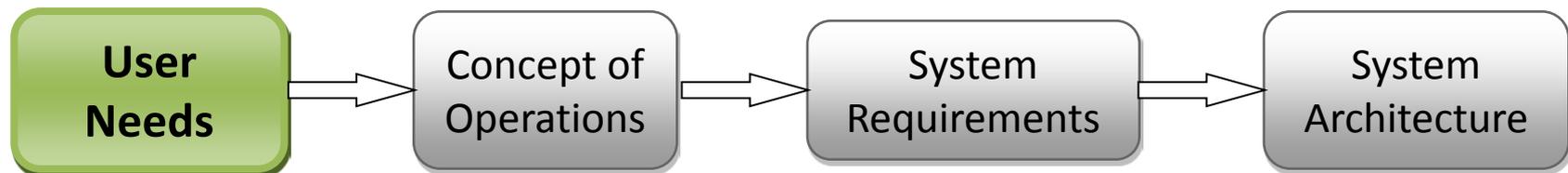


# IntelliDrive<sup>SM</sup> System Engineering User Needs Workshop



# Agenda

- Introductions & Logistics
- IntelliDrive Program Overview
- Transitioning from Vehicle Infrastructure Integration (VII) to IntelliDrive
- Systems Engineering Process and the IntelliDrive SE Program
- User Needs Overview / Examples
- User Needs Discussion
- Wrap Up

# Introductions

- IntelliDrive SE Team
- Participants
  - Organizational Representation
    - State/Local Transportation Agency
    - Public Safety/ Emergency Services
    - Automotive/Vehicle equipment developer
    - Traveler Information Service Provider
    - Academic / Research organization
    - Networking / Telecommunications Provider
  - Involvement in VII/IntelliDrive efforts

# **INTELLIDRIVE PROGRAM OVERVIEW**

# What is IntelliDrive?

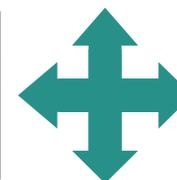
- Suite of technologies and applications that use wireless communications to provide connectivity:
  - Between vehicles (of all types)
  - Between vehicles and roadway infrastructure
  - Between vehicles and wireless communication devices
  - Between wireless communication devices and roadway infrastructure



Drivers



Vehicles



Infrastructure

Wireless  
Devices

# The Problem!!!

## Safety

- 33,963 deaths/year (2009)
- 5,800,000 crashes/year
- **Leading cause of death for ages 4 to 34**



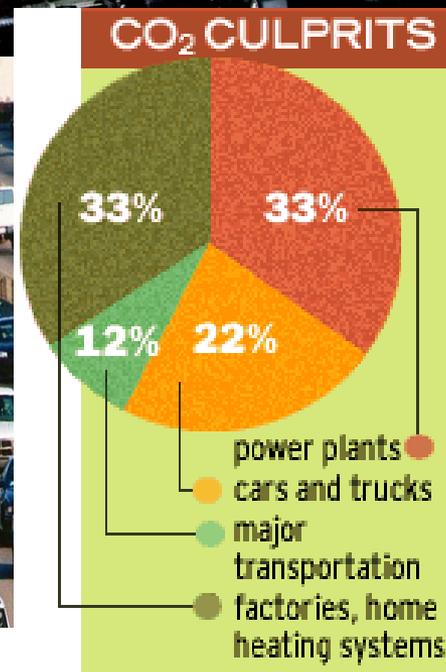
## Mobility

- 4.2 billion hours of travel delay
- \$78 billion cost of urban congestion

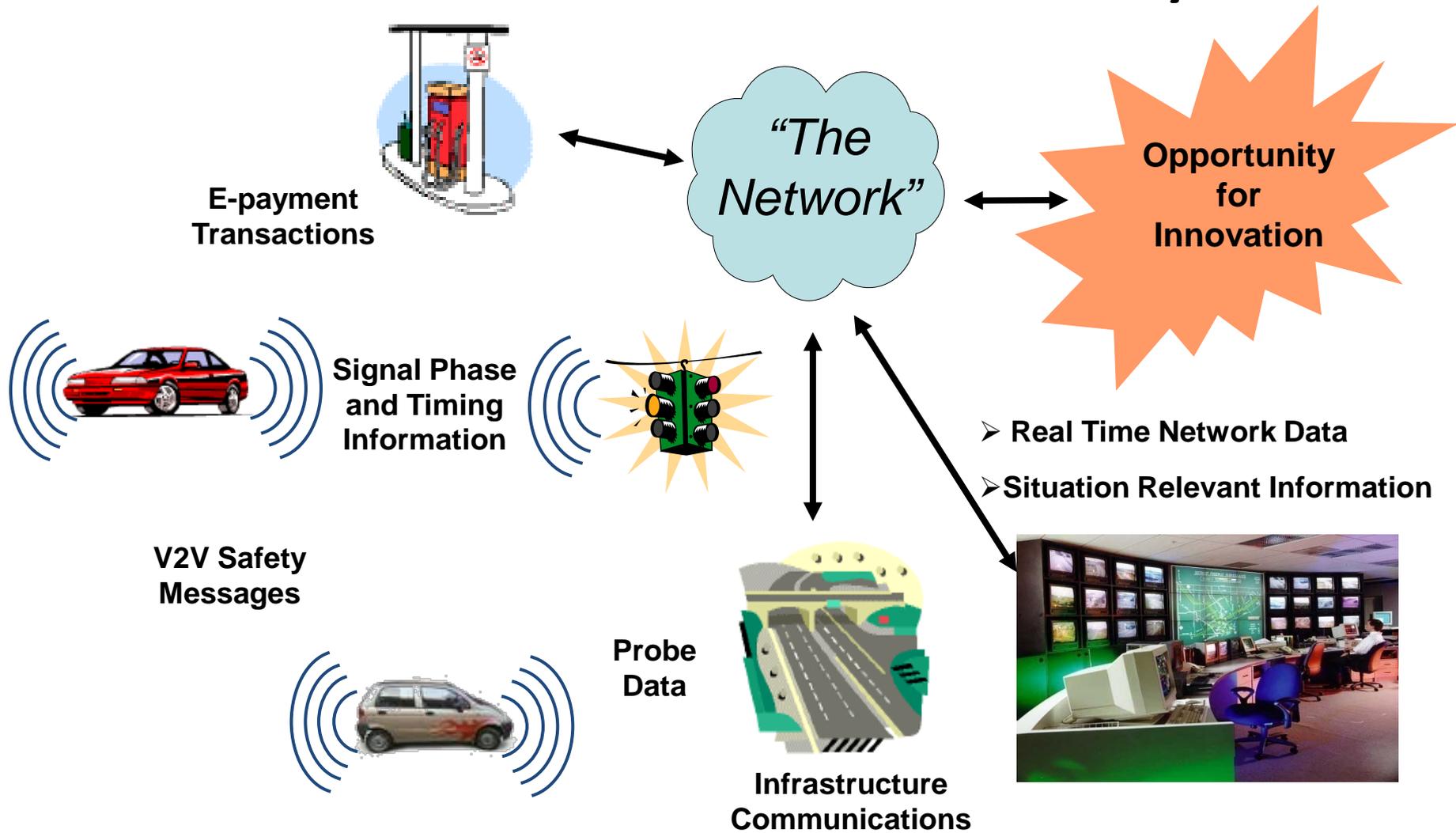


## Environment

- 2.9 billion gallons of wasted fuel



# It's All About Connectivity



# Potential IntelliDrive Users

## Mobile users may include:

- Private individuals traveling in motor vehicles
- Public safety personnel traveling in public safety vehicles
- Commercial vehicle operators in commercial vehicles
- Pedestrians and bicyclists
- Transit vehicle riders in transit vehicles
- Transit vehicle operators in transit vehicles
- Traffic management personnel traveling in maintenance and construction vehicles

## Non-mobile users may include:

- Traffic operations personnel
- Transit system operators
- Toll management authorities
- Value added service providers
- Rail system operators
- Fleet dispatchers
- Emergency management personnel

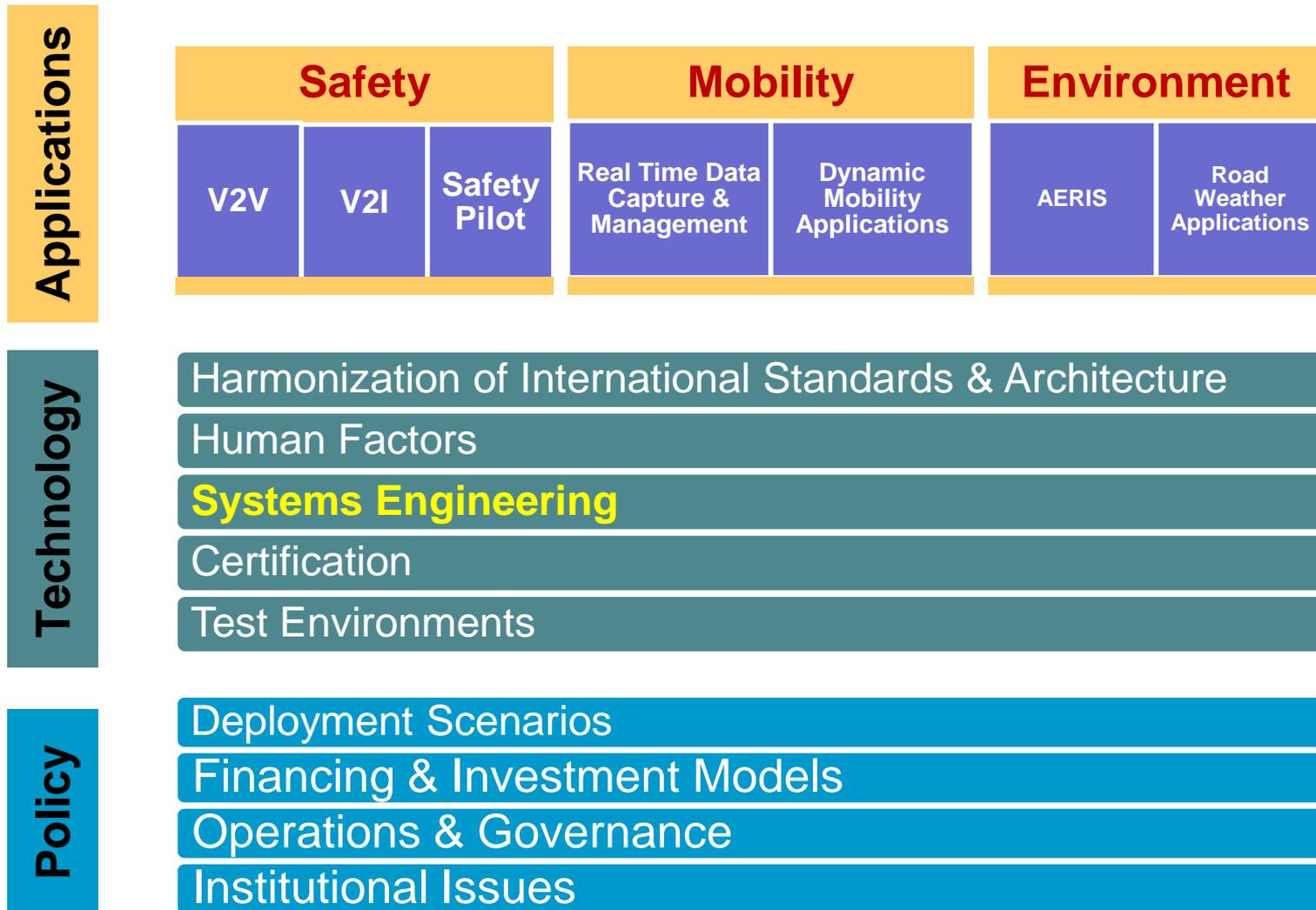
# Safety & Mobility & Environment

- Safety and mobility services, while a continual focus of the program over the last several years, are not intended to be its limit.
- Services that provide environmental benefit are a new focus for IntelliDrive support.
- While strictly commercial applications are no longer a point of focus for the IntelliDrive program, commercial applications that enhance safety, provide mobility services and/or are environmentally-focused may also be supported.

# US DOT Activities

- Broad program of research to address all aspects of IntelliDrive
  - Safety – V2V, V2I
  - Mobility – Data Capture Management, Dynamic Mobility Applications
  - Environment – AERIS along with road weather management (*Clarus*)
- As well as looking at higher level issues
  - Regulatory needs
  - Policy framework
  - Standards evolution

# IntelliDrive Program Structure



# IntelliDrive SE Program

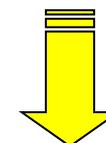
- Focus on the Core, Enabling System necessary to form the basis for the safety, mobility, environmental applications
- Revisit and update the IntelliDrive concept of operations, requirements, and architecture
  - Develop a revised baseline of documentation for the definition of the IntelliDrive system
- Use existing documentation and lessons learned as a starting point

# IntelliDrive SE Program

- Provide the technical foundation for future activities
  - next generation of field tests
  - initial and ongoing deployments
  - continued research as the core technologies and program evolve

# Timeline

We are here



2004

2005

2006

...

2008

2009

2010

FCC allocates 5.9 GHz spectrum for DSRC

Prototypes for Vehicle-to-vehicle (safety applications) and Vehicle-to-Infrastructure (public applications) developed based on DSRC 5.9 GHz and tested in a Proof of Concept test bed

IntelliDrive SE Program initiated to re-baseline

Re-baselined IntelliDrive Concept of Operations, Requirements, & Architecture completed

VII Architecture developed based on Day 1 Use Cases

“VII” rebranded as “IntelliDrive” to reflect new assumptions

Stakeholder workshops to solicit user needs

# How does DSRC fit in?

- Dedicated Short Range Communications (DSRC)
  - Remains *one of* the important technologies used within the IntelliDrive System
- 75MHz of spectrum in 5.9 GHz range allocated by FCC to:
  - “[provide] vehicle-to-vehicle and vehicle-to-infrastructure communications, helping to protect the safety of the traveling public. It can save lives by warning drivers of an impending dangerous condition or event in time to take corrective or evasive actions.”
  - “The band is also eligible for use by non-public safety entities for commercial or private DSRC operations.”

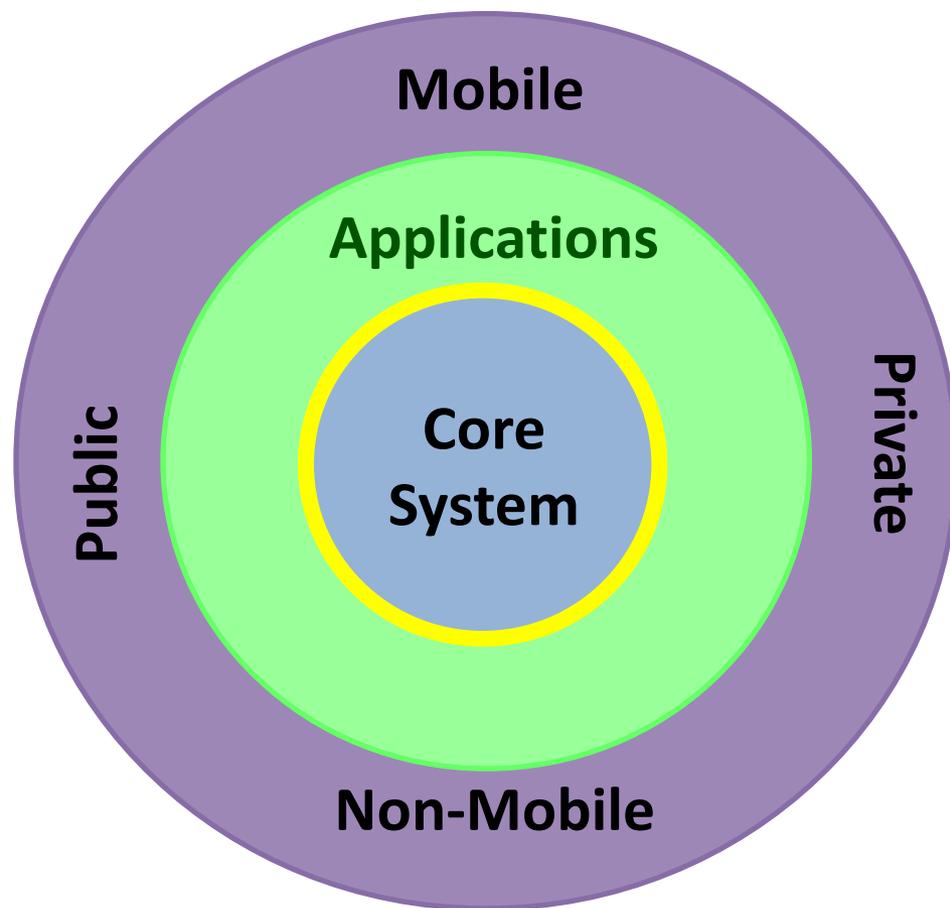
# Changing Assumptions & Constraints

- Wireless Technologies such as Wi-Fi and Cellular Communications may supplement DSRC at 5.9 GHz
- Aftermarket and Retrofit Devices – both on-board and handheld
- Reassessment of Deployment Strategy
- Consideration of Various Vehicle Types
- Reconsideration of Approaches to Privacy and Anonymity
- Reevaluation of Functions and Services

# Additional Stakeholders

- Reaching out to familiar and new stakeholders to validate past approaches and identify new ideas:
  - Traffic system operators
  - Transit and rail communities
  - Commercial vehicle operations
  - Tolling agencies
  - Aftermarket broadcast device vendors
  - Aftermarket auto-maker/retrofit device vendors
  - Aftermarket & Carry-in Device Vendors
  - Backhaul, Data Aggregators, and Network providers

# Scope of IntelliDrive



- IntelliDrive is composed of 2 layers:
  - (1) Applications, which bring about safer, smarter, and greener transportation, and
  - (2) a Core System, which enables applications by providing cooperative data exchange capabilities.
- IntelliDrive may be further divided
  - Mobile communications endpoints - not typically connected to any wired network during normal operation
  - Fixed communications endpoints - typically connected to a wired network during normal operation
- Consider also the different stakeholders, each with its own interests, including
  - Public sector entities
  - Private industry
  - Individual private users
- Our Focus today is on the Core System

# For More Information...

<http://www.intellidriveusa.org/>

Site sponsored by the US Department of Transportation  
[Research and Innovative Technology Administration](#)

[Download This Video](#)

### News & Updates

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**Proof of Concept Test Results Released**  
 March 11th, 2009 at 4:04pm

**IntelliDrive<sup>SM</sup> Brand Replaces VII**  
 February 23rd, 2009 at 10:12am

**SAFETRIP-21 News**  
 December 4th, 2008 at 3:12pm

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**About IntelliDrive**

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Overview  
FAQs

**Who We Are**

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DOT's IntelliDrive Program  
Coalition

**Benefits**

---

Future Vision  
Consumers

**Research**

---

DOT-Sponsored Research  
Activities  
[State and International Research](#)

**Library**

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Research Reports  
Presentations

# **TRANSITIONING FROM VEHICLE INFRASTRUCTURE INTEGRATION (VII) TO INTELLIDRIVE**

# VII to IntelliDrive Overview

- Who was involved
- When was it
- What VII meant
  - Vision and constraints
  - Users
  - Data Exchanges
- What IntelliDrive means
  - What has changed
  - What hasn't changed

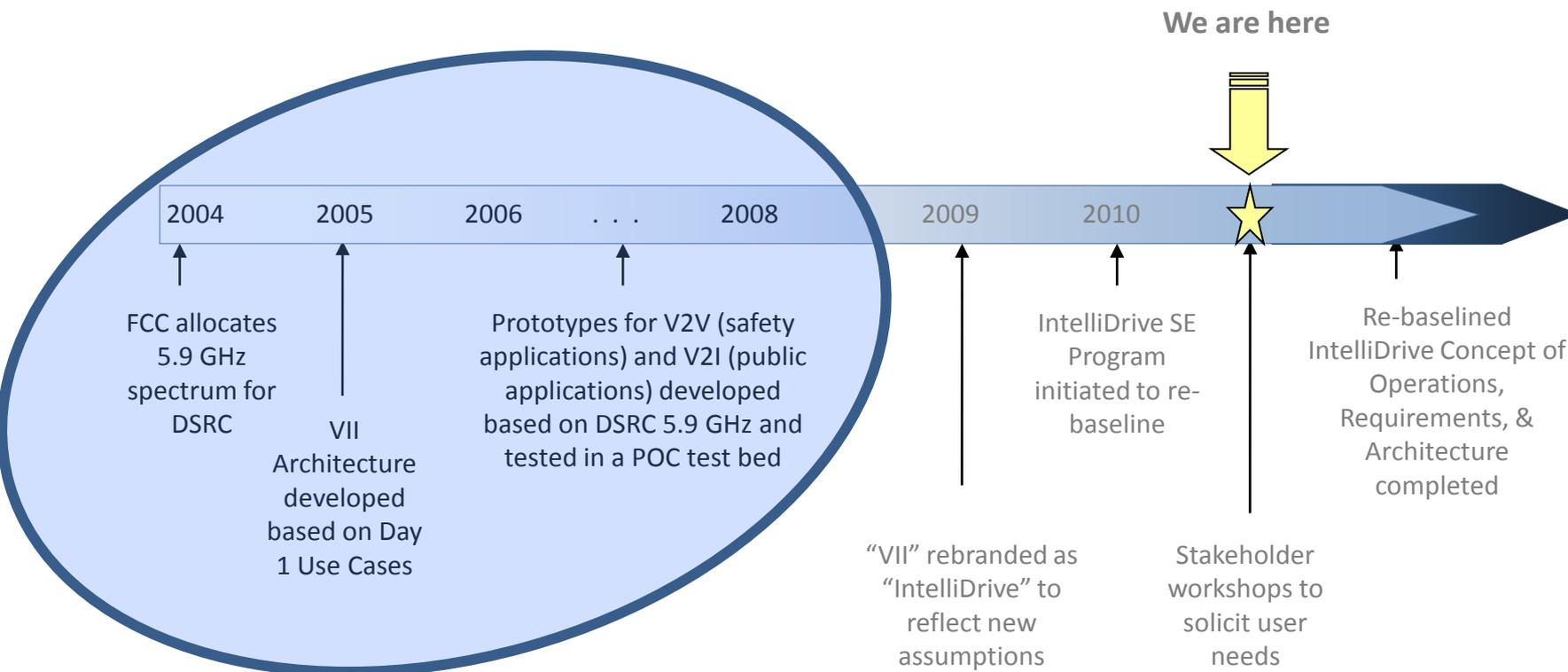
# The VII Vision

- “Internet for the car” enabling safety, mobility and commercial applications
- Comprehensive coverage in urban areas
- Spotty, focused coverage in rural areas (National Highway System)
- Nationwide rollout
- Focused on cars
- Funded by Congress

# VII - Who was Involved

- State DOTs through AASHTO
- Vehicle manufacturers and suppliers
- USDOT

# When Did VII Take Place



# VII Initiative Organization

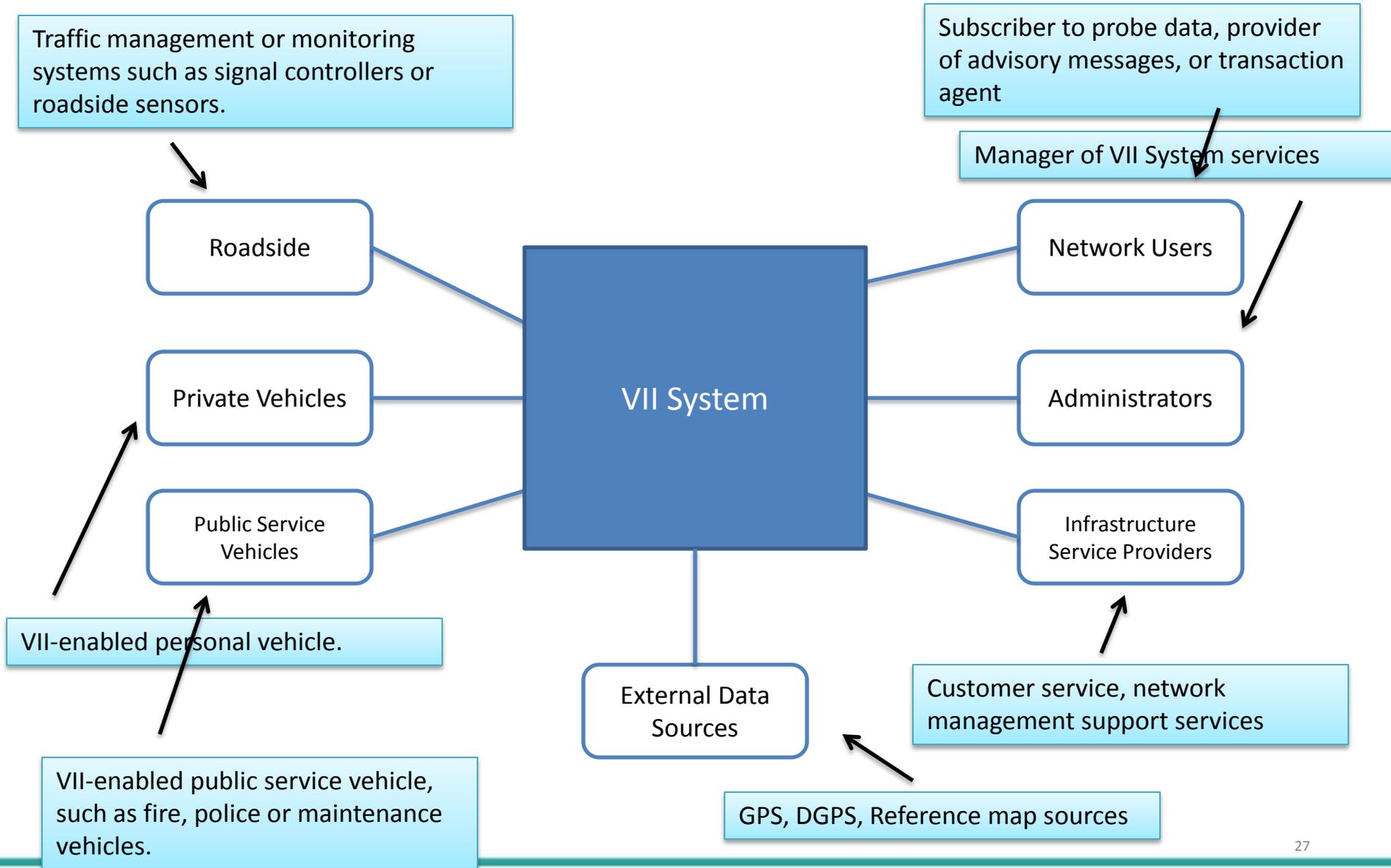


Ref: VII Concept of Operations v1.2

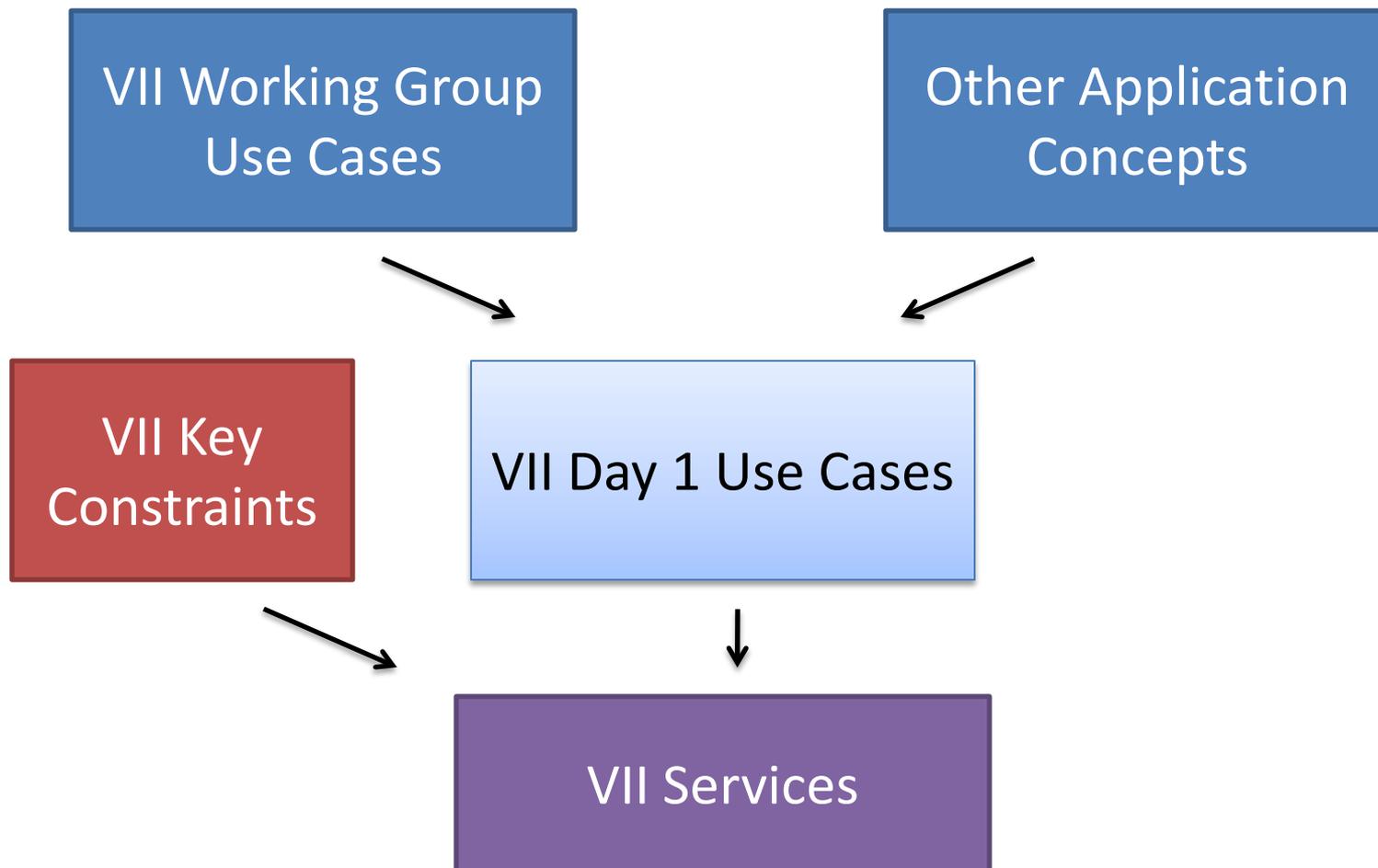
# VII Key Constraints

- Communications – air gap bridged by 5.9 GHz DSRC and only 5.9 GHz DSRC
- Vehicles equipped as new production only
- VII Network not to be used to replace existing infrastructure (e.g. to provide communications between centers and signal controllers)
- Probe data required
- Privacy principles

# VII-era Users



# VII Service Definition Process



# VII-era Resulting Services

- VII defined 10 services that facilitated the “Day 1 Use Cases” and safety applications, and worked within VII constraints

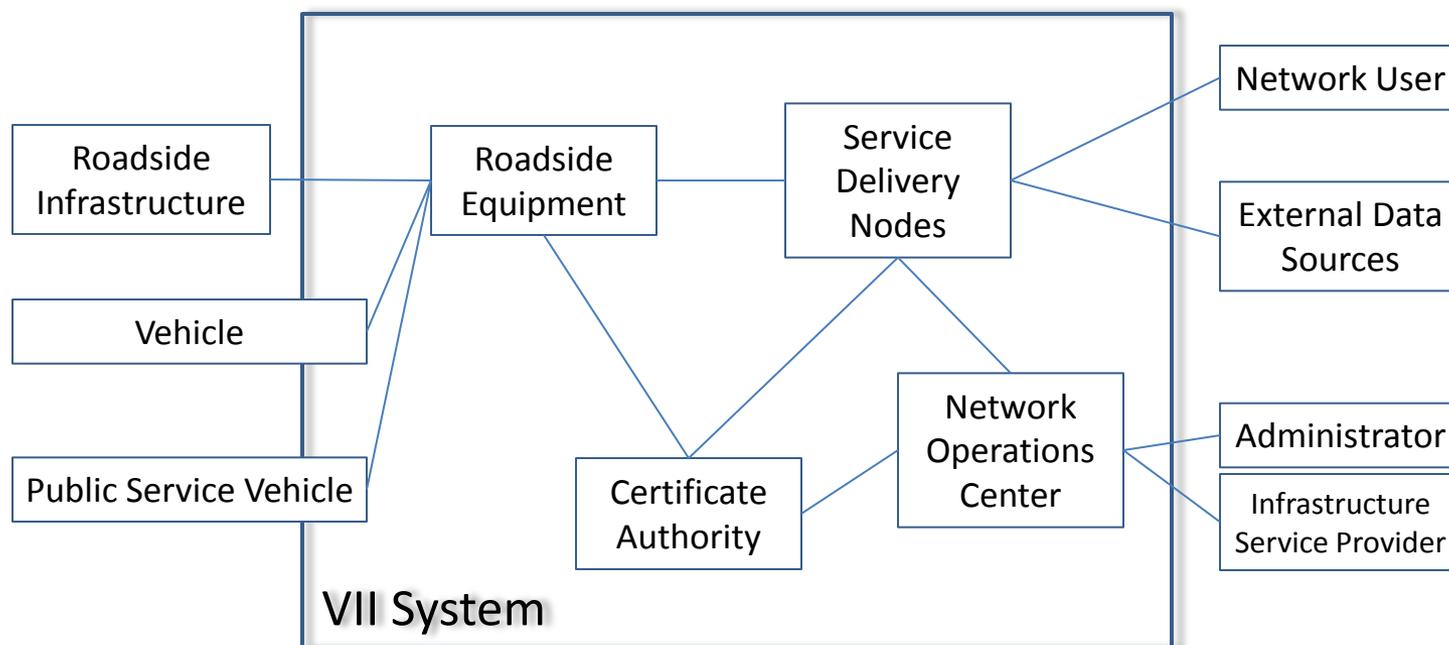
## Communications Enablers

- Advisory Message Distribution
- Transactional Communications
- Probe Data
- Map Element Distribution
- Roadside Infrastructure Support

## Supporting Services

- Information Lookup
- Management
- Positioning
- Security
- System Time

# VII-era Resulting Architecture



# And Now... The IntelliDrive Vision

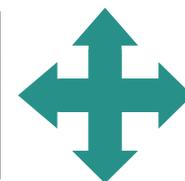
- Wireless communications between vehicles, roadside and handhelds enabling safety, mobility and environmentally-focused applications
- Flexible deployment
  - Management
  - Coverage
  - Services
- All vehicle types
- Nationally interoperable



Drivers



Vehicles



Infrastructure

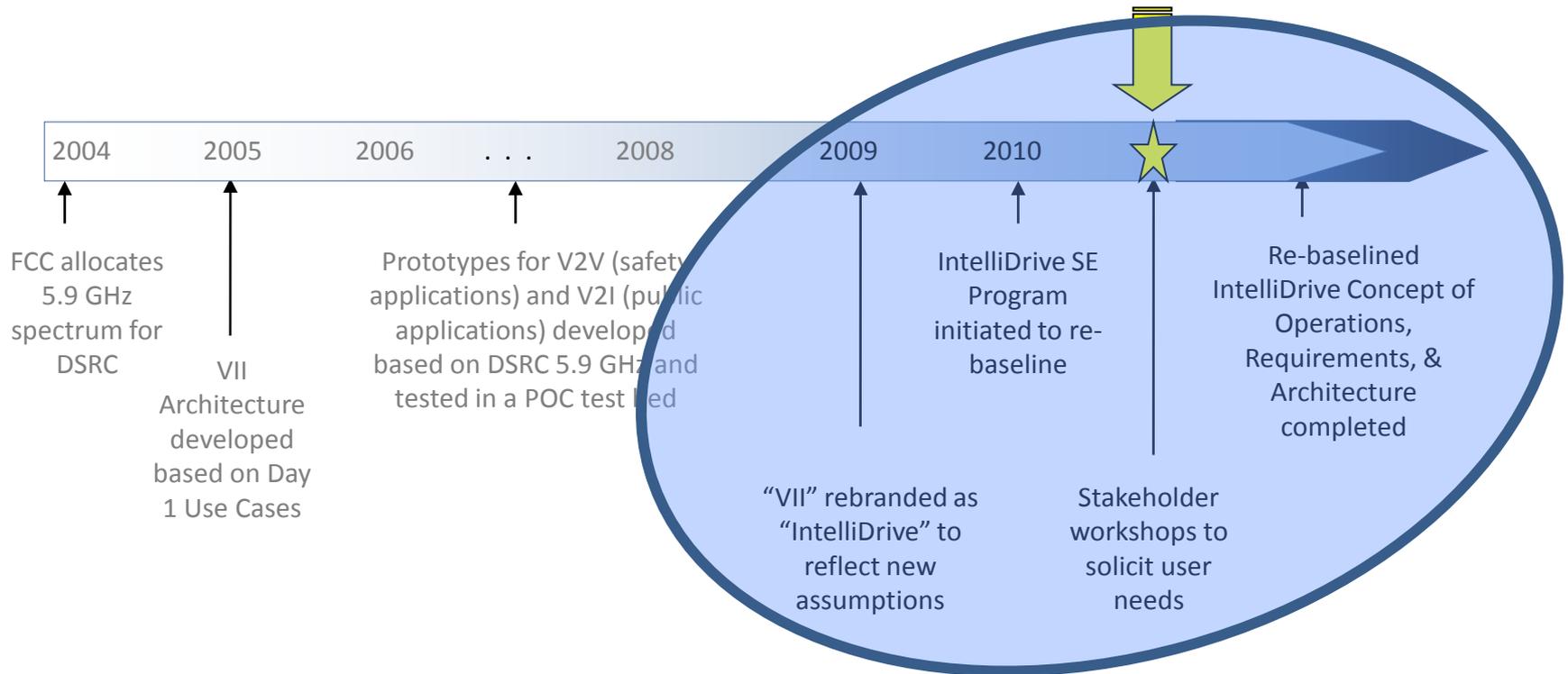
Wireless  
Devices

# IntelliDrive - Who is Included

- State and local transportation agencies
- USDOT
- Vehicle manufacturers
- Aftermarket manufacturers
- Infrastructure equipment manufacturers
- Service Providers
- Commercial Vehicle Operators
- Public Safety
- Transit
- and More!

# When is IntelliDrive Taking Place

We are here



# IntelliDrive Assumptions

- Unchanged from VII-era
  - IntelliDrive must not compromise safety
  - IntelliDrive must protect the integrity of its connected devices
  - IntelliDrive must prevent the involuntary divulgence of personally identifying information

# IntelliDrive Assumptions

- Different than VII-era
  - DSRC for safety applications requiring low communications latency, such as “last half-second” safety applications
  - Other wireless technologies considered, including cellular and Wi-Fi
  - Possible retrofit of existing vehicles
  - Aftermarket devices possible

# VII vs. IntelliDrive

## VII

---

5.9 GHz DSRC only

OEM only

Light vehicles

National interoperability

Must not compromise safety, security

Must protect privacy

Probe data, publish-subscribe

## IntelliDrive

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5.9 GHz DSRC for safety

OEM, aftermarket and retrofit

All vehicles

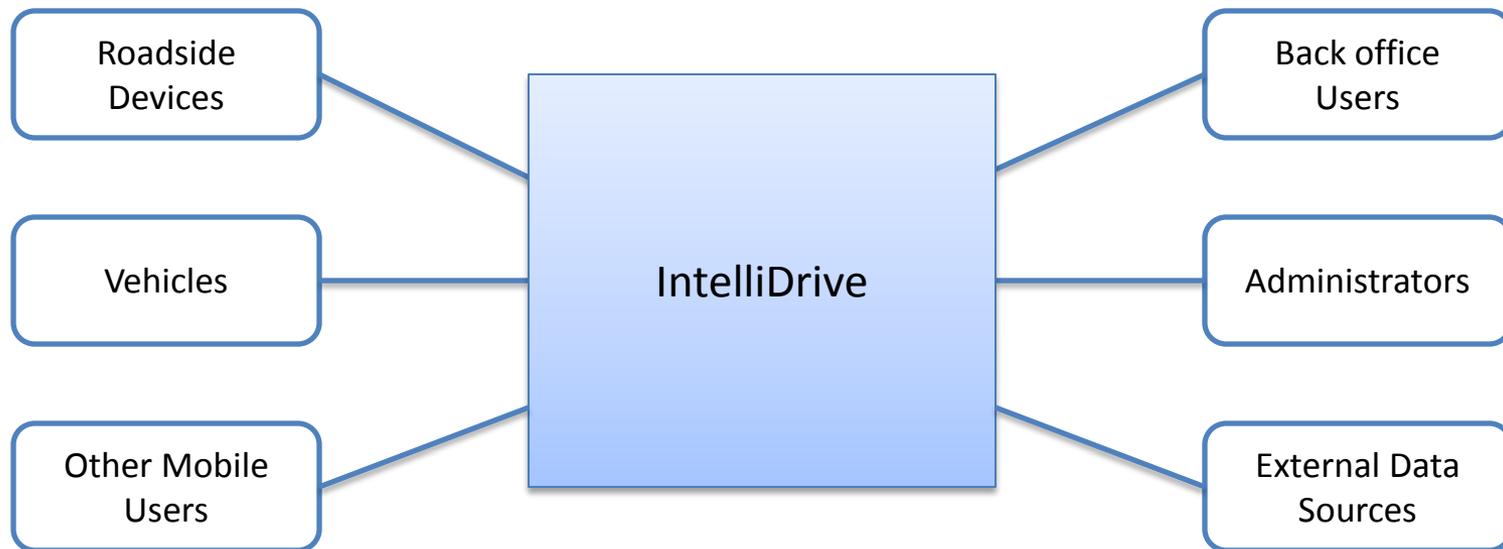
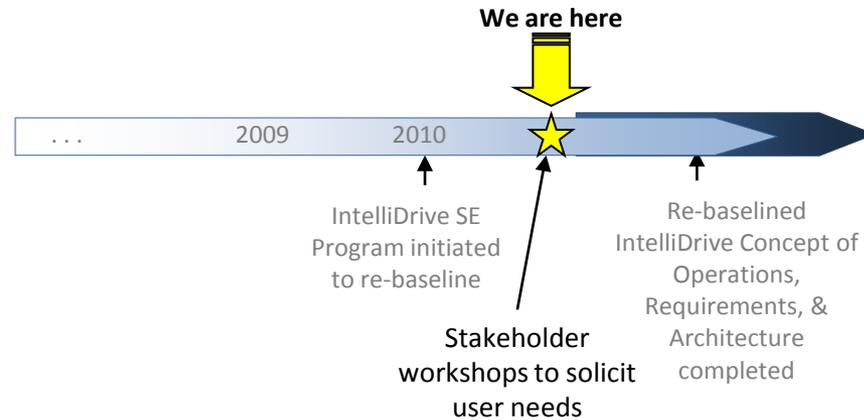
National interoperability

Must not compromise safety, security

Must protect privacy

Probe data?

# IntelliDrive Next Steps



# Now What?

What do you NEED?

Why do you need it?

How important is it to you?

Evolution and Revolution

- New measures
- New techniques

# SYSTEMS ENGINEERING PROCESSES AND INTELLIDRIVE

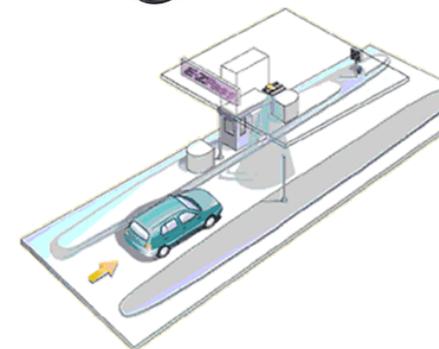
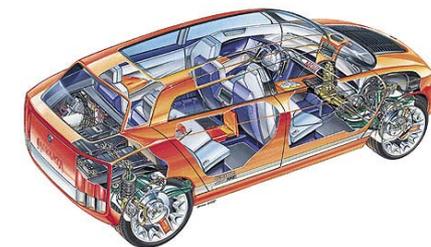
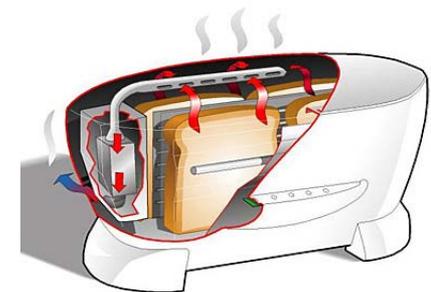
# What is a System?

“A combination of interacting elements organized to achieve one or more stated purposes.”

International Council of Systems Engineering

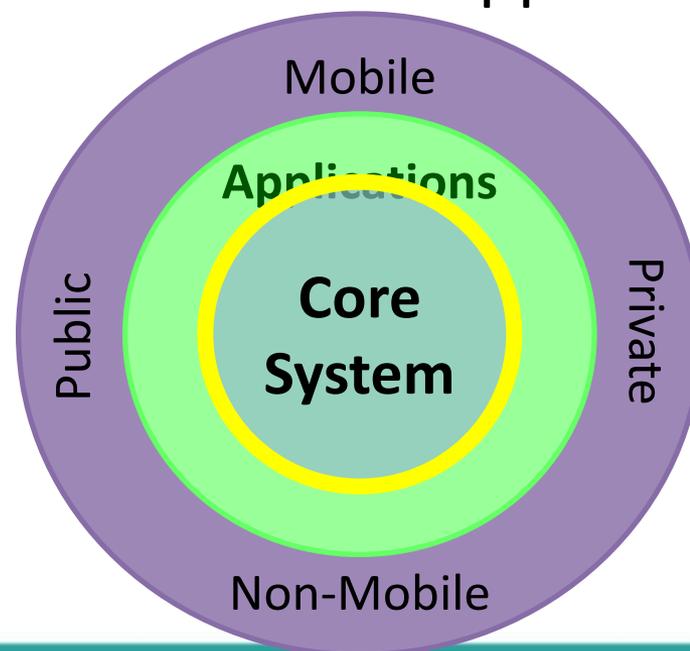
“An aggregation of end products and enabling products to achieve a given purpose”

Electronics Industry Association EIA-632

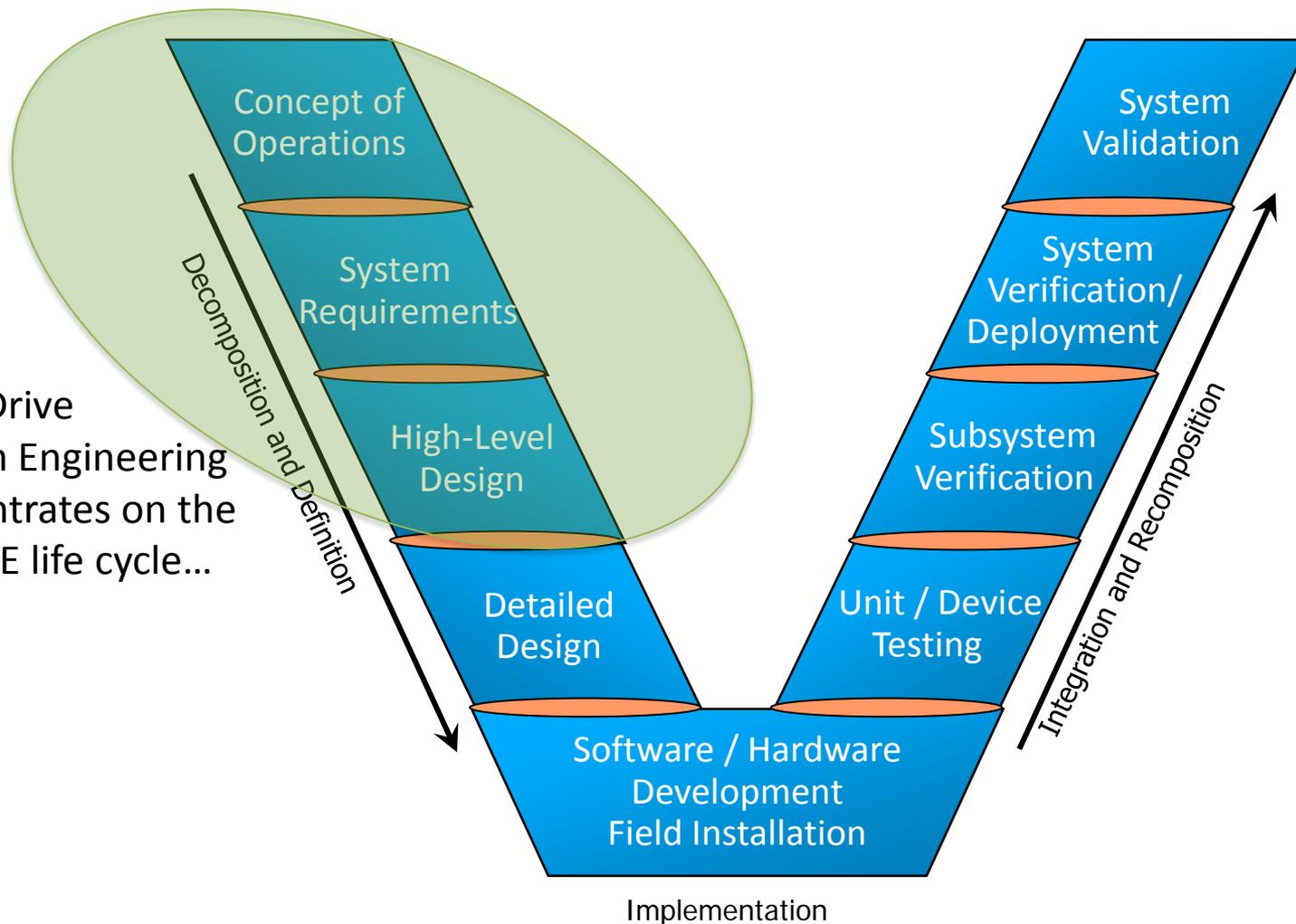


# What is a System?

- For IntelliDrive:
  - Think “System” not “Applications”
  - Focus on the core, enabling capabilities and communications services that will support future Applications



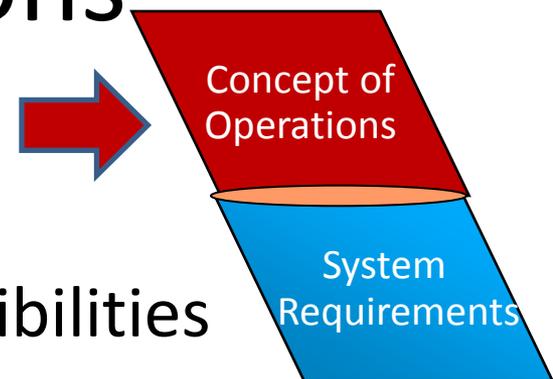
# Systems Engineering Model for ITS: The “V”



IntelliDrive  
System Engineering  
concentrates on the  
early SE life cycle...

# Concept of Operations

- The ConOps defines
  - Who: Stakeholder roles and responsibilities
  - What: Needs, system boundaries and high-level capabilities
  - Where: Geographic and physical extent
  - When: Sequence of activities performed
  - How: Development, operation, and maintenance of system



# Benefits of Developing a Concept of Operations

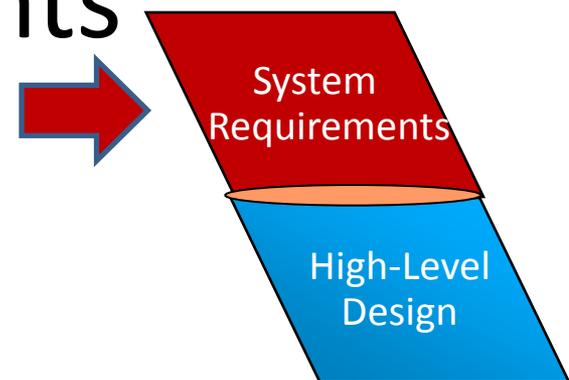
- Early stakeholder agreement on:
  - System capabilities
  - Roles and responsibilities
  - Key performance measures and a basic plan for system validation
- Manage stakeholder expectations



## Start with Your Eye on the Finish Line

A ConOps helps the project team visualize the final system at the beginning of the project.

# System Requirements

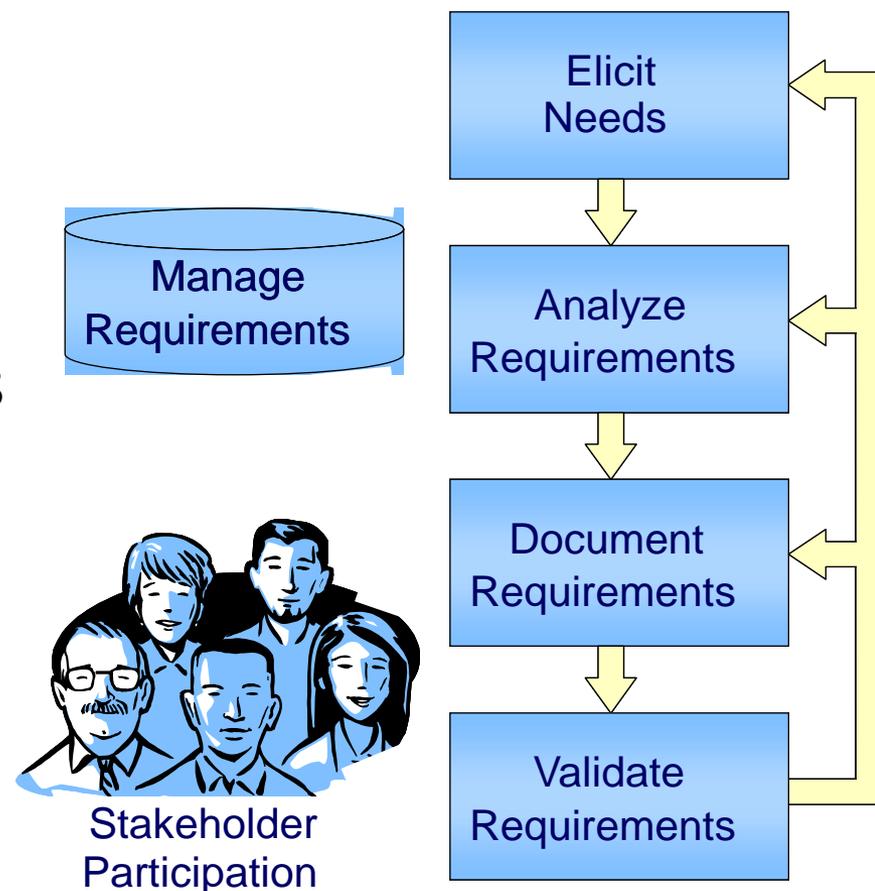


“Something that governs *what, how well, and under what conditions* a product will achieve a given purpose”

- EIA-632, Electronics Industry Association Standard “Processes for Engineering a System”

# System Requirements

- Key activities
  - Elicit Needs
  - Analyze Requirements
  - Document Requirements
  - Validate Requirements
  - Manage Requirements



# Benefits of System Requirements

- A clear statement of requirements provides:
  - A shared understanding of the problem to be solved by customer and developer
  - A firm basis for managing project scope
  - The connection between user needs and system design
  - The foundation for system verification/testing

Problem

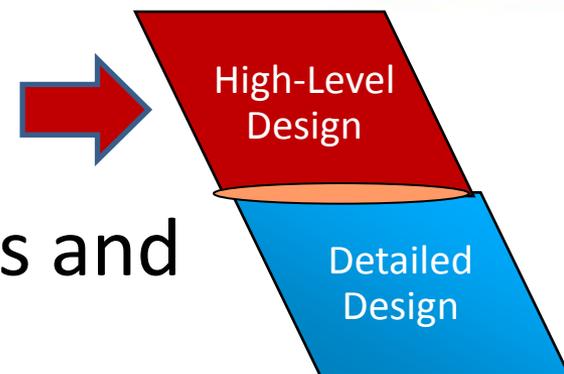


Solution

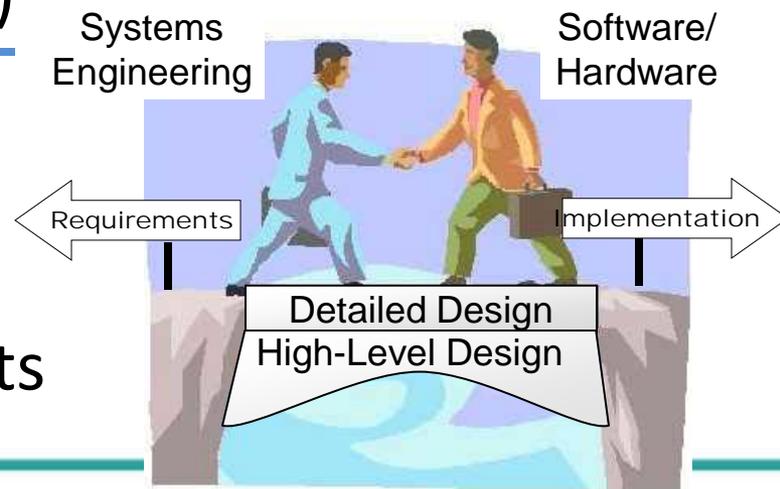
A clear statement of requirements is frequently identified as a key factor in successful IT projects.

# System Design

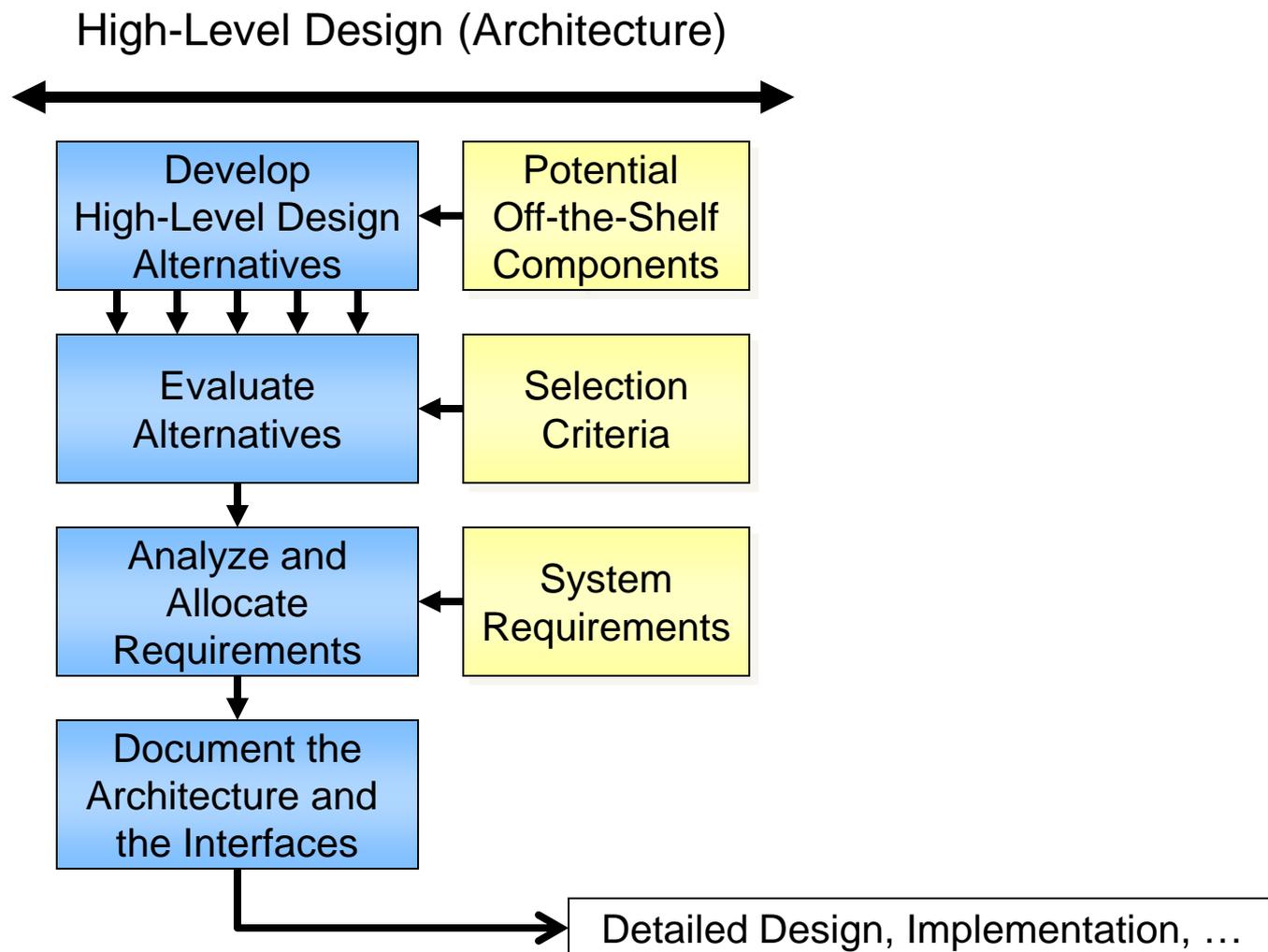
- The bridge between requirements and implementation
- Two distinct levels
  - High-Level Design – Overall structure (architecture) of the system (subsystems, components, and interfaces)
  - Detailed Design – Complete specification of hardware, software, and communications components



SE  
Project  
Scope



# System Design Activities



# Benefits of System Design

- A good system architecture:
  - Relates requirements to the system specifications
  - Defines open interfaces that supports different vendor solutions and off-the-shelf products
  - Supports efficient hardware and software development
  - Provides a roadmap for system integration and testing
  - Facilitates maintenance and future expansion and upgrade of the system



A superior system design allows new technologies to be cost-effectively incorporated.

# IntelliDrive System Engineering



IntelliDrive System Engineering concentrates on the early SE life cycle...

Concept of Operations

System Requirements

High-Level Design

Detailed Design

Software / Hardware Development  
Field Installation



... while staying focused on the overall program goals

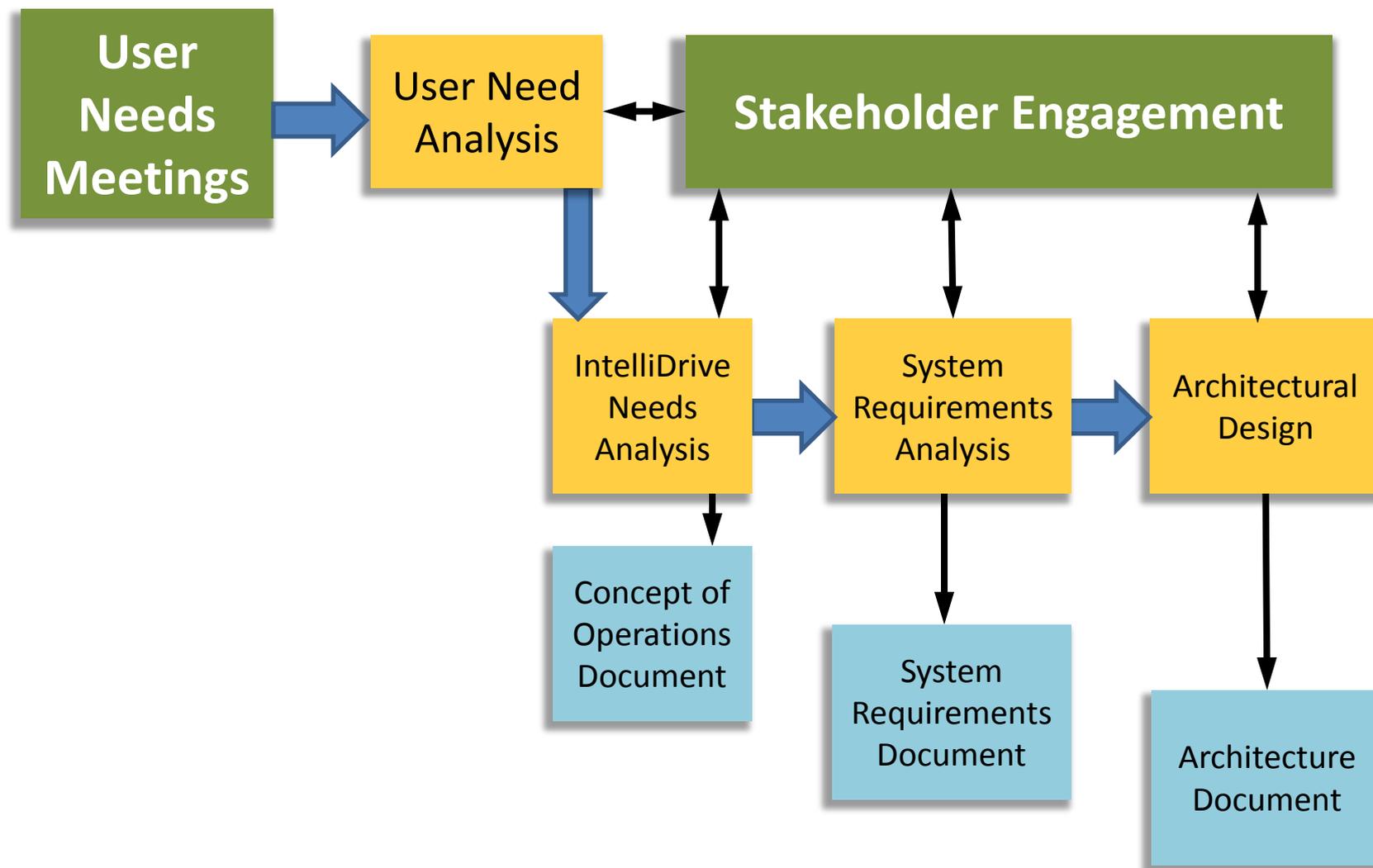
System Validation

System Verification/  
Deployment

Subsystem Verification

Unit / Device Testing

# IntelliDrive SE Process



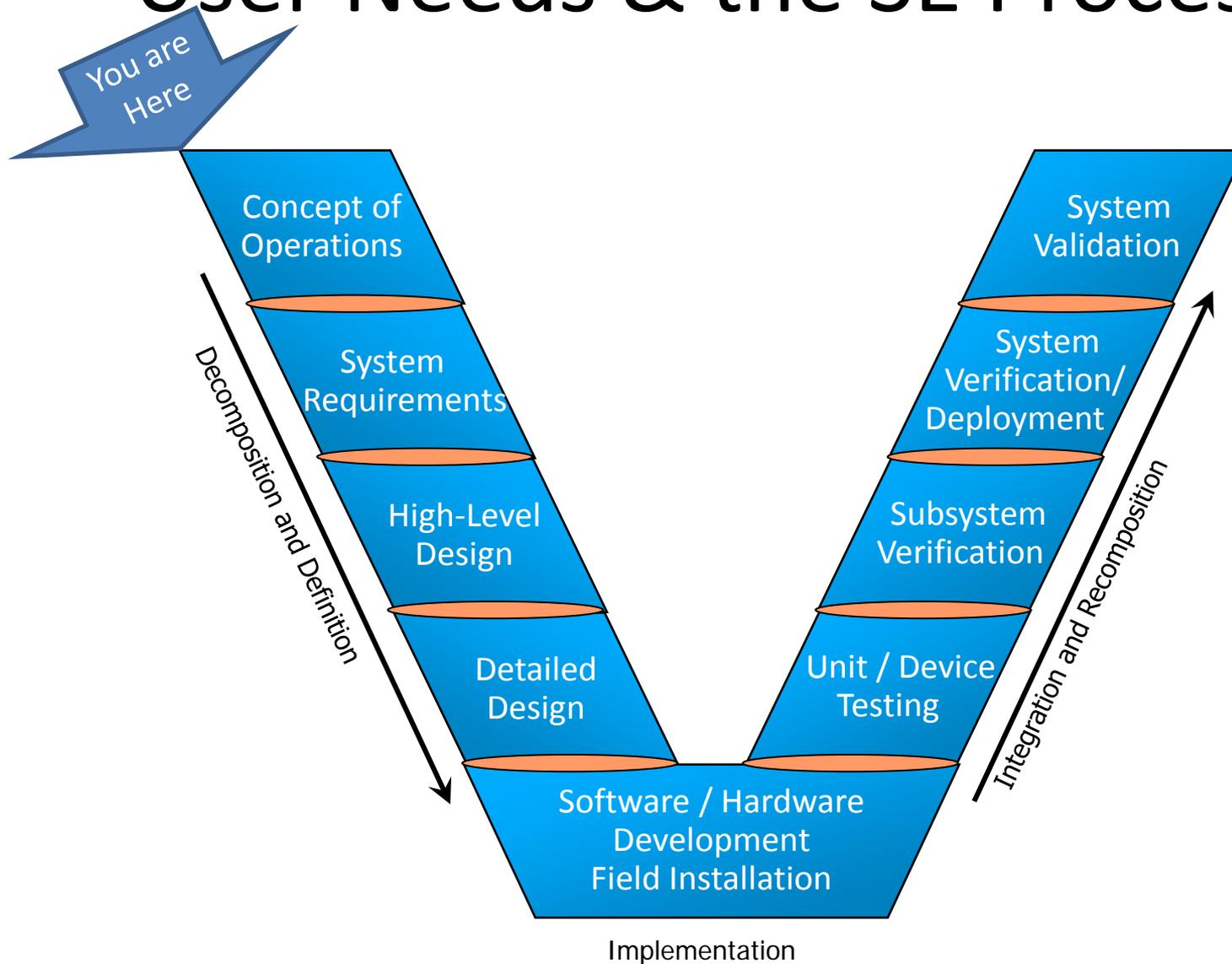
**END DAY 1**

# **INTELLIDRIVE USER NEEDS DISCUSSIONS - OVERVIEW**

# IntelliDrive SE Process Involves You

- Revisit and update the IntelliDrive concept of operations, requirements, and architecture
- Existing documentation and lessons learned will be used as a resource
- The first step in this process is to elicit User Needs from you.

# User Needs & the SE Process



# What is a User Need?

- A “User Need” is defined as a capability that is identified to accomplish a specific goal or solve a problem that is to be supported by the IntelliDrive System.
- “A user requirement for a system that a user believes would solve a problem experienced by the user.”
  - IEEE Std 1362-1998, Section 3.26 - User Need
- Describes “what” is needed and not “how” it is to be implemented

# Characteristics of User Needs

- Scoped to the appropriate level
  - Too general -- needs to be further defined
  - Too specific -- may imply design
- Not Application specific
- Why?
- How much?
- How often?
- How fast?

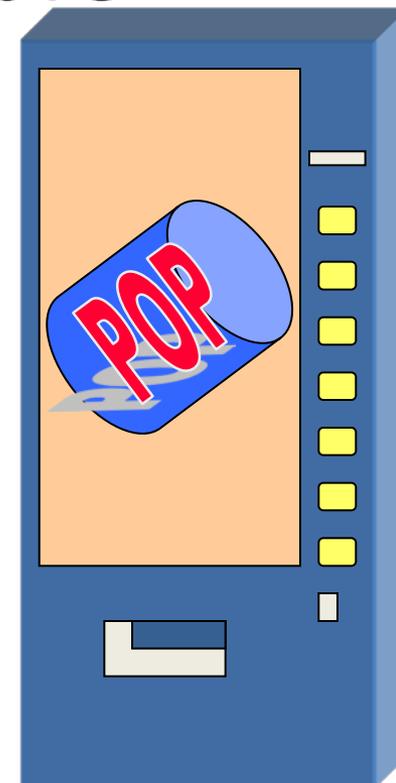
# User Needs – The User's Role

- Identify User Needs (capabilities, problems to be solved, processes to be improved)
  - Provide your rationale
- Attribute each need to an individual/group/organization
- Tell us your perspective
  - What “hat” are you wearing?

# User Needs Examples

User Need Example 1:

## Vending Machine Example



# User Needs Examples – Transit

- Problem experienced by the user:
  - Transit vehicles have difficulty adhering to their published schedule.
- Need of the System:
  - Provide information concerning current location of transit vehicles and the traffic situation to assist in maintaining on-time performance
- Fleet Manager's rationale:
  - Improve on-time performance and to reduce fuel costs (efficiency in operation).

# User Needs Examples – Work Zones

- Problem experienced by the user:
  - Maintenance workers are subject to injuries from vehicles violating work zones
- Need of the system:
  - Provide vehicles with information about upcoming work zones
- Rationale:
  - Driver's perspective: I don't want to hit anyone
  - Maintenance worker's perspective: I don't want to be hit

# DISCUSSION FOR USER NEEDS

# What Happens Next

- The inputs from this workshop will be collected and organized
- Findings Report provided to DOT
  - DOT will disseminate to the participants
- Next Step for the program will be to update the IntelliDrive System Concept of Operations

**THANK YOU FOR YOUR  
PARTICIPATION!**