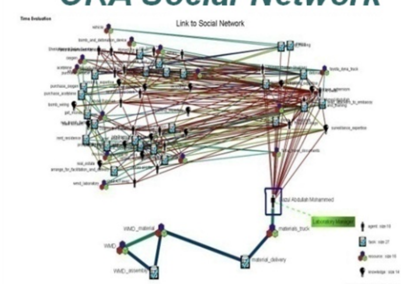


Key Events/Messages Blue's View

Cell Phone Intercept
UAV 1 Tracking Vehicle
UAV 1 locates building
….

isis.vanderbilt.edu
C2 by Himanshu Neema

ORA Social Network



Rapidly advancing disruptions

There may no longer exist spare parts inventory. It will not be necessary.

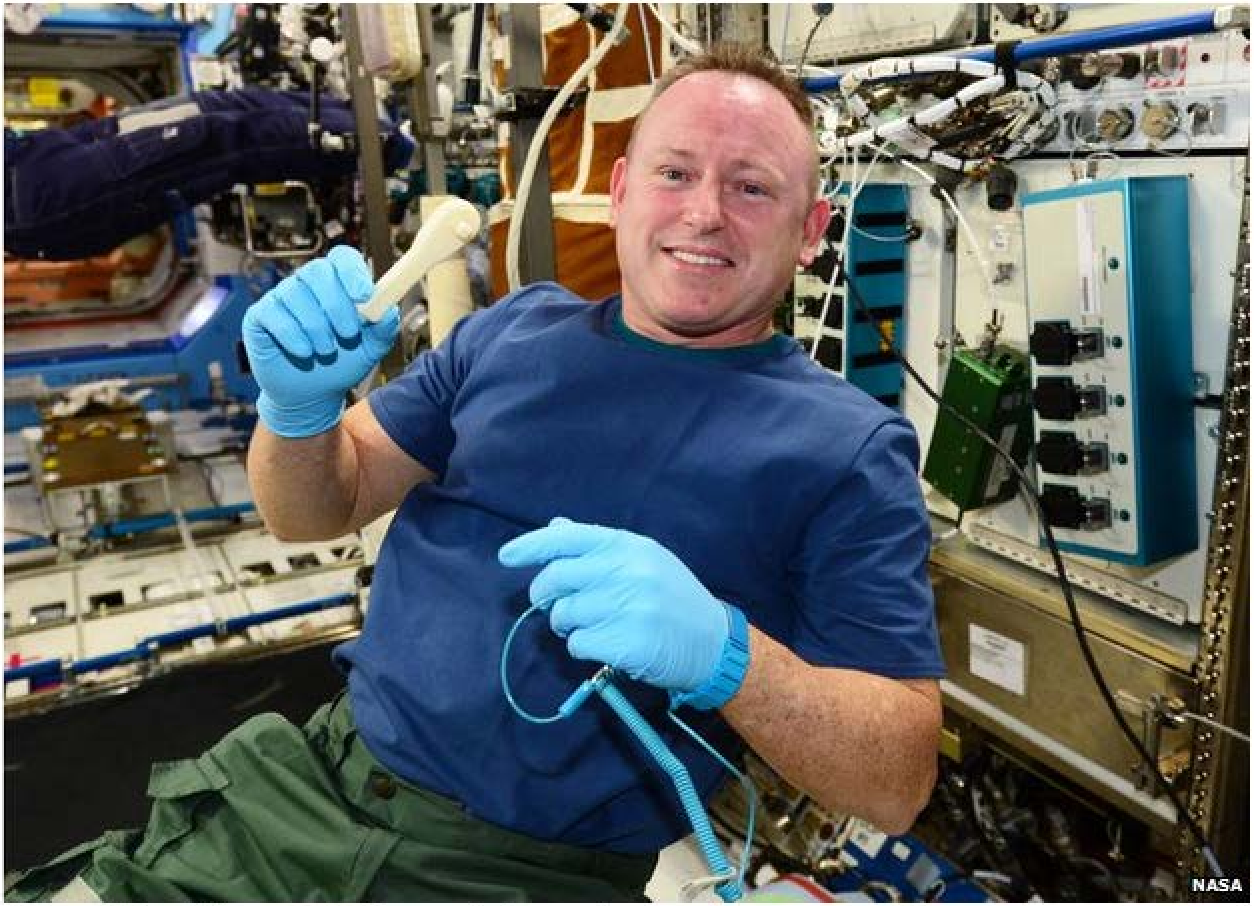
3D Printing ● It took about 30 years

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.

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.

3D

http://bit.ly/3D-JET-ENGINE

The FAA Cleared the First 3D Printed Part to Fly in Engine from GE

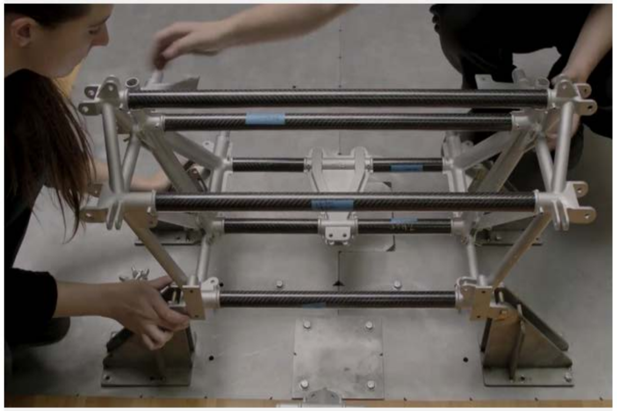
April 14, 2015

Jet Engines with 3D-Printed Parts Power Next-Gen Airbus Passenger Jet

May 19, 2015

World's First 3D Printed Supercar is Unveiled – 0-60 in 2.2 Seconds, 700 HP Motor – Built from Unique Node System http://bit.ly/3D-SUPERCAR-PLATFORM

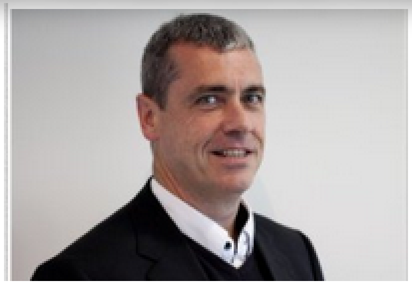
AUTOMOBILE PLATFORM



Assembling of the 3D printed nodes and carbon fiber tubing to construct the chassis

http://3dprint.com/74810/3d-printed-supercar-blade/

IoT – We've been doing this for a long time …
CIO, Williams Martini Racing (Formula 1)



Graeme K Hackland
IT Director at Williams F1 Team
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Previous	Lotus F1 Team, Benetton Formula Ltd, Effective Computer Solutions
Education	Technikon Natal

We've been doing this for a long time, instrumenting the car. We've got over 200 sensors, a 1000 channels of data, 30 to 40 people constantly reading that data over the course of the race weekend in order to improve performances and make sure that we are reliable and we get to the end of the race.

We have about 200 sensors on the car, and that's everything from brakes to tires, two fluid levels, fuel levels, heat, temperature in different parts of the car, engine sensors. All of which are capturing about 1000 channels of data.

On a Friday, we have two 90-minute practice sessions, that's probably where we generate the most data. We'll put more sensors in so that we can take that data back into the factory, run it in a simulator, run it in our vehicle science groups using the computer power that they've got.

www.zdnet.com/article/formula-1-racing-sensors-data-speed-and-the-internet-of-things/

Thank you

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