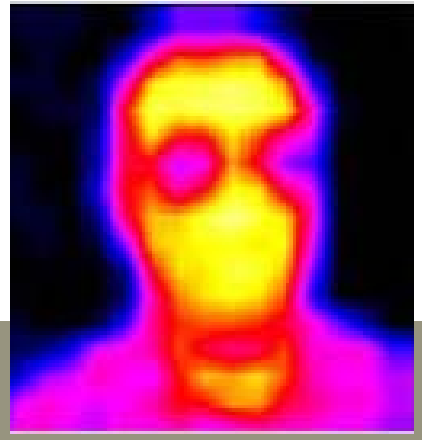
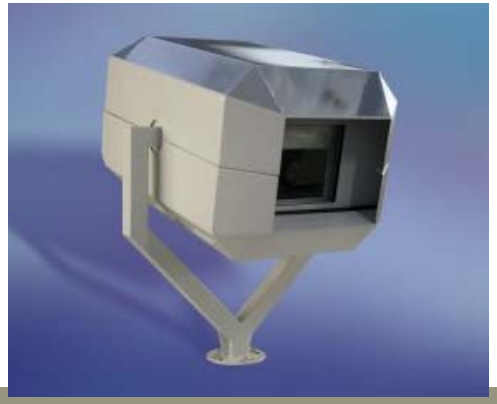
HOVpfs

HOV Pooled Fund Study

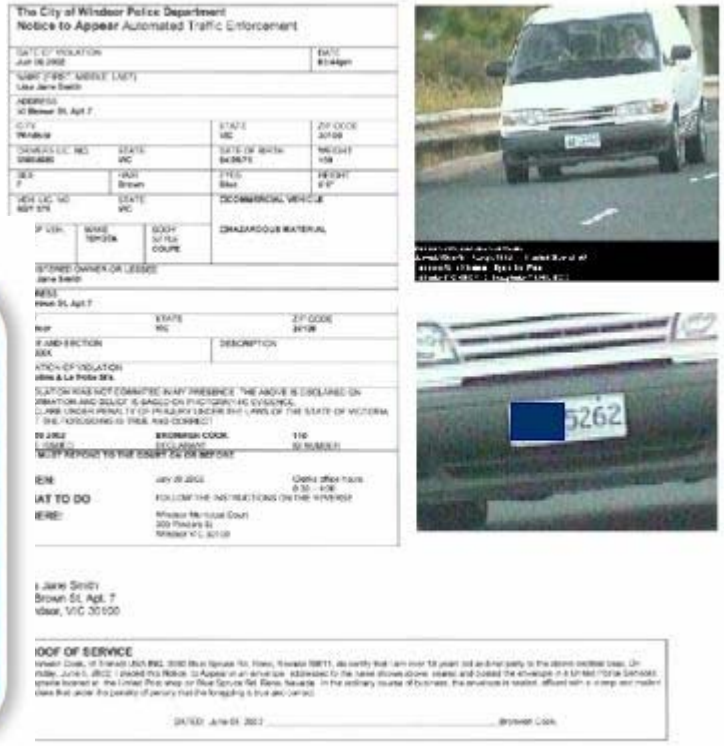
Automated Vehicle-Occupancy Verification Technologies Study





Addressing the HOV Enforcement Challenge

- Automated Vehicle Occupancy Verification (AVOV)



HOV Pooled-Fund Study

Objectives

- Identify Issues Common Among Agencies
- Suggest Projects and Initiatives
- Select and Initiate Projects
- Disseminate Reports
- Assist in Solution Deployment
- Track Innovations and Practices

HOV Pooled-Fund Study

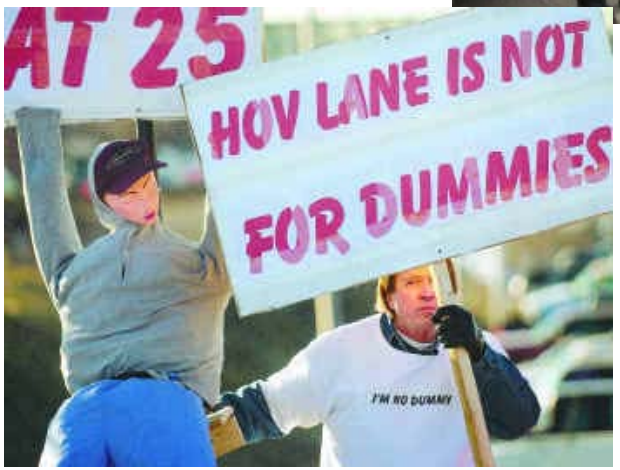
Participating State Transportation Agencies

- California
- Georgia
- Maryland
- Massachusetts
- Minnesota
- New Jersey
- New York
- Tennessee
- Virginia
- Washington

Federal Highway Administration (FHWA)

Study Team

- TTI
  - Ginger Goodin, Research Supervisor
  - John Wikander
  - John Lowery
  - David Ungemah
  - Robert DeRoche
  - Chris Poe
- Battelle
  - Denny Stephens



Presentation Overview

- Problem
- Overview of Project Objectives
- Project Deliverables
- Next Steps

Key Questions for AVOV Research

- How do various AVOV technologies work?
- What obstacles do they face?
- What is the outlook for success or widespread use of these technologies?
- What technologies are on the horizon, including “pie-in-the-sky” ideas that are perhaps years away from being considered?
- What technologies, if any, have been devised, but rejected, and why?

Purpose and Objectives

- Review concepts, methods and technologies for AVOV
- Identify feasible technologies
- Develop criteria for improved AVOV
- Develop implementation guidelines

Project Deliverables

- Synthesis Report
- Research White Paper
- Concept of Operations Document*
- Outreach Materials
  - Project Fact Sheet
  - Subject Presentation
  - Distribution Plan, Letter, Notice

*supplemental deliverable

Synthesis Report

- Synthesizes current state of the practice in pertinent AVOV technologies
- Serves as a guide for identifying improved methods
- Detailed information provided on
  - Roadside-based technologies
  - In-vehicle technologies

Research White Paper

- Chapter One Introduction
- Chapter Two State of the Practice
- Chapter Three Roadside Systems
- Chapter Four In-Vehicle Systems
- Chapter Five Legal and Privacy Considerations
- Chapter Six Conclusions and Recommendations
- References

Chapter One – Introduction

- Purpose and Objectives
- Traditional HOV/HOT Enforcement Practices and Shortcomings
- Criteria for Improved Occupancy Verification

Problems with Visual Enforcement

- Insufficient Accuracy and Reliability
- Costs and Manpower Requirements
- Safety Concerns

Growing Need for AVOV

- Better Occupancy Enforcement Needed for Existing and Proposed HOV Lanes
  - Over 100 HOV projects in operation
  - 33 projects planned
- Growing Number of Managed Lanes Projects Will Require Enforcement to Protect Toll Revenues
  - 24 HOT projects in six states
    - 7 HOT projects in operation
    - 17 projects in development

Traditional Enforcement Methods

- Geometric design methods to aid visual check
- Technology-assisted methods
- Supporting regulatory measures
- Policy and administrative approaches
- Shortcomings
  - Reliability
  - Safety
  - Cost

Chapter Two – State of the Practice

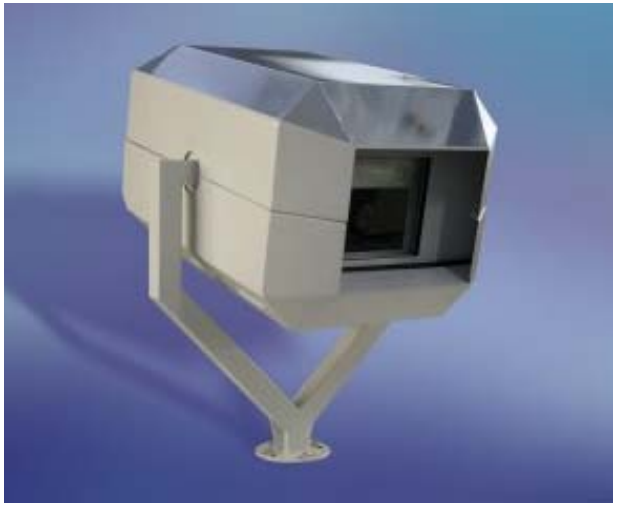
- Overview
- Description of AVOV Systems
  - Roadside
  - In-vehicle
- Research and Development Overview

Research and Development Overview

- Domestic Initiatives and Projects
  - Federal Motor Vehicle Safety Occupant Crash Protection Standard (FMVSS 208)
  - Vehicle Infrastructure Integration Initiative (VII)
  - I-15 Violation Enforcement Study
- International Initiatives
  - E.U. Advanced Passive Safety Network
  - PRISM Project
  - AIDER Project
  - ENTERPRISE Report

Chapter Three – Roadside Systems

- Overview
- Sensing Technologies
- Technology Trends and Outlook
- Key Challenges
- Functional Requirements



3-Step Process:

1) Image or data acquisition
   - Via sensors
2) Data processing/feature extractions
   - Render data into useful form
3) Classification
   - Compare data to set of pre-defined criteria to find the match.

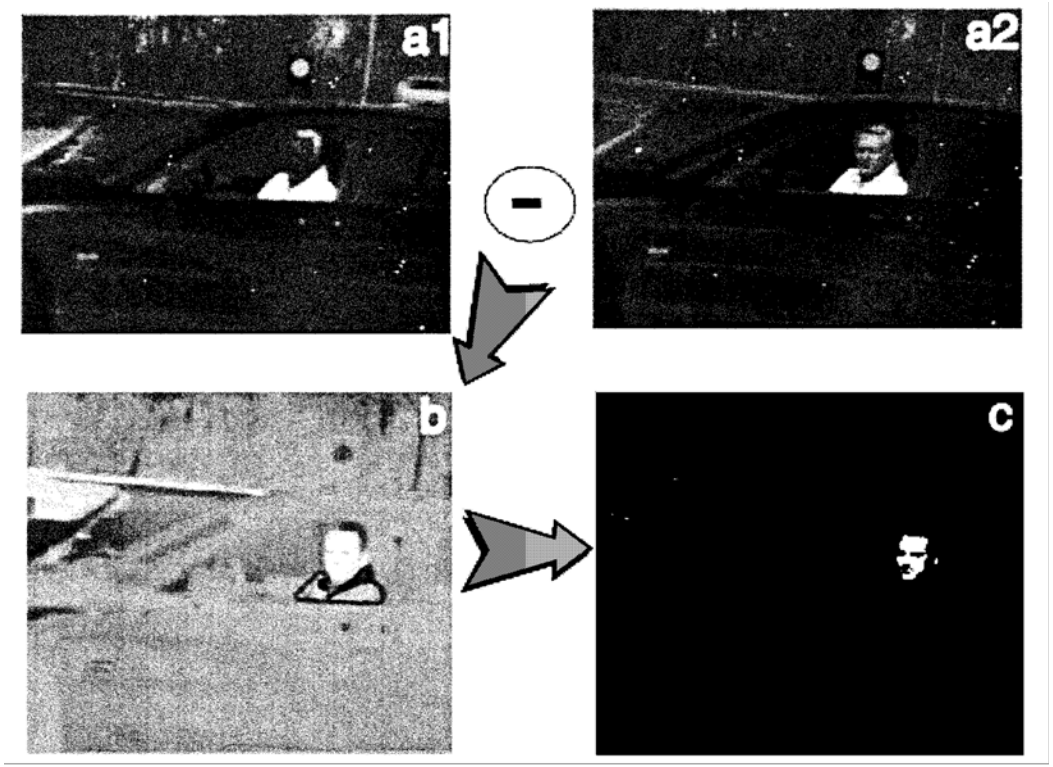
Sensing Technologies

- Viable Technologies
  - Multiband Infrared Systems
  - Infrared Systems
- Non-viable Technologies
  - Photo and Video Systems
  - Passive Microwave
  - Ultrawideband (UWB) Radar

Key Challenges for Roadside Systems

Property	Visible Light (Passive)	Near Infrared	Thermal Infrared	UWB Radar	Microwave
Cabin Penetration	✗	✓	✗	✗	✗
Environmental Conditions	✗	✓	✓	✓	✓
Image Resolution	✓	✓	✗	✗	✗
Capture at freeway speed	✓	✓	✓	✗	✗

Infrared Composite Imaging

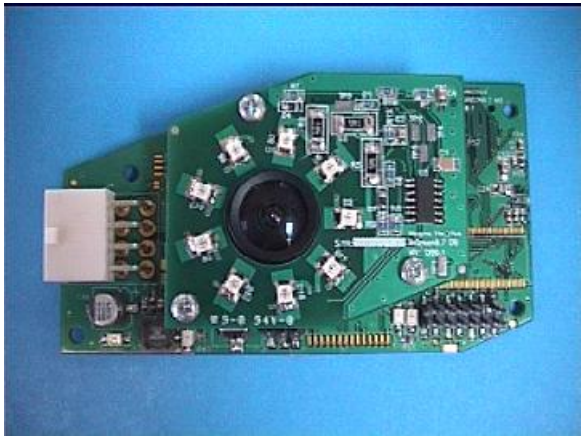


Technology Trends and Outlook

- Viable research and technologies nearly in place
  - Sensor technologies
    - Faster and cheaper infrared sensors
  - Image processing
    - NIR fusion isolates skin signature
  - Pattern classification
    - Neural networks
- No systems in current production
  - Cyclops/dtect

Chapter Four – In-Vehicle Systems

- Sensing Technologies
- Telematics / Communications Technologies
- Technology Trends and Outlook
- Key Challenges and Functional Requirements

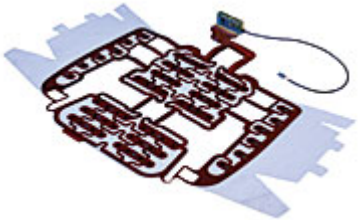


In-vehicle Sensing Technologies

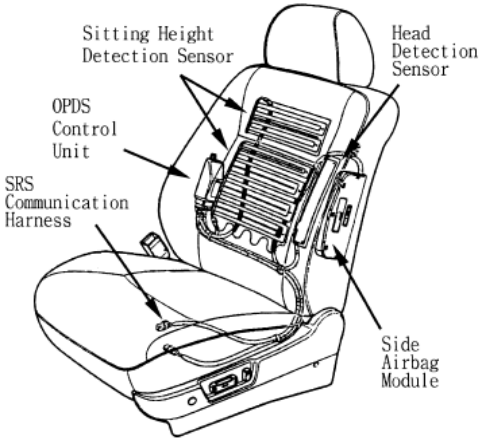
- High Interest Technologies (Near Term Viable)
  - Weight Sensors
  - Optical and NIR Sensors
  - Capacitive and Electric Field Sensors
- Low Interest Technologies (Near Term Unviable)
  - Biometric Smart Cards
  - Thermal Infrared Imaging
  - Ultrasonic Sensors
  - Smart Cards and Readers

Weight Sensors

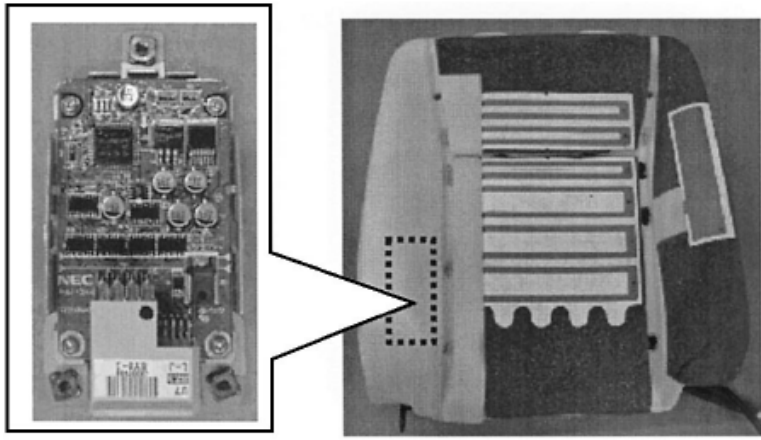
Development Status	Production
Development Interest	Large – nearly every manufacturer and parts supplier
Market Forecast	Continued strong demand



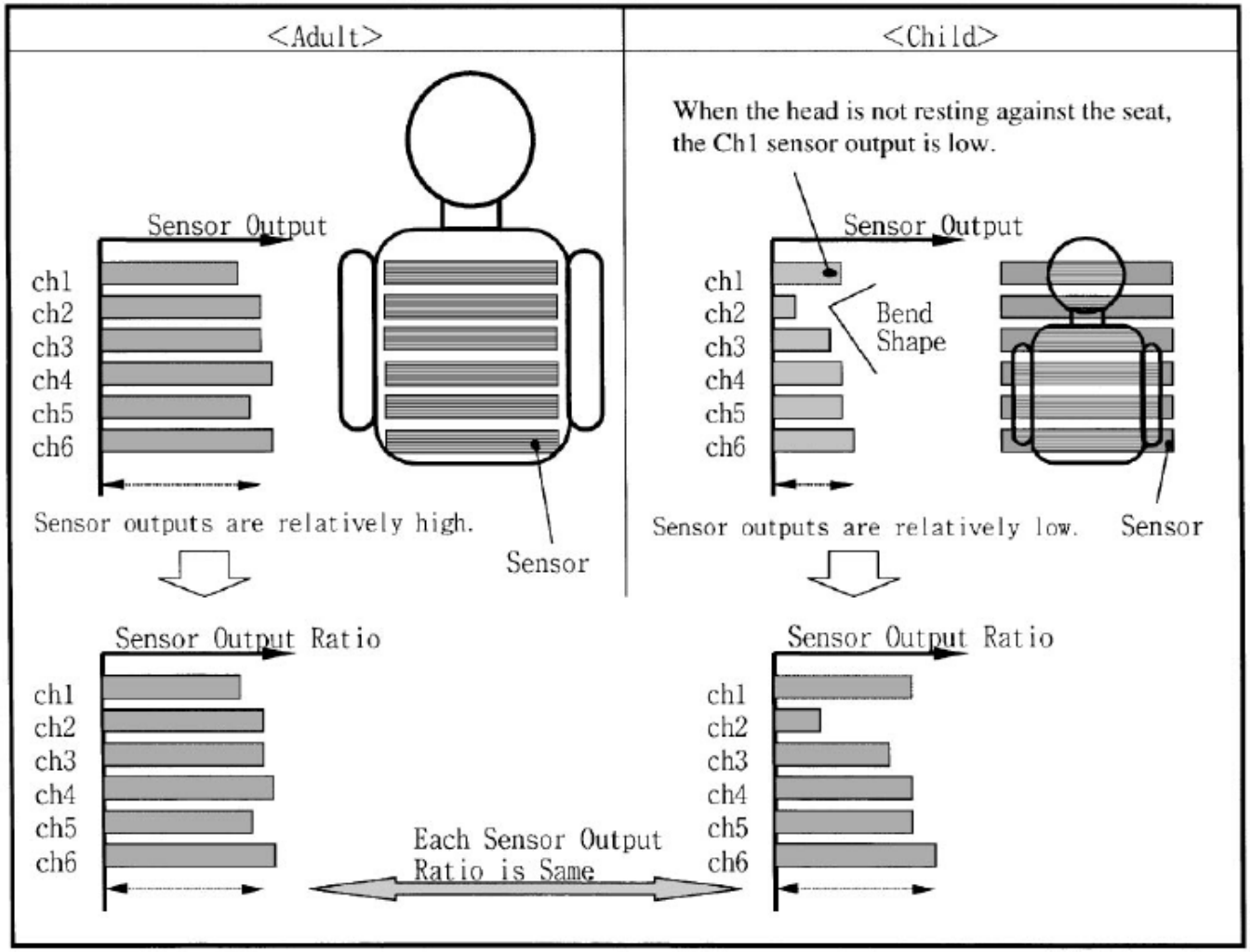
Electric Field Sensors



Development Status	Production
Development Interest	Moderate – systems have been investigated by NEC/Honda/Elesys, IEE, Allied Signal, Siemens, and TRW
Market Forecast	Wider application foreseen for rear seats with side curtain airbags

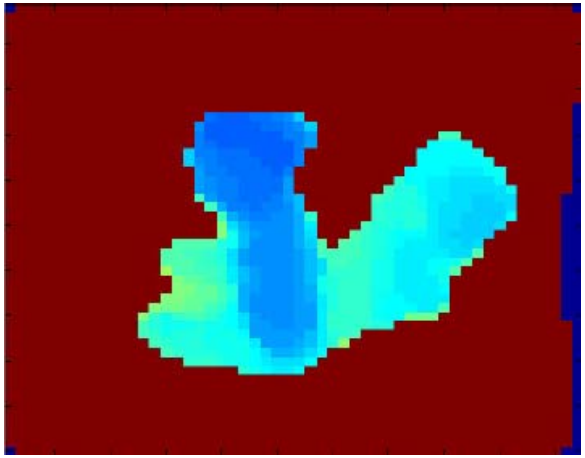


Electric Field Sensors - Operation

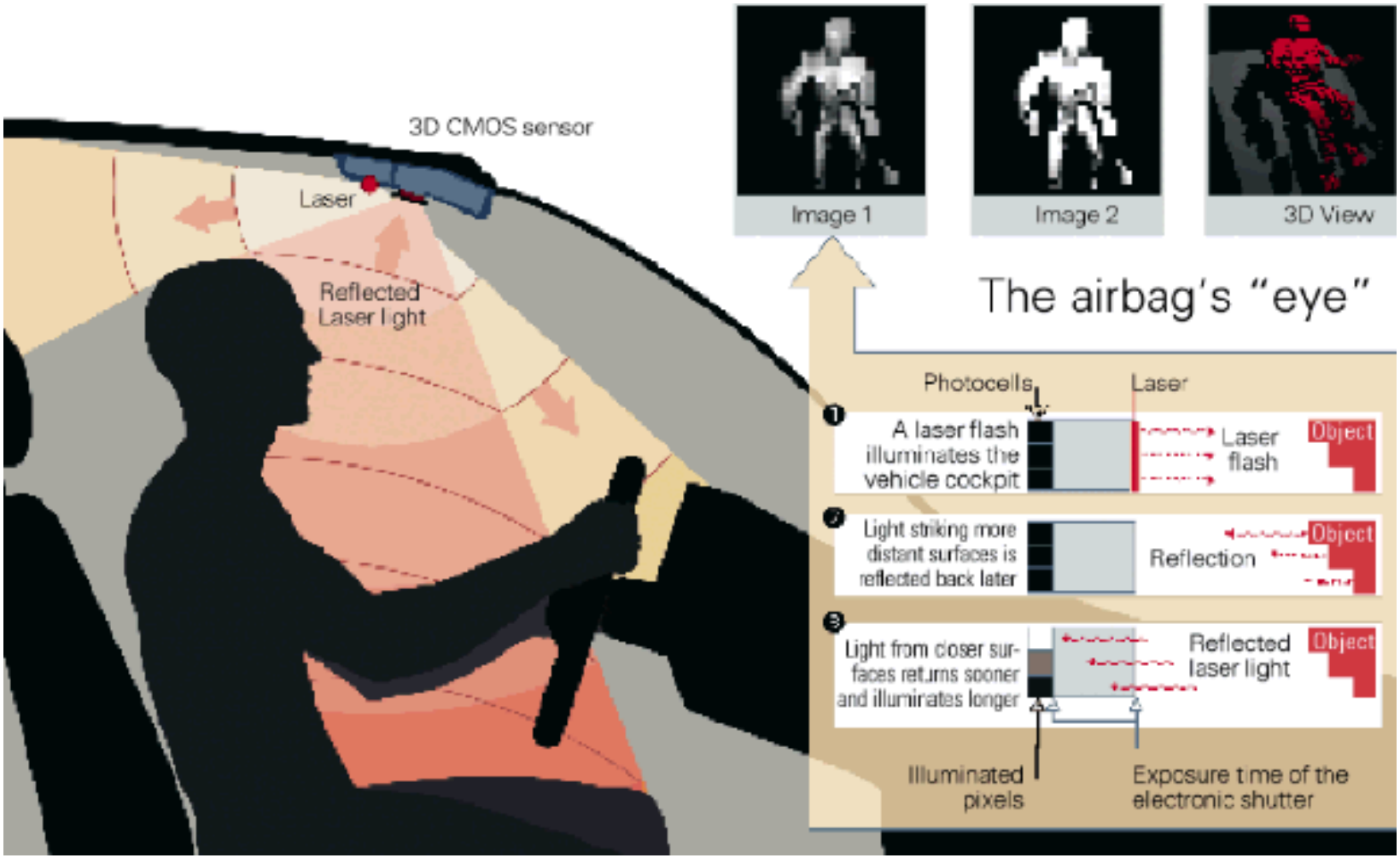


3D Time-of-Flight (TOF) Sensors

Development Status	Pre-production
Development Interest	Large – systems have been researched by IEE, Canesta, Fraunhofer/Siemens, DaimlerChrysler/Conti Temic
Market Forecast	Wide application foreseen



3D TOF Sensor Operation



Trends: In-vehicle Systems

- Sensing Technologies
  - OEM advanced airbag systems will detect front occupants
    - 100% of new vehicles by 2009
    - Weight sensing
    - Active Optical / NIR, Ultrasonic, Electric Field sensors
  - Increasing monitoring of rear passengers as rear side curtain airbags gain adoption
    - Electric Field sensors
- Telematics
  - DSRC units for roadside communications (2008-2015 est.)
  - Higher speed in-vehicle networks

Key Challenges

- Accuracy and Reliability
- Rear Occupant Detection Capability
- Communications Integration
- Retrofit Feasibility and Costs
- Market Penetration

Chapter Five - Legal and Privacy Considerations

- Overview
  - Moving violations vs. toll evasion
- Statutory Framework
  - Examination of statutes related to automated enforcement
- Legal Issues
  - Legal challenges

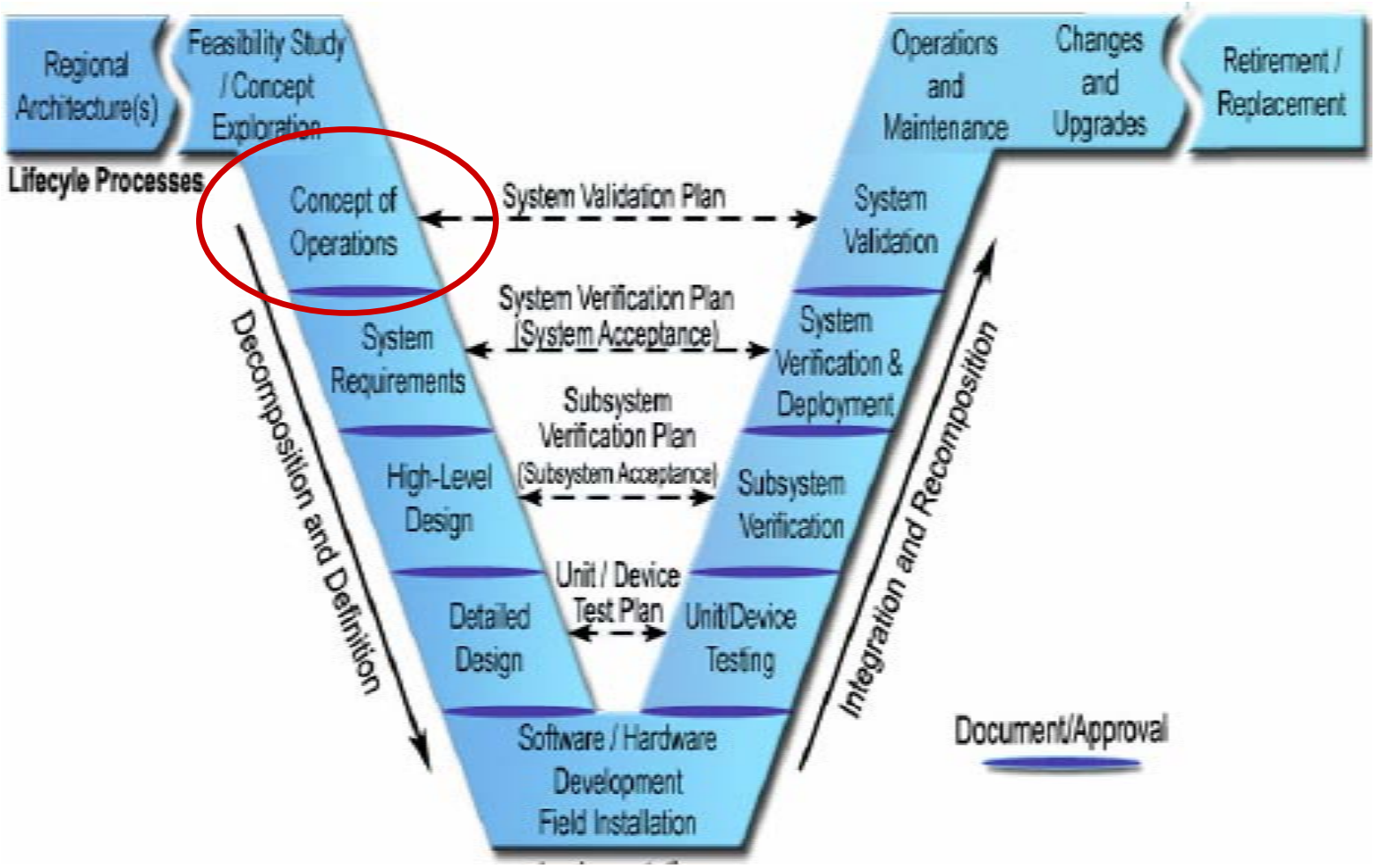
Privacy Considerations

- Privacy Concerns
  - Threats
- Resolving Concerns
  - Photographic record of occupants
  - VII barriers
  - Legal definition of HOV infraction
- Role of Public Education

Conclusions and Recommendations

- Phased Approach
  - Near Term (2-5 years)
    - Growth of HOT lanes provides a market for roadside systems in the near term
    - Use as enforcement tool
    - Engage in VII development
  - Intermediate Term (5-15 years)
    - Legal authority for automated roadside system
    - Continue VII engagement and address public privacy concerns
  - Long Term (15-20+ years)
    - VII-based in-vehicle system for occupancy verification

Concept of Operations



Concept of Operations Document

- *Purpose*: To define user needs and functional requirements for a roadside AVOV system
- How can AVOV equipment fit into the larger context of an ITS network?
- Provides a starting point in the procurement process
  - Describes equipment features that can be tailored for a specific application
  - Helps determine what the procurement specification will need to address in order to support the desired feature

Questions?