Portable Work Zone Data Collection

Blaine Van Dyke
ODOT ITS Designer
Year 1

- Construction Zone Travel Time project.

- Provide work zone information to public.

- Test OSU Bluetooth travel time sensors in new application.
Year 1 - Construction Zone

- 15 mile repaving project on I-5.
- North of Roseburg and South of Cottage Grove.
- Project anticipated having a large impact to traffic flow.

ITS project goals:
- Test the Bluetooth travel time technology in a new application.
- Inform the public of traffic impact.
- Analyze the impact of traffic delay.
Travel Time Collection

- Device collects Bluetooth MAC addresses.
- Stores the data and presents it with a web interface.
- ODOT database collects the MAC addresses from the web interface.
- Database subtracts timestamps to determine travel time.
Bluetooth Collection Device

- The larger gain antenna provides a collection radius of 600 feet.
- The DCU will ask for Bluetooth MAC addresses every few seconds.
- Multiple MAC addresses will be reduced to the one with best RSSI.
- Studies have shown that roughly 6% of vehicles have Bluetooth devices.
DCUs transmit hashed Bluetooth MAC Addresses and signal strength.

Hashed MAC Addresses are halved when received.
Data Collection Unit Components

- ALIX Enclosure
- 4GB compact flash card
- Linux operating system
- ALIX.3D3
- Bluetooth to USB adapter
- 2.4 GHz 9dBi Omni Antenna

Linux operating system
Year 1 – Trailer #1

- Custom built camera trailer.
- Propane powered.
- Bluetooth DCU installed.
- Communicates via a wireless router.
Year 1 – Trailer #2

- Refurbished PCMS trailer.
- Message sign removed, and camera mast added.
- Solar powered.
- Camera and Bluetooth DCU installed.
- Communicates via a wireless router.
Year 1 – Trailer #2

Solar Panels 360W

Communication
Power

AC Power
12VDC

Charge Controller

12VDC

Cell Router

ODOT

Camera

Travel Time DCU

AC Charger

Batteries Qty 6, 6V, 250AH
<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wireless router</td>
</tr>
<tr>
<td>2</td>
<td>Camera encoder</td>
</tr>
<tr>
<td>3</td>
<td>Charge controller</td>
</tr>
<tr>
<td>4</td>
<td>Bluetooth DCU</td>
</tr>
<tr>
<td>5</td>
<td>Terminal blocks</td>
</tr>
<tr>
<td>6</td>
<td>Trailer brake wiring</td>
</tr>
<tr>
<td>7</td>
<td>AC battery charger</td>
</tr>
</tbody>
</table>
Utilizing Existing ITS Equipment in Zone

- Additional DCUs were added to provide greater travel time accuracy.
- Temporary DCUs were added to a VMS sign cabinet and an RWIS cabinet that were located within the construction zone.
Integration of BT Units

- Communication
- Power

Existing network gear <-> ODOT

Travel Time DCU

Antenna Omni, 9 dBi

Existing AC power source

Power Supply

120VAC

12VDC
Year 1 – Device Locations

- Trailers are placed outside the bounds of the construction zone to detect queues.

- Intermediate DCUs provide sections of travel times within the zone.

- Locations are limited by existing infrastructure and the number of portable trailers.
ODOT Central Services

ATM/DMS SERVER

Travel Time Data Processor

CLIENT REPORT

Travel Time Client

TRAILER
- Bluetooth
- Camera

TRIPCHECK
- Cameras
- Travel Time Delay
Public Information - Travel Delay

I-5
MP 160 - 171
I-5, 14 miles South of Cottage Grove

NB Estimated Delay 2 minutes
SB Estimated Delay 2 minutes

Construction Work

Lanes Affected: (Southbound) 2 Lanes
Comments: All I-5 travel lanes, both directions, will be open for the Independence day Weekend. Expect slow NB traffic on Sunday afternoon. From July 7 to July 31, watch for intermittent single-lane closures through the work zone (MP 162-170). Watch for congestion and delays during peak travel times, including Sunday afternoons and evenings. Consider alternate routes. The SB Exit 170 on-ramp is...
Public Information - Cameras

West Oregon

Street Incidents in: Lane County

I-5 Near Curtis Creek Rd.
Updated: Jul 03 2014 9:12 AM

http://www.tripcheck.com/popup/Cam.asp?curRegion=

Elevation 0
TripCheck.com Milepost 157.00

Road Conditions | NOAA Forecasts | Weather Stations | Cameras
Year 1 - Operational Experience

- Propane trailer component failure.
- Constant refueling of propane.
- Trailer location adjustments due to large delays.
- Bluetooth travel time bugs:
  - Delay maximum was reached on several occasions.
  - DCU interface and web hosting lockup.
  - Periods with unrealistic travel time.
  - Cell connectivity issues.
  - System “fills in” travel time data for failed segments.
Year 1 – Trailer #3

- Replacement for propane trailer.
- Custom built camera trailer.
- Solar powered.
- PTZ camera
- Bluetooth and network gear installed.
Lessons Learned

- Use solar powered trailers.
- Better understanding of Bluetooth travel time system.
- More equally spaced detectors for analysis.
- Barricade equipment needs to be included.
- PTZ cameras do not travel well.
Year 2

➢ Construction Zone Travel Time became Smart Work Zone.

➢ Traffic financed project.

➢ Project scope transitioned to enhancing safety and reducing congestion.

➢ Traffic impact analysis.
Year 2 - Construction Zone

- 9 mile repaving project on I-5.
- Project anticipated having a large impact to traffic flow.
- Work Zone Traffic partnered with ITS.
- ITS/Traffic project goals:
  - Inform the public, local and web users, of traffic impact.
  - Analyze the impact of traffic delay.
  - Analyze the vehicle count, congestion, and classification of I-5 traffic impacted by construction.
Bluetooth Travel Time Upgrades

- DCU Upgrades
  - BT to USB adapter failure recognition.
  - Web service lockup detection and reboot.
  - DCU auto-reboot.
  - RS-232 adapter instead of USB.
  - Files are easier to configure.

- Software Upgrades
  - Delay maximum removed.
  - Eliminated route redundancy (duplicate MACs at one location causing additional routes).
  - Delay time can be used by VMS.
  - Historical data collection.
Traffic Sensor

- Radar sensor measuring traffic perpendicular to the roadway.
- Able to monitor all northbound and southbound lanes from either side of the roadway.
- Provides volume counts, average lane speed, and vehicle size classification.
- 9,000 data intervals stored in sensor.
Traffic Sensor Components

- Wavetronix Smart Sensor HD
- Surge Protector
- Serial to Ethernet Converter
Traffic Sensor Configuration

- Lanes are automatically generated when vehicles pass by.
- Areas can be disregarded.
- Configuration needs to be done at each trailer deployment.
- Configuration is saved in device and loads automatically when power cycled.
Year 2 – Trailers

- 4 trailers were built.
- Included cameras, travel time sensors, and radar traffic sensors.
- Solar powered systems.
- Custom sensor mast and solar panel mounts were created and attached to PCMS frames.
- Trailers cost around $30,000.
Portability

- 6 barrels and a barricade are required for roadside deployment within the clear zone.
- During travel this equipment can all be attached to the trailer for ease of portability.
- Toolboxes and additional trailer hitches are included in each trailer.
- Sensor carrying cases were added for safer transportation.
Barrels and Barricade
Trailer Design

- **Solar Panels 360W**
- **Communication**
- **Power**
- **Charge Controller**
- **Traffic Sensor**
- **Camera**
- **Cell Router**
- **Travel Time DCU**
- **ODOT**

- **AC Power**
- **12VDC**
- **AC Charger**
- **Qty 12, 6V, 250AH Batteries**
# Trailer Cabinet

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal blocks</td>
</tr>
<tr>
<td>2</td>
<td>Radar signal converter</td>
</tr>
<tr>
<td>3</td>
<td>Wireless router</td>
</tr>
<tr>
<td>4</td>
<td>Power supply</td>
</tr>
<tr>
<td>5</td>
<td>AC battery charger</td>
</tr>
<tr>
<td>6</td>
<td>Bluetooth DCU</td>
</tr>
<tr>
<td>7</td>
<td>Camera encoder</td>
</tr>
<tr>
<td>8</td>
<td>Charge controller</td>
</tr>
<tr>
<td>9</td>
<td>Trailer brake wiring</td>
</tr>
</tbody>
</table>
Remote Access

- Wireless Router
- Bluetooth DCU
- Camera Encoder
- Radar Traffic Sensor
Public Information - TripCheck
**Public Information - TripCheck**

**Detailed Information**

**I-5**
- **MP 163 - 154**
  - I-5, 11 miles South of Cottage Grove
  - SB Estimated Delay 1 minutes.
  - NB Estimated Delay 5 minutes.
  - Construction Work

**Lanes Affected:**
- (Northbound) 2 Lanes
- (Southbound) 2 Lanes, Shoulder

**Comments:** Road construction is occurring, use caution. Intermittent traffic slowdowns for northbound and southbound traffic. Expect delays. Expect rolling slow downs northbound and southbound during daylight hours. Lane closures and 19' width restrictions in both the northbound and southbound directions.

**Public Contact:** ODOT/STOC Central
  - Portland/Madford
Public Information - TripCheck
Camera Images Saved

- Camera images are saved every 5 minutes for 10 days.

- Allows for data validation and monitoring traffic patterns.

- Large congestion events are recorded for analysis.
Portability of the midpoints allows for a more dynamic view of the zone.

Trailers were relocated at various times to focus on different work points.

Deployment locations are only limited by the landscape and road height.
Public Information – Message Signs

- PVMS and VMS provide travelers of real time travel delay at the beginning of the construction zone.
Public Information – Message Signs
Message Signs – Inner PVMS

- Messages posted on signs are determined only from travel time data.
- Delay values posted are in 5 minute increments.
- Values round up, so 1 second of delay is reported as 5 minutes.
- There is a constant message displayed.
- During periods of no delay “--” is the placeholder.
Message Signs – Inner PVMS

Panel 1

Panel 2
Message Signs – Outer PVMS & VMS

- Activated when travel time delay is greater than 5 min.
- Messages will automatically clear when delay is reduced.
- After congestion reaches a certain threshold the message signs display:
  - WZ AHEAD       CURRENT
  - CONSIDER → WZ DELAY
  - ALT RTE       XX MIN

- VMS is activated when delay is greater than 20 min.
  - CONGESTION AHEAD
  - MP 154-162 SEVERE
  - DELAY XX MINUTES
**ODOT Notifications**

- When traffic delay reaches a certain threshold, notifications are sent to designated personnel via text and email.

- Allows for project manager to take corrective action to reduce the traffic backup.

- Alert messages are saved for historical reports.
Traffic Analysis Benefit

The sensors from the trailers provide the following data:

- Travel time (1 min. updates).
- Volume by lane (20 sec. updates).
- Speed by lane (20 sec. updates).
- Occupancy by lane (20 sec. updates).
- Vehicle classification (20 sec. updates).
- Historical camera images.
Traffic Analysis Benefit

- Prior to construction, traffic data allows for prediction of work zone traffic.
- Lane closure strategies can be developed to improve flow.
- Vehicle counts can be used for project funding.
**Year 2 - Operational Experience**

- Project location impacts sun exposure.
- Abnormally heavy rain this year.
- Generator used frequently to charge batteries.
- Radar firmware issues.
- Radar is sensitive to reflections caused by median barriers or trees.
Future Improvements

- Battery voltage monitor with email notification.

- Secondary power system, onboard generator.

- Powered adjustment of the traffic sensor and camera on the mast.