FHWA Activities in Navigation

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Outline

- HA-NDGPS
- Compression
- Timing
- Fast Integer Resolution – Long Range/Multiple Baseline
- Signal Phase & Timing
HA-NDGPS

- Continue Research using
  - Hagerstown
  - Hawk Run
  - Pueblo

- Documentation Development for Additional Test Sites Complete
New Compression Algorithm

• Goal – Develop a compression algorithm to ensure delivery of GNSS Observables over multiple data services
• Small Business Innovative Research – SBIR
  – Awarded September 2010
  – Completed March 2011
• Output
  – Non-proprietary compression algorithm
    • Can achieve 1000 bps
    • Includes iono and tropo models
    • Integrity Included!
  – Exceeded Expectations – details to follow
• Phase II – Awaiting Contract Award
Timing

• In the event of a GPS failure, are there timing backups?

• Why?
  – Telecom
  – Traffic Signals
  – Network Control

• Options
  – Procedural
  – High end clocks
  – NDGPS/HA-NDGPS

• Working with DHS
  • Proposed Network Solution
  • Need Last Mile
Fast Integer Resolution

• User receives GNSS Observables from multiple reference stations
• Reference station baselines may exceed 200 miles
• Discussion focused on 3 epoch solution
Fast Integer Resolution

• Initial Code Solution
• Minimizes Search Area
• Each second changes satellite Geometry

Note: Diagram is conceptual.
Signal Phase and Timing (SPaT)

- **Preliminary Requirements**
  - Identify high-Level Preliminary Requirements
    - Final Requirements – NO!
    - First high-level cut at requirements
    - Further work under Systems Engineering Study

- **Examine Technology**
  - Examine Available Technology
    - What can it do?
    - Technology holes
    - Target further research?

- **Implement**
  - Implement at TFHRC
    - Create Test Bed
    - Test applications in safe environment
Signal Phase and Timing (SPaT)

- **Goal** – Build something that works!!
  - Vehicle Positioning
  - Mapping
  - Telecommunications
  - Traffic Controller Interface

- **Final Requirements** – NO!
  - First high-level cut at requirements
  - Further work under Systems Engineering

Red Light Extension
## Application Requirements

### - SAMPLE -

<table>
<thead>
<tr>
<th>Application</th>
<th>Rationale</th>
<th>Basic Positioning Requirements</th>
<th>Higher Order Position Related Parameter Requirements</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Position (m)</td>
<td>Location Reference Required?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Confidence (%)*</td>
<td>Time Error (sec)</td>
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<tr>
<td></td>
<td></td>
<td>Integrity?</td>
<td>Availability Indication?</td>
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<tr>
<td></td>
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<td>Logical Directionality?</td>
<td>Dimension</td>
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<td></td>
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<td>Acceleration</td>
<td>Velocity</td>
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<tr>
<td></td>
<td></td>
<td>Yaw</td>
<td>Slip</td>
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<tr>
<td>Hazards, Information, and Traffic Control</td>
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<tr>
<td>Intersection Collision Avoidance - Red Extension</td>
<td>0.5</td>
<td>99.9</td>
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*The confidence associated with the error radius represents the tolerable frequency with which the application may make a false positive or false negative error. It is also possible to bias the application in favor of either false positive or false negative errors, although biasing in one direction increases the occurrence of errors in the other direction.*
Summary

- Longer Range, Faster, High Resolution Mapping
- Timing Backup
- Goal of Improved Vehicle Positioning
- Understanding Our Needs

New Apps + New Accuracies + New Systems = NEW OPPORTUNITIES
Questions?

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Backup Slides
Direction of Travel: West to East. GPS indicated positions jumped to SW West Virginia from 282345 to 2349Z Jul 01
### Reality versus Measured

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Reality</th>
<th>Event Present</th>
<th>Event Not Present</th>
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<tbody>
<tr>
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<tr>
<td>Event Not Present</td>
<td>False Negative</td>
<td>True Negative</td>
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