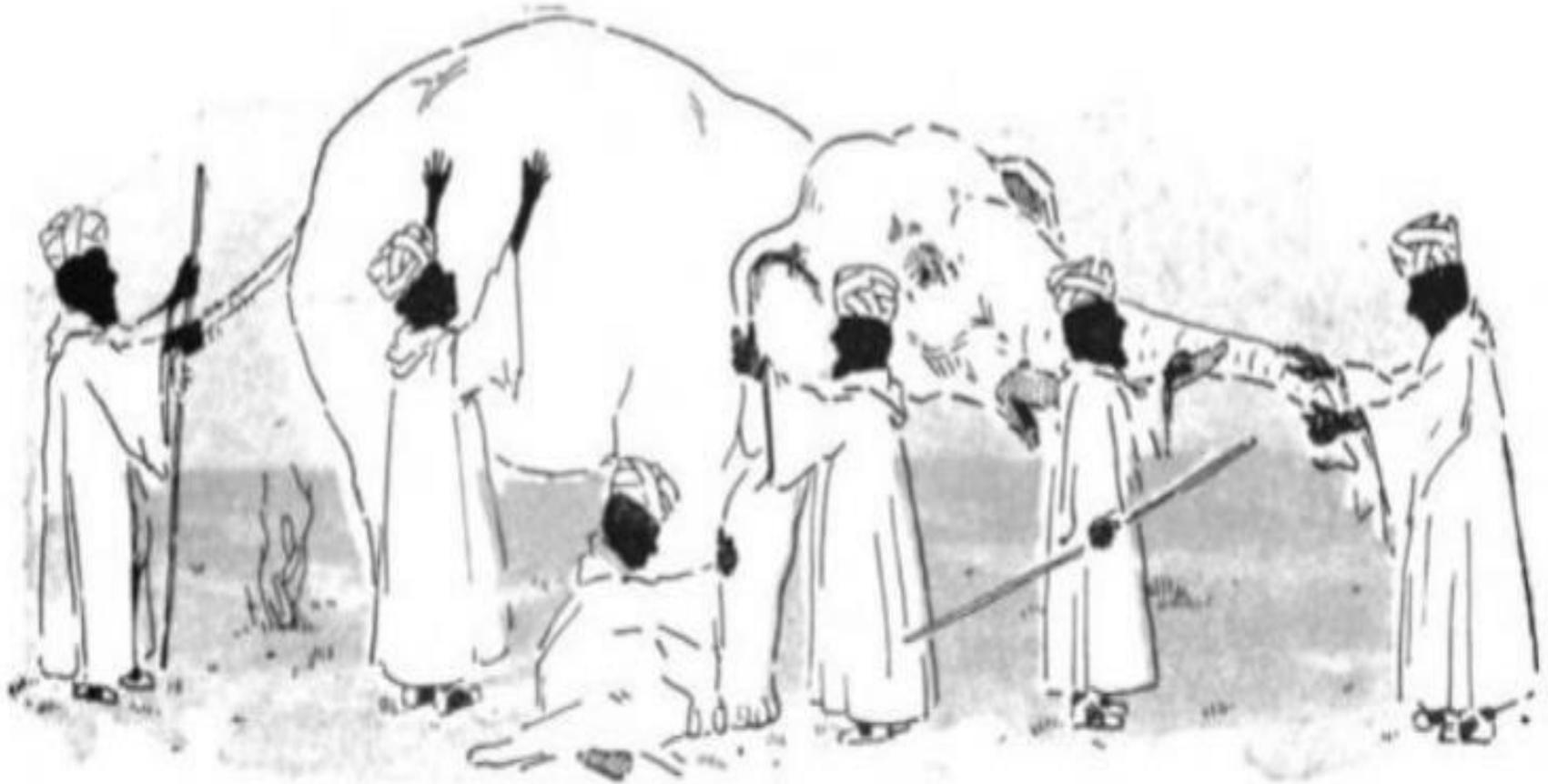


Blind men and an elephant

American poet John Godfrey Saxe (1816-1887) based this poem on a fable that was told in India many years ago.



Blind men and an elephant

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind

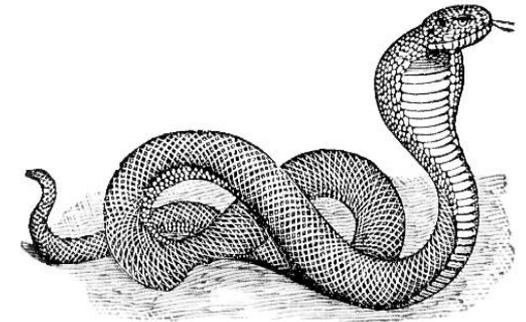
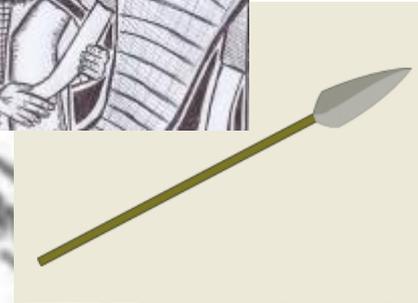
The First approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the Elephant
Is very like a wall!"



Blind men and an elephant

The Second, feeling of the tusk,
Cried, "Ho! what have we here
So very round and smooth and sharp?
To me 'tis mighty clear
This wonder of an Elephant
Is very like a spear!"

The Third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
"I see," quoth he, "the Elephant
Is very like a snake!"



Blind men and an elephant

The Fourth reached out an eager hand,
And felt about the knee.

"What most this wondrous beast is like
Is mighty plain," quoth he;

" 'Tis clear enough the Elephant
Is very like a tree!"

The Fifth, who chanced to touch the ear,
Said: "E'en the blindest man

Can tell what this resembles most;

Deny the fact who can
This marvel of an Elephant
Is very like a fan!"



Blind men and an elephant

The Sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the Elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!



The Traffic Management Center of the Future



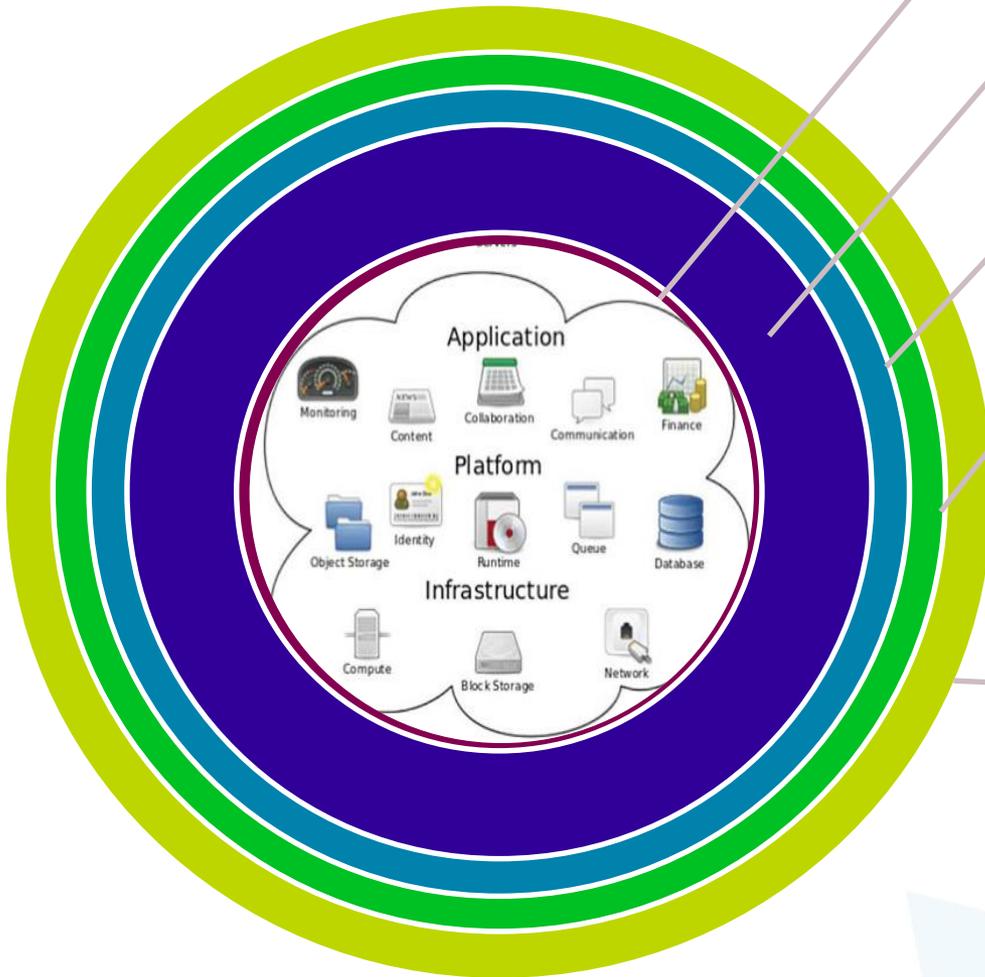
ITS like an Elephant



Software Development View



Applications, Platform, Infrastructure, Systems Engineering



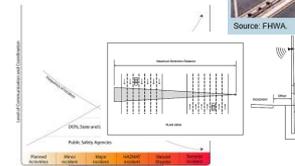
User - TMC



Network & Field Devices



Engineering



First responders



Civil Engineering View



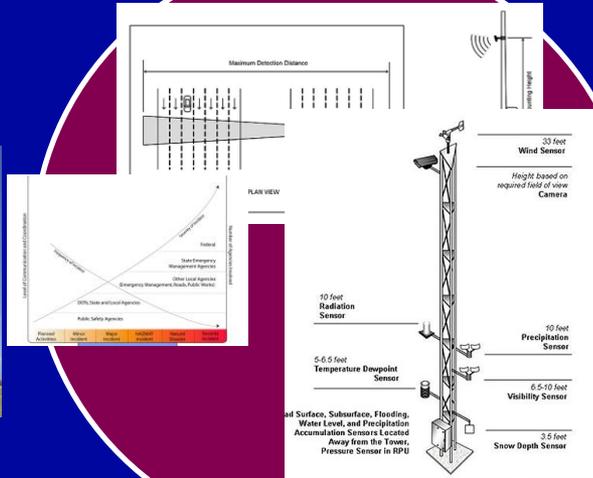
Plans/Design/Structure



Source: FHWA.



Figure 7. Radar Vehicle Detection Unit



Field Devices

Software/ Networks



TMC and First responders



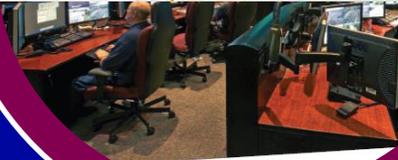
TMC Operations View



ATKINS

The Road Network

First Responders



Traffic Management Center
Georgia Department of Transportation



Source: FHWA

Field Devices
Software/
Networks



Plans, Design, Structure

First Responders View Safety, Liability



ATKINS



Other Stakeholders / TMC



Software / Networks /
Field Devices

Plan, Design, Structure

As we move into the future
One thing is certain
Perspective will change



The future ain't
what it used to be.

Yogi Berra

[@yogiberra](#)

TMC - There is a significant range of TMC operating environments in the United States.

- State DOT's or large urban/regional
- Highway Management



Highway



Arterial

- Local city or county
- Arterial management

What does a TMC Do??

Transportation Challenges



Safety

32,367 highway deaths in 2011
5.3 million crashes in 2011
Leading cause of death for ages 4, 11–27



Mobility

5.5 billion hours of travel delay
\$121 billion cost of urban congestion



Environment

2.9 billion gallons of wasted fuel
56 billion lbs of additional CO₂



TMC of Today

Traffic Engineering



Planned Event Management



Congestion Management

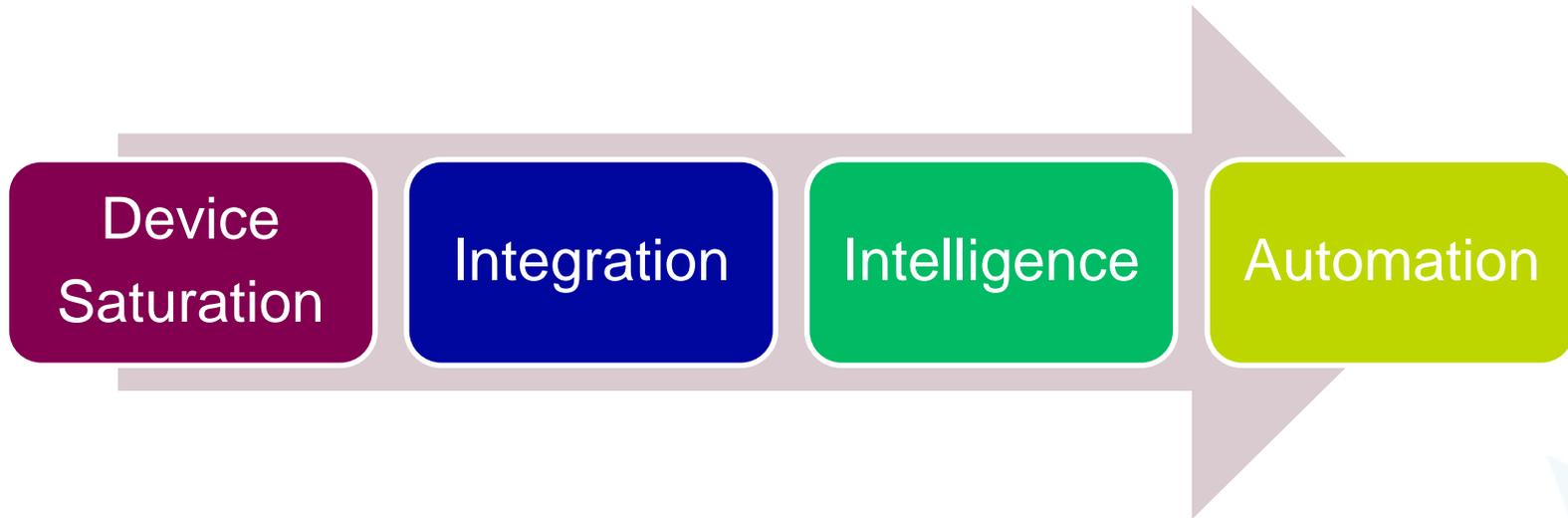


Un Planned Event Management



Emergency Management

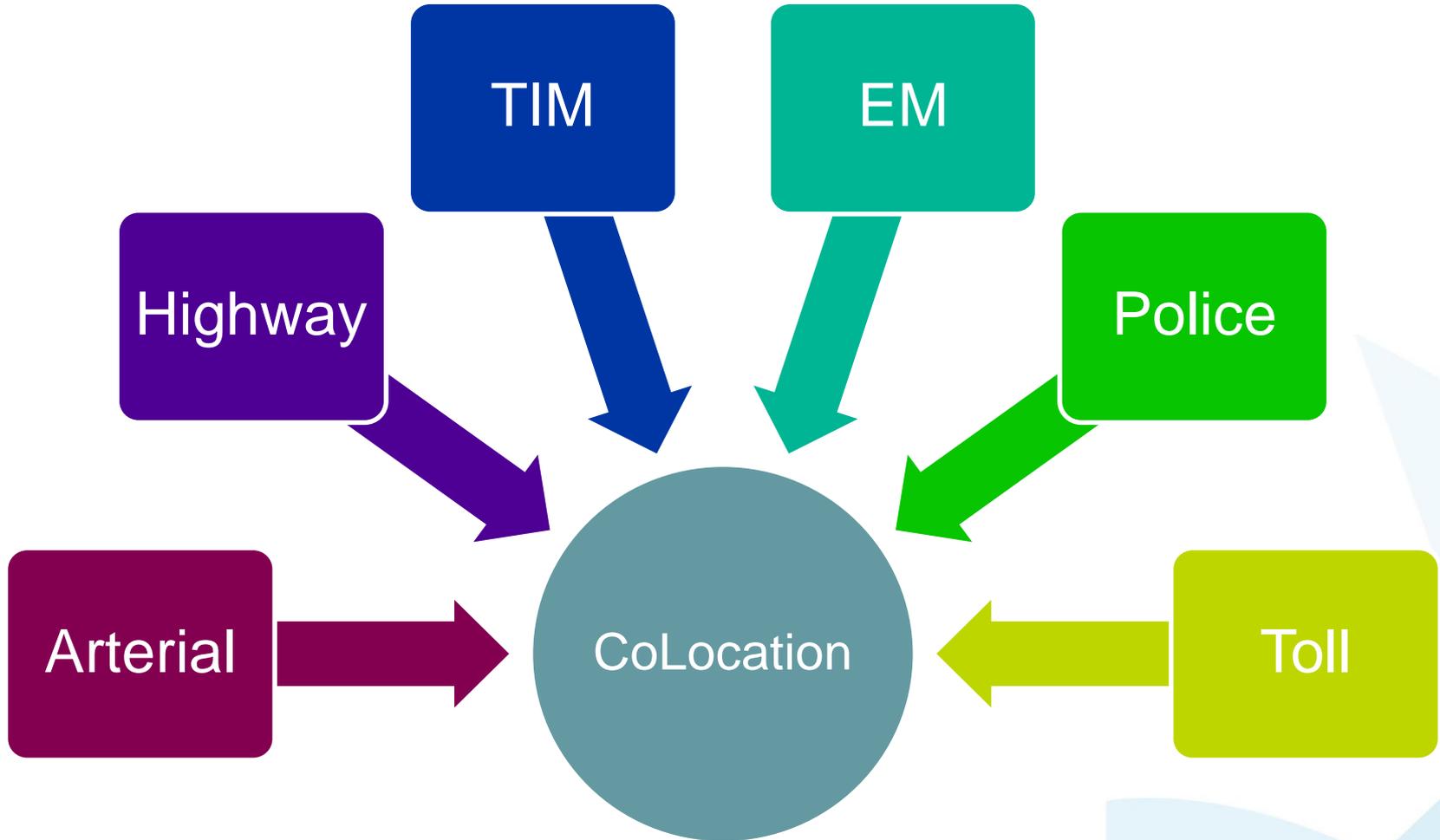
TMC of Today – Trends



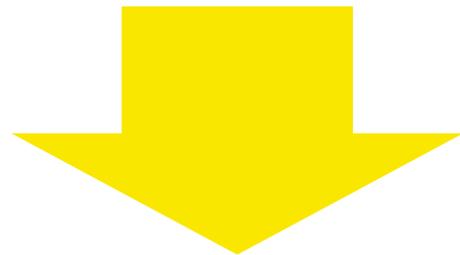
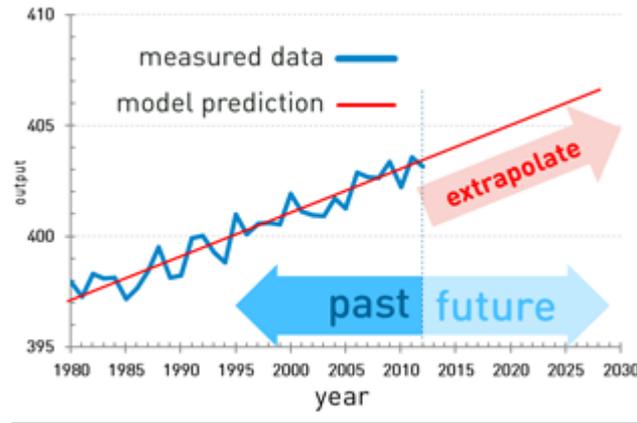
- Most TMC are not yet mature with the technology available today
 - Integrated ATMS vs. Silo Apps for CMS/DMS, CCTV, IM
 - Response Plans
 - Automated Travel Times
- Freeway Management/Arterial Management

TMC of Today – Trends

Integration - consolidation



TMC of Tomorrow – Trends



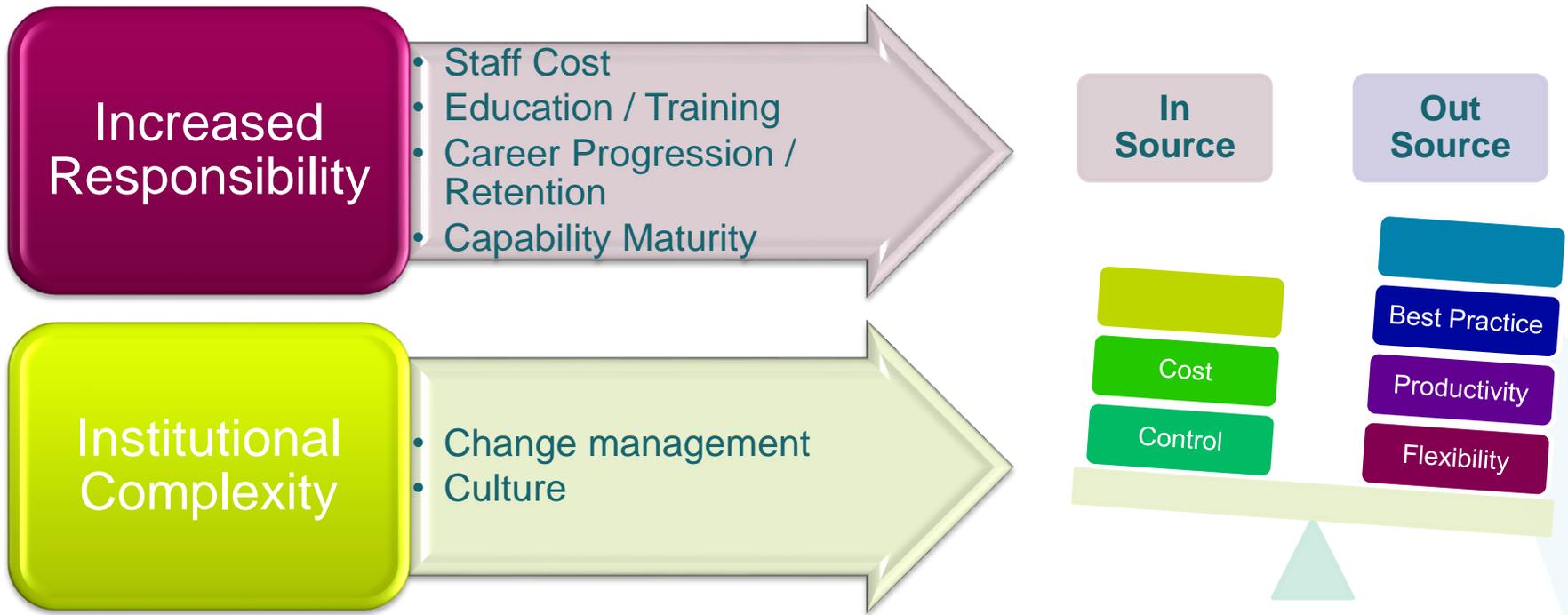
Proactive

- Predictive Analytics
- Active Traffic Management
- Variable Speeds
- Adaptive Signals
- Managed Lanes, HOV, HOT
- Traffic Calming
- Automated Enforcement

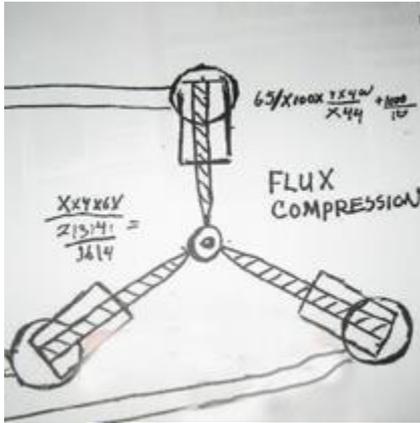
Reactive



TMC of tomorrow – Impact



The Future – things get exciting



It's tough to make predictions, especially about the future.

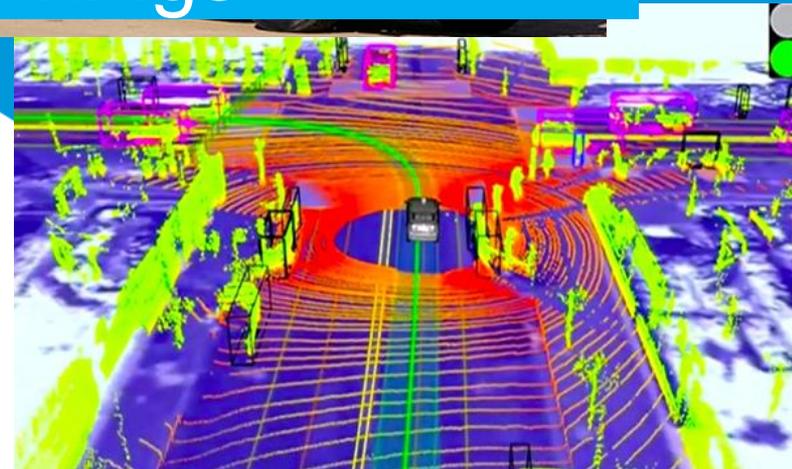
(Yogi Berra)



Connected Vehicle \neq Autonomous Vehicle



CAVConnected Automated Vehicle
IOT, Internet of Things



Driver attention^(a)



The Question is not **IF**
but when and how

Low Speed (mph)

High Speed (mph)^(b)



- NHTSA defines 4 levels of Vehicle Automation
 - Level 0 - None
 - Level 1 – Function-Specific Automation
 - Level 2 – Combined Function Automation
 - Level 3 - Limited Self Driving Automation
 - Level 4 – Full Self-Driving Automation

2002 - 2004



ATKINS

2005

ATKINS



2007 – DARPA Urban Challenge

The Six Finishers of the DARPA Urban Challenge



Tartan Racing – Pittsburgh, PA
1st Place



Stanford Racing – Stanford, CA
2nd Place



Victor Tango – Blacksburg, VA
3rd Place



MIT - Cambridge, MA



Ben Franklin Racing Team – Philadelphia, PA



Team Cornell – Ithaca, NY



2012

“The revolution, when it comes, will be engendered by the advent of autonomous or “self-driving” vehicles. And the timing may be sooner than you think.”



August 2012
the Connected Vehicle Safety Pilot Model Deployment Program will see some 3,000 vehicles hitting the road in Ann Arbor MI



AUTOMOTIVE

World's largest field test of connected vehicle technology gets underway in the U.S.

By Darren Quick
August 22, 2012

4 Comments
2 Pictures



Some 3,000 vehicles equipped with wireless technology that allows them to communicate have taken to the roads in the Ann Arbor in the world's biggest field test of V2V and V2I technology (Image: GM)

[Image Gallery \(2 images\)](#)

2013



GOOGLE - We expect to release the technology in the next five years

GM and CMU demo drive U.S. Rep. Bill Shuster



Michigan



Google's \$258 million investment

Public Act 231 into law
December 2013



Nissan, Mercedes Benz & GM promising autonomous car production by 2020 with Semi-autonomous offerings coming in the next several years



TESLA - We should be able to do 90 per cent of miles driven within three years

2014

ITS World Congress in Detroit

GM Mary Barra – 2017
Cadillac - Super Cruise
 and vehicle-to-vehicle (V2V)

Level 3 - Limited Self
 Driving Automation



A 2015 Cadillac CTS, equipped with V2V technology, notifies the driver of the approaching Cadillac SRX from the left before the driver could see the vehicle.

TESLA – 90 % of hwy miles
 next year



July 30, 2014:

NEWS >>

Government to allow driverless cars on UK roads



UK Business Secretary, Vince Cable has announced two new measures to give the green light for driverless cars to take to the country's roads from January 2015. UK cities can now bid for a share of a £10m (US\$16.9m) competition to host a driverless car trial. The government is calling on research organisations to put forward proposals to become a test location. Three cities will be selected to host the trials from January next year.

launched a review to look at the forefront of driverless car testing driverless cars in the country, as well as to place in other countries. Two



ed to last be...
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 K can remain...
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Feb 13, 2014:



NHTSAannounced today that it will begin taking steps to enable vehicle-to-vehicle (V2V) communication technology for light vehicles. This technology would improve safety by allowing vehicles to "talk" to each other and ultimately avoid many crashes altogether by exchanging basic safety data, such as speed and position, ten times per second.



700,000 Miles

Google



2015

Carnegie Mellon University



50 Billion Valuation

ATKINS

14 minor accidents over more than 1.8 million miles of testing.



self-driving car available to consumers 2020



Mercedes E Class - stick to its lane, drive itself through dark tunnels and make lane changes, at 80 mph

the governor of Arizona paved the way for the world's first driverless taxis on public roads



March 2015 – 90 % of hwy miles this year

Audi to 'race' autonomous RS 7 at Hockenheimring



Wikipedia 2016 to 2040

By 2016, Mercedes plans to introduce "Autobahn Pilot" aka Highway Pilot, the system allows hands-free highway driving with autonomous overtaking of other vehicles.^[91]

By 2016, [Mobileye](#) expects to release hands-free driving technology for highways.^[92]

By 2018, Elon Musk expects Tesla Motors to have developed mature serial production version of fully self-driving cars, where the driver can fall asleep. However, he expects they would be allowed only some years after that, due to regulatory issues.^[95]

By 2018, Mobileye expects autonomous capabilities for country roads and city traffic.^[96]

By 2018, Nissan anticipates to have a feature that can allow the vehicle manoeuvre its way on multi-lane highways.^[97]

By 2020, Volvo envisages having cars in which passengers would be immune from injuries.^[98] Volvo also claims vehicles will effectively be "crash free." ^[99]

By 2020, GM, Mercedes-Benz, Audi, Nissan, BMW, [Renault](#), Tesla and Google all expect to sell vehicles that can drive themselves at least part of the time.^{[64][100][101][102][103][104][105]}

By 2020, Google autonomous car project head's goal to have all outstanding problems with the autonomous car be resolved.^{[106][107]}

By 2024, [Jaguar](#) expects to release an autonomous car.^[108]

By 2025, Daimler and Ford expect autonomous vehicles on the market.^{[109][110]} Ford predicts it will have the first mass-market autonomous vehicle, but released no target date.^[111]

By 2025, most new GM vehicles will have automated driving functions as well as vehicle-to-vehicle communication technology.^[112]

By 2035, IHS Automotive report says will be the year most self-driving vehicles will be operated completely independently from a human occupant's control.^[113]

By 2035, Navigant Research forecasts that autonomous sales of will reach 95.4 million annually, representing 75% of all light-duty vehicle sales.^[114]

By **2040**, expert members of the Institute of Electrical and Electronics Engineers (**IEEE**) have estimated that up to **75% of all vehicles will be autonomous**.^[115]

Imagine in the not to distant future.....



You've got to be very careful if you don't know where you are going, because you might not get there.

"It's deja vu all over again."

I NEVER SAID
MOST OF THE THINGS
I SAID

IF YOU COME TO
A **FORK** IN THE ROAD
TAKE IT

Disruptive Innovation



Auto Manufacture and software developers are on a collision course

- Auto Manufacture (new product cycle measured in years)
- Software Developers (new product cycle measured in months or even weeks)
- Convergence -> Transportation provider



Mercedes-Benz



KABOOM

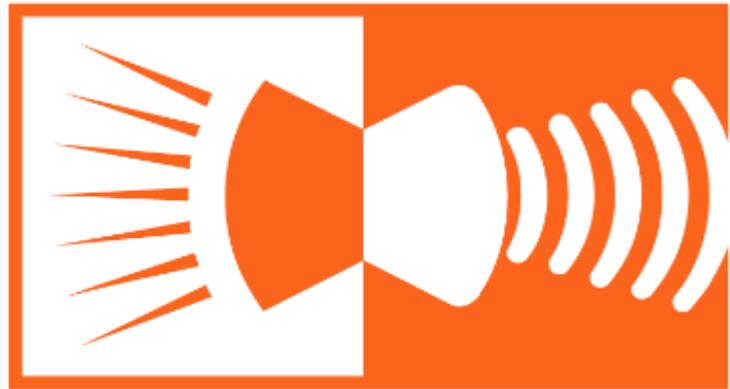


Google

some of the challenges and issues this future will bring



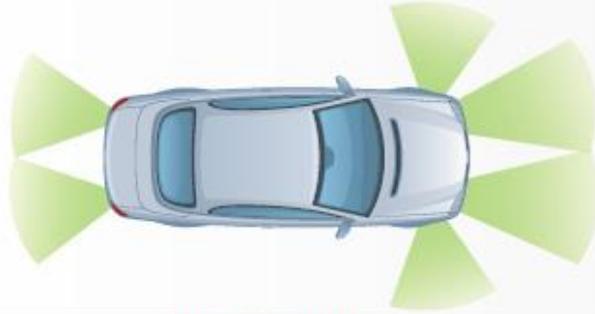
SYSTEM



CHECK

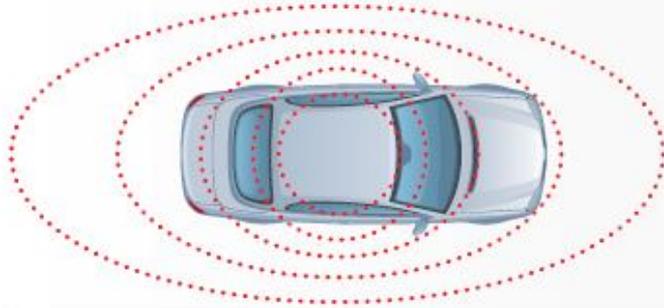
ATKIN

Transition will be Complex and Messy



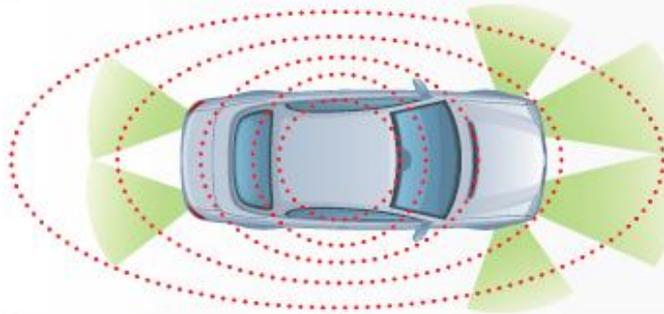
Sensor-Based Solution Only

- Cannot sufficiently mimic human senses
- Not cost-effective for mass market adoption
- Lack of adequate 360° mapping of environment in urban grids



Connected Vehicle Solution Only

- DSRC does not currently work with pedestrians, bicyclists, etc.
- DSRC-based V2I might require significant infrastructure investment
- V2V requires high market penetration to deliver value reliably



Converged Solution

- Convergence will facilitate adequate mimicking of human senses
- Convergence will reduce need for an expensive mix of sensors and reduce the need for blanket V2I investment
- Convergence will provide the necessary level of functional redundancy to ensure that the technology will work 100 percent of the time



Impact on the TMC of the future...

Traffic Management
(Signal)

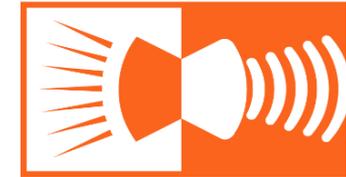


Planned Event
Management



Congestion
Management
System Monitoring

SYSTEM



CHECK

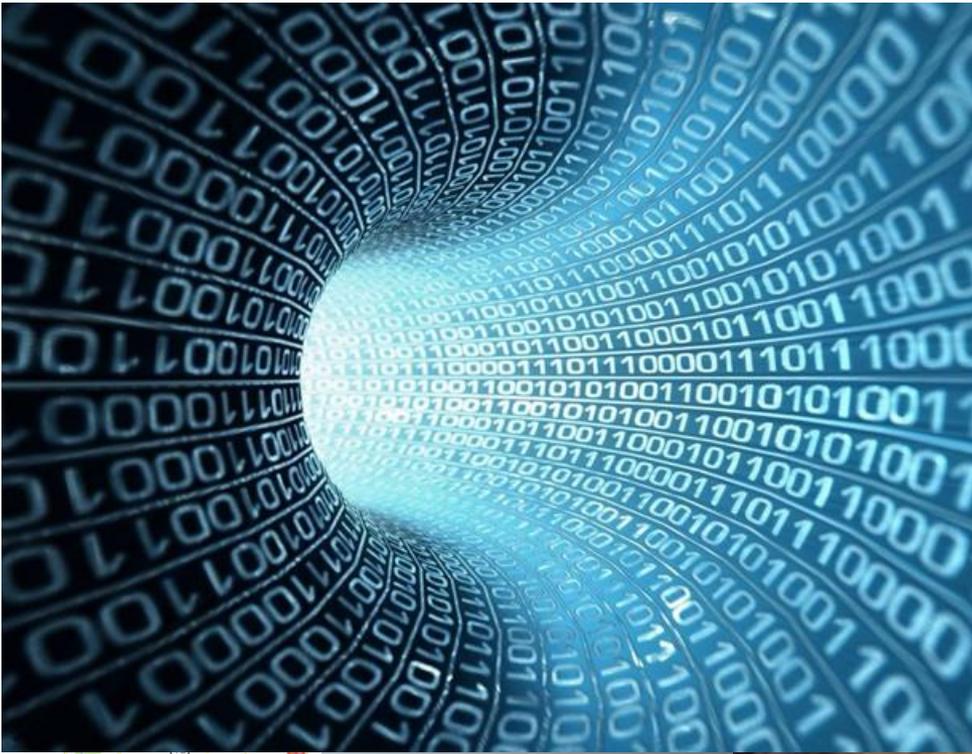


Un Planned Event
Management
CYBER Police



Emergency
Management





Public



For further notice, WisDOT recommends northbound I-43 southbound traffic can

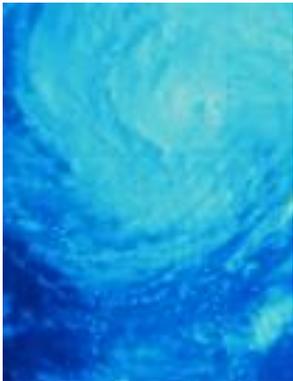
[View All](#)

[Low Bandwidth](#)



PPP & Toll

Keeper of the Kill Button?



M 4 The WEST Reading Slough
London (W & C) Heathrow (Terminals 1, 2 & 3) M 4
(M40, M1, M11) Oxford, Watford, Stansted M 25

he revolution is coming....

and it may be sooner than you think

"The future ain't what it used to be"
- Yogi Berra



- Today, a report from ReportsnReports revealed that the connected car services market will be worth \$40 billion by 2020, driven by a host of applications, including infotainment, navigation, fleet management, remote diagnostics, automatic crash notification, enhanced safety, UBI (Usage Based Insurance), traffic management and autonomous driving.
- **Governor McAuliffe Announces New Partnership to Make Virginia a Leader in Automated-Vehicle Industry**
- **Virginia opens up 70 miles of highway for driverless car testing**
- The Virginia Department of Transportation and the Department of Motor Vehicles have entered into a new partnership with the Virginia Tech Transportation Institute, Transurban and HERE—Nokia's mapping business—to create the Virginia Automated Corridors. The new initiative will streamline the use of Virginia roads and state-of-the-art test facilities for automated-vehicle testing, certification, and migration towards deployment.
- <https://governor.virginia.gov/newsroom/newsarticle?articleId=8526>
- **Apple is building self-driving electric car**
- <http://www.theguardian.com/technology/2015/aug/14/apple-self-driving-car-project-titan-sooner-than-expected>



- Rule for DSRC – 5.9 GHZ – must be completed by Jan 2017
- Feb 2015 proposed rulemaking came out
- Expect rule language to come out for comment this year

BMW considers future in the face of driverless cars



BMW is re-evaluating its products, design and business models in order to stay competitive in a future where completely driverless cars could change the automotive market, said BMW board member Peter Schwarzenbauer. "New mobility concepts will emerge with autonomous vehicles, which are robot cars. Fleet management will become a much more significant business," he said. [Reuters](#) (9/16)