



Portable Work Zone Data Collection

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ODOT ITS Designer



Year 1

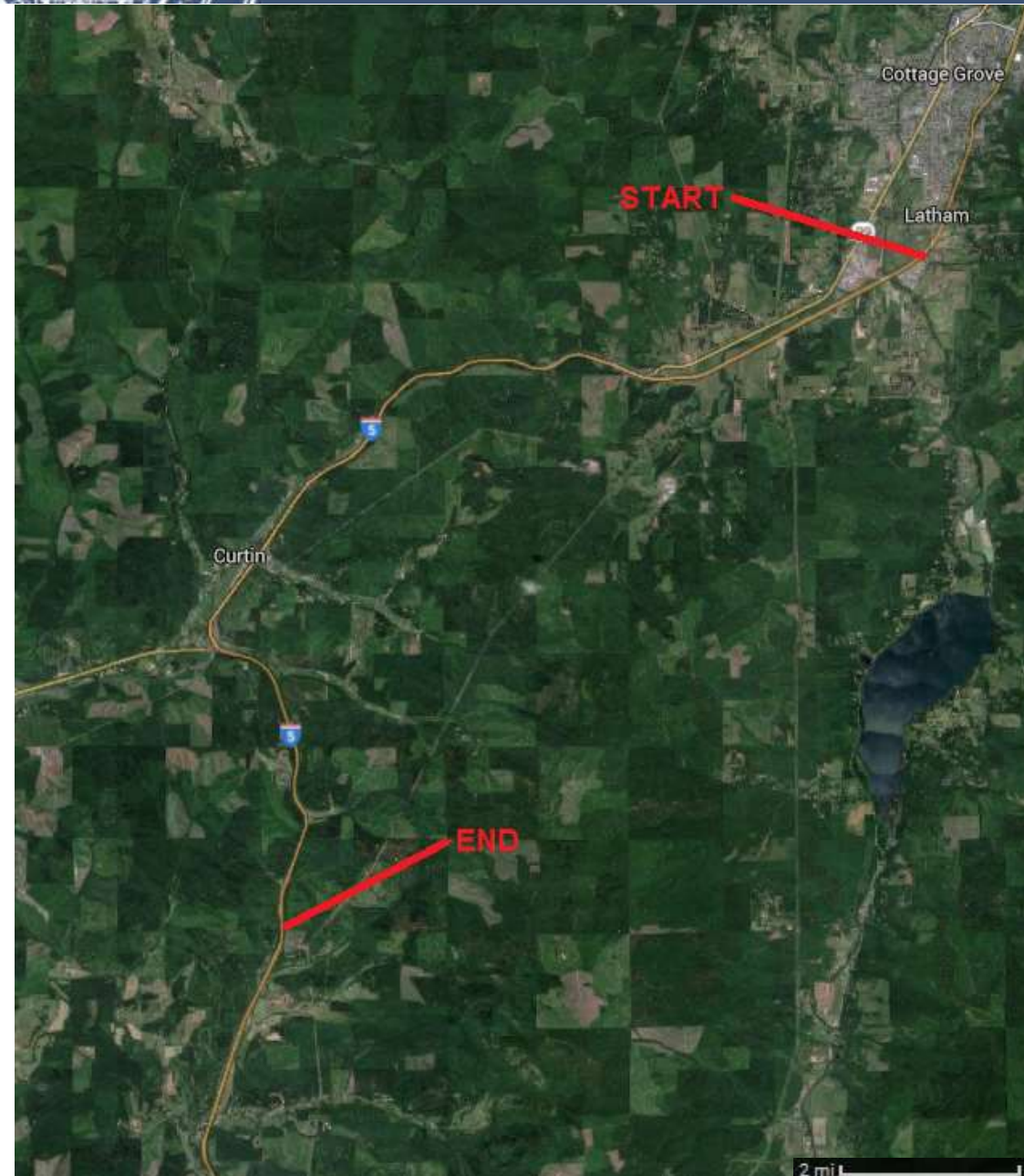
- Construction Zone Travel Time project.
- Provide work zone information to public.
- Test OSU Bluetooth travel time sensors in new application.





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

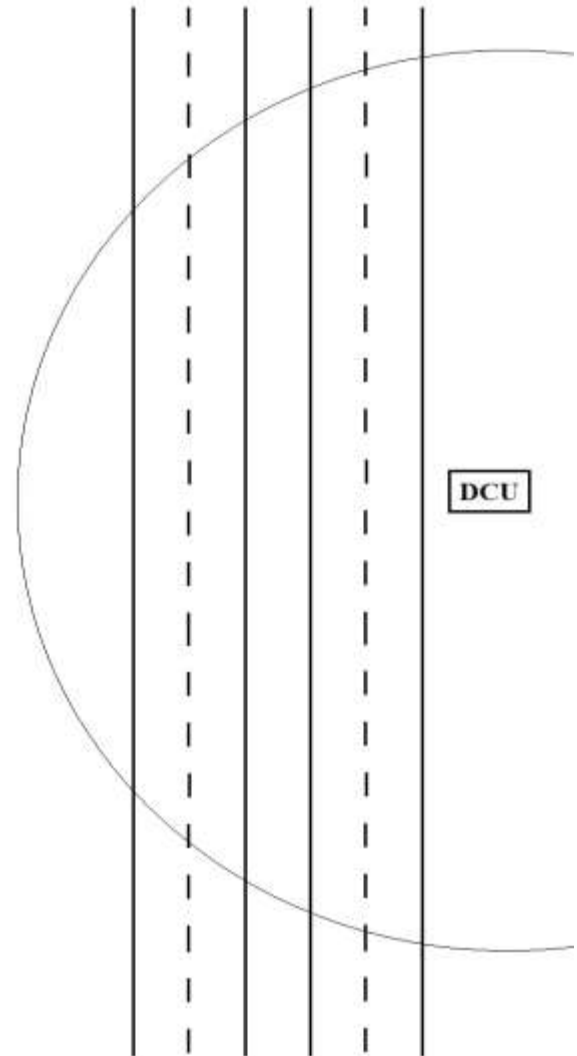
- Device collects Bluetooth MAC addresses.
- Stores the data and presents it with a web interface.
- ODOT database collects the MAC addresses from the web interface.
- Database subtracts timestamps to determine travel time.





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.





Public Security/Privacy

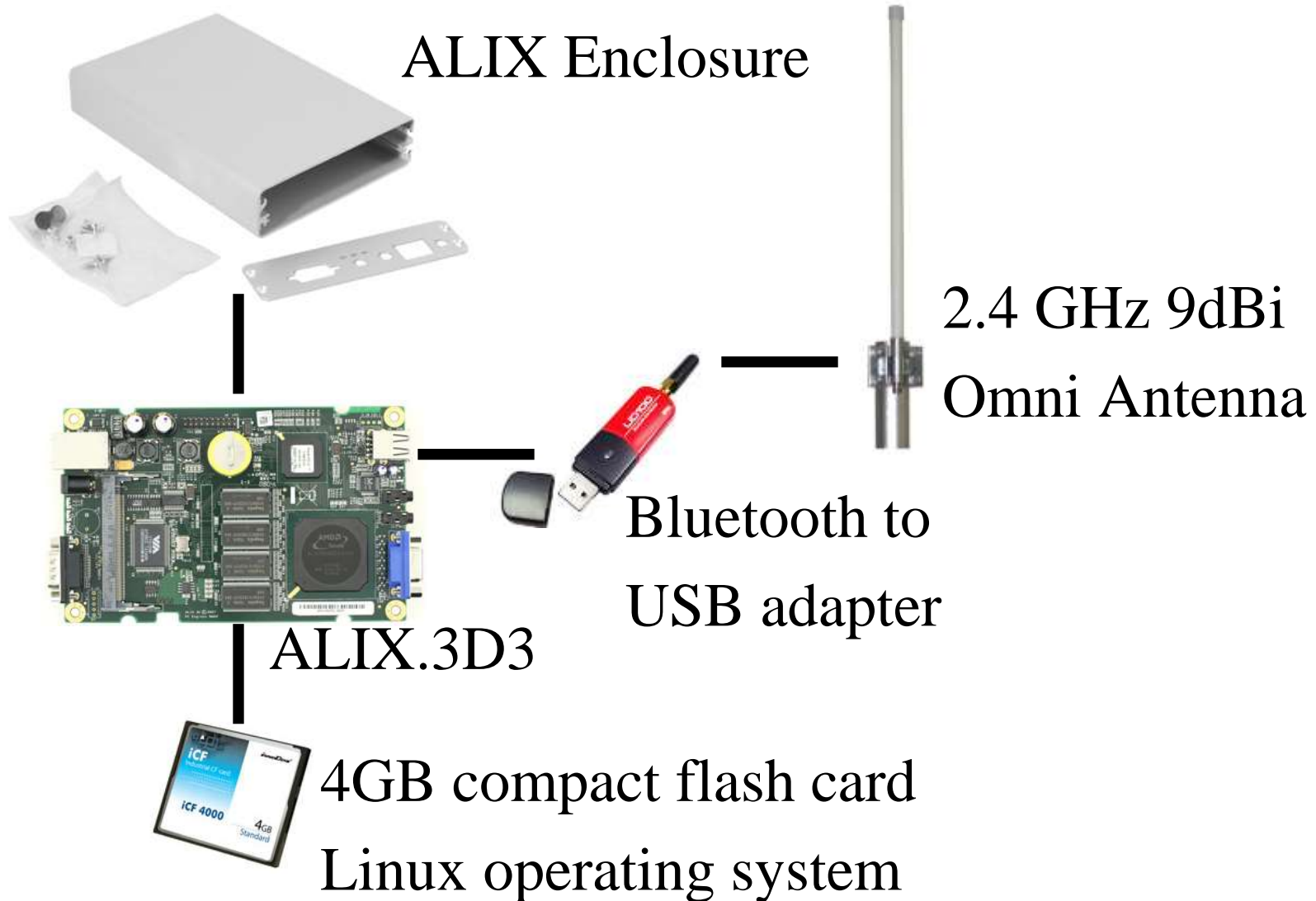
- DCUs transmit hashed Bluetooth MAC Addresses and signal strength.
- Hashed MAC Addresses are halved when received.

2014/07/01 12:05:11

3e8f4d4d21f6746aa31cbd9d0b5000fd,	2014-07-01 11:05:51, 1, -67, 0:1:95:1D:93:FB
65d4681a7fdc720bd07b517fdaa287ed	2014-07-01 11:06:12, 1, -61, 0:1:95:1D:93:FB
c61eada0ce92bfb3d3a1dcea81a2aebf,	2014-07-01 11:06:31, 4, -54, 0:1:95:1D:93:FB
20652040d6f01c3fbde8ee9269a05c4f,	2014-07-01 11:07:28, 1, -77, 0:1:95:1D:93:FB
df5a5df8faf016c2b9e44b9e6b7f87de,	2014-07-01 11:08:15, 1, -67, 0:1:95:1D:93:FB
e37511e49694390cd42cd61981e6d308,	2014-07-01 11:08:15, 3, -55, 0:1:95:1D:93:FB
1eab6056e808c48cb6a42acc3715755d,	2014-07-01 11:08:32, 2, -57, 0:1:95:1D:93:FB
907f9ddb1d24bd1c1883d4298ffc9916,	2014-07-01 11:09:41, 2, -70, 0:1:95:1D:93:FB
c05db3d7b64a0feafa392108618ac044,	2014-07-01 11:09:45, 1, -76, 0:1:95:1D:93:FB



Data Collection Unit Components





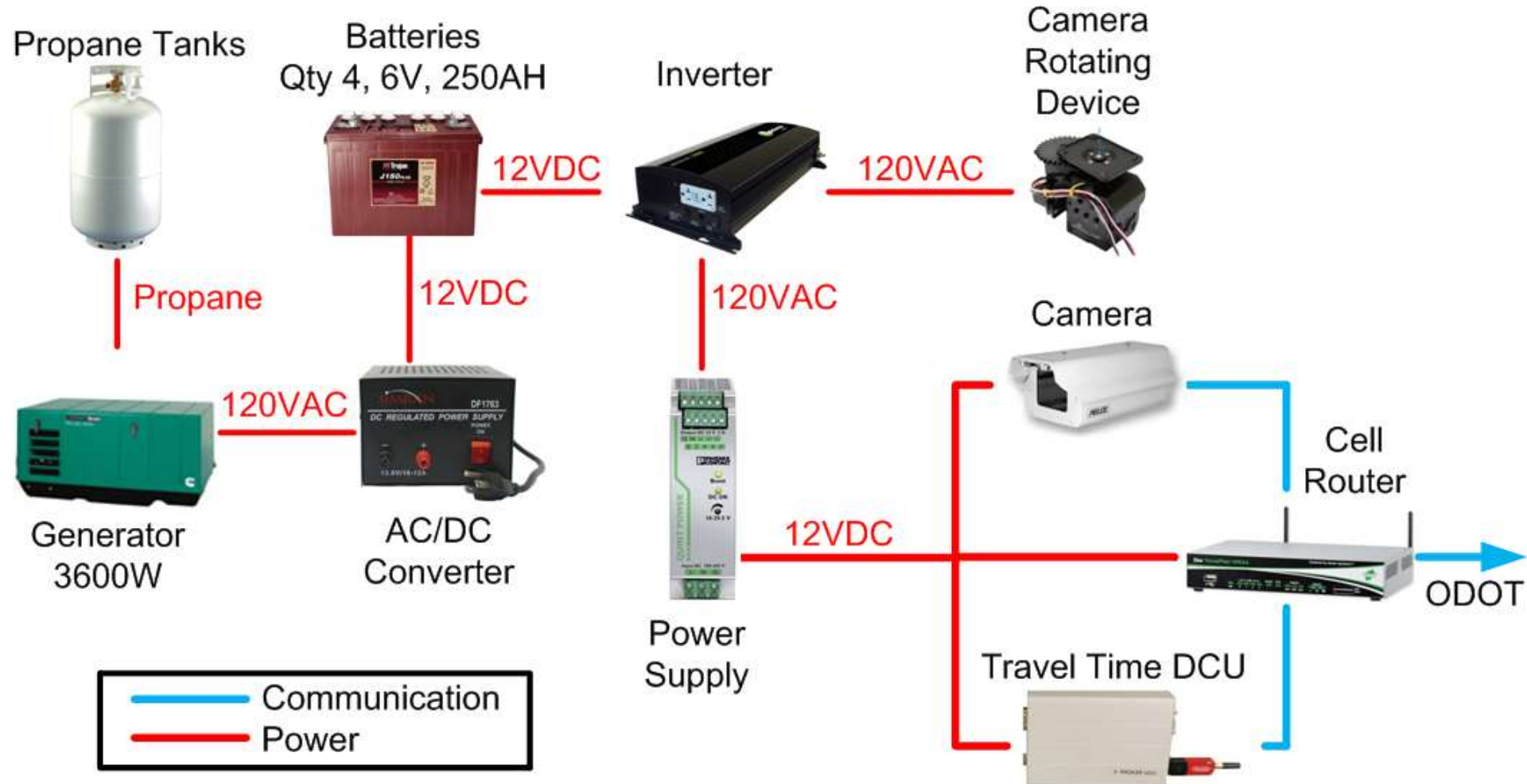
Year 1 – Trailer #1



- Custom built camera trailer.
- Propane powered.
- Bluetooth DCU installed.
- Communicates via a wireless router.



Year 1 – Trailer #1





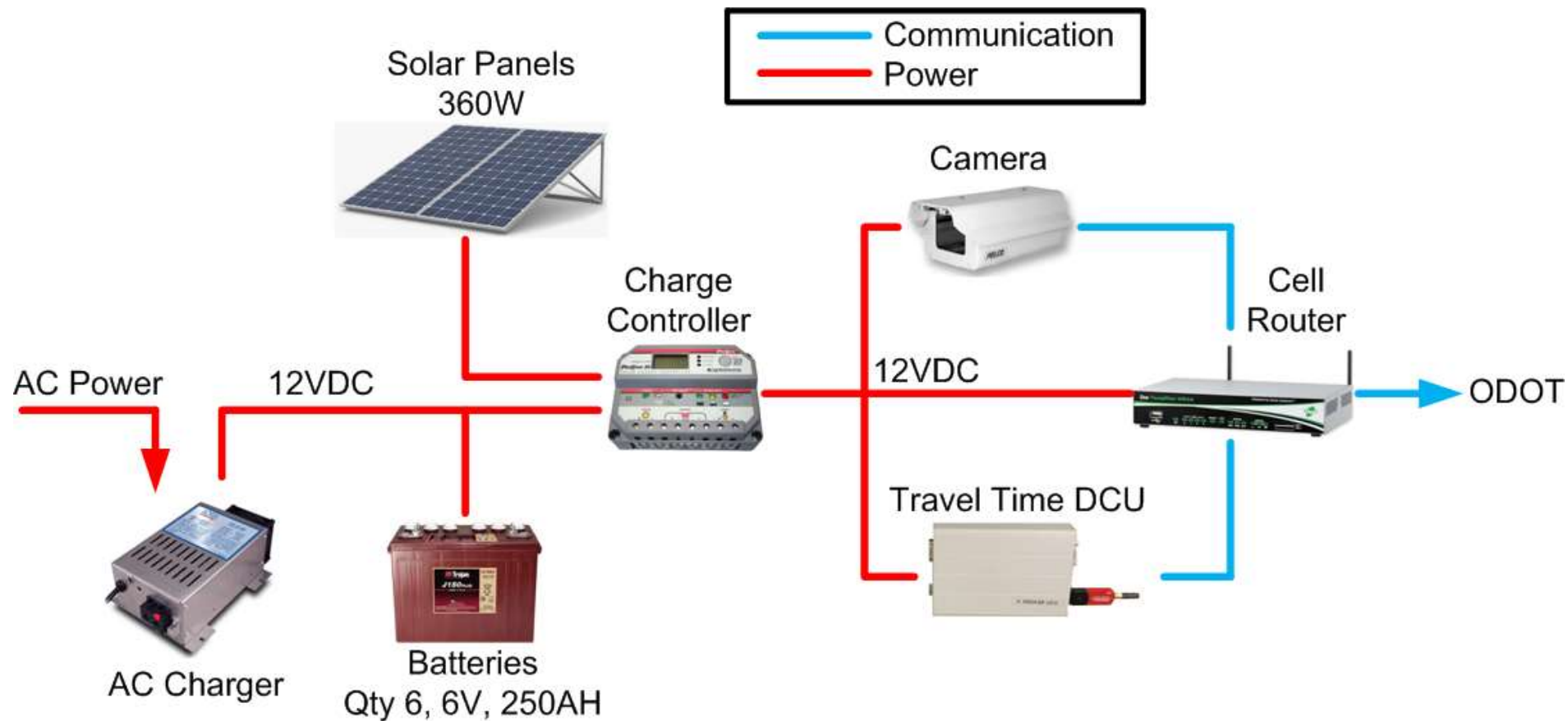
Year 1 – Trailer #2

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



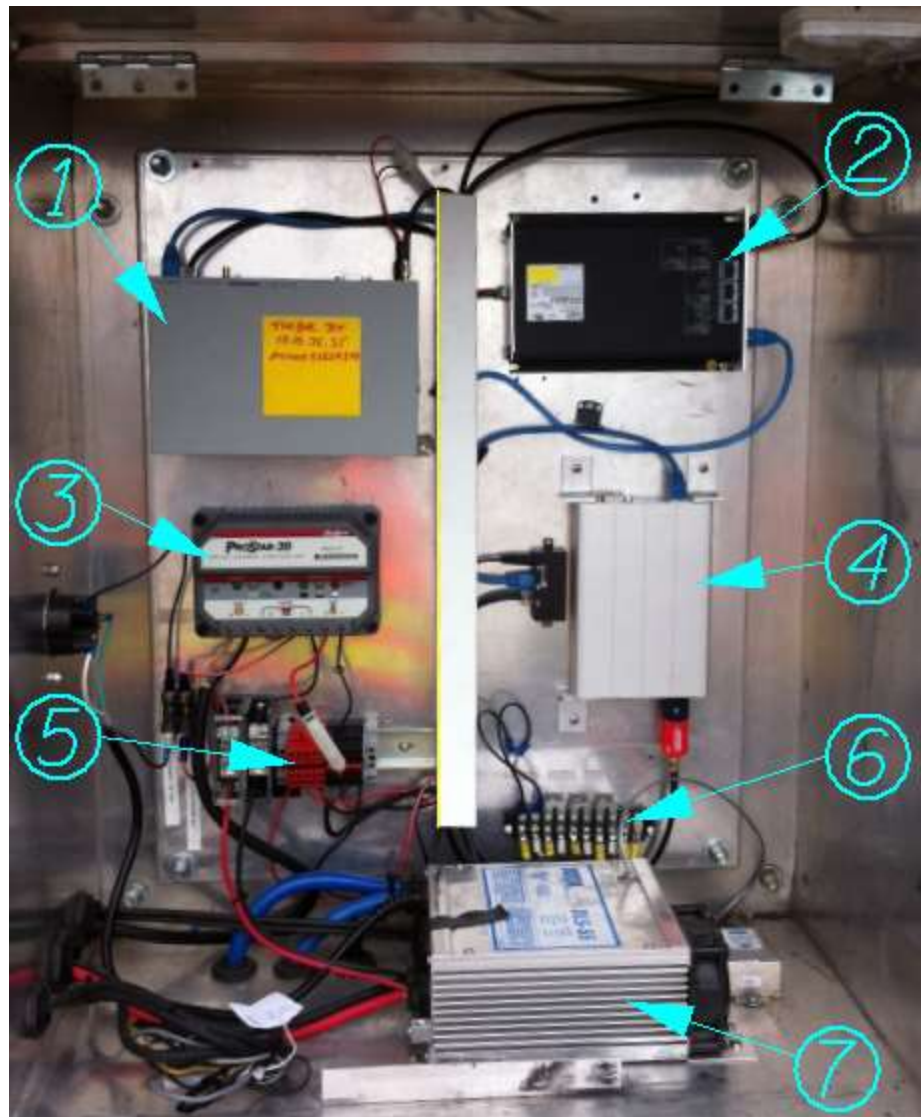


Year 1 – Trailer #2





Trailer Cabinet



#	Description
1	Wireless router
2	Camera encoder
3	Charge controller
4	Bluetooth DCU
5	Terminal blocks
6	Trailer brake wiring
7	AC battery charger



Utilizing Existing ITS Equipment in Zone

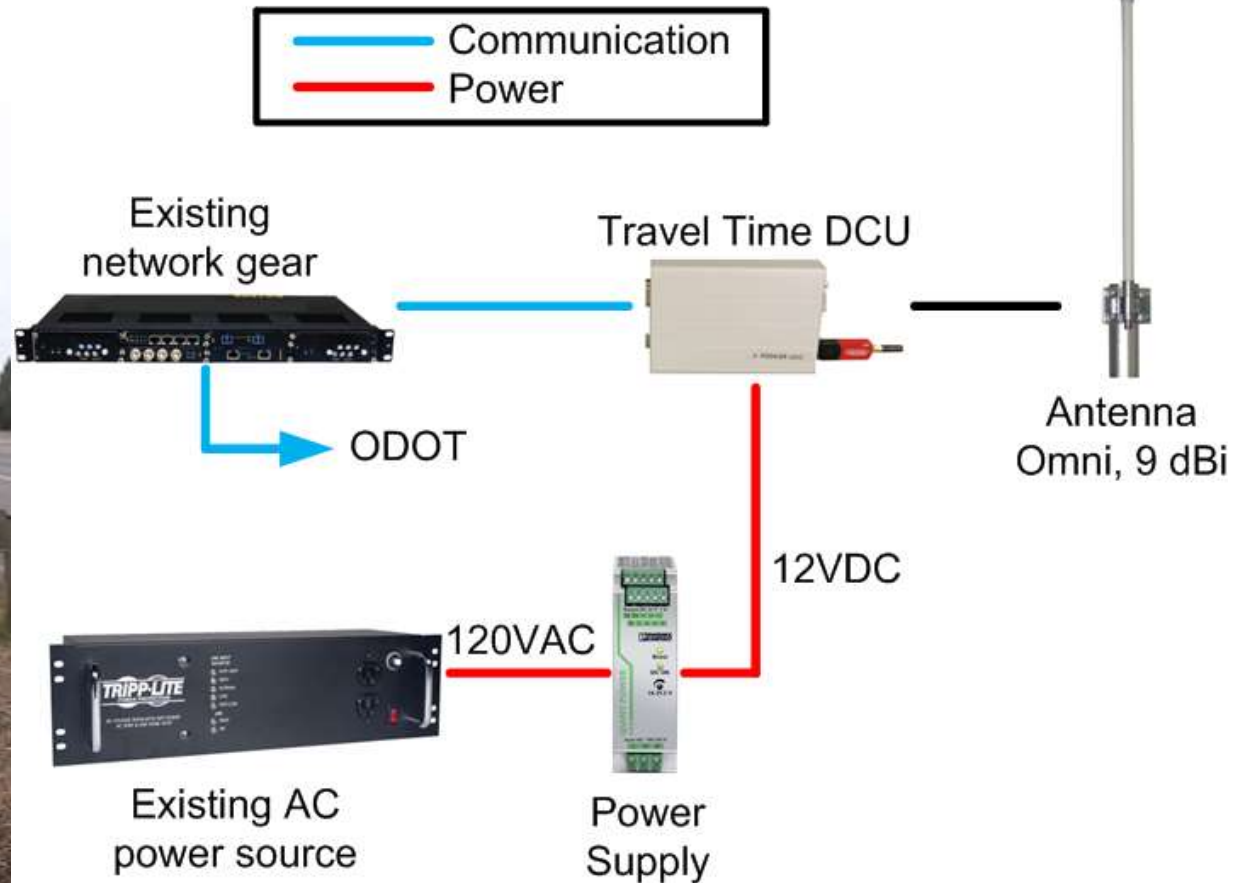


- Additional DCUs were added to provide greater travel time accuracy.
- Temporary DCUs were added to a VMS sign cabinet and an RWIS cabinet that were located within the construction zone.





Integration of BT Units





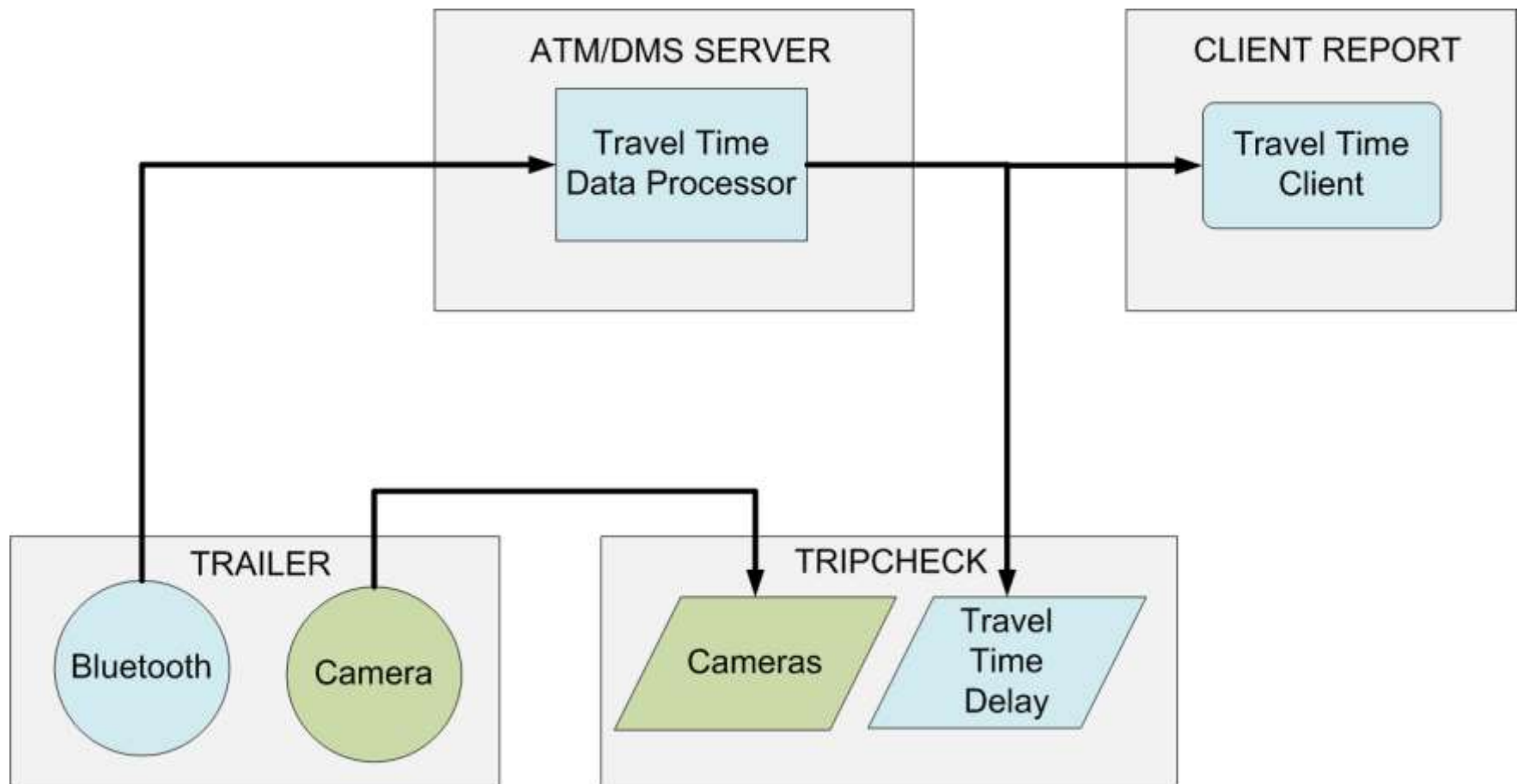
Year 1 – Device Locations

- 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





Public Information - Travel Delay

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[Statewide Map](#)
Map Legend
Road cameras

- ✖ Road closed
- > 2hr delay
- 20mn-2hr delay
- < 20mn delay
- No to Min. delay
- ❓ Unconfirmed
- ℹ Informational
- ◆ Weather hazard
- ◆ Weather warning
- Snow zone
- 📶 Weather stations
- ▲ Construction
- 🚛 Truck restrictions

West Oregon

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Street Incidents in: [Lane County](#)

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Minimum Chain Requirements
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Public Information - Travel Delay

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West Oregon

View Road Conditions | View W

Street Incidents in: Lane County

CLICK HERE for Eugene Map

TripCheck-Detailed Information - Windows Inter...

<http://www.tripcheck.com/popups/CDetails.asp?INCD=186031>

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	

Road Conditions | NOAA Forecasts | Weather Stations | Cameras | ODOT/OSP Report



Public Information - Cameras

OREGON DEPARTMENT OF TRANSPORTATION

TripCheck

West Oregon

View Road Conditions View Weather Outlook View

Street Incidents in: Lane County

CLICK HERE for Eugene Map

2014-07-03 9:12:00
ODOT

Elevation 0 TripCheck.com Milepost 157.00

Road Conditions | NOAA Forecasts | Weather Stations | Cameras

1-5 Near Curtis Creek Rd.
Updated: Jul 03 2014 9:12 AM



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.





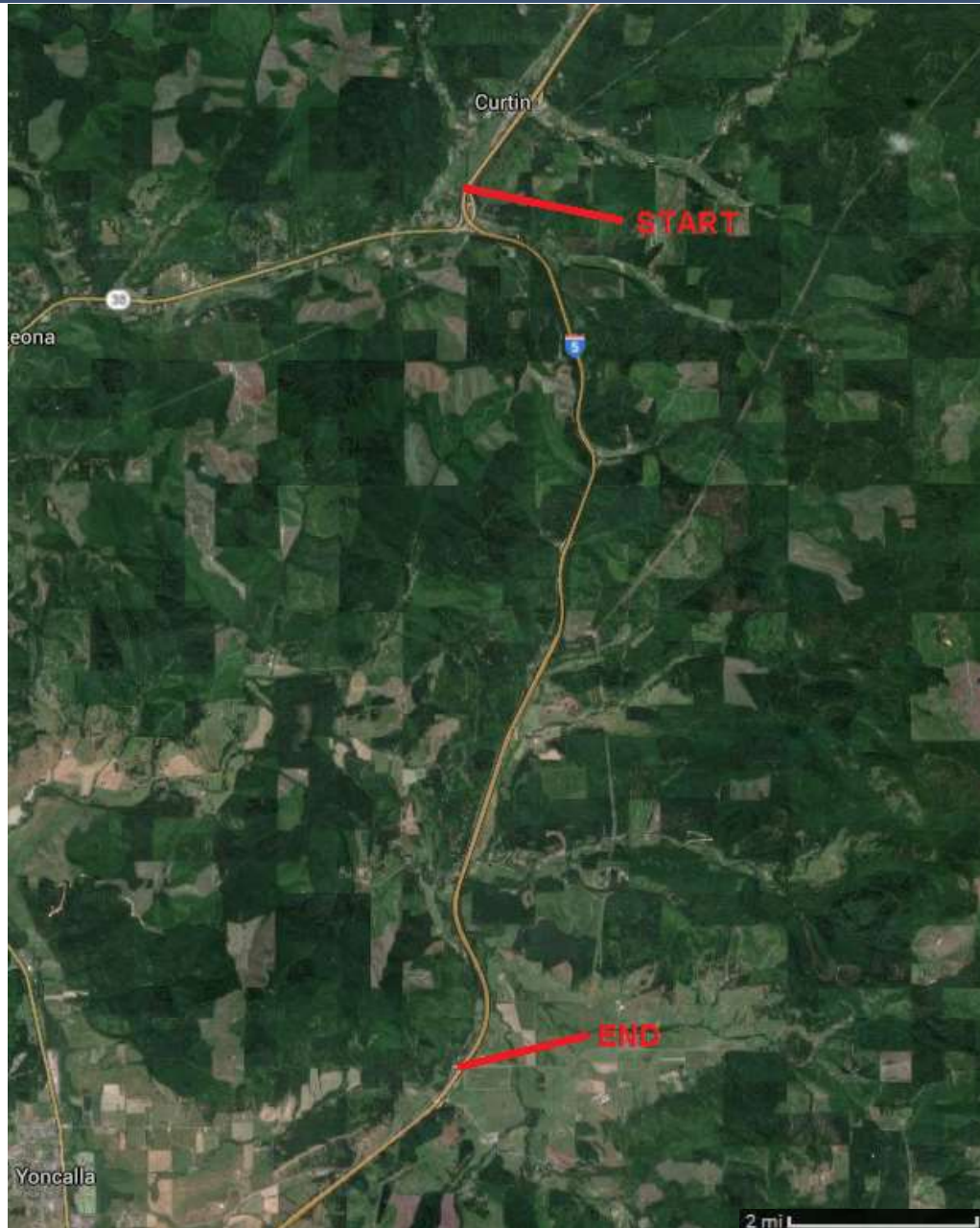
Year 2

- 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.

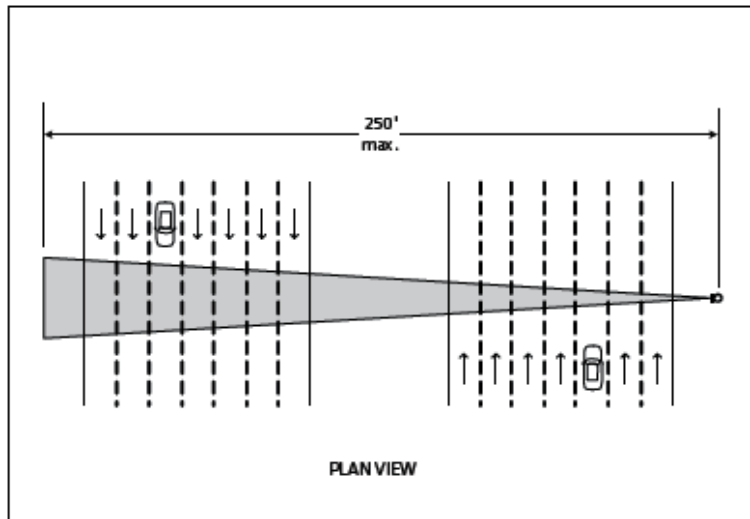
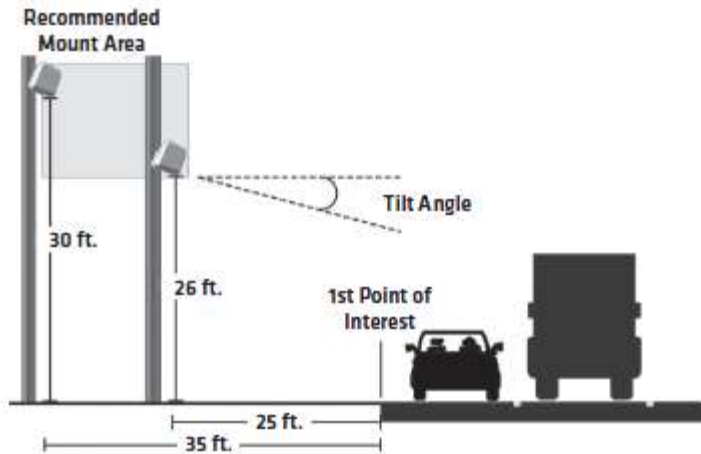
➤ Software Upgrades

- ❖ 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

RS-485



Surge
Protector

RS-485

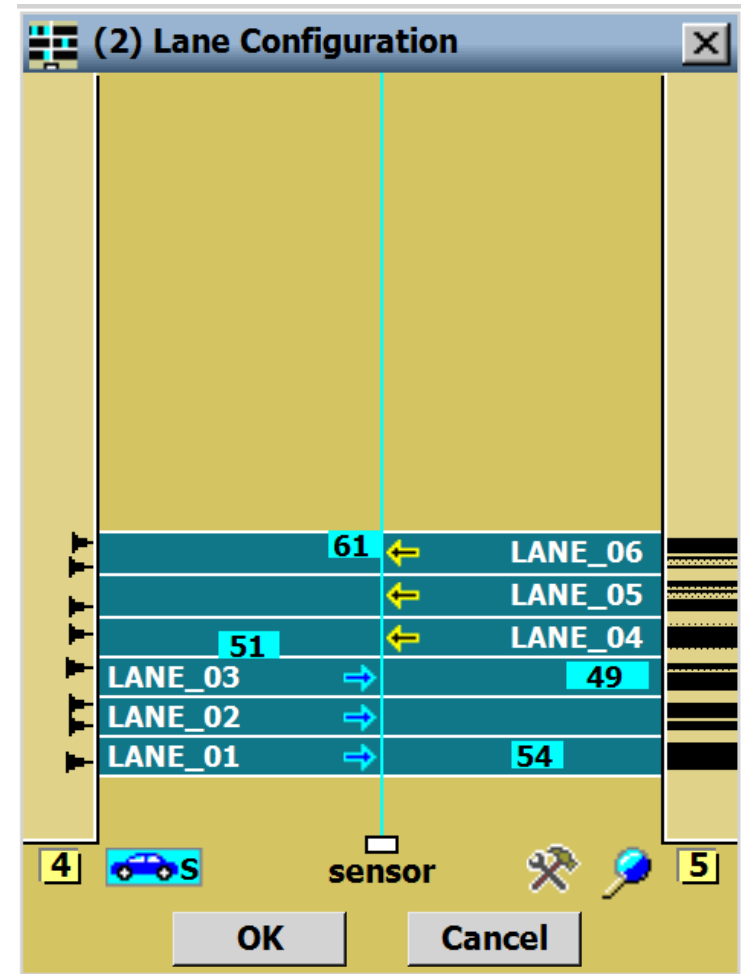


Serial to
Ethernet
Converter



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.



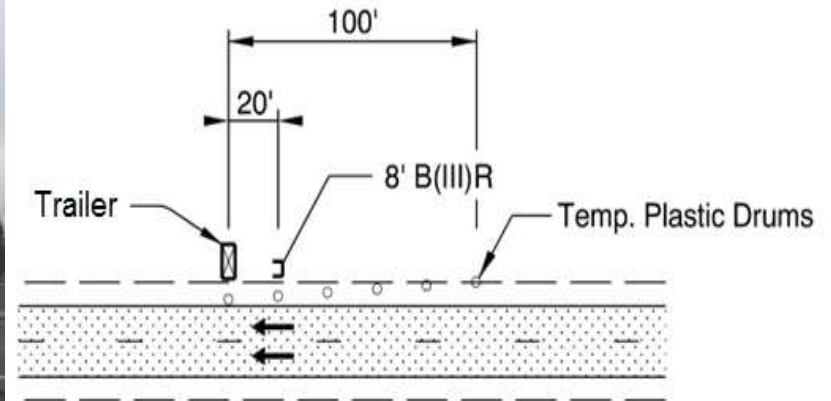


Portability

- 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



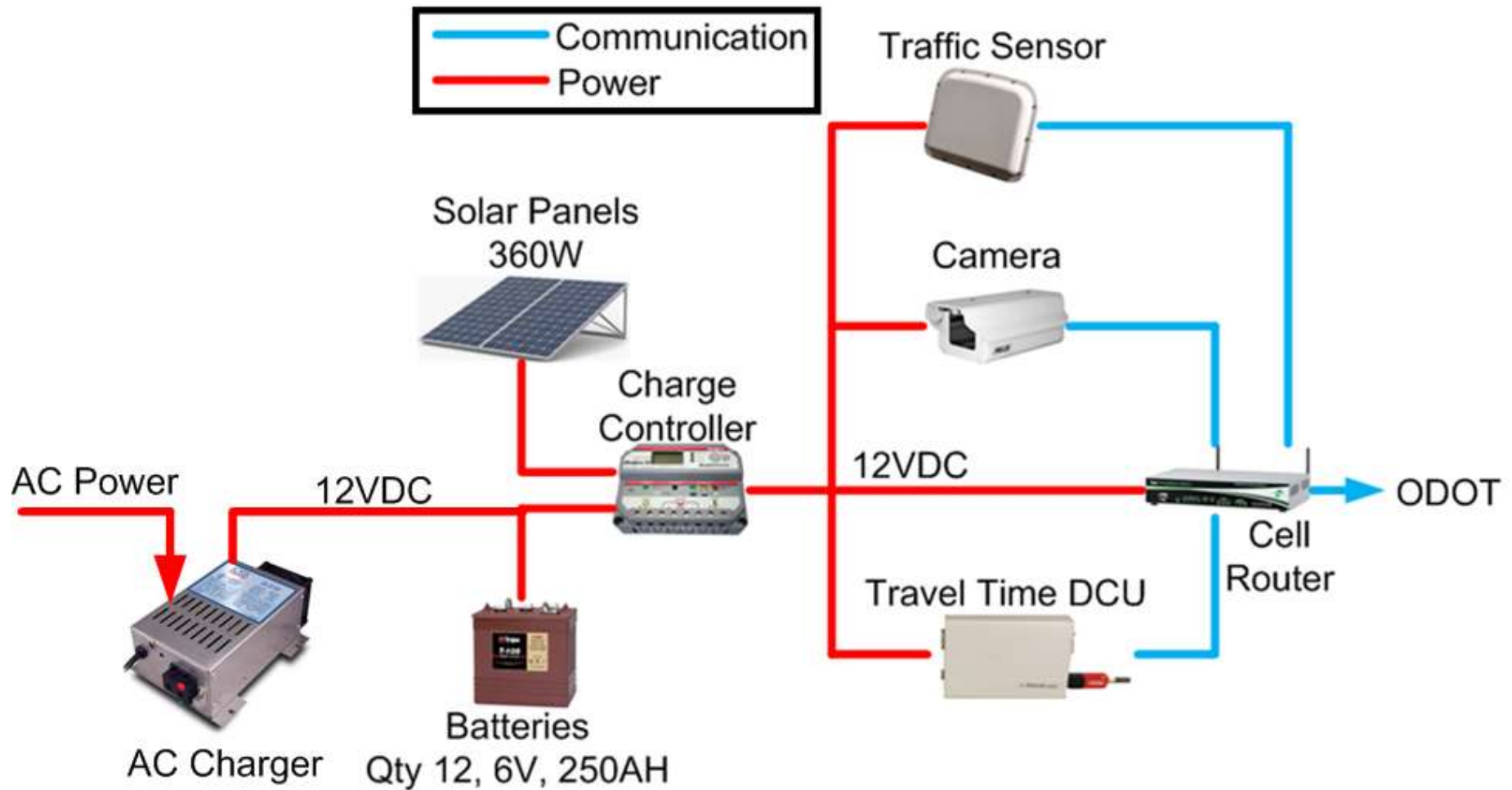


Trailer Deployment



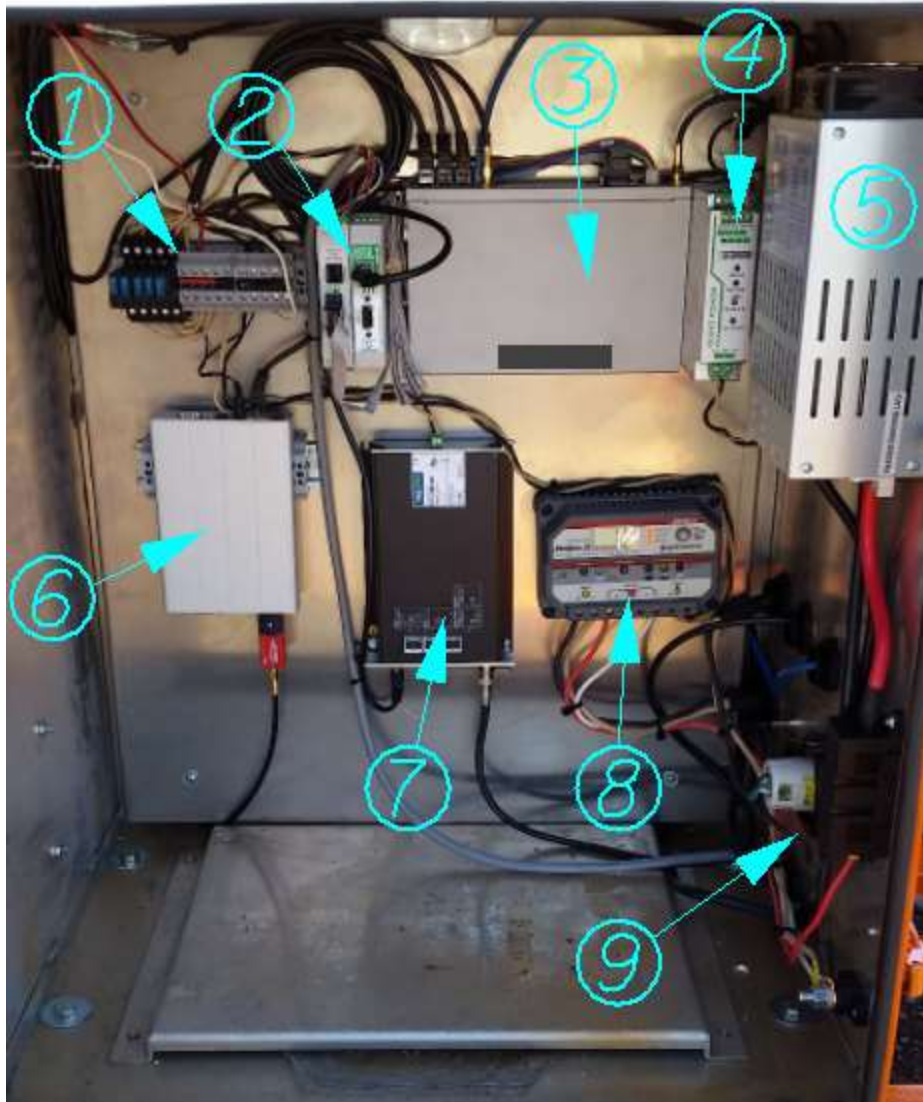


Trailer Design





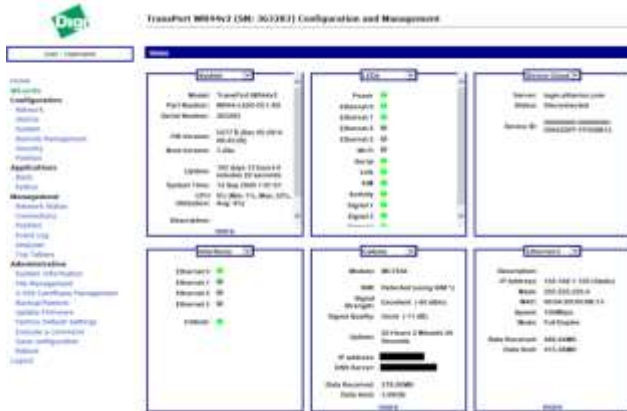
Trailer Cabinet



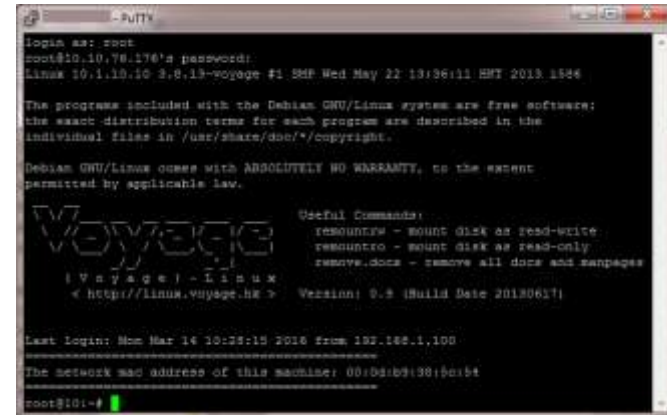
#	Description
1	Terminal blocks
2	Radar signal converter
3	Wireless router
4	Power supply
5	AC battery charger
6	Bluetooth DCU
7	Camera encoder
8	Charge controller
9	Trailer brake wiring



Remote Access



Wireless Router



Bluetooth DCU




Camera Encoder



Radar Traffic Sensor



Public Information - TripCheck



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Level: 5

+

-







Base Maps +

Quick Links +





My Maps +

Map Legend -


Road

-  Road cameras
-  Road closed
-  > 2hr delay
-  20mn-2hr delay
-  < 20mn delay
-  No to Min. delay
-  Unconfirmed
-  Informational

Weather

-  Weather hazard
-  Weather warning
-  Snow zone
-  Weather stations

Restrictions





Public Information - TripCheck



Base Maps +

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Map Legend -

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Restrictions

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Level: 5

3mi 6km

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

Point/Medford

43.66, -123.14

Slide 41



Public Information - TripCheck

Base Maps +

Quick Links +

My Maps +

Map Legend -

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Weather

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Restrictions

Level: 5

+

-

Drain

Yon

99

3mi

6km

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Road Camera

I-5 at Milepost 156.53

Updated: Jan 13 2016 1:25 PM

Looking North

ODOT

Elevation 0

TripCheck.com

Milepost 156.53

43.66, -123.14



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.



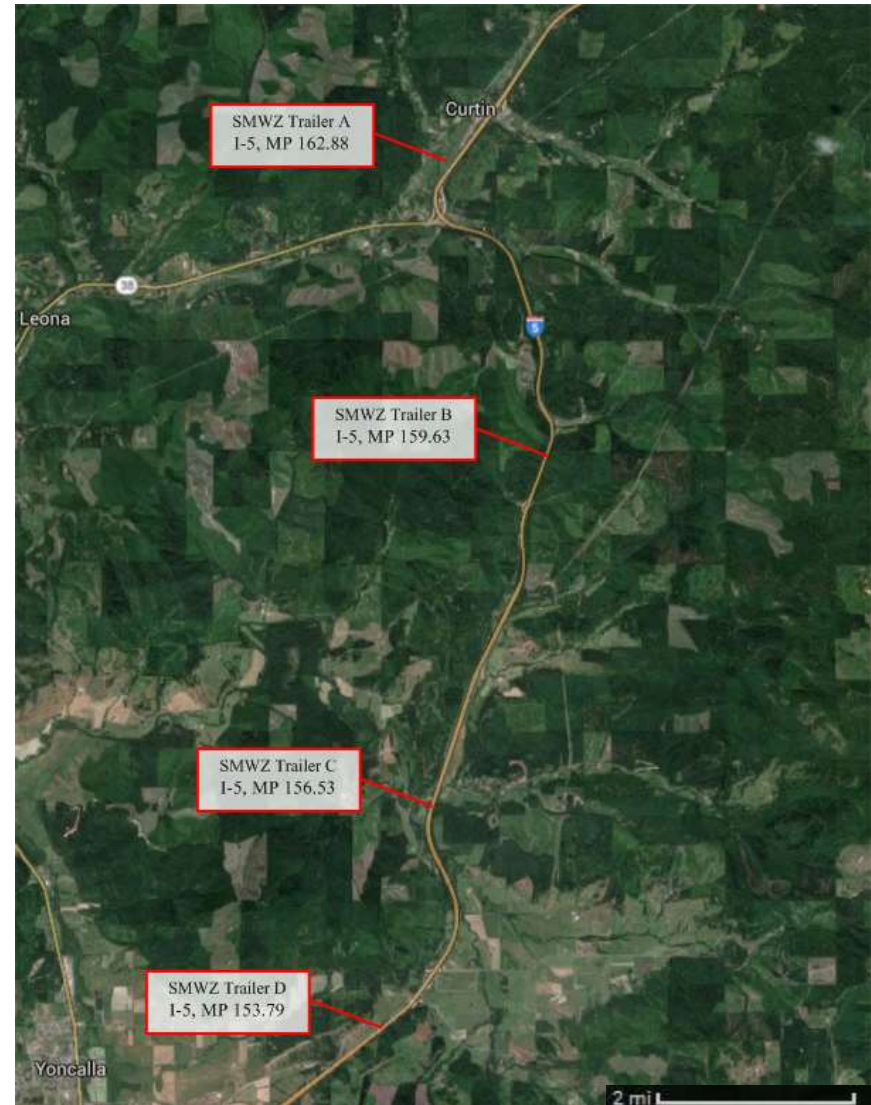
Camera Time Lapse





Year 2 – Equipment Placement

- 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.





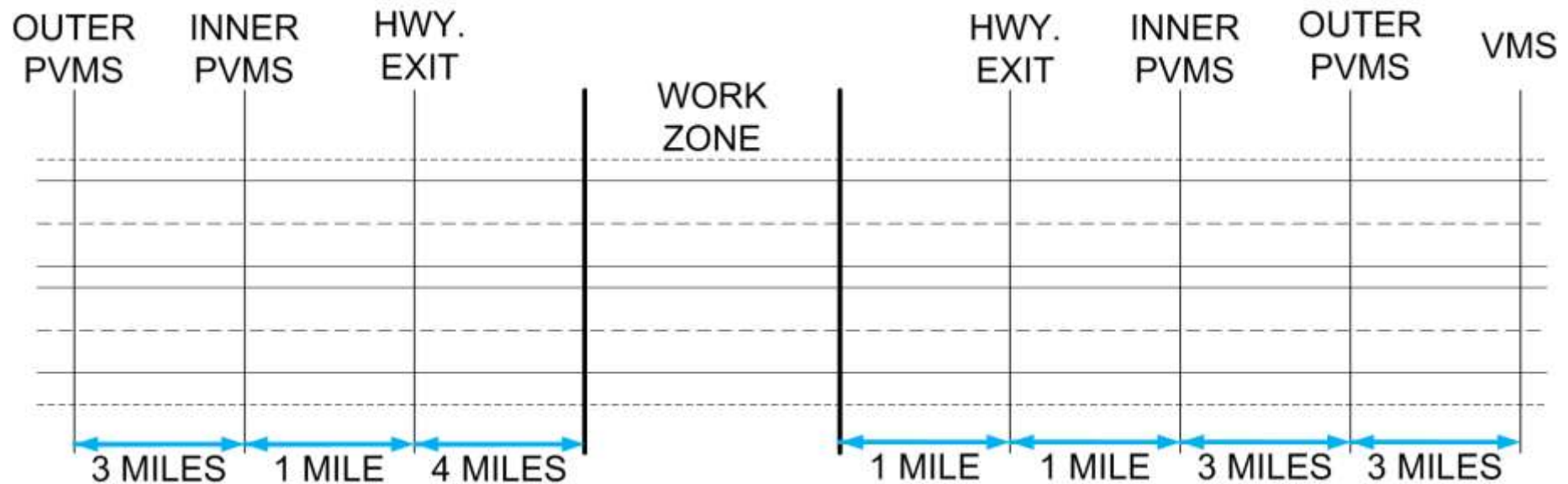
Public Information – Message Signs

- 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

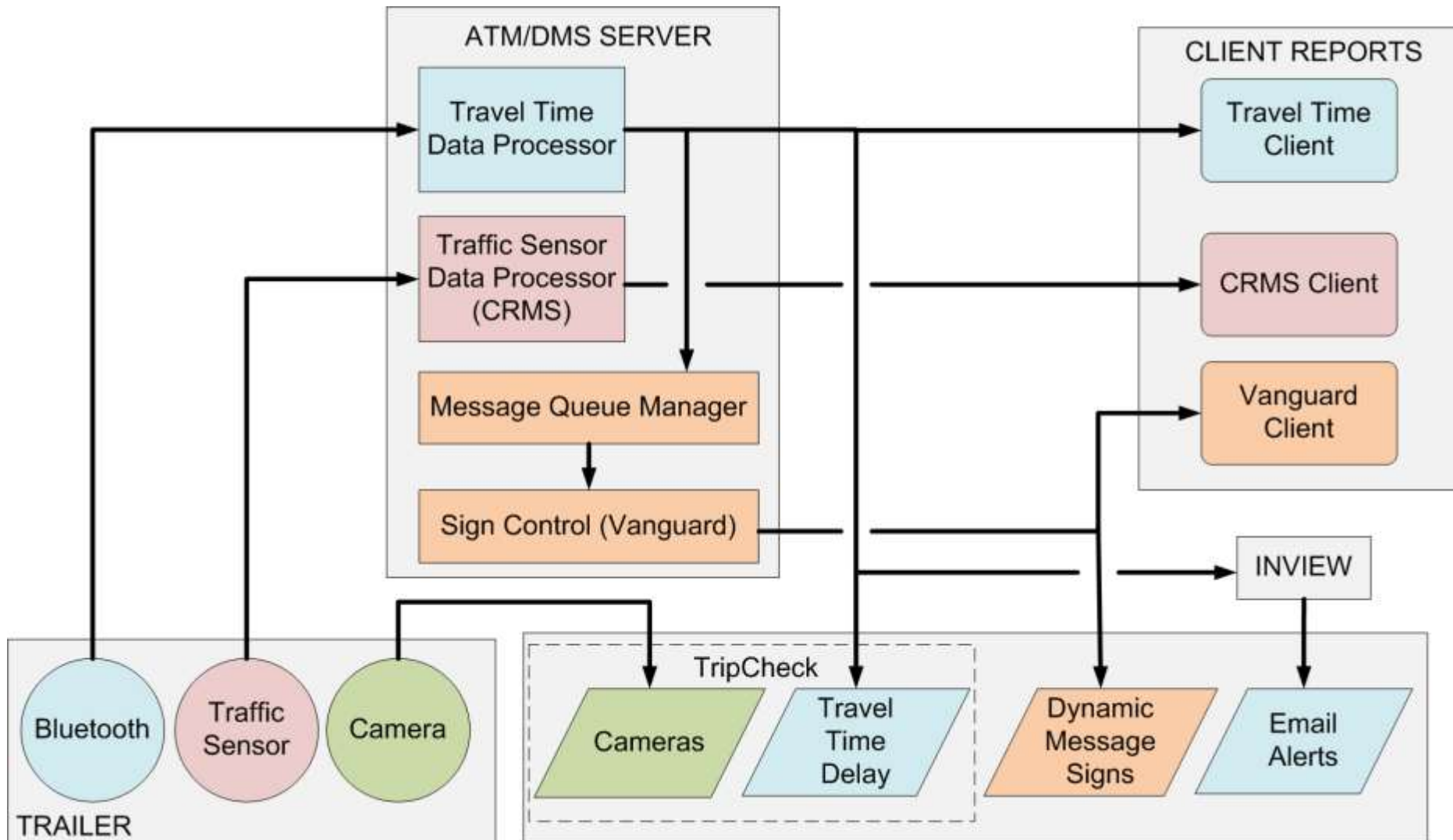


ODOT Notifications

- 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.



ODOT Central Services





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.



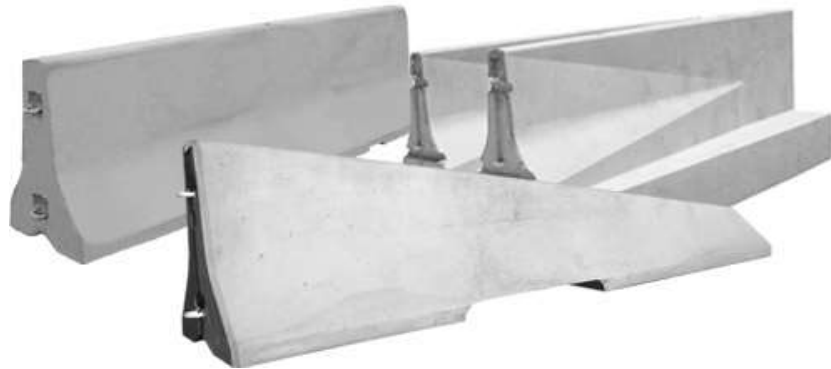
Traffic Analysis Benefit

- 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.