DAIMLERCHRYSLER

Research and Technology North America, Inc.

Vehicle Infrastructure Integration

Caltrans Research Connection

October 5th, 2005

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Who is DaimlerChrysler?

Mercedes Car Group

MAYBACH

Mercedes-Benz

smart

Chrysler Group

DODGE

CHRYSLER

Jeep

Commercial Vehicles Division

SETRA

Mercedes-Benz

FREIGHTLINER

STERLING TRUCKS

WESTERN STAR TRUCKS

FUSO

DaimlerChrysler Services

DaimlerChrysler Services

DaimlerChrysler Bank

Strategic Partners

MITSUBISHI MOTORS

DC Research

2,200 people worldwide

DaimlerChrysler Research & Technology North America Inc.

Works within DC Research, reporting directly to the Board of Management

- DC RTNA in Palo Alto, California is located in the heart of Silicon Valley. Its mission is to build on the innovative scientific community, technology and business environment of Silicon Valley to have a positive impact on DaimlerChrysler products, services and processes.

- DC RTNA in Portland, Oregon is co-located at the Freightliner Group headquarters with the charter to conduct research and develop technologies that are of direct value to the DaimlerChrysler commercial vehicle and other North American business units.

- DC RTNA is a member of The California Fuel Cell Partnership, in West Sacramento, California. The Sacramento location serves as a testing ground to advance fuel cell technology in DaimlerChrysler vehicles, both in North America and worldwide.

Why am I here?

Safety. Safety. Safety.

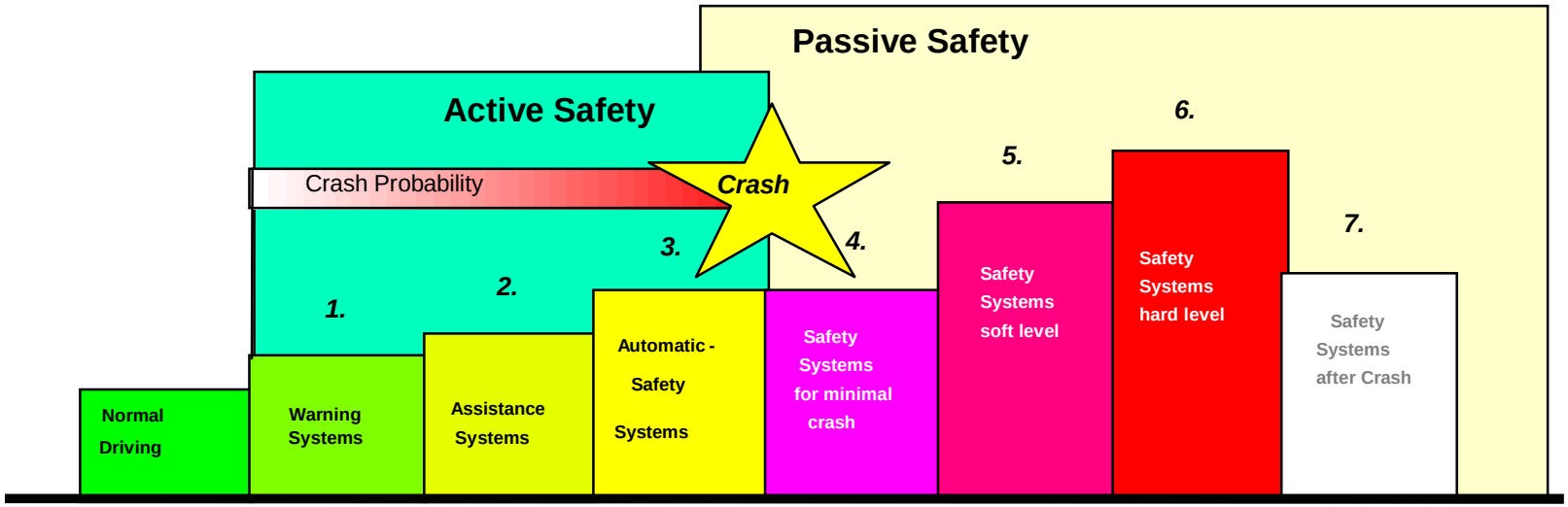
Active Safety Prevents crashes rather than mitigating damage

Knowledge about other vehicles and the roadway is the critical element of active safety

For many safety applications, communications is the best way to distribute this information

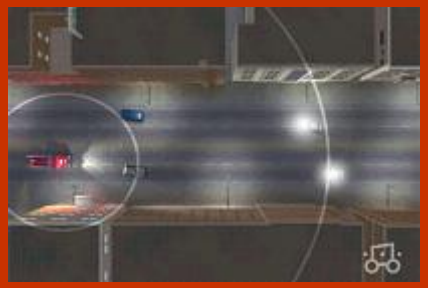
Communications requires cooperation

We need to cooperate… and VII may provide the business model.



Benefits of Cooperation

Safety Statistics (US)	All accidents (2003)
Fatalities	42,643
Injuries	2,889,000
Accidents	6,328,000
Cost	$230 Billion



Emergency Vehicle Warning

Inter-vehicle Hazard Warning

Intersection Collision Avoidance

Intersection Safety

A major safety opportunity

With a cooperative approach we

- address a major safety problem early on (violation related accidents)
- …and expand to address all intersection crashes (eventually).
- Relatively easy topology- single vehicle, limited infrastructure.
- Low cost and no new technology required
- Relatively direct test of our ability to cooperate.
- Has significant 'beyond safety' expansion capability.

Intersection Related Accidents

Intersection Statistics (US)	Violation related	All accidents
Fatalities	2,300	9,500
Injuries	240,000	1,300,000
Accidents	316,000	2,600,000
Cost	$19 Billion	$100 Billion

Vehicle Approach

- Vision system 'reads' traffic light.
- Spatial database help vision system find signal heads

Works well most of the time, but problems in the same places people have problems

- Bad lighting
- Lights obscured or lots of clutter

Navigation PC tells vision system where to look

Jeep Liberty Test Vehicle

Vision System recognizes traffic lights

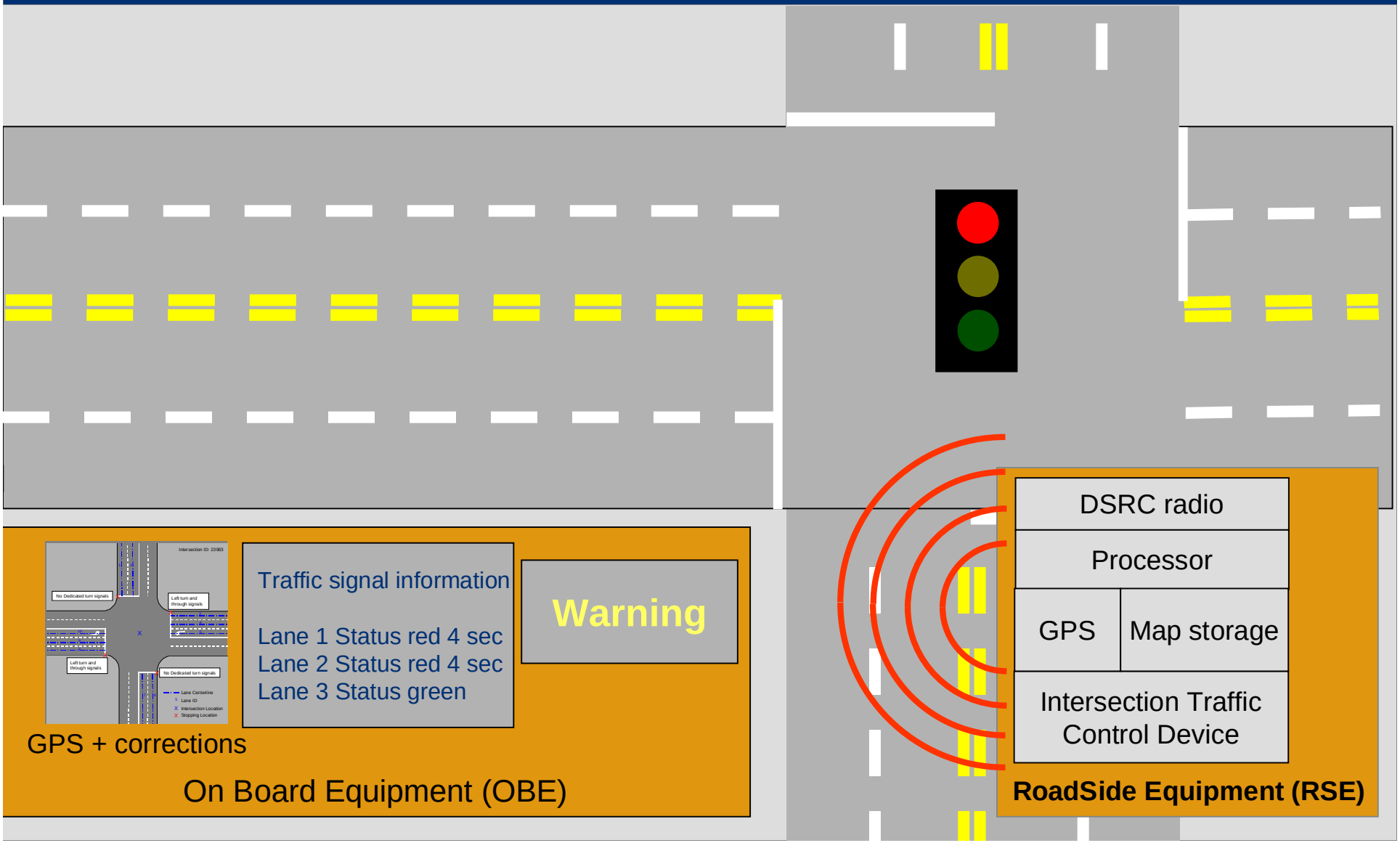
Infrastructure Approach

Heavily instrumented intersections

- Driver interface is difficult
- Benefit ‘out of the box’

Suitable for problem intersections, but probably doesn’t scale.

Cooperative Approach



Cooperative Intersection Collision Avoidance System Partners

In planning stages for a year, expected to start soon

5 year project with FOT in 2007

U.S. Department of Transportation
Federal Highway Administration

NHTSA
People Saving People
www.nhtsa.dot.gov

FMCSA
Federal Motor Carrier Safety Administration

FTA

the VOLPE center

Caltrans

VDOT

MDOT Department of Transportation

GM

Ford

DAIMLERCHRYSLER
DaimlerChrysler Research and Technology North America, Inc.

TOYOTA
TOYOTA TECHNICAL CENTER, USA, INC.

NISSAN

BMW

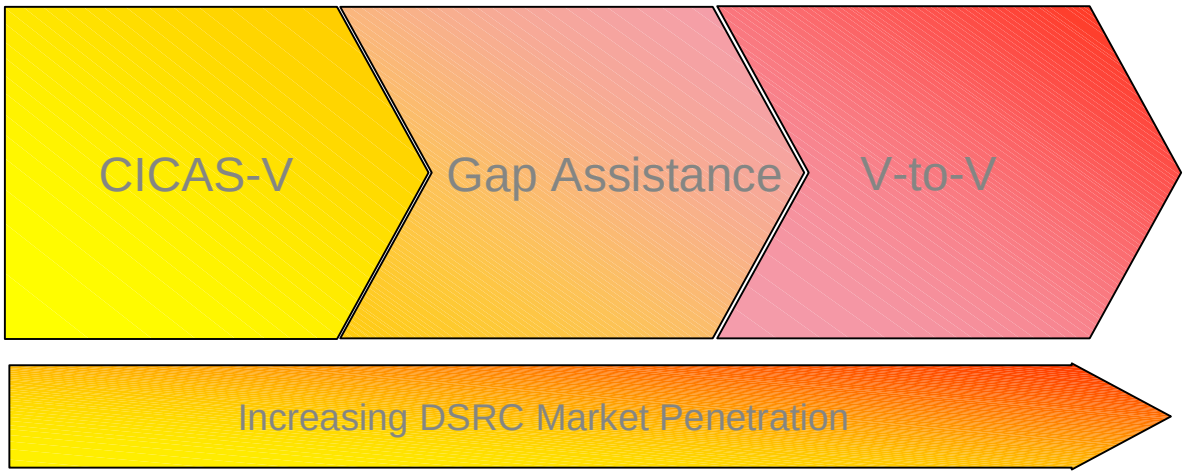
Virginia Tech

Progression of CICAS systems

First: traffic signal and stop sign violation warning

Then: infrastructure assisted gap assistance

Later: Comprehensive Vehicle-to-Vehicle communication based intersection collision avoidance systems (very high DSRC market penetration



More DSRC-based Safety Applications

Between Vehicles:

- Approaching Emergency Vehicle Warning
- Blind Spot Warning
- Cooperative Adaptive Cruise Control
- Cooperative Collision Warning
- Cooperative Forward Collision Warning
- Emergency Electronic Brake Lights
- Highway Merge Assistant
- Lane Change Warning
- Post-Crash Warning
- Pre-Crash Sensing
- Vehicle-Based Road Condition Warning
- Vehicle-to-Vehicle Road Feature Notification
- Visibility Enhancer
- Wrong Way Driver Warning

CAMP
Vehicle Safety Communications Consortium
DAIMLERCHRYSLER Research and Technology North America, Inc. | GM | TOYOTA | NISSAN | VW | Ford | BMW
IVI Light Vehicle Enabling Research Program

Between Vehicles and Infrastructure:

- Blind Merge Warning
- Curve Speed Warning
- Emergency Vehicle Signal Preemption
- Highway/Rail Collision Warning
- Intersection Collision Warning
- In-Vehicle Amber Alert
- In-Vehicle Signage
- Just-In-Time Repair Notification
- Left Turn Assistant
- Low Bridge Warning
- Low Parking Structure Warning
- Pedestrian Crossing Information at Intersection
- Road Condition Warning
- Safety Recall Notice
- SOS Services
- Stop Sign Movement Assistance
- Stop Sign Violation Warning
- Traffic Signal Violation Warning
- Work Zone Warning

So what? Lets be realistic here.

Technically- practical

Financially- realistic

BUT…

Not deployable

Car companies have to make a profit- and this will be difficult to get customers to pay for.

DOTs have enough problems to fix today without sinking money into some future fantasy

How do we ensure our investment doesn't go to waste if you screw up!

Car companies and DOTs have never cooperated on a national project of this scope- why now?

Vehicle Infrastructure Integration (VII) tries to address these questions.

How do we make it in our self interests to cooperate?

What else can we do with this communications link?

Probe Data Applications

Probe data is data anonymously collected from existing sensors on vehicles driven for mundane purposes

- Location, speed, direction (GPS)
- Weather (wipers)
- Potholes (suspension)
- Incident detection
- Low friction detection
- Hard braking events (ABS, ESP)
- Occupancy
- Origin/Destination data
- Snowplow deployments
- Location of traffic controls
- Precise mapping
- Fleet management
- Queue management
- Electronic tolling
- Evacuations/ emergency response

Direct benefits to DOTs

New and reliable data source that directly measures system performance

Ability to perform real time system-wide and local optimization

Good planning data

Standardized mechanism for electronic tolling

Mechanism to send data into vehicles

…All for the cost of a RoadSide Unit (RSU),

Plus…

Institutions to optimize transportation system (vehicle-roadways)

But you need to know…

What's it going to cost each DOT?

Jurisdiction and responsibility issues?

What will you get? (and how much control do you have over this in the future?)

Commitment by vehicle manufacturers to install

- Number of vehicles
- Types of applications

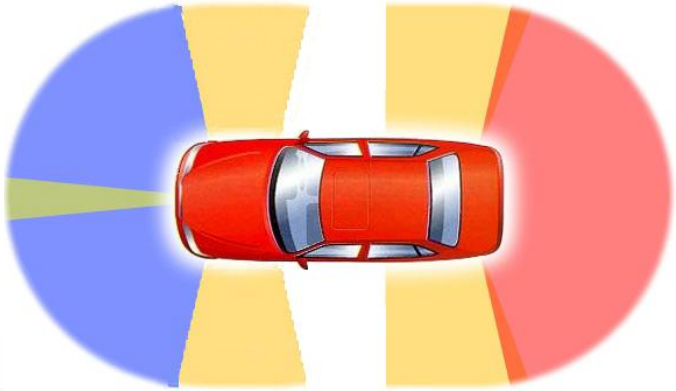
How reliable are these commitments?

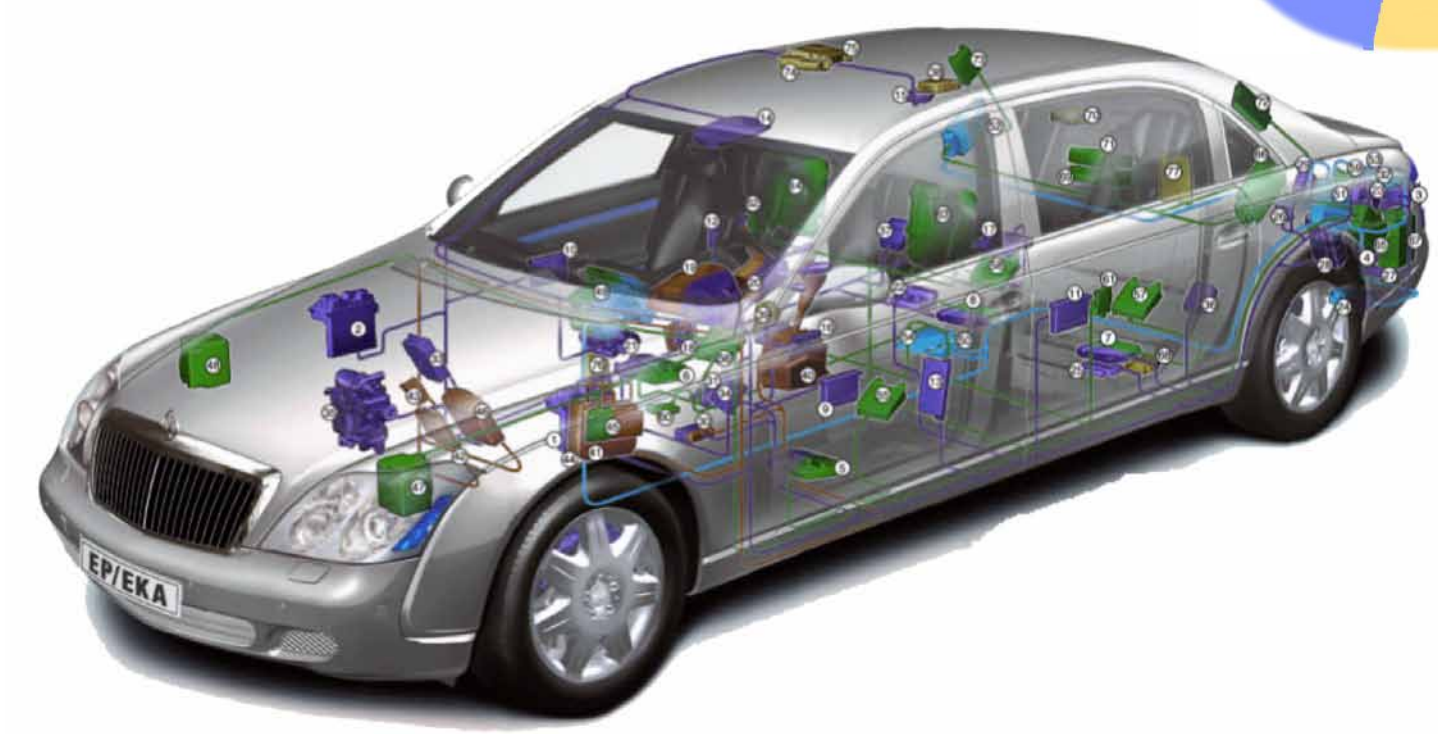
- Can you count on this in 2030?
- Who is making these commitments?
  - Automotive industry?
  - Individual companies?
  - Federal government?
  - Communications provider?

And What About the Vehicle Manufacturers?

Today's cars…

- Dozens of computers
- 100s of sensors





Radars

Vision systems

Active suspensions

GPS

Communications

Software is of ever increasing importance

Software & new technology bring a new level of intelligence into vehicles.

But-

- Incredibly complex interactions
- Software QA is difficult
- Update is expensive
- 'Build & forget' is not working

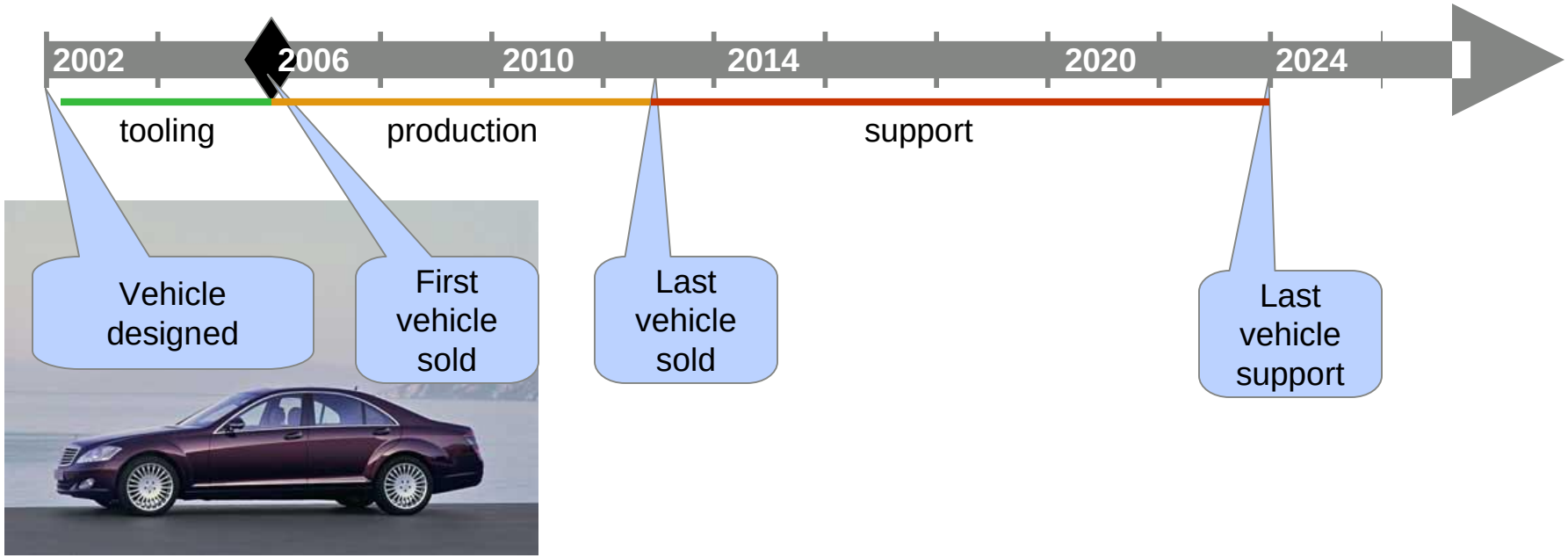
Technology Synchronization Problem

Vehicle lifetime (cradle to crusher) is about 22 years

Consumer electronics have lifetimes of 18 months

Communications technologies change every 2-3 years

First Cellular-phone network went operational 22 years ago!



OEM/commercial 'Mobility' Applications

Diagnostics
- Engineering
- Service
- Warranty
- Emissions

Remote reflashing (software updates)
- Assembly line
- Dealers
- In the field

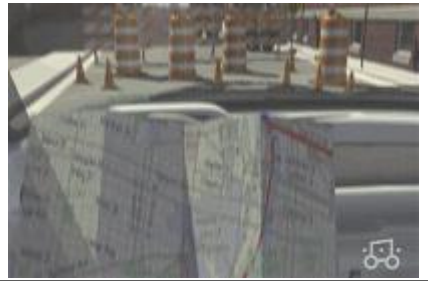
Customer/Vehicle relationship management

Traveler Information
- Traffic, congestion, etc
- Points of interest

Data updates
- Digital maps
- Local advisories
- Entertainment media
- Local interest

Fleet management
- Commercial
- Family

Electronic Funds transfers
- Tolling
- Parking
- Drive through



Timeline- Application stability

Diagnostics- engineering

Diagnostics- warranty

Reflash

Vehicle Relationship Management

Traveler Information

Data Updates

Safety

2002 2006 2010 2014 2020 2024

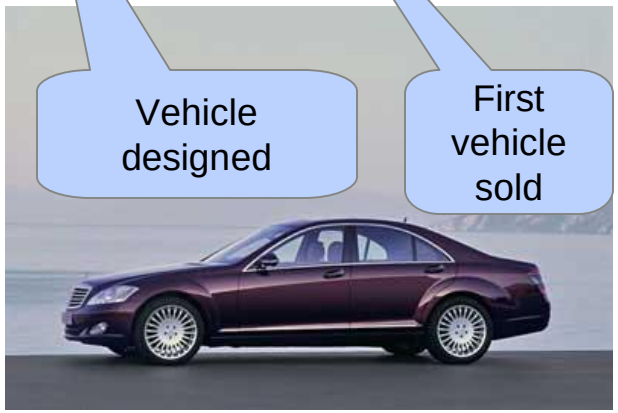
tooling production support

Vehicle designed

First vehicle sold

Last vehicle sold

Last vehicle support



Guarantee of Connectivity for Vehicle Manufacturers

Connectivity:

- Communications to/from vehicle with specified parameters
  - bandwidth/data volume per vehicle
  - connection frequency/ RSU distribution
  - Availability- nationwide!

Attributes

- Lifetime of vehicle
- Quality of Service
- Known cost

Guarantee of public services for our customers

Service Type (e.g.):

- Safety
  - Signal violation warning
  - Fog warning
- Information
  - Speed limit
  - Work zone warning
  - Map data
- Traffic information

Features

- Nationwide
- Frequent access
- Availability by date certain
- Long-term commitment
- Potential for future expansion
  - More services
  - More RSUs

Protection for our customers and our investment

Assurances that our customers interests will be protected

- Privacy
- Security of data network and collection
- Defined uses for system (e.g. no enforcement!)
- Fee structures

Understanding how our investment will be protected

- Changes to agreements
- Extensions to agreements
- Cost is important, but predictability is paramount

Opportunity

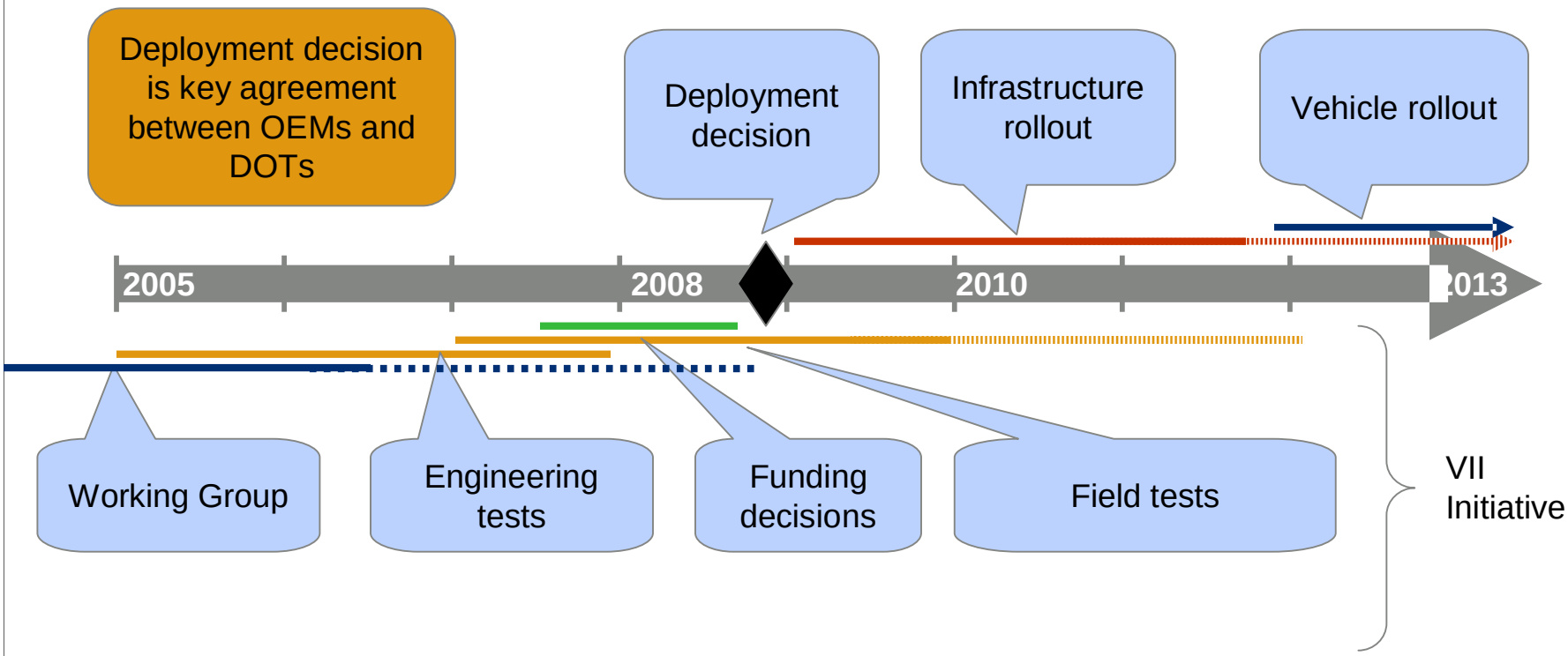
We know that we don't know what people will want

We believe there is a need out there

Vehicle Infrastructure Integration

The Vehicle Infrastructure Integration (VII) initiative is a public-private effort to investigate the feasibility of a nationwide deployment of vehicle-to-vehicle and vehicle-to-infrastructure DSRC based communication with the primary goal of enhancing road safety and improving mobility and convenience.

Timeline



National rollout of communications infrastructure followed by rollout in vehicles

Committed applications, committed dates, committed organization

Infrastructure rollout may be by private contractors with federal funds on your roads

Who's involved?

Federal DOT (FHWA)

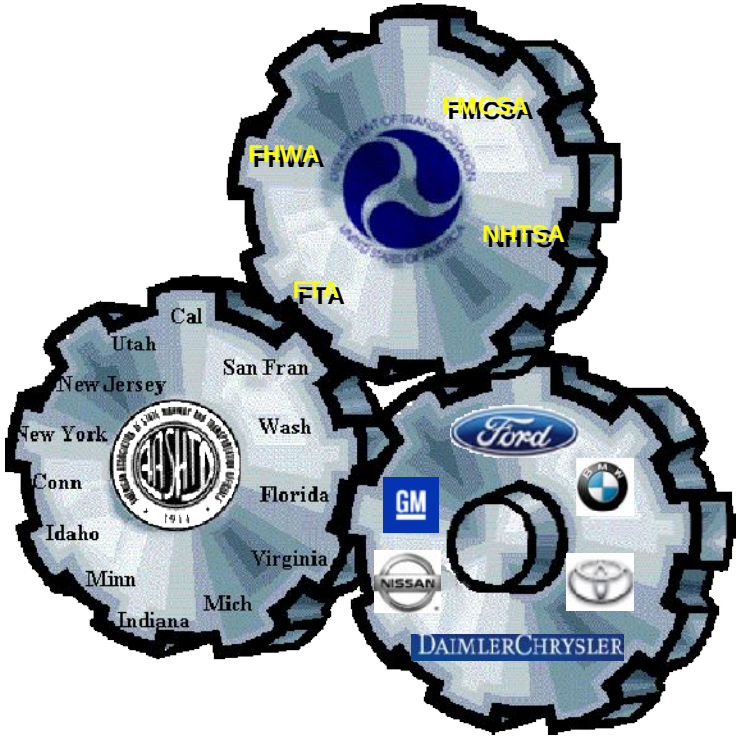
State & local DOTs (AASHTO)

Vehicle Manufacturers

Dr Jeff Runge emphasized the safety opportunities and his organization's full commitment to support this program.

Mary Peters recognized the safety opportunities as well as the mobility opportunities. She expressed the idea that FHWA is seeking to focus their financial resources on a few beneficial areas that will make an impact.

From 26 Feb '04 VII ELT meeting minutes



Initiated, March 2003

Uses for the VII system

Three classes of applications:

Safety (provided free to all)

- Provides political and financial support for the effort
- Unified vision

Mobility (transportation related, no fees)

- Provides benefits for primary stakeholders
  - DOTs
  - Vehicle Manufacturers

Commercial (everything else but voice, opt in, with fees)

- Large upside potential
- Unsure returns

Running on 75 MHz of dedicated spectrum at 5.9GHz (allocated by FCC)

Simple Block Diagram

Driver

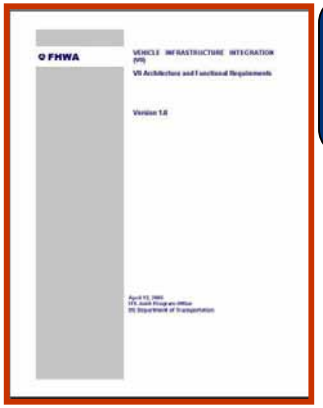
Vehicle Data

Driver interface

Vehicle #2

DOT Applications

End User



VII Architecture

On Board Unit

Message Switch

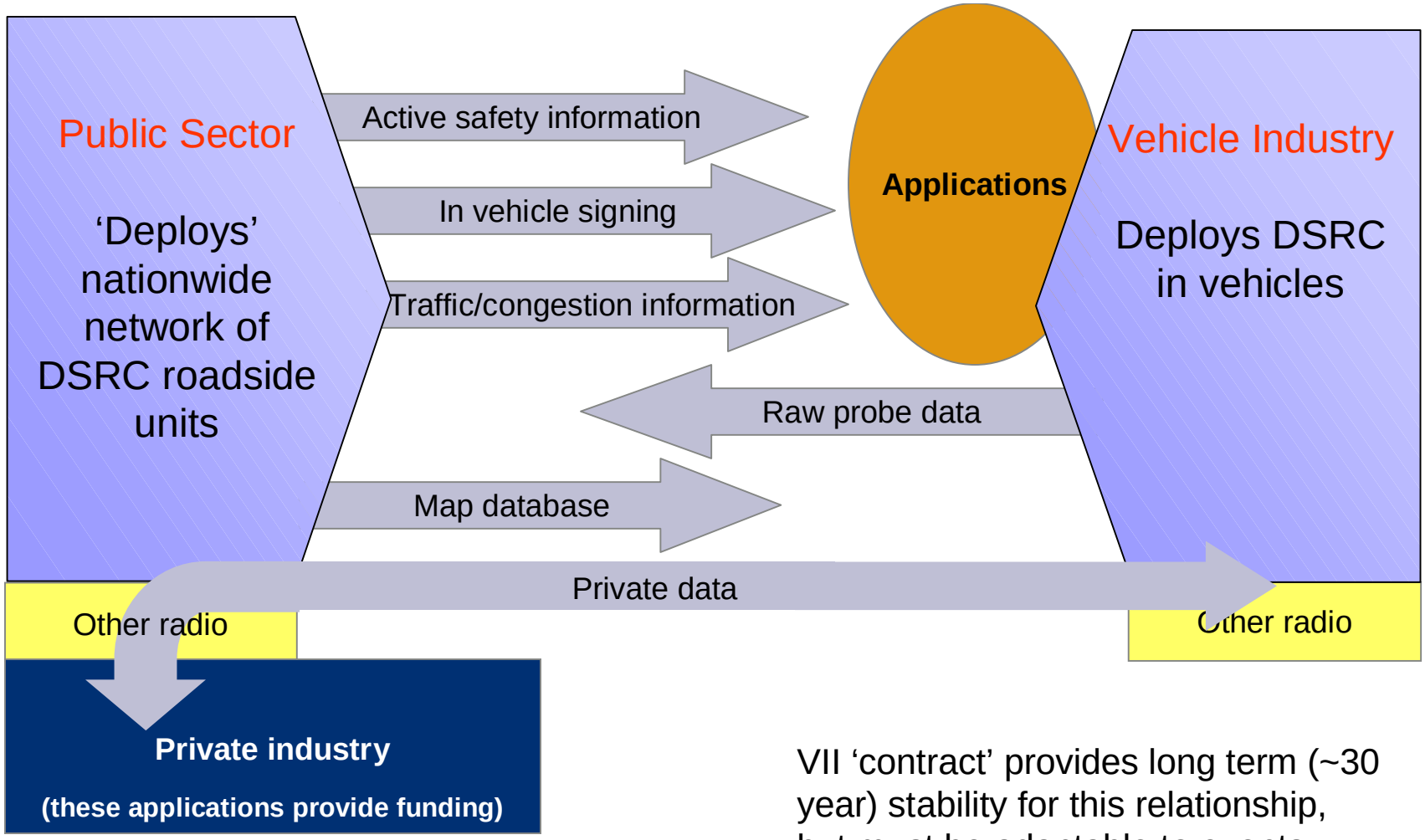
5.9 DSRC

Road Side Unit

'Private' Applications

The VII Deal

Exchange vehicle data for network bandwidth



VII 'contract' provides long term (~30 year) stability for this relationship, but must be adaptable to events

Initial 'Day 1' VII Applications

Electronic Brake Lights

Advance Warning Information to Vehicles

In Vehicle Signing

Ramp Metering

Signal Timing & Adjustment

Corridor Management

Traveler Information – VMS, 511, Web site

Electronic Payment – Tolls, private

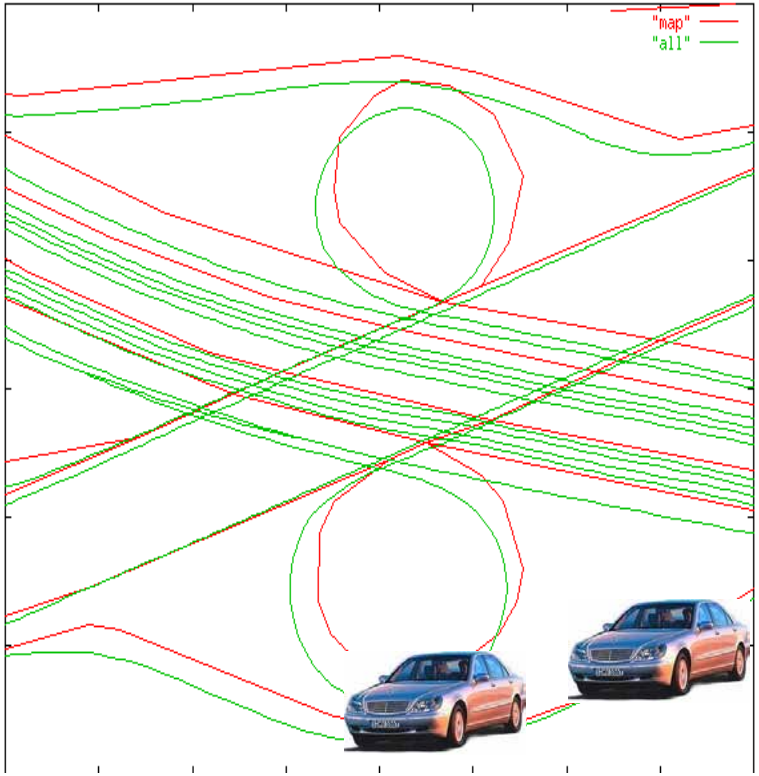
Localized Weather/Road Condition Warning

Winter Maintenance

Probe Based Mapping

OEM Applications - private

Probe Based Mapping



RSU Deployments

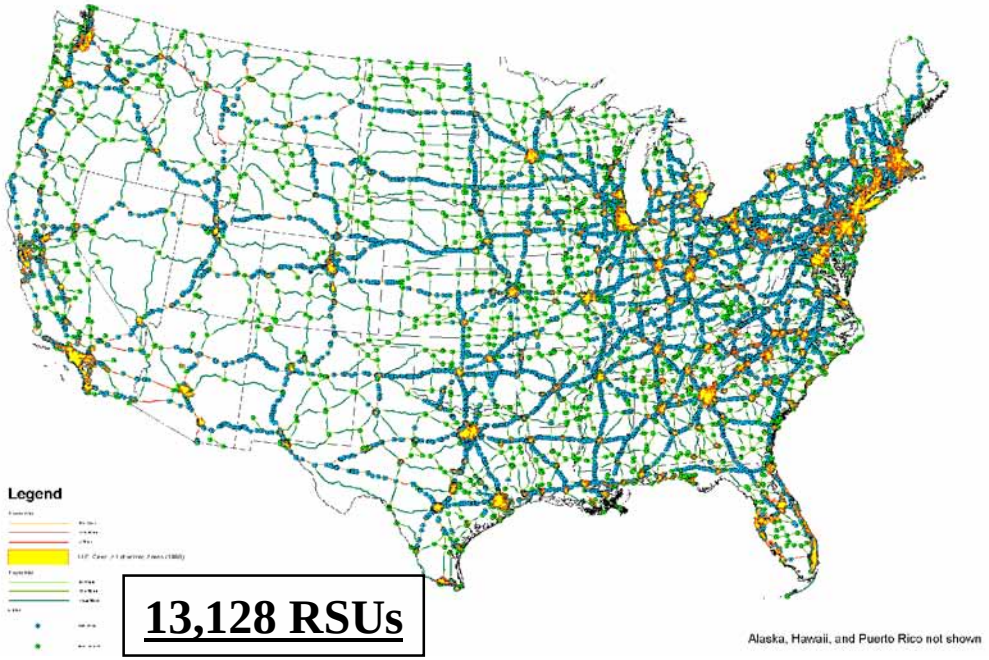
Urban RSU Deployments	
Number of Traffic Signals in US	265,000
RSUs at 20 % of Traffic Signals	53,000
Miles of Interstates and Freeways within Urban Areas	19,706
RSUs per Mile	0.95
Freeway RSUs	18,721
Centerline Miles of Arterials and Collectors in Urban Areas	178,849
% Not within 5 minutes of RSUs at the 20% of Signalized Intersections at Highest Accident Locations	10%
Miles per RSU for Gap	3
Additional RSUs	5,962
Urban Total	**77,682**

Rural RSU Deployments	
NHS Intersections	4,250
Additonal Freeway Interchanges	6,061
Minutes to an RSU	
30 Minute Drive Interstates & Freeway	142
30 Minute Drive Rest of NHS System	2,675
Rural Total	**13,128**

Additional RSU's for Special Needs	**10,000**

National Total	**100,810**

Rural RSU Deployment Analysis



$3-5 Billion nationwide for infrastructure

Activities with states

California:

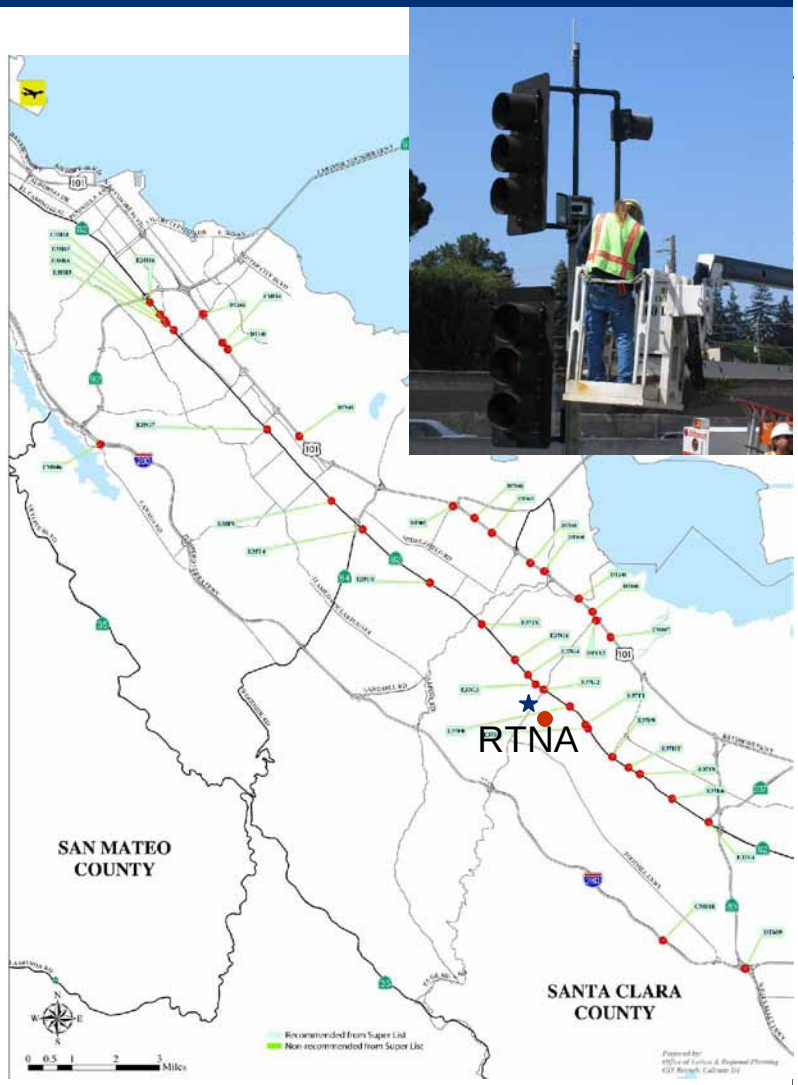
- Built up several vehicles for test & demonstration activities
  - VII-California
  - ITS World Congress 2005 (November)
- ~40 DSRC Units installed on roadways (7 today)
  - Mobility/ private applications
  - Safety applications

Michigan:

- Installing 802.11b units around DCX campus in Auburn Hills
  - Support for diagnostics (fast feedback fleet)
- Ford working with Motorola on similar activity

Florida:

- Commitment to provide some vehicles with probe data capability.



VII California RSE Cabinet Installation

PC/104 processor and GPRS modem in 19” rack enclosure

- Serial cable out

GPS antenna

GPRS antenna

Photos courtesy of PATH

Testbed Value

Provides test environment

- Validating technology, business and institutional assumptions
- Incremental commitments

Provides discussion venue

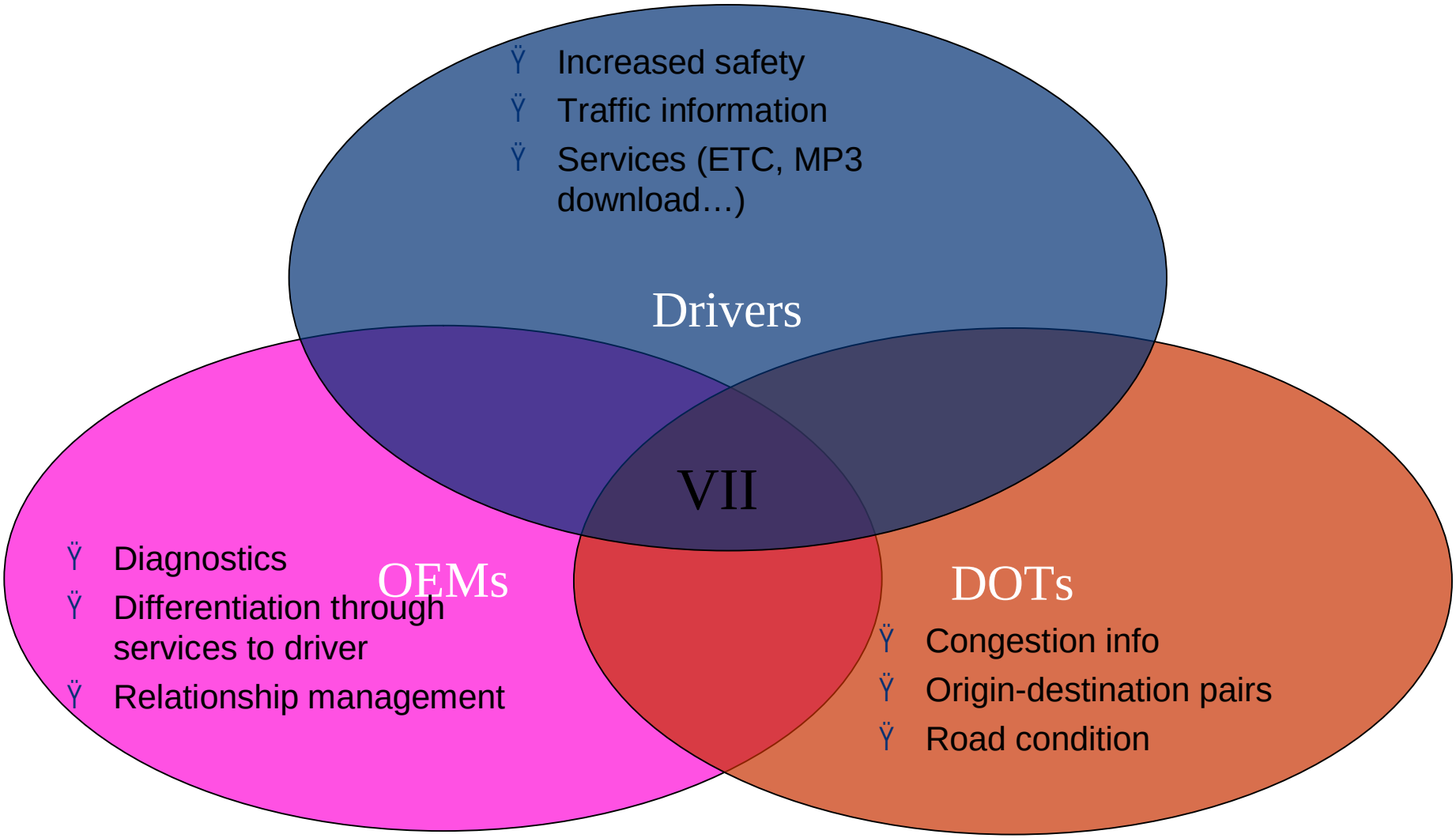
- Incremental trust and understanding
- Relationship building between principal stakeholders

Demonstrate value to key stakeholders

- DOTs and OEMs
- Drivers
- Transportation businesses

Progressive commitment between OEMs and infrastructure

Mutual benefits- aligned interests



The future

VII is not a ‘done deal’

Need to demonstrate cooperation and commitment (particularly OEMs)

Need to demonstrate benefits to each stakeholder

Need to prepare to sell nationwide (particularly to non involved DOT’s)

If we can work together on our national transportation system, today’s technologies will allow us to achieve amazing improvements.

For Further Information

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