Human Factors Research Issues for Cooperative Intersection Collision Avoidance Systems (CICAS)

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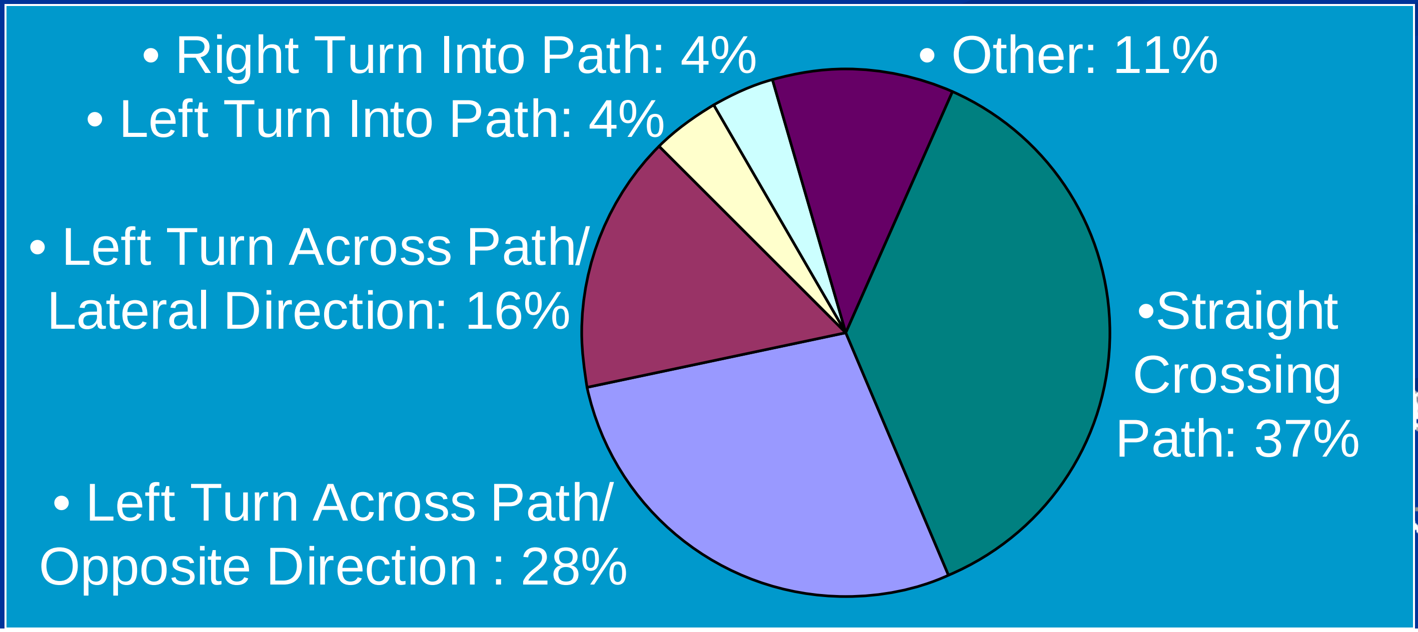
CICAS Overview

- CICAS will use vehicle/infrastructure communications to address traffic signal and stop sign intersection crashes.
  - ~2 M Crashes Per Year
  - 32% of All Police-Reported Crashes (TSF, 2005)



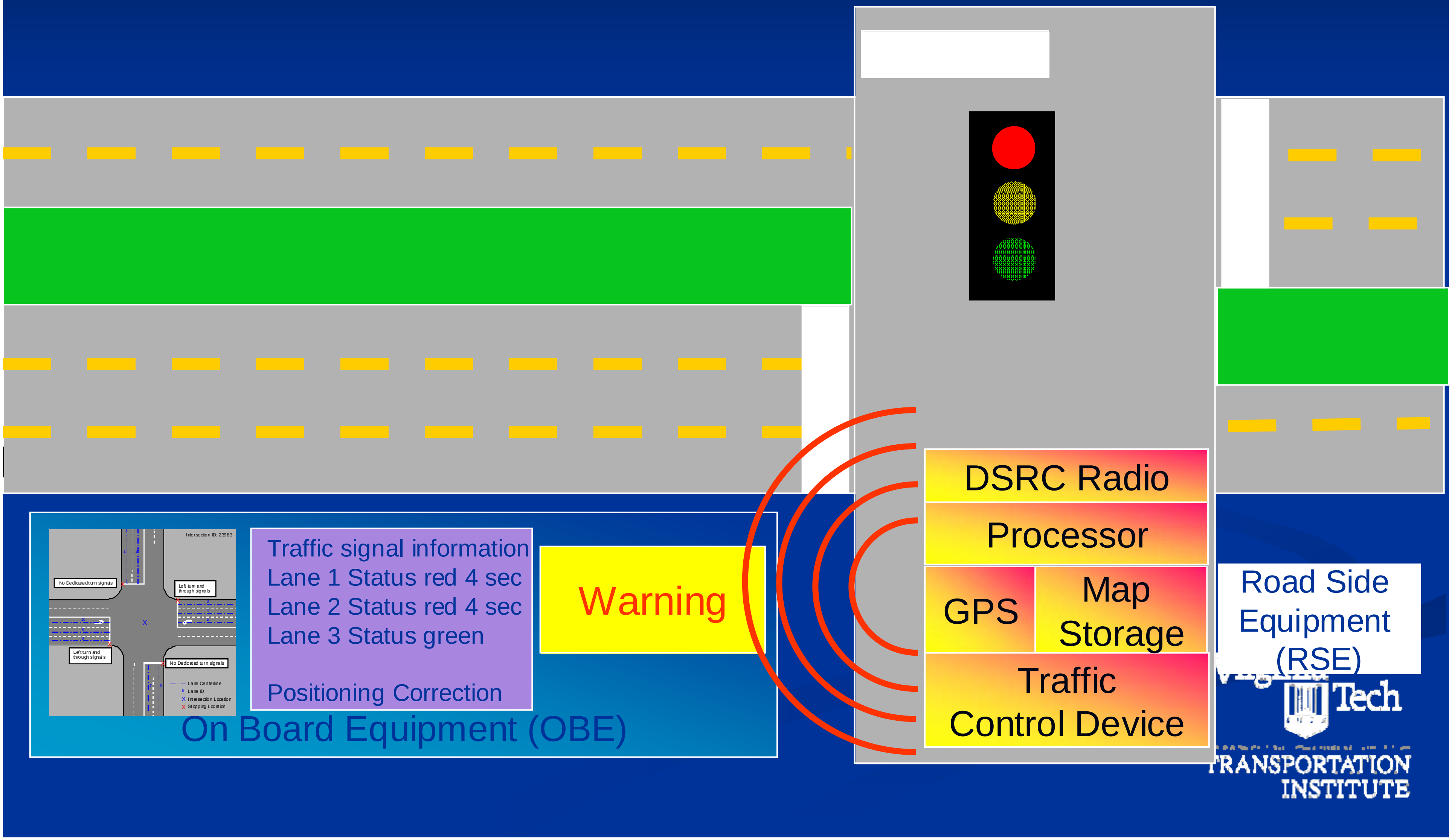
Intersection Crash Types of Focus

- Straight-Crossing Path Crashes

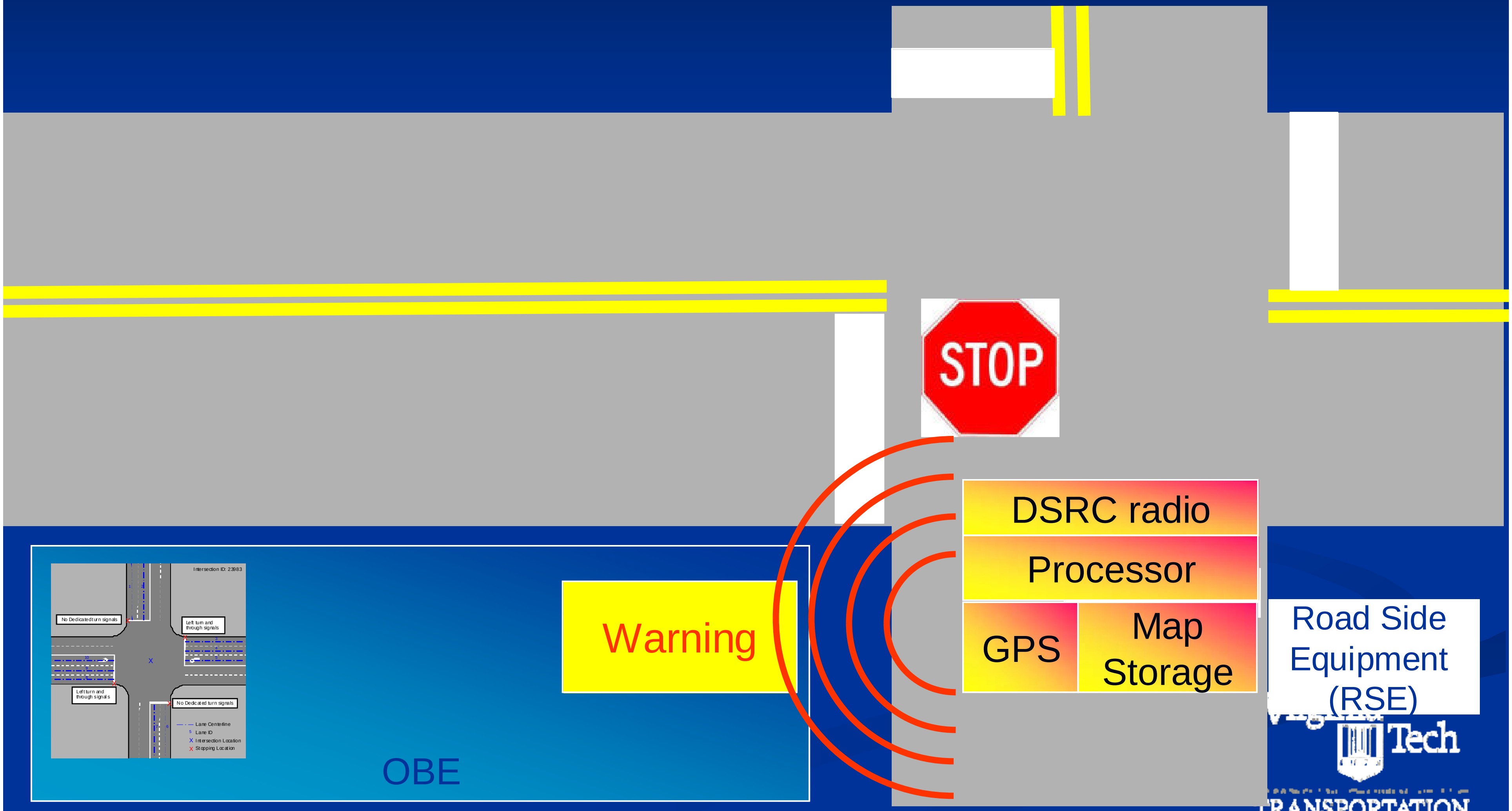
- Left Turn Across Path/Opposite Direction

- Stop Sign Assist

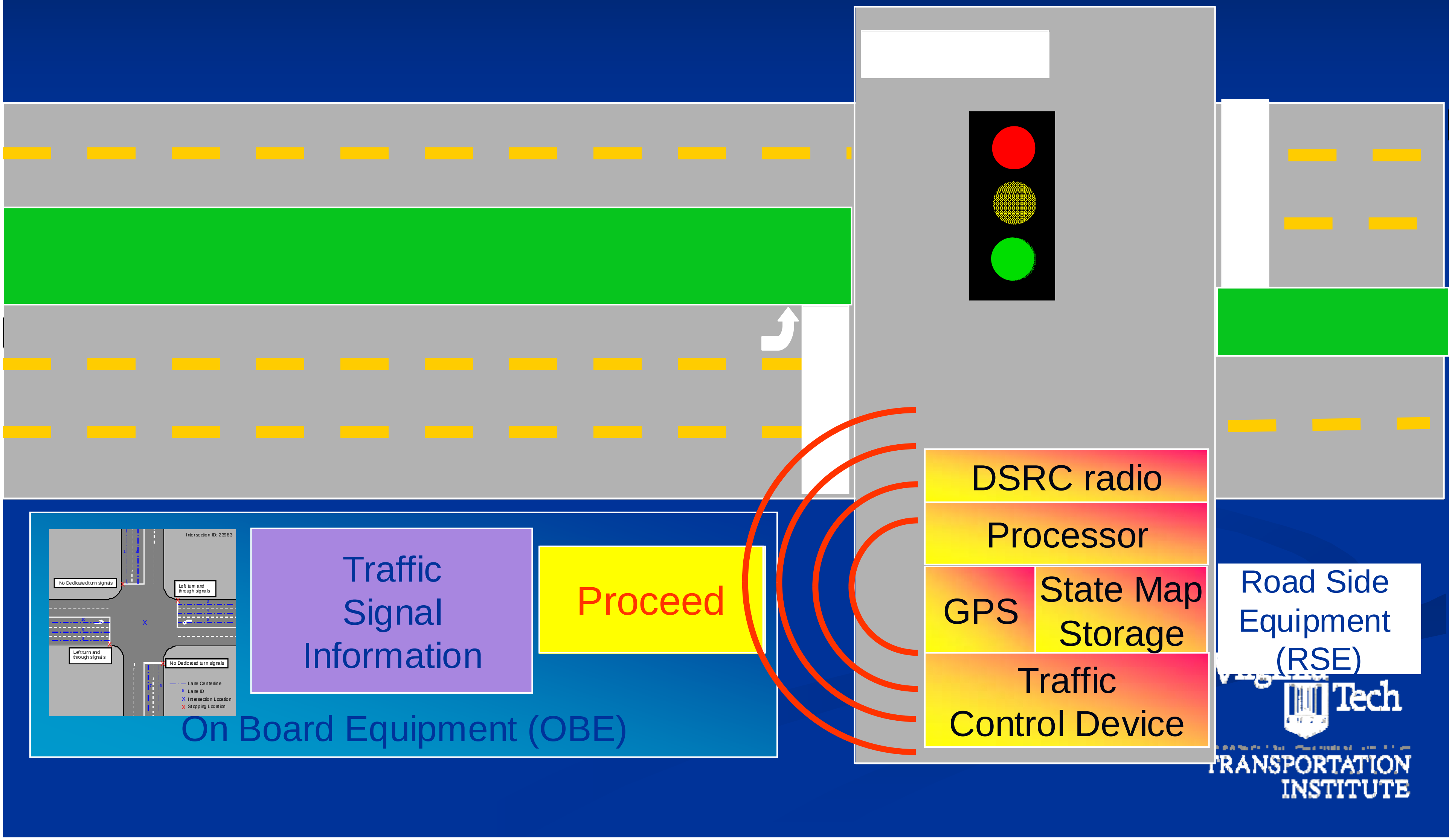
CICAS-V Signal System (Addresses SCP and Some LTAP Crashes)



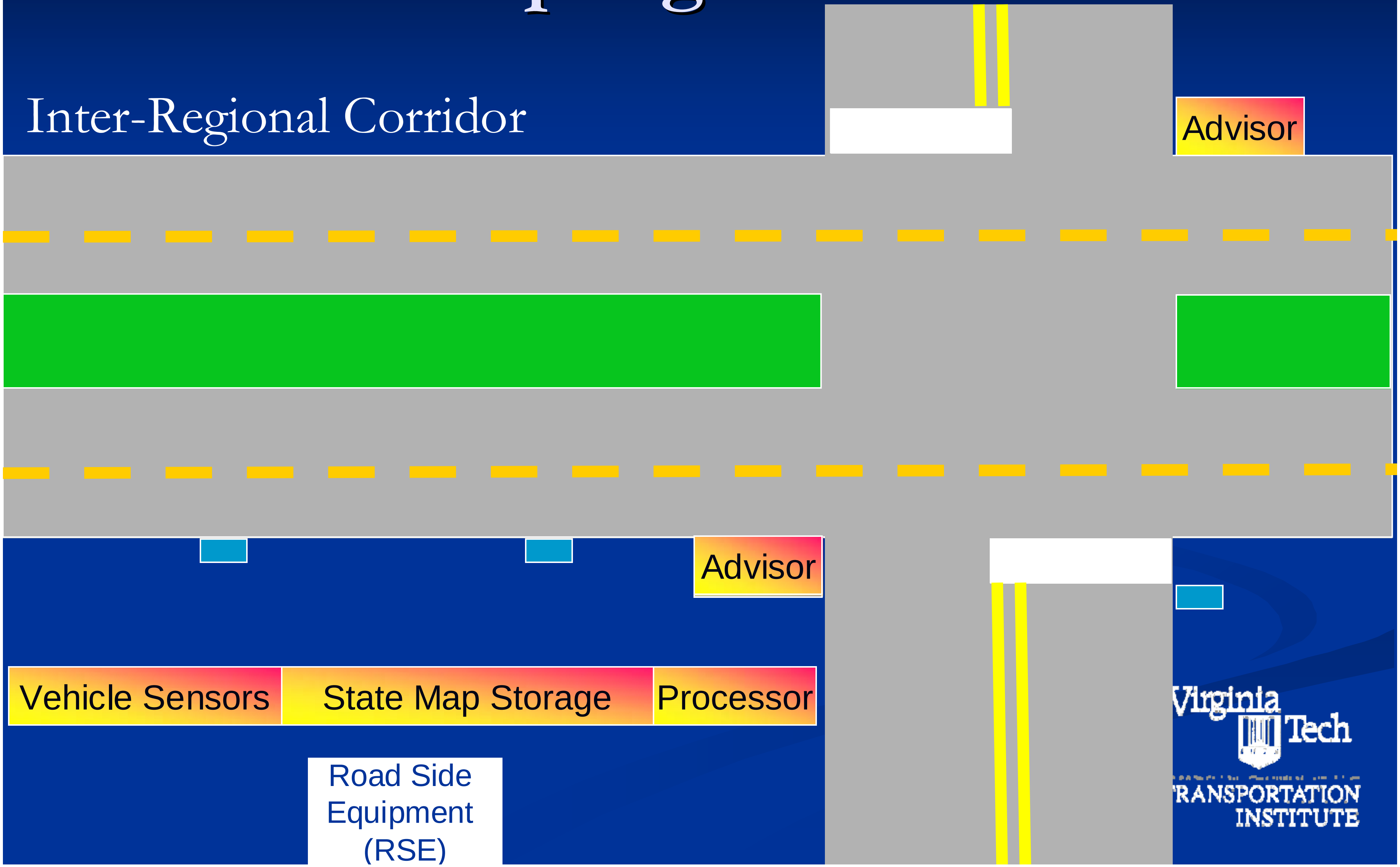
CICAS-V Stop-Control System



LTAP/OD System



Stop Sign Assist



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Human Factors Research Issues

- Each warning system has human factors research needs in common, although the method to address the research need and final answer may be different for each.
  - Development of an Algorithm (Warning timing)
    - Depends on warning type and driver characteristics
      - Driver alertness (Willful violation vs. Unintentional due to distraction)
      - Age
        - For example, with Gap acceptance issues, if design for older drivers, younger drivers may consider warning "too early"
  - Determining the driver interface (in-vehicle or infrastructure)
  - Determining acceptance of alert rates, including nuisance alarm rates
  - Determining scenarios for which warning is appropriate
  - Determining overall system reliability

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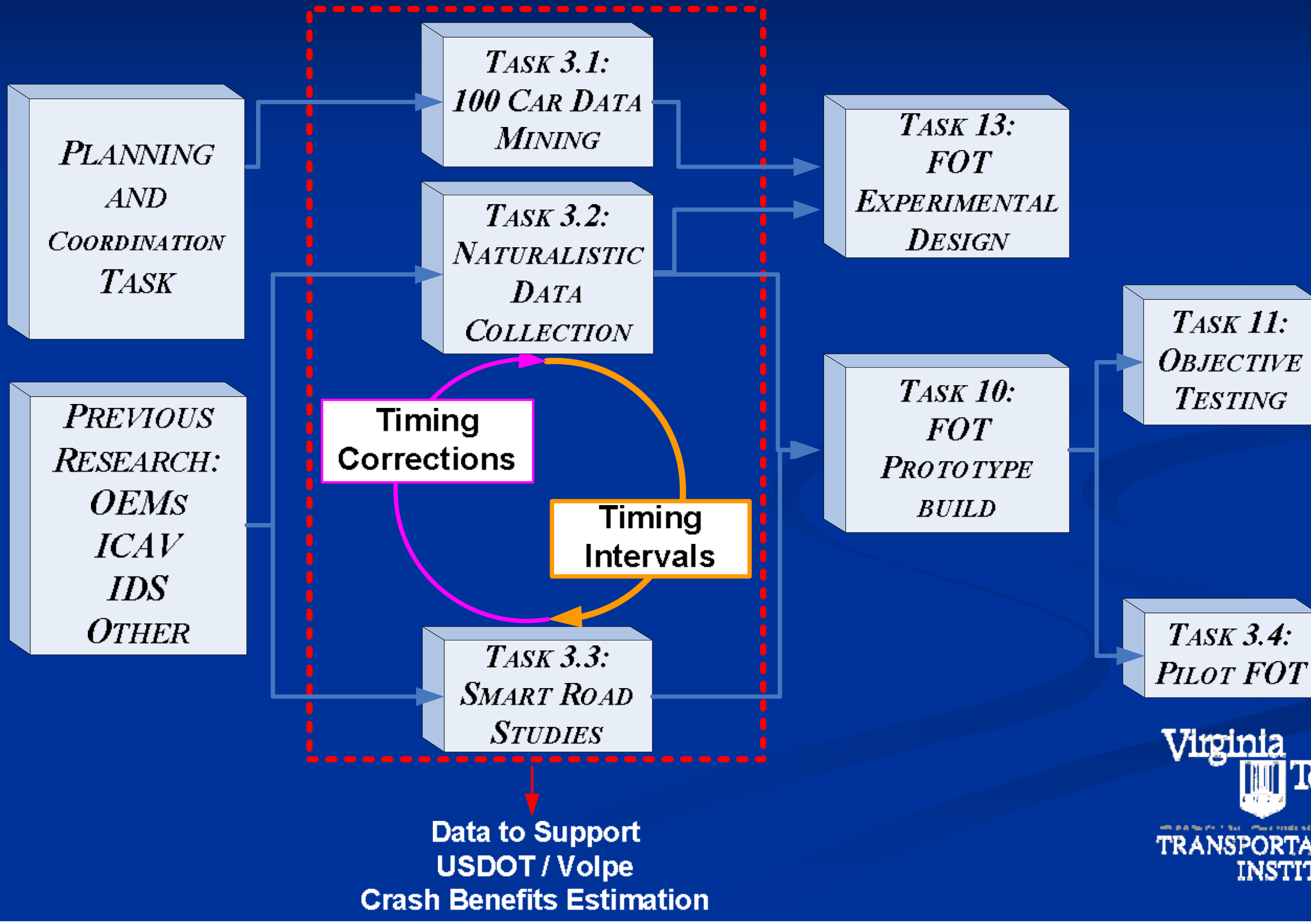
Example: Addressing HF Issues in CICAS-V



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CICAS-V Subtask 3.1

- Sample Research Question:
- What are the circumstances under which a driver violates?
  - Willful vs. unintentional violator
    - Driver distraction observed
      - Distraction types observed
  - Intersection control type (signal, stop sign)
    - Time after red phase onset (for signalized intersection only)
  - Visual checking behavior (e.g., looking both ways at intersection)
  - Driver age
  - Driver gender
  - Driver aggressiveness (e.g., car following behavior)
  - Following driver presence/headway
  - Intersection approach speed
  - Posted speed limit
  - Traffic density
  - Time of day
  - Weather/Visibility/Road conditions

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To Address the Research Qs

- Mining the 100-Car Database to understand what drivers are doing when they commit violations and near-violations.

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CICAS-V Subtask 3.2

- Research Questions
  - How many false alarms and misses result from any particular algorithm?
  - How often do vehicles violate any particular signalized or stop controlled intersection?

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To Address the Research Qs

- Use naturalistic driving approaches to intersections to refine the alert timing approach and determine rates of violations and near-violations

Metric Example		Predicted	
		Compliance	Violator
Observed	Compliance	Correct Rejection	False Alarm
	Violator	Miss	Hit

CICAS-V Subtask 3.3

- Determine the Driver Vehicle Interface
  - Is the warning meaningful?
  - Does it illicit the appropriate response in a timely manner?
- DVI Issues
  - Driver perception of scenario
  - Driver reaction time
  - Final algorithm

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To Address the Research Qs

- Conducting a series of controlled Smart Road tests to evaluate drivers' response to DVIs in a "surprise" trial.

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IDS/ICAV Occlusion Technique

Open State
(light is green)

Closed State for 2 Seconds
(light turns amber)

Open State
(alert issued; light turns from amber to red)

Occlusion technique used to simulate driver distraction and place precise experimental control over when forward scene and traffic signal phase can be viewed

VTTI Smart Road intersection

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CICAS-V Subtask 3.4

- How will the final CICAS-V system function in the real-world with naïve drivers?
- What needs to be changed?
- Are we FOT ready?

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To Address the Research Qs

- Conduct a pilot FOT with naïve drivers using the final FOT CICAS-V system design.
- This final HF task is the culmination of the coordination of all of the HF and non-HF tasks.

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Challenges/Next Steps

- Conduct FOT to investigate potential safety benefits and customer acceptance associated with the system
- Determine how to integrate the CICAS warnings with each other and with other in-vehicle warnings
  - Understand how integrated systems perform in the real world
- Maintaining the necessary coordination and collaboration

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