



Where Utah is  
Where Utah is going

Josh Van Jura



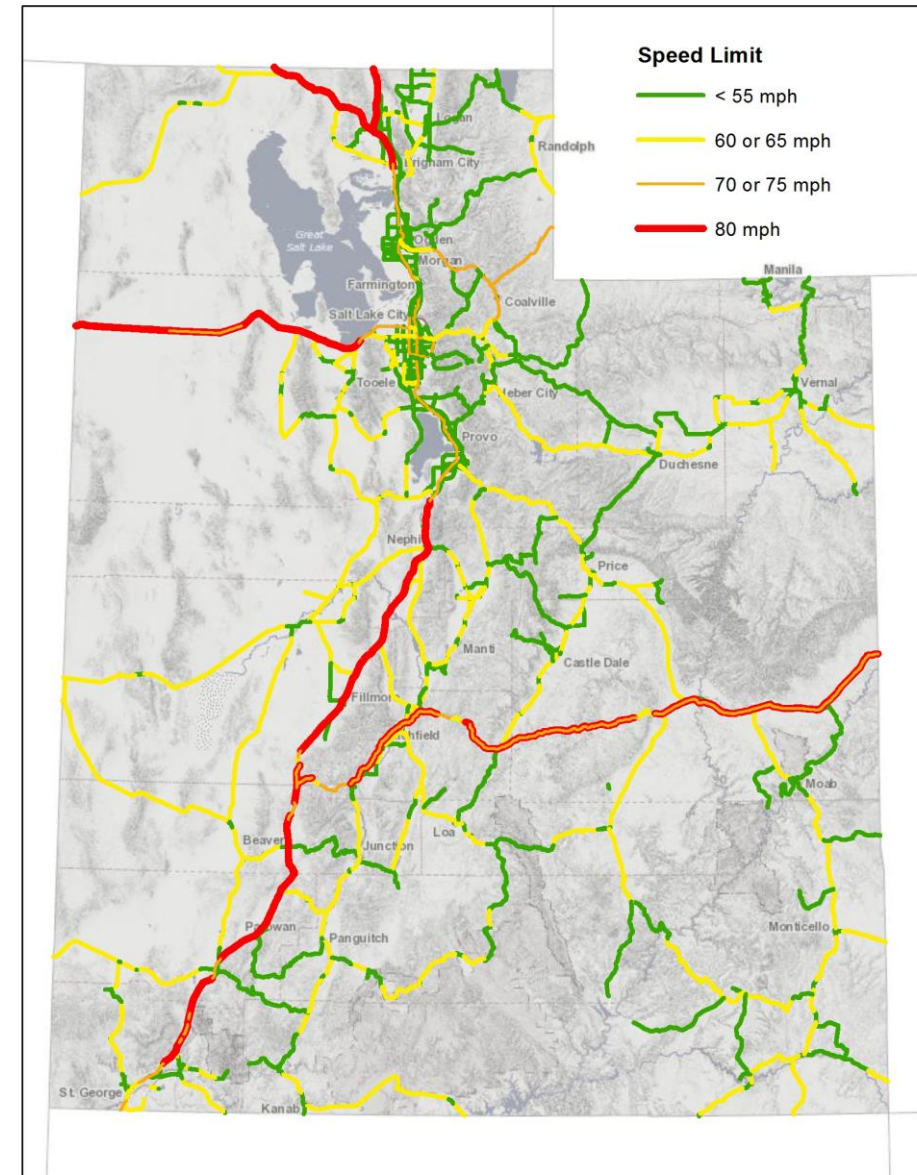
## Overview of UDOT

### ➤ Centerline Miles by Type

- 935 miles of Interstate
- 2,945 miles of Level 1 (AADT>1,000)
- 1,985 miles of Level 2 (AADT<1,000)
- 5,865 miles total

### ➤ Speed Limits

- 13% @ 80 mph
- 35% @ 70mph or higher
- 60% @ 60mph or higher
- 82% @ 50mph or higher





# Project Goal

**Goal:** Improve safety within construction work zones through significant reduction in traveler speed within the boundary of Active Work Space.





# Slower $\neq$ Safer

- Motorists:

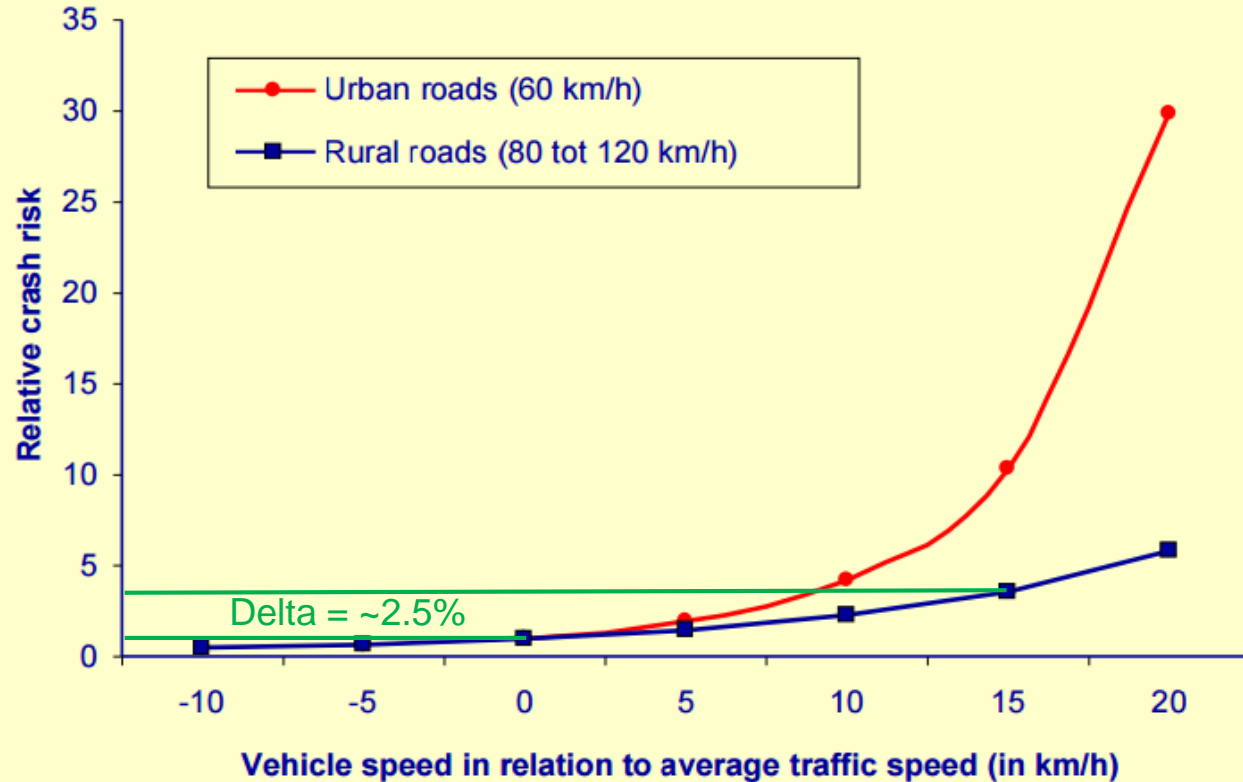
- Increase the time available for a motorist to react
- Reduce stopping distances
- Allow more significant (recoverable) evasive maneuvers

- Workers:

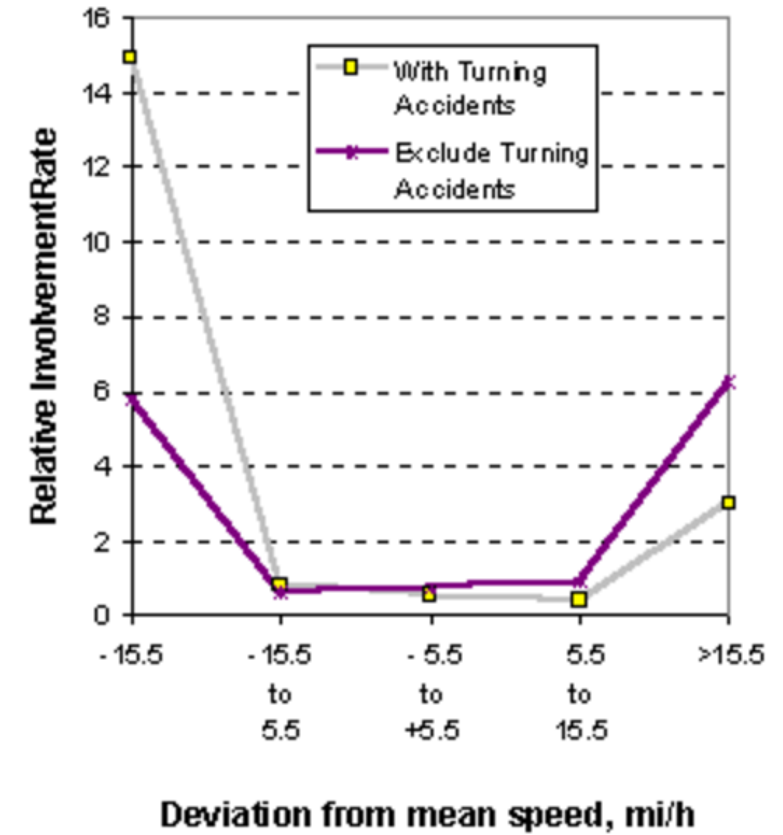
- Greater time for workers to move out of the way
- Reduce the likelihood of severe injury



# Operating vs. Posted



Kloeden et al., 1997,2002



West and Dunn 1971

## Speed Harmonization!!!



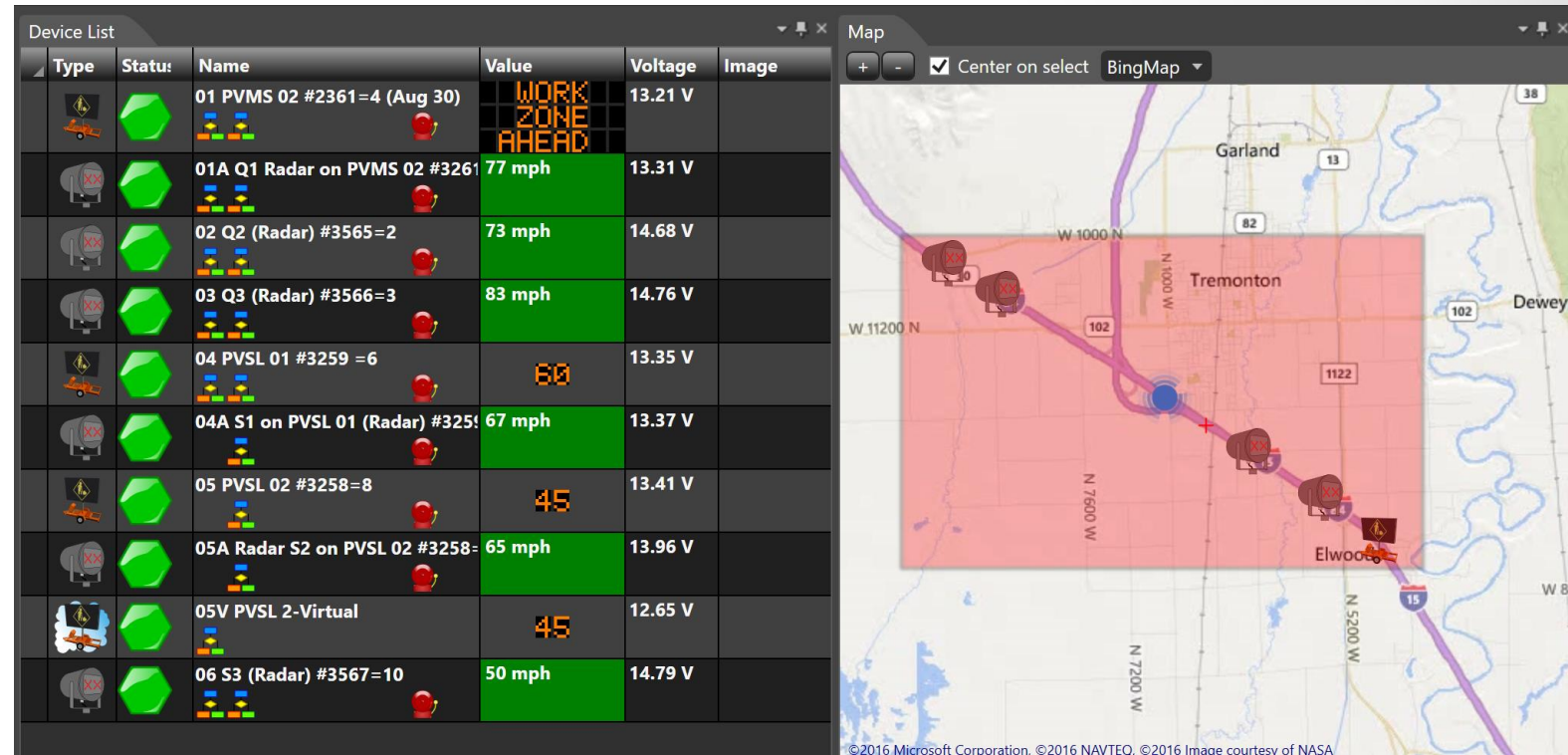
# PVSL Candidate Projects

- 4 lane divided / undivided roads
- High Speed (50mph +)
- Project with simple geometries
- Example
  - Resurfacing
  - Slab Replacement
  - Bridge Work
  - Maintenance Work



## Regulatory Enforcement

- Work with Highway Patrol
- System logs speed changes & time of
- Document location of device
- Not tested in court to date





# SMRT System

## *A Marginally Smart Work Zone*

- We have done 12+ projects to date with PVSL
- No detection
- Field crew remotely changes speeds per TEO
- There is data collection
- Basically low or high





# SMRT- Success Stories

## US 40 Deck Replacement

- Original Posted Speed = 65 mph
- Reduced Speed = 45mph
  - Single drop

Number of data points: 70343

Posted speed: 45

Average speed: 51.4

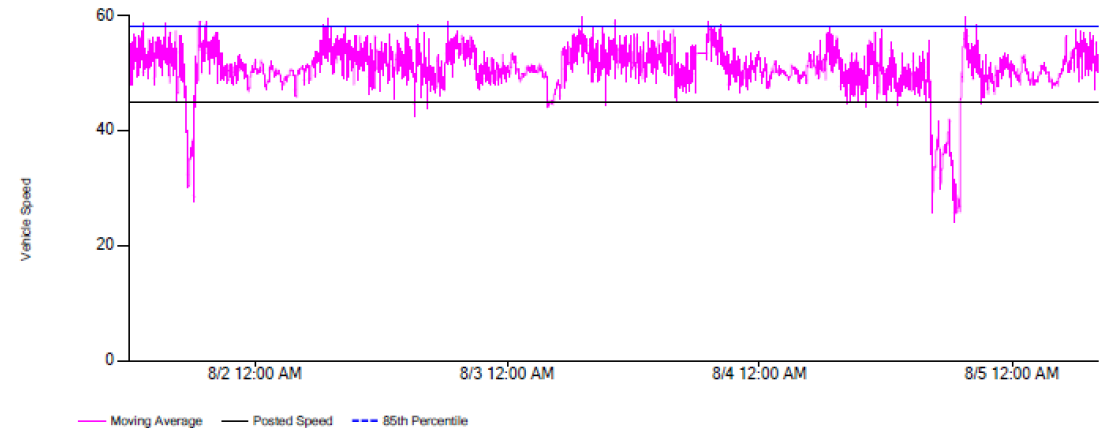
Percentiles:

--- 85th 58

### Vehicle Speed Report

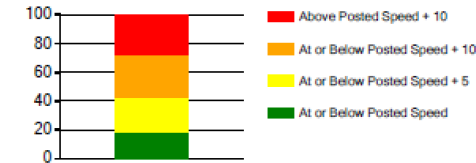
Data File: UDOT03\_Aug-17-16\_08:54.csv

Date Range: 8/1/16 12:00 PM to 8/5/16 8:15 AM



Number of data points: 70343  
Posted speed: 45  
Average speed: 51.4  
Percentiles:  
--- 85th 58

### Percentage Compliance



Report Date: 8/17/2016



# SMRT - Success Stories





- PVSL: Where we are going?



# PVSL: Where we are going

- PVSL *System*
- Portable, Intelligent and Dynamic
- Multiple Devices (PVSL, Detectors, PVMS)
  - Integrated as one system
  - Dynamically posting speed limits, and
  - Traveler information messages
  - Operated by RE and Roadway Contractor (No TOC)





# PVSL System: How we are getting there

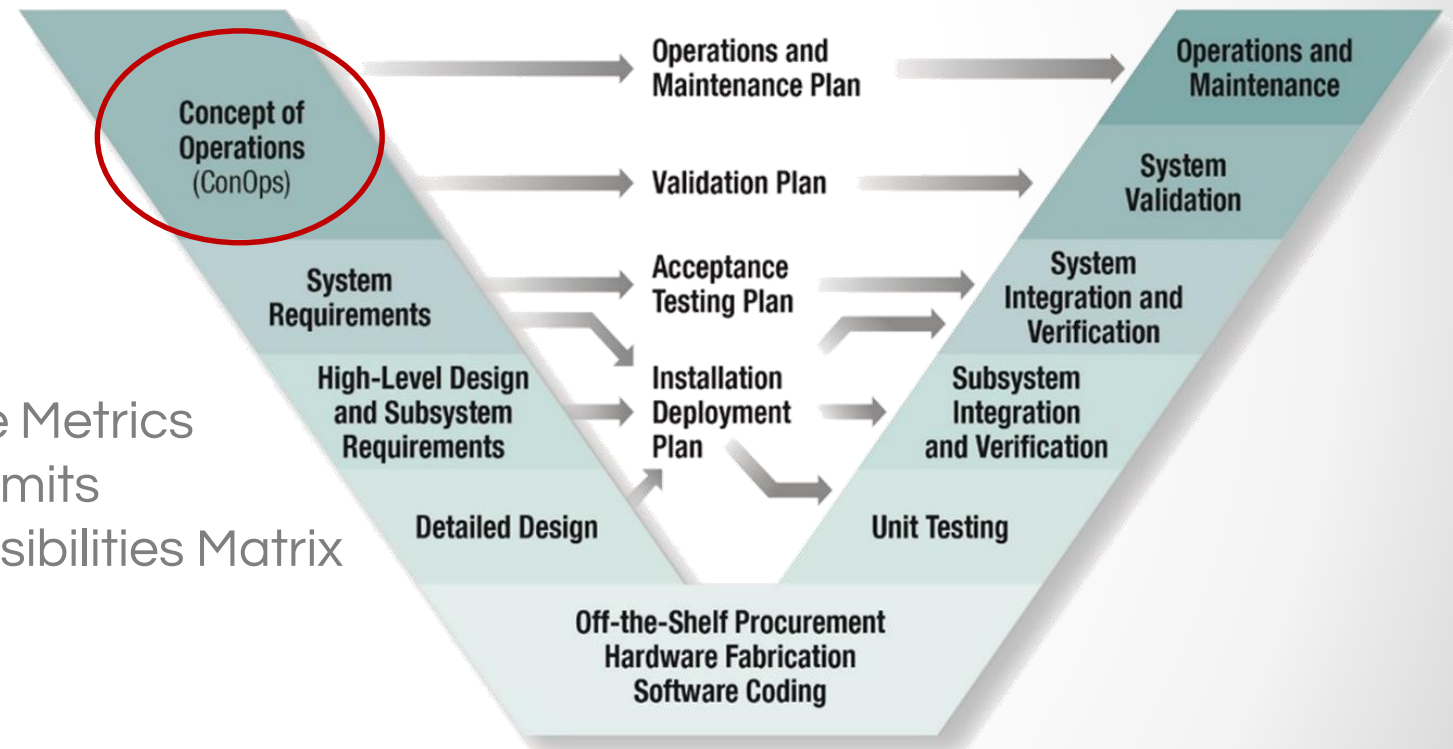
- FHWA AID Grant
  - Awarded December 2014
- System Planning & Design
  - NTP June 2015
  - **Kimley»Horn** and **avenue** | CONSULTANTS
- Turn-key Solution Provider
  - NTP May 2016
  - Ver-Mac and Interstate Barricades





# PVSL System: Con Ops

## Systems Engineering Process



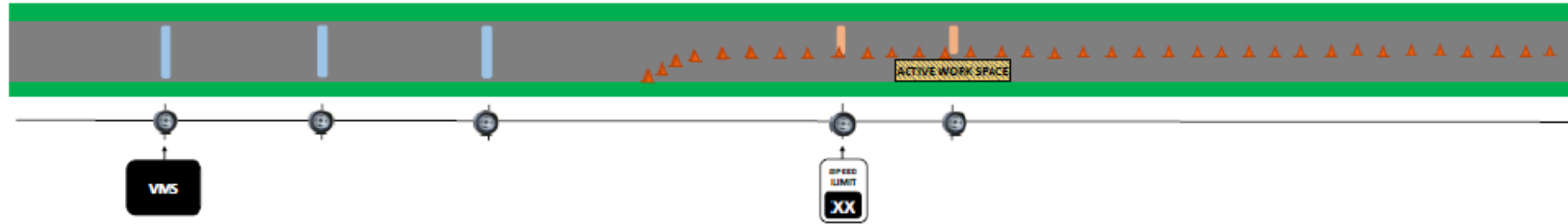
### • Con Ops Phase

- Goals/Objectives/Performance Metrics
- Operational Parameters and Limits
- Stakeholder Roles and Responsibilities Matrix
- Operational Scenarios
- User and System Needs

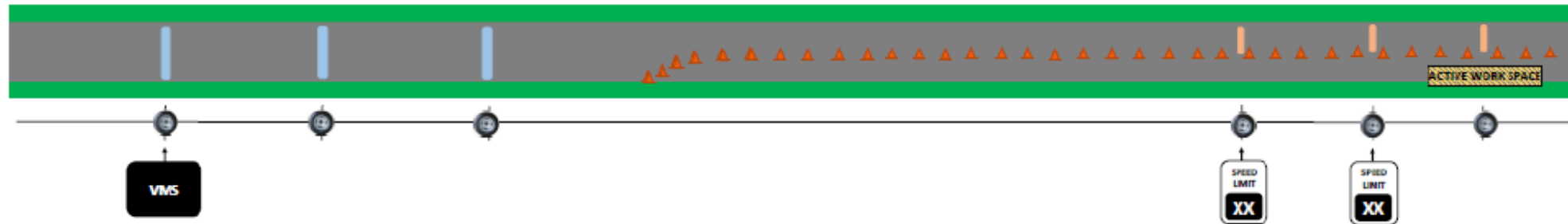


## Operational Scenarios

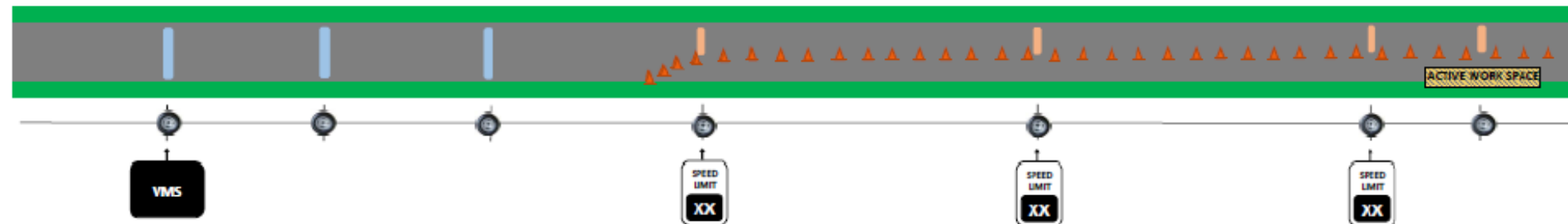
Scenario 1



Scenario 2



Scenario 3

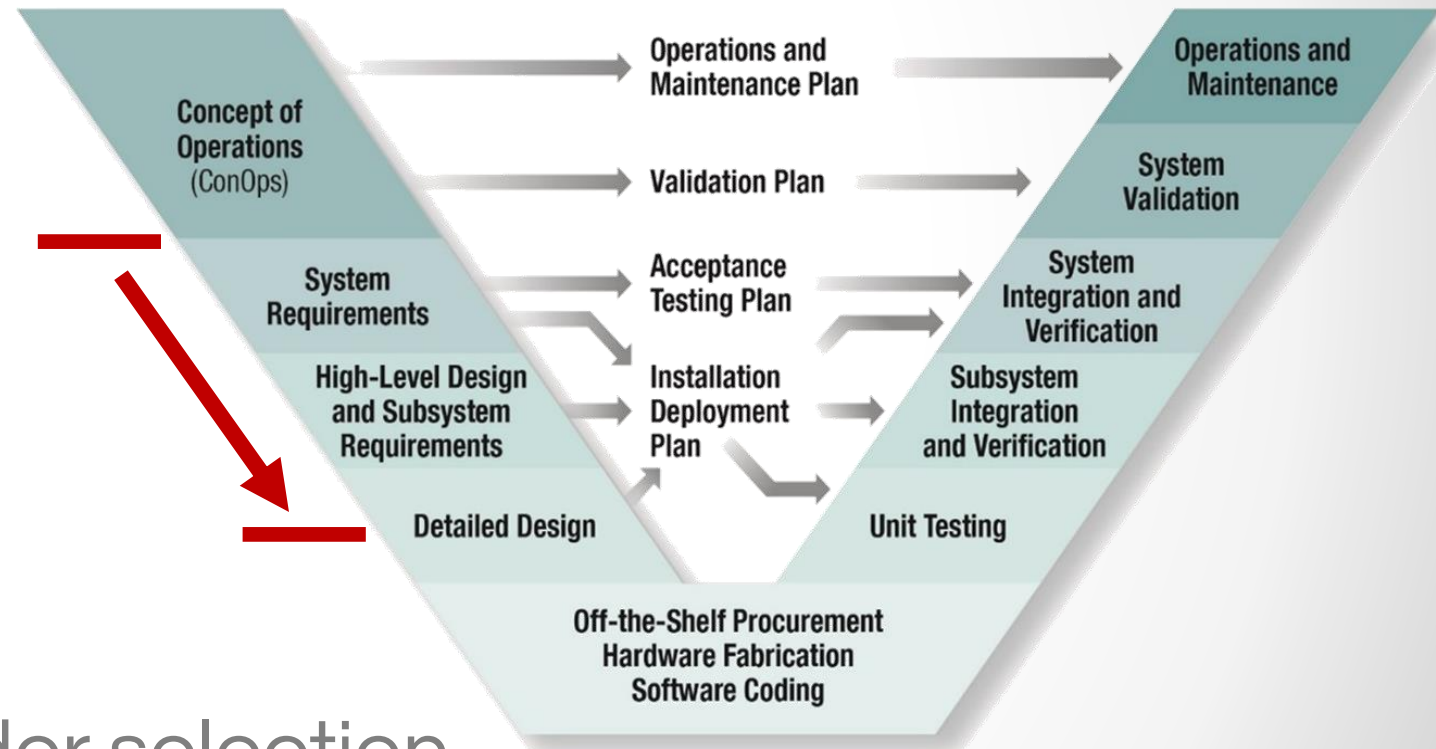




# PVSL System: RFP Development

## Systems Engineering Process

- RFP Development
  - System Requirements
  - High-Level Design
  - System Algorithms

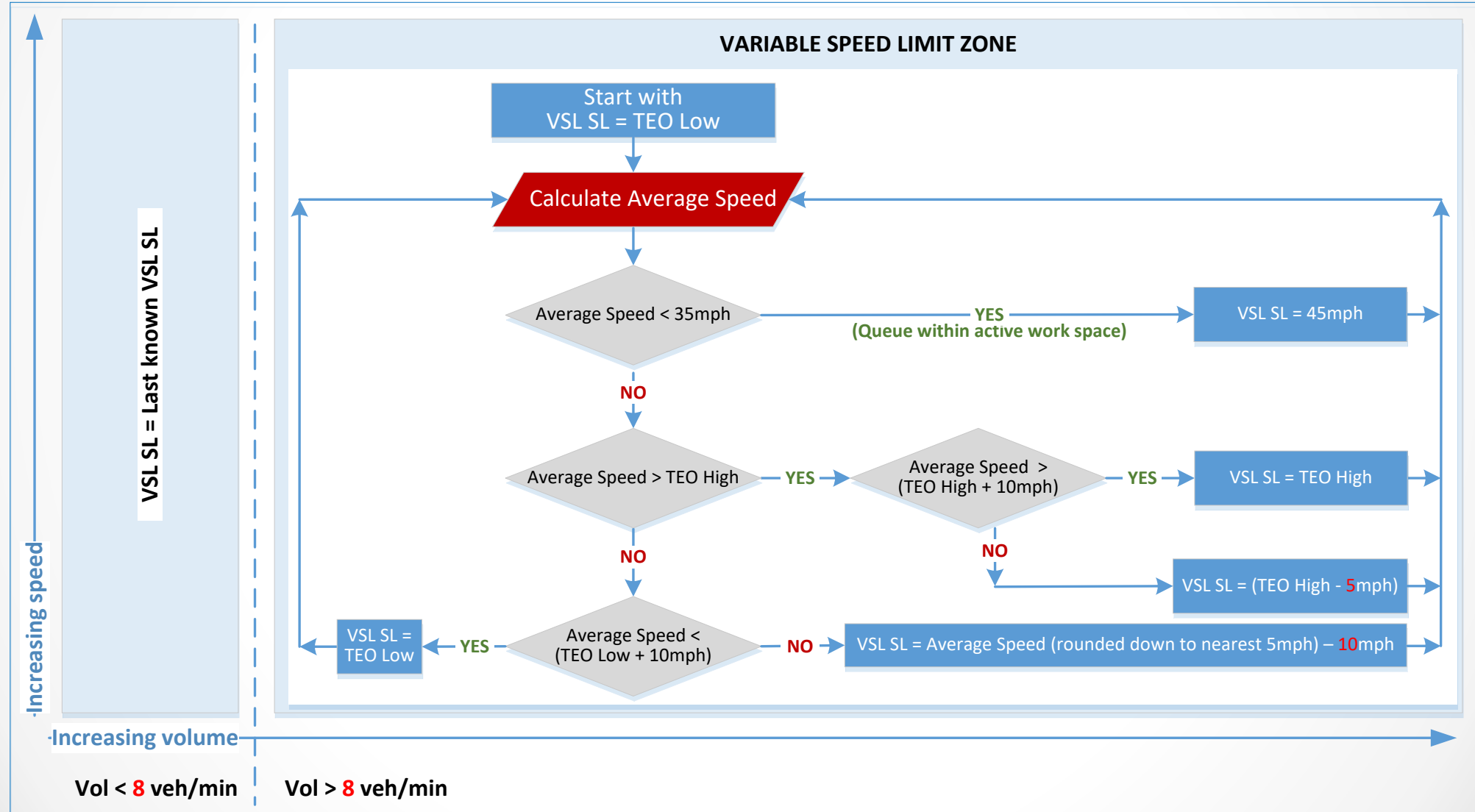


- Turn-key Solution Provider selection





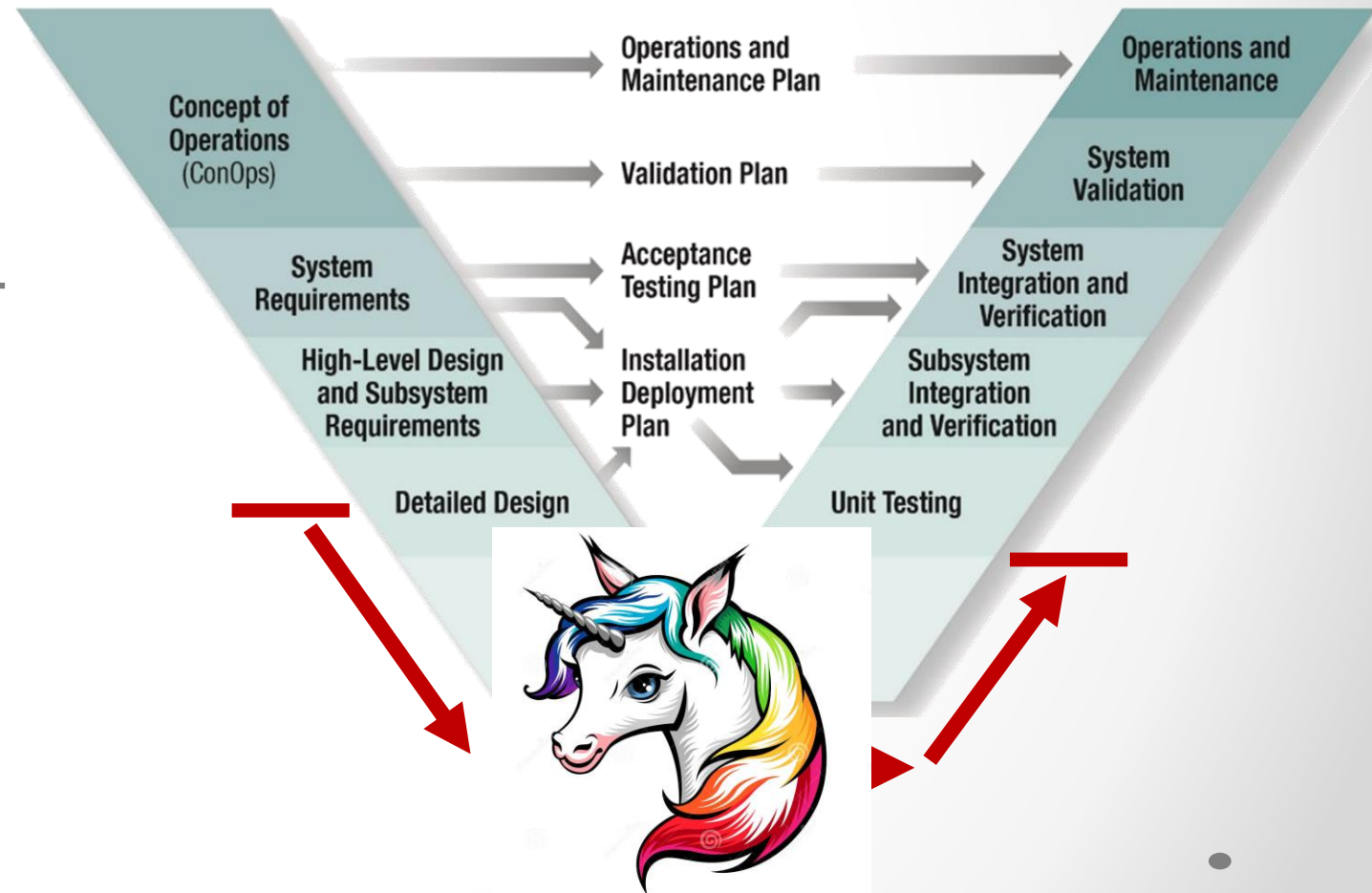
# VSL Subsystem Algorithm





# PVSL System: System Procurement

## Systems Engineering Process



- System Development
  - Submittal Reviews
  - Hardware Fabrication
  - Algorithm Refinement
  - Test Plan Development



# System Components

- **Portable Variable Speed Limit Signs (PVSL)**
  - Trailer Mounted with variable speed digits
  - White LEDs on black background (Regulatory)
- **Portable Operator Control Device**
  - Cell Service Req'd
- **Speed Detection Trailers**
  - K-Band Doppler – ease of use
  - Trailer Mounted



# PVSL Trailers



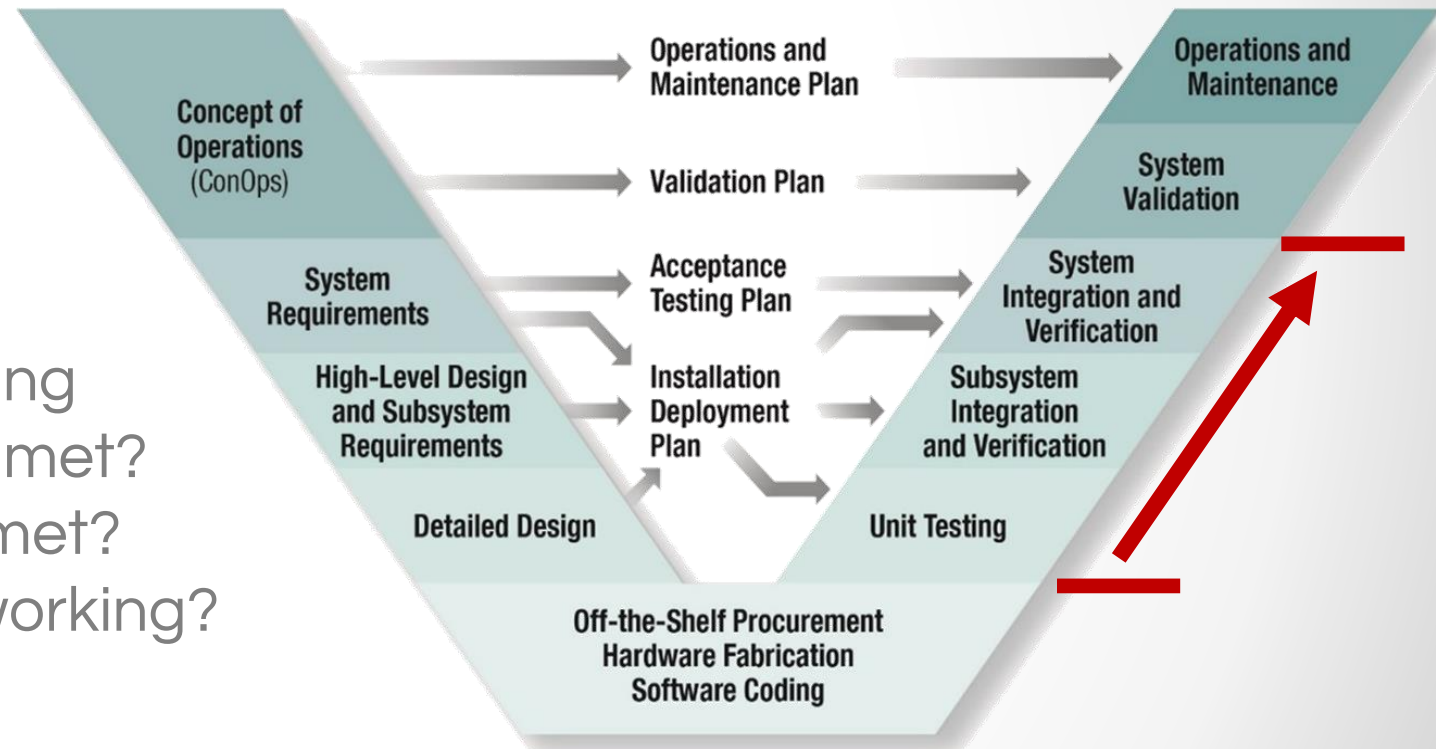




# PVSL System: System Testing

## Systems Engineering Process

- Testing & Verification
  - Testbed Deployment
  - Pass/Fail Acceptance Testing
    - Hardware requirements met?
    - Software requirements met?
    - Integration/algorithms working?





# Software (Mobile)

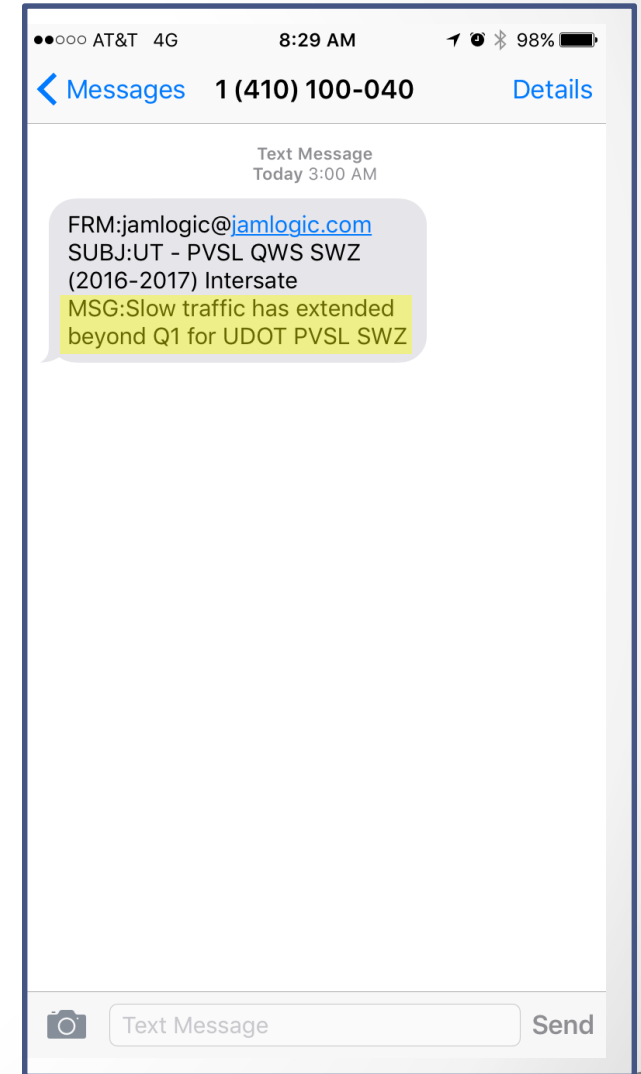
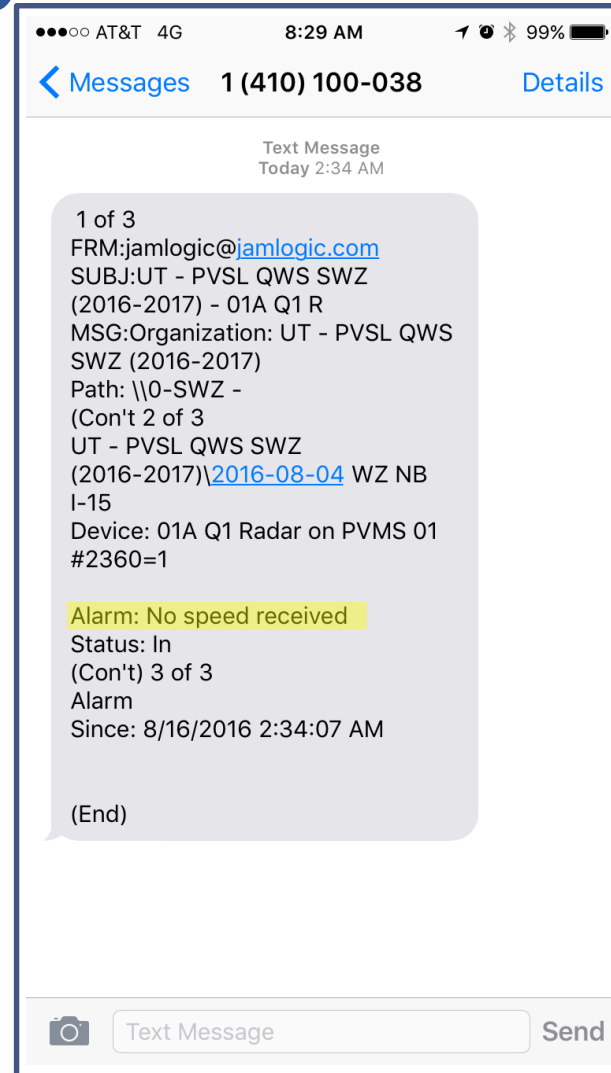
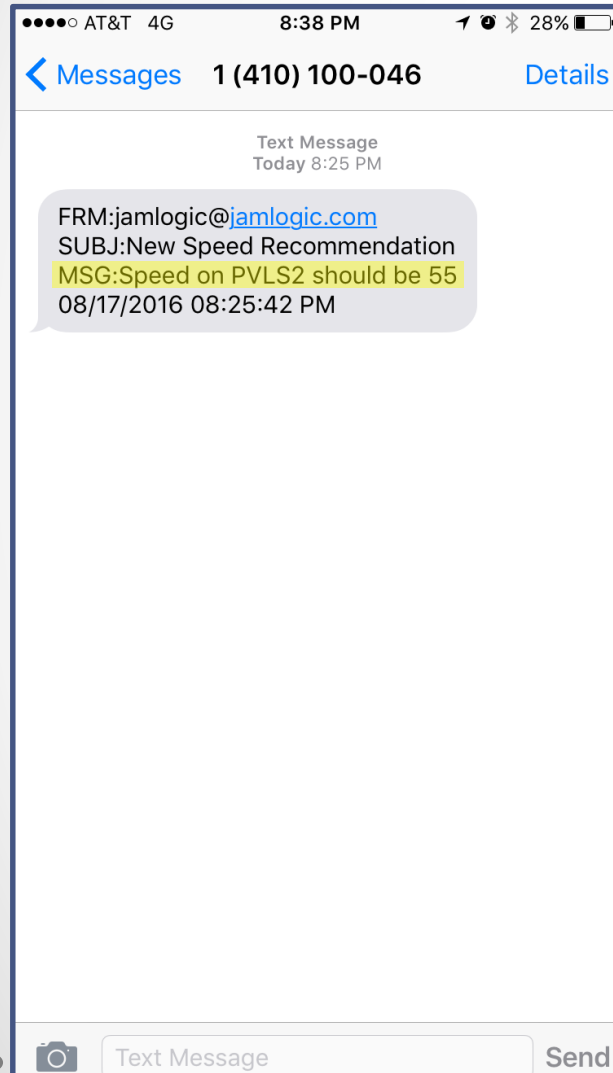
Queue  
Warning

PVSL

JamLogic Mobile					Actions
<input type="checkbox"/>			01 Q1 PVMS 01 #2360=1	13.25 V	
<input type="checkbox"/>			01A Q1 Radar on PVMS 01 #2360=1	13.22 V	
<input type="checkbox"/>			02 Q2 (Radar) #3565=2	13.97 V	
<input type="checkbox"/>			03 Q3 (Radar) #3566=3	13.69 V	
<input type="checkbox"/>			04 PVSL 01 #3259 =6	13.21 V	
<input type="checkbox"/>			04A S1 on PVSL 01 (Radar) #3259=6	13.23 V	

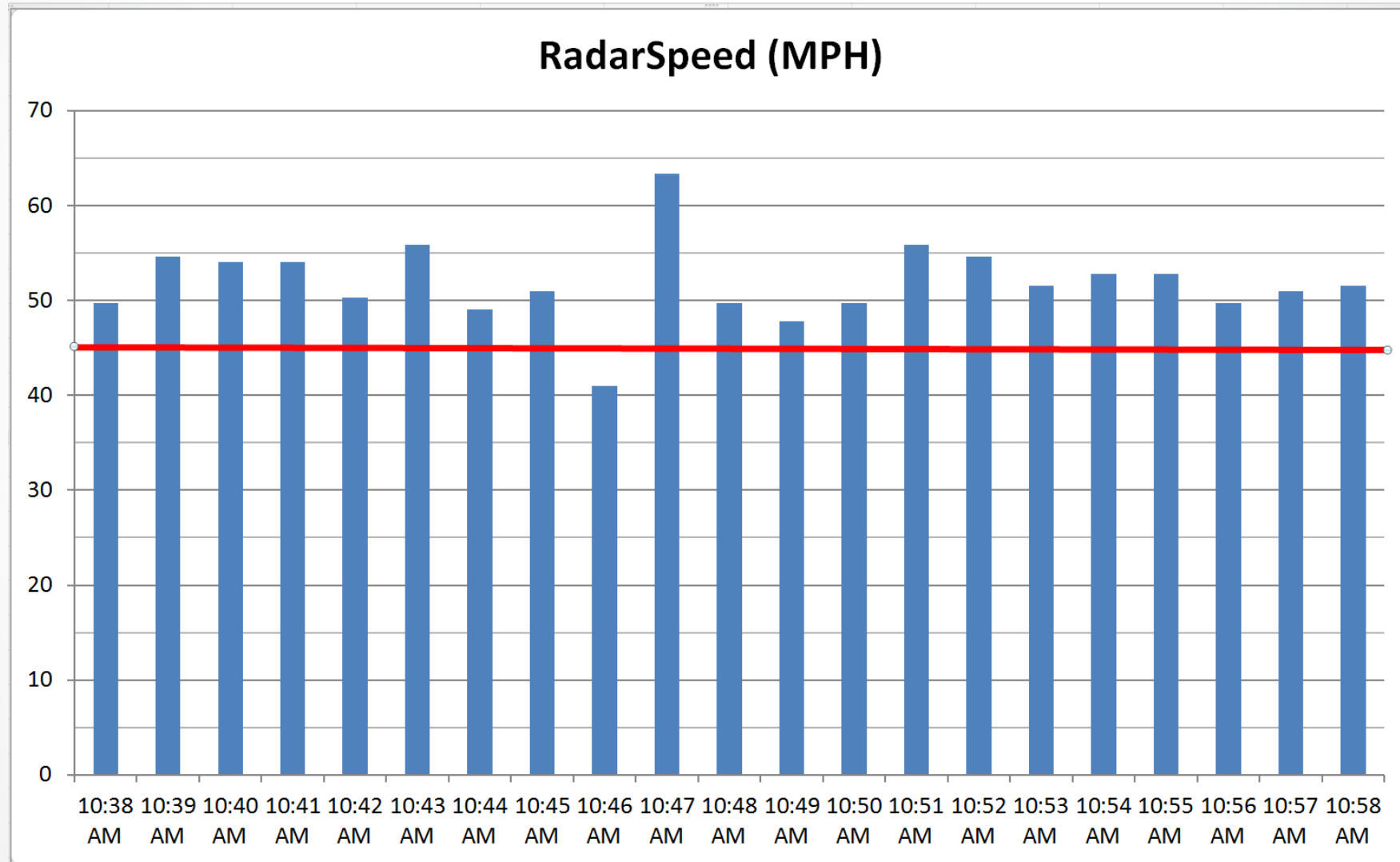


## System Alerts





# Project 1 Preliminary Results







# Spot Speed Study

- Same timeframe
- 99% C.I.
- +/- 2mph
- AVG = 45.7 mph
- 85<sup>th</sup>% = 52 mph

Speed Study

Date 9-13-2016

Time from 10:10:30 am

Time to 10:50 am

Location SBI-15

Direction EB / WB / NB / SB

Diagram

1/2 mile Down Stream from 45 VSL  
Honeyville to ~~the~~ Tremonton.

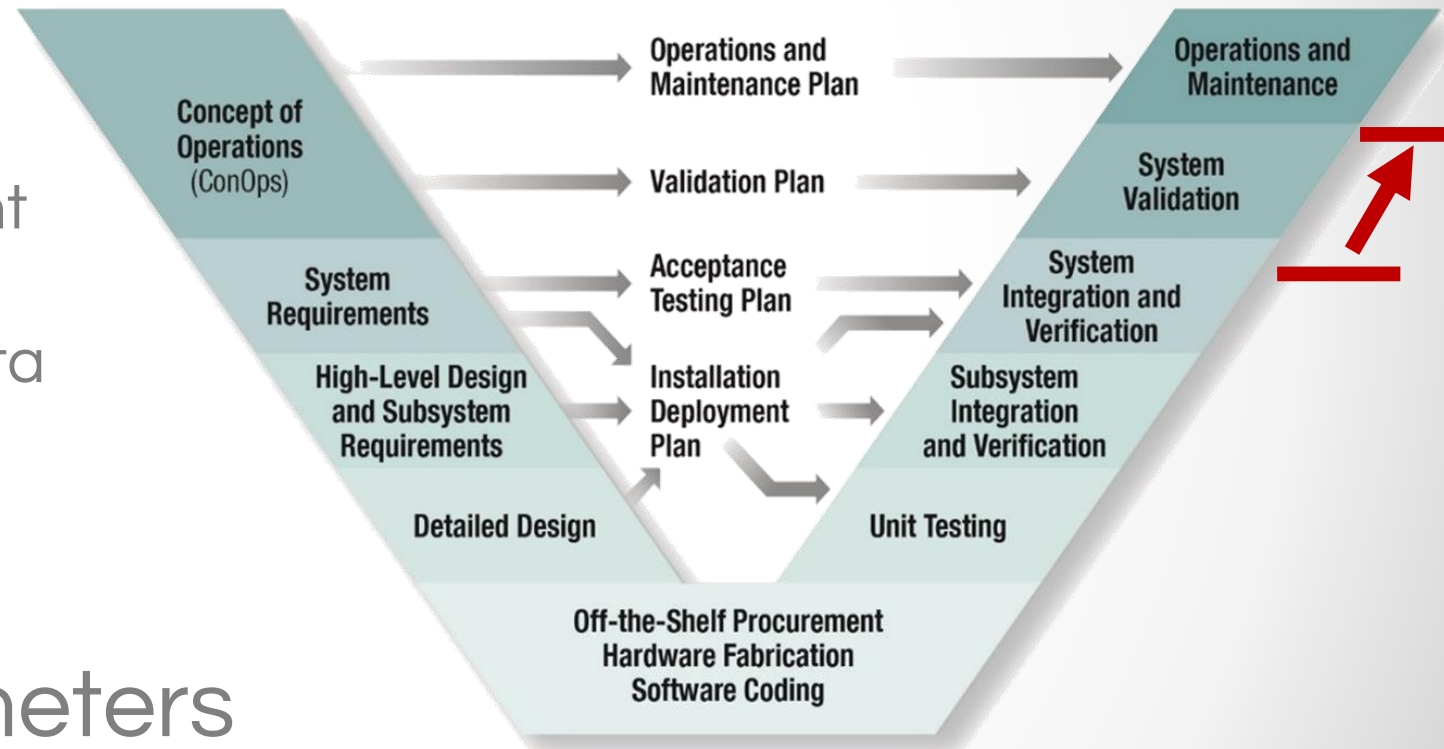
99%  
+/- 2mph

40				66			
41				67			
42				68			
43	110			69			
44	11			70			
45	111			71			
46	111			72			
47	110			73			
48	111			74			
49	111			75			
50	111			76			
51	110			77			
52	111			78			
53	11			79			
54	11			80			
55				81			
56	11			82			
57	1			83			
58				84			
59	1			85			
60				86			
61				87			
62				88			
63				89			
64	1			90			
65				91			



# PVSL System: Next Steps

## Systems Engineering Process



- System Validation
  - Year 1 Project 1 deployment
    - Baseline data collection
  - Full system deployment data
  - Compute & compare with performance measurers
  - Lessons learned workshop
- Refine System Parameters
- Repeat Validation Steps 3 more deployments



# Other Important Factors:

- Public Information:
  - Communicate impact and duration
  - 1.5 miles = 52 seconds
  - Real time messages
- Challenges
  - Getting the change made
  - Lag time (Camera)







# Contact Information

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