UNITED STATES
DEPARTMENT OF TRANSPORTATION

Vehicle-to-Infrastructure Research - Track 1
Enabling Technologies

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V2I Track 1 – Enabling Technologies

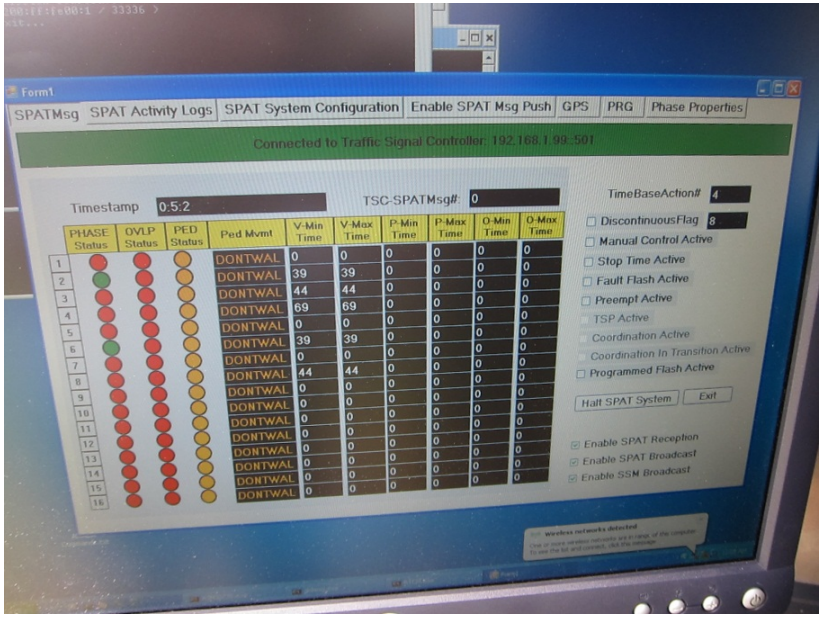
Goal – Develop and integrate the infrastructure components necessary to provide the foundation for V2I deployment.

- Signal Phase and Timing (SPaT)
- Mapping
- Positioning
- Communications
- Roadside Equipment (RSE)
- Integrated Prototype

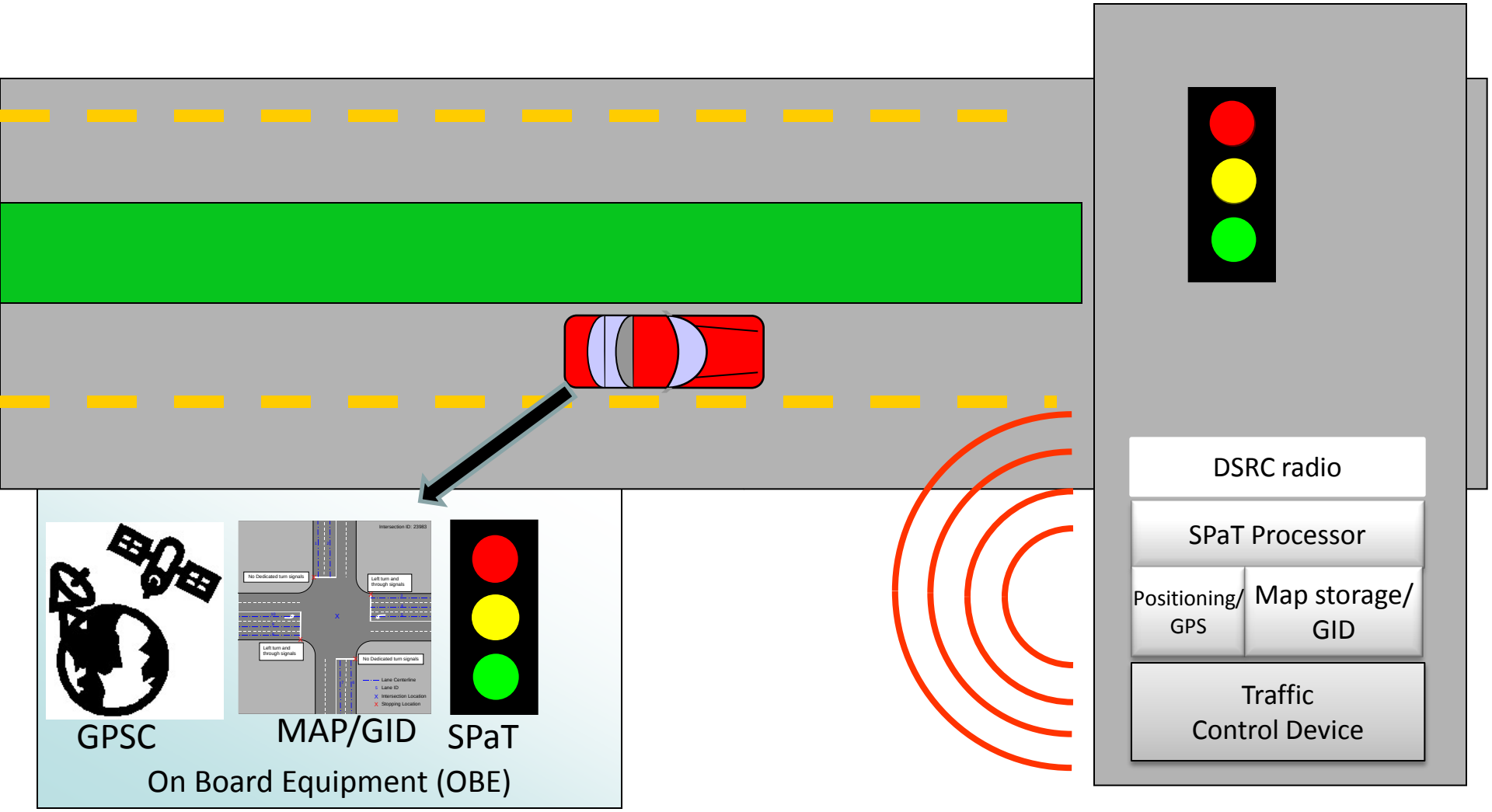
Signal Phase and Timing (SPaT)

Goal: Develop an interface between signal controllers and RSE to enable 2-way data exchange between vehicles and controllers

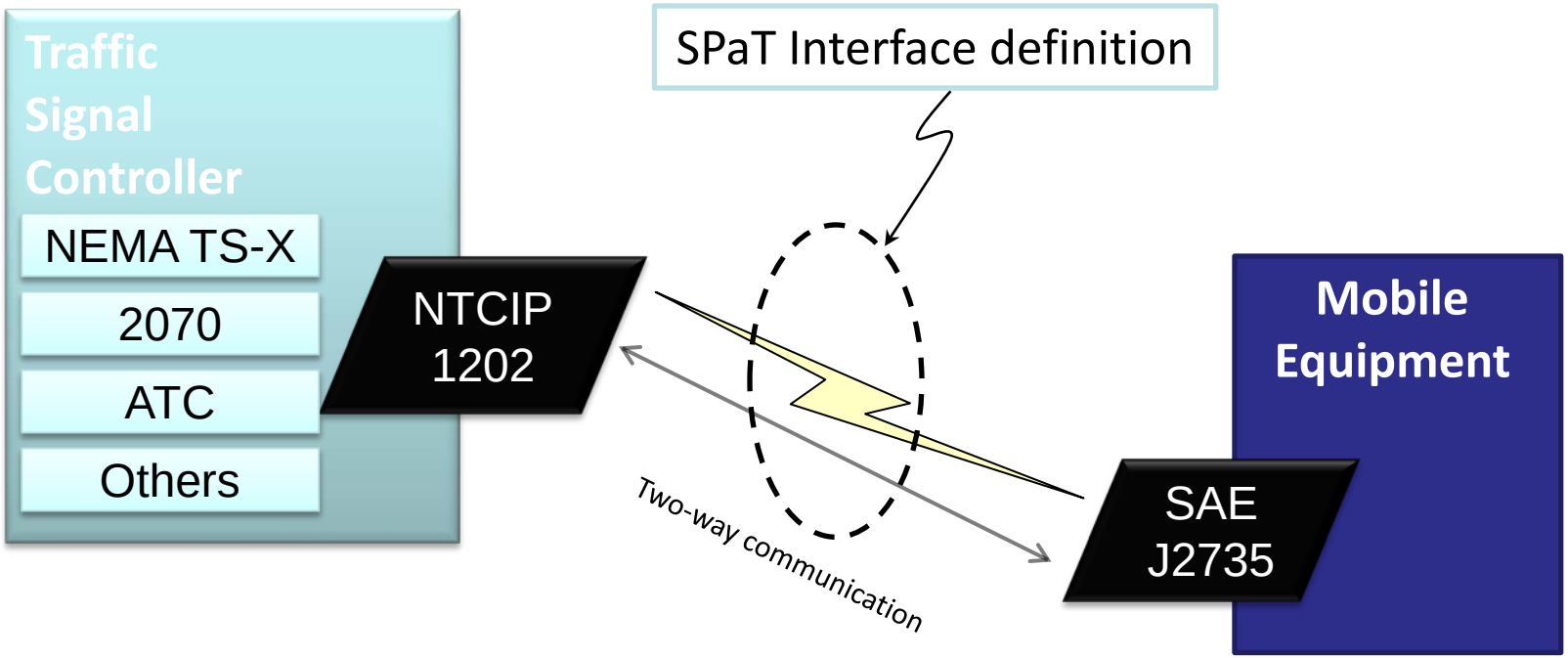
- SPaT Data
  - Signal state by movement
  - Min/max time remaining by movement
  - Exact time remaining in yellow
- Geometric intersection description (GID)
- Signal request messages (Emergency vehicle preemption, transit signal priority, etc.)
- RTCP position correction message
- Standards to promote interoperability
  - NTCIP 1202 and 1211
  - SAE J2735



SPaT Operation Overview



Open Interface – Concept



Signal Phase and Timing (SPaT)

- Interface tested in the Connected Vehicle Highway Testbed (CVHT) at the Turner Fairbank Highway Research Center (TFHRC)
- Safety Pilot - 12 intersections equipped
  - broadcast the SPaT information
    - Transit apps plan to use data, required a new field for pedestrian detection
  - SPaT data will be logged to facilitate future application development
- Safety, mobility and environmental V2I applications will need SPaT data

Mapping

Goal: Collect relevant roadway geometry and attributes data and broadcast it for use in V2I applications.

- Mapping Data
  - Pavement marking
  - Roadway signs
  - Roadside furniture (poles, cabinets, other potential obstructions)
  - Roadway geometry (e.g. curvature)
- Mapping Technology
  - LIDAR
  - Aerial Photogrammetry
  - As-built plans/maps
  - Data Fusion
  - Probe Data/crowd sourcing

Mapping Findings

- Vehicle mounted technologies solution (LIDAR) provides the most detailed data for use as a core mapping solution
- Vehicle mounted technologies solution is relatively costly and requires an investment in resources including skilled personnel and equipment.
- The other mapping solutions will remain useful for change detection as well as for mapping under certain specific conditions.
- Collection, preparation, and use of mapping data completed at the TFHRC Testbed May 2012.
- Three lane-level applications were demonstrated using decimeter-level positioning techniques
  - Lane departure warning
  - Curve speed warning
  - Signal Phase and Timing, at lane-level

Positioning

Goal: Ascertain which current or near-term positioning technologies can meet requirements of V2I applications

- Which road?
- Which lane?
- Within lane?

- Two technology platforms for positioning
  - On-board vehicle equipment
  - Infrastructure-based correction messages

Positioning Findings

- Positioning and mapping are closely related
- Two approaches based on application type
  - V2I relies on absolute positioning solution
  - V2V relies on relative positioning solution
- Accurate vehicle position at intersection is critical
  - SPaT information is based on a phase to lane assignment
  - Requires lane-level accuracy
- Testing technologies at the CVHT in early fall
  - Baseline OEM grade GPS
  - Inertial Measurement Units (IMU)
  - GPS code and carrier solutions (correction messages)

Communications

Goal: To test multiple communication technologies for potential use in V2I applications

- Quantify capabilities of the technologies against requirements of key V2I applications
- Gather subject matter expert opinions to select the most promising candidates
  - Dedicated Short Range Communications (DSRC)
  - Cellular 4G/LTE
  - High definition radio
- Test the technologies in a laboratory field test at CVHT this fall

Communications Findings

- Connected vehicle program will likely utilize multiple technologies
  - Active safety applications to use DSRC
  - mobility and environmental applications to use DSRC and/or cellular (4G/LTE)
- Deployment of 4G/LTE is limited and dependent on private development
- DSRC has limited bandwidth and footprint
- Some wireless communications appear to interfere with GPS signals

Roadside Equipment (RSE)

Goal: Foster the development of RSE that meets the requirements of the connected vehicle program

- Current RSE to broadcast and receive using DSRC
- Modular in both physical and logical architectures
- Immediate forwarding (e.g. SPaT)
- Store and replay (mapping data, traffic incident management messages)
- Connected to backhaul for data logging

Roadside Equipment (RSE)

- 5 vendors participated in prototyping
- Research qualified products list (rQPL) issued 5/11/12 for use by Safety Pilot
- Development will continue to refine design based on Safety Pilot results
- Refinements will be made to incorporate multiple radio chipsets, if warranted

Integrated V2I Prototype

- Comprehensive solution to connected vehicle infrastructure needs
  - Incorporate all parts of Track 1 to work seamlessly to enable V2I applications
  - Comprehensive review of V2I system requirements
  - Integration and testing of a complete infrastructure system.
    - Data flows
    - Information exchange
    - Standards

For More Information…..

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