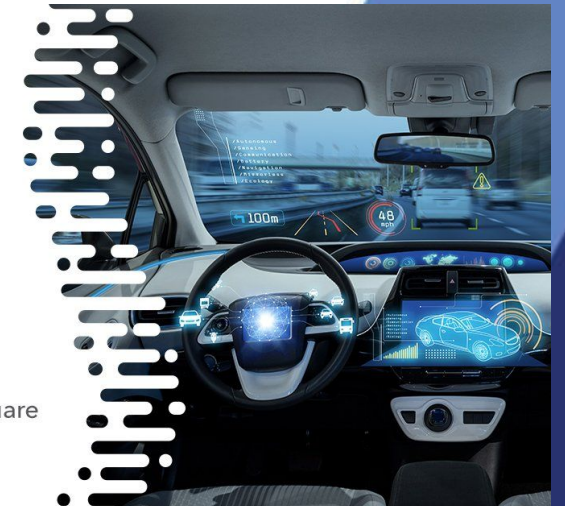


# V2I Deployment in Utah: The Redwood Road MMITSS Operation

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Hilton San Francisco Union Square  
San Francisco



# Overview

- Deployment - Redwood Road MMITSS Deployment
  - Deployment Goals
  - Deployment Location – Redwood Road
  - Installation Details
  - Utah Version of MMITSS
- Operational Results
  - Data Used for Performance Assessment
  - Assessment Results





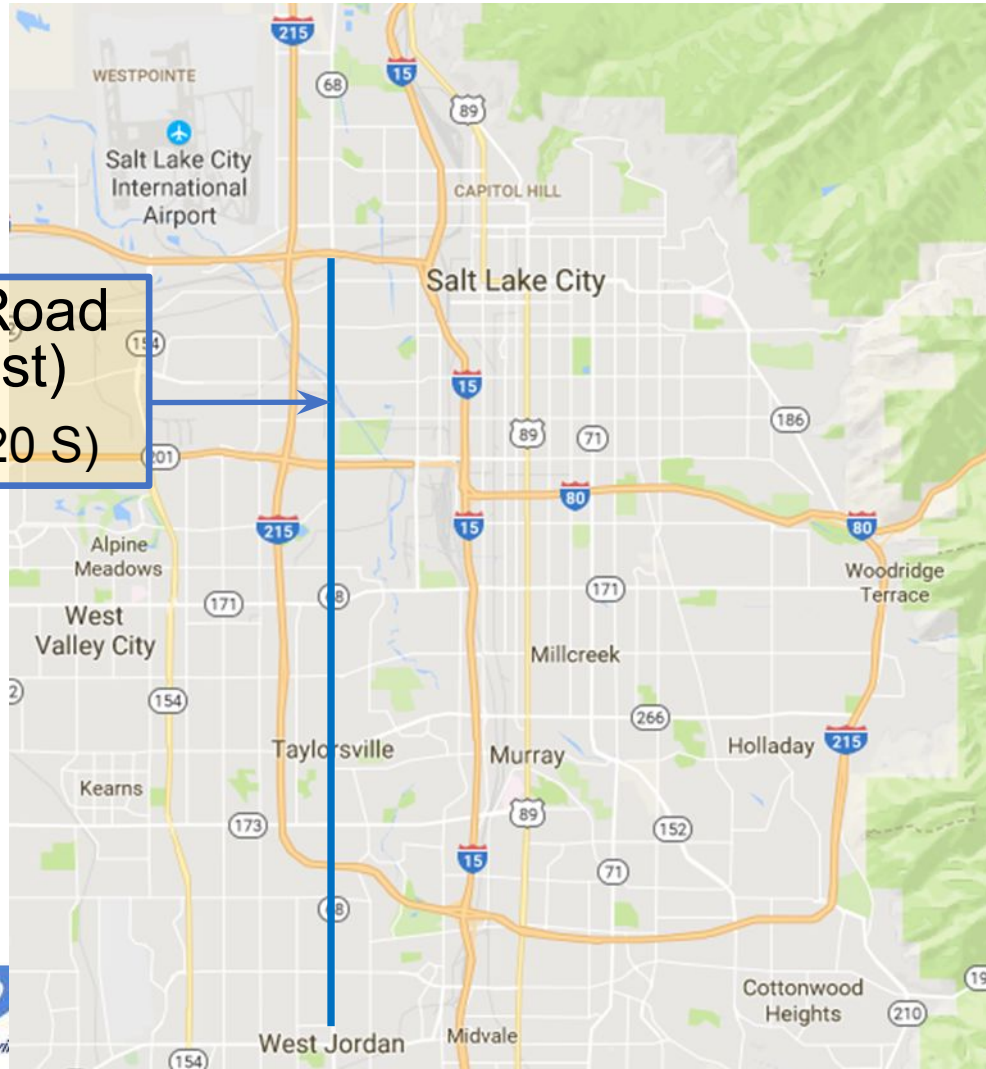
- Full DSRC Corridor
  - Facilitate testing / deployment
  - Prepare for equipped vehicles



- Transit Signal Priority for Improved Schedule Reliability
  - MMITSS Software (Utah Version)
  - Goal: increase from 86% to 94%
  - Minimal impact to other traffic
- Meet the SPaT Challenge



# Utah Deployment Site – Redwood Road



Redwood Road  
(1700 West)  
(400 S to 8020 S)

## 11-mile urban arterial corridor

- UDOT-owned corridor
- 30 signalized intersections
- Varies from 5 to 7 lanes
- ADT: 18,000 to 40,000
  - 60,000 peak at I-215
  - Truck Traffic: 24%
- Two light-rail crossings
- Demographic variety
  - Commercial / Retail
  - Residential
  - College / High School



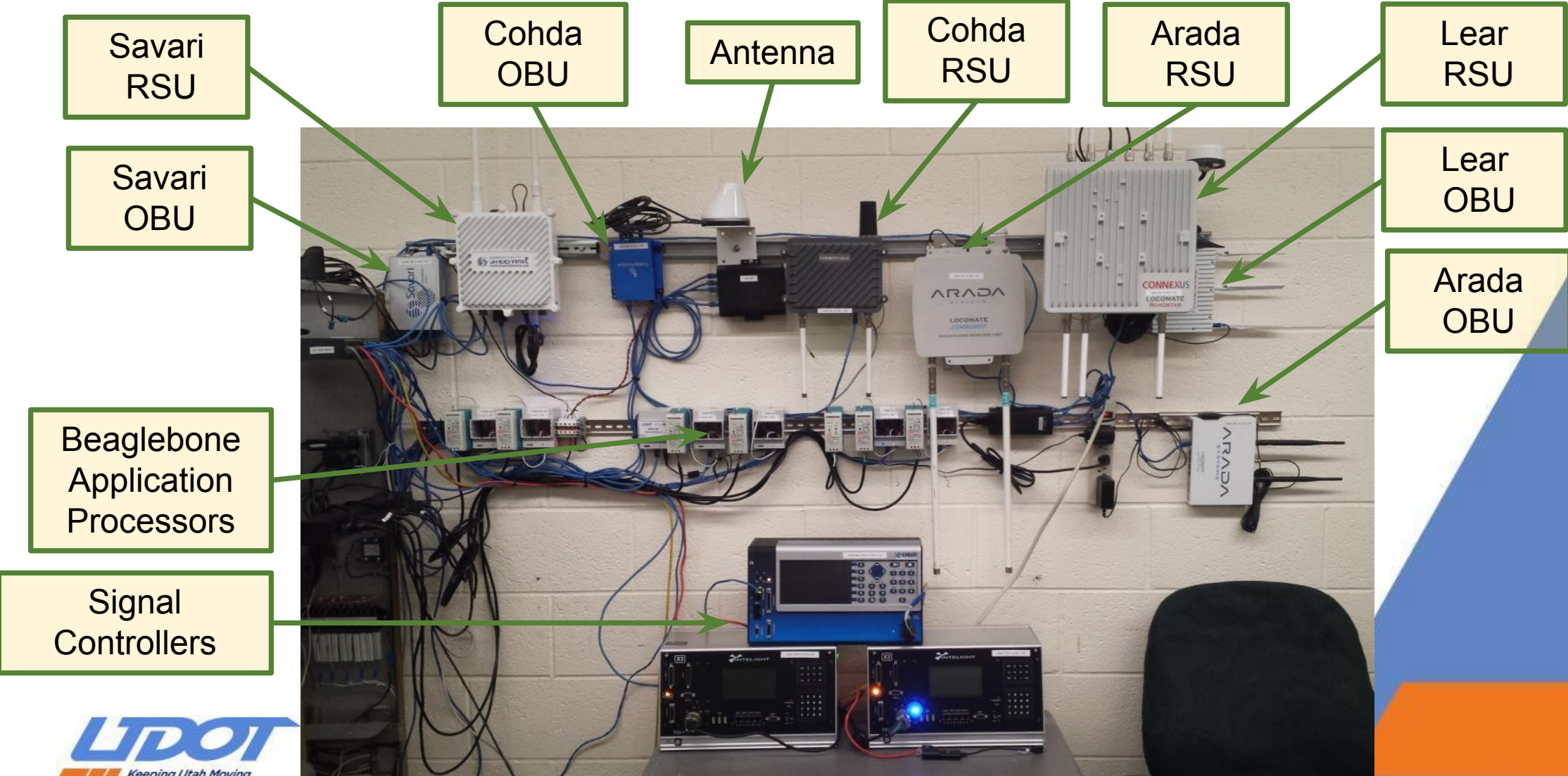
# Redwood Road DSRC Corridor

- Full Fiber Optic Connectivity
  - All signals connected to central system
    - Intelight MaxView
    - Signal Performance Measures (ATSPM)
- Two Brands of Signal Controller
  - Econolite (4) – Cobalt / ASC3
  - Intelight (26)
- Single Board Linux Computer (Beagle Bone)
- Four brands of DSRC RSUs/OBUs
  - Arada / Lear
  - Cohda
  - Savari

Signalized Intersections are the “low hanging fruit” for early V2I



# DSRC Hardware Test Lab



# Redwood Road Installation

- RSU mounted on signal pole, mast arm, luminaire pole
  - Omni-directional antenna, but obstructions can impair signal
  - 300 meter range (nominal minimum – usually longer)
- Ethernet cable to cabinet



# On-Board Installation

- DSRC OBU
  - “Beaglebone” On-board Processor (OBP)
  - Mounted on pin-rail
- Power Supply
- Antenna (roof of bus)
  - DSRC and GPS





# User Interface

- Monitor & troubleshoot
- Observe data flow
- Demonstrate the system

**LTDOT**  
Keeping Utah Moving

**Central Interface**

Poplar Blvd (400 S)

Clear SRM SRM MAP Intersection

Map Satellite

Last SRM Received	
400 S:	12/1/2017, 15:19:20
500 S:	12/1/2017, 15:21:07
850 S:	No Data
1340 S:	No Data
1500 S:	No Data
1700 S:	No Data
2100 S:	No Data
2200 S:	No Data
2320 S:	No Data
2495 S:	No Data
3100 S:	No Data
3500 S:	No Data
3800 S:	No Data
4100 S:	12/1/2017, 14:02:06
4200 S:	12/1/2017, 14:00:11
4450 S:	12/1/2017, 13:58:40
4610 S:	12/1/2017, 13:54:09
4700 S:	12/1/2017, 13:53:42
4800 S:	12/1/2017, 13:52:26
5225 S:	12/1/2017, 13:50:13
5600 S:	12/1/2017, 13:47:13
7000 S:	12/1/2017, 13:43:10
7800 S:	No Data
8210 S:	No Data

SRM Data			
Timestamp:	12/1/2017, 15:19:20	Heading:	South
Intersection:	Poplar Blvd (400 S)	Request:	135
ETA:	12/1/2017, 15:19:29	Inbound:	0
Type:	cancel	Speed:	25 mph
Location:	40.7606/-111.9391	Elevation:	1294.1

SSM Data			
Timestamp:	12/1/2017, 15:19:20	Sequence:	1
Intersection:	Poplar Blvd (400 S)	Inbound:	15
RqSeqNum:	1	Request:	135
Vehicle:	17598	Status:	requested

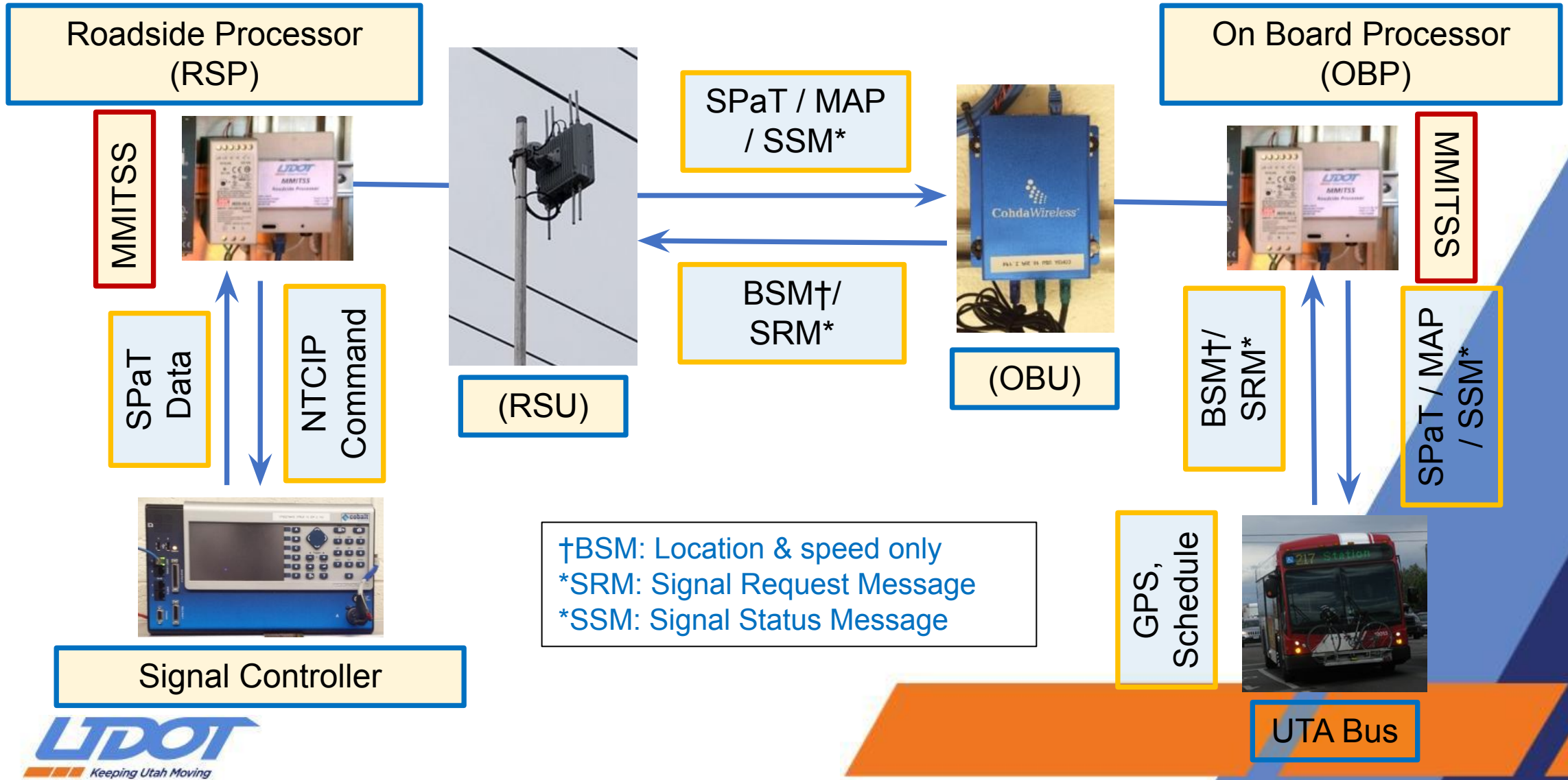
SPAT Data	
Timestamp:	
Intersection:	

BSM Data - 0			
Timestamp:	12/1/2017, 15:21:20	Speed:	29 mph
Location:	40.7562/-111.9391	Heading:	South

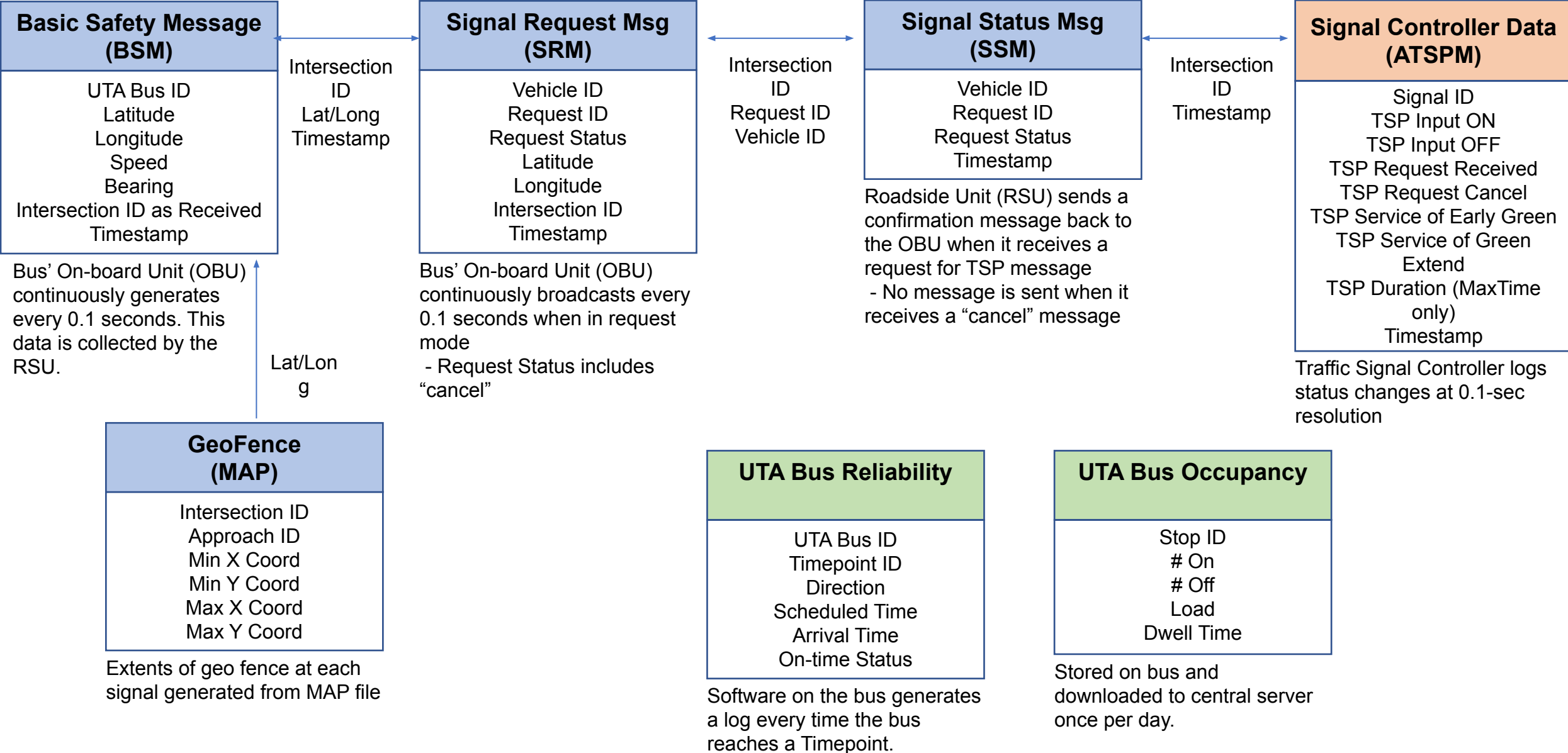
SPAT  SSM  BSM  SRM

Intersection  Selected Intersection  
 Siri Bus  Bsm Bus  Ingress  Egress  
 Request  Update  Cancel

# Utah MMITSS Schematic



# Redwood Road DSRC Database Diagram



### Basic Safety Message (BSM)

	Pk_Id	Timestamp	ReceivedAtIntersectionId	VehicleId	Latitude	Longitude	Elevation	Heading	Speed	DateCreated
1	23994	2018-01-12 14:09:53.0000000	7105	4	40.6849775	-111.9389926	1301.6	179.8875	50	2018-01-12 14:09:57.0000000
2	23995	2018-01-12 14:09:54.0000000	7105	4	40.684952	-111.9389923	1301.6	179.875	50	2018-01-12 14:09:57.0000000
3	23996	2018-01-12 14:09:54.0000000	7105	4	40.6849393	-111.938992	1301.6	179.5375	50	2018-01-12 14:09:57.0000000
4	23997	2018-01-12 14:09:54.0000000	7105	4	40.6849266	-111.938992	1301.6	180.0125	50	2018-01-12 14:09:57.0000000
5	23998	2018-01-12 14:09:54.0000000	7105	4	40.6849013	-111.9389915	1301.6	179.8	50	2018-01-12 14:09:57.0000000

### Signal Request Message (SRM)

	Pk_Id	Timestamp	Seq...	VehicleId	Vehicle...	Veicl...	Inbou...	Inters...	RequestId	Reque...	VehicleLatitude	VehicleLongitude	VehicleElev...	VehicleHe...	VehicleSpeed
1	1	2018-01-17 18:36:35.0...	1	4873	OBE	transit	15	7105	3	request	40.6806408	-111.9389637	1299.7	179.85	58
2	2	2018-01-17 18:36:35.0...	1	4873	OBE	transit	15	7105	3	request	40.6806408	-111.9389637	1299.7	179.85	58
3	3	2018-01-17 18:36:35.0...	1	4873	OBE	transit	15	7105	3	request	40.6806408	-111.9389637	1299.7	179.85	58
4	4	2018-01-17 18:36:35.0...	1	4873	OBE	transit	15	7105	3	request	40.6806408	-111.9389637	1299.7	179.85	58
5	5	2018-01-17 18:36:36.0...	1	4873	OBE	transit	15	7105	3	request	40.6806408	-111.9389637	1299.7	179.85	58

### Signal Safety Message (SSM)

	Pk_Id	IntersectionId	Timestamp	RequestId	VehicleId	SequenceNumber	InboundLaneId	Status	DateCreated
1	1	7605	2018-01-17 18:37:40.0000000	5	4873	1	16	requested	2018-01-17 18:37:41.0000000
2	2	7605	2018-01-17 18:37:40.0000000	5	4873	1	16	requested	2018-01-17 18:37:41.0000000
3	3	7107	2018-01-17 18:38:05.0000000	6	4873	1	28	requested	2018-01-17 18:38:06.0000000
4	4	7107	2018-01-17 18:38:05.0000000	6	4873	1	28	requested	2018-01-17 18:38:06.0000000
5	5	7107	2018-01-17 18:38:42.0000000	6	4873	2	29	requested	2018-01-17 18:38:46.0000000

### GeoFence (MAP)

	IntersectionID	Intersection	GeoCoordSys	Datum	MinOfX_COORD	MinOfY_COORD	MaxOfX_COORD	MaxOfY_COORD
1	7080	2770 South and Redwood Road	GCS_WGS_1984	D_WGS_1984	40.708410822000	-111.940361023000	40.713889558300	-111.938830214000
2	7090	400 South and Redwood Road	GCS_WGS_1984	D_WGS_1984	40.759560489990	-111.940649399630	40.762192548310	-111.937034413700
3	7091	500 South and Redwood Road	GCS_WGS_1984	D_WGS_1984	40.756297687700	-111.941018783000	40.759513640400	-111.937372501000
4	7092	Indiana Avenue and Redwood Road Intersection	GCS_WGS_1984	D_WGS_1984	40.750304576600	-111.940459416000	40.752359443000	-111.937508171000
5	7093	California Ave and Redwood Road	GCS_WGS_1984	D_WGS_1984	40.739575557320	-111.940012758390	40.741563004760	-111.938133642780

### Signal Controller Data (ATSPM)

	id	tstamp	code	param
1	7103	2018-02-14 14:14:56.1000000	176	6
2	7103	2018-02-14 14:14:56.2000000	604	4
3	7103	2018-02-14 14:14:56.4000000	603	3
4	7103	2018-02-14 14:14:56.4000000	112	6
5	7103	2018-02-14 14:14:56.5000000	114	6
6	7103	2018-02-14 14:15:12.3000000	177	6
7	7103	2018-02-14 14:15:12.4000000	604	3
8	7103	2018-02-14 14:15:12.6000000	603	4
9	7103	2018-02-14 14:15:12.6000000	115	6

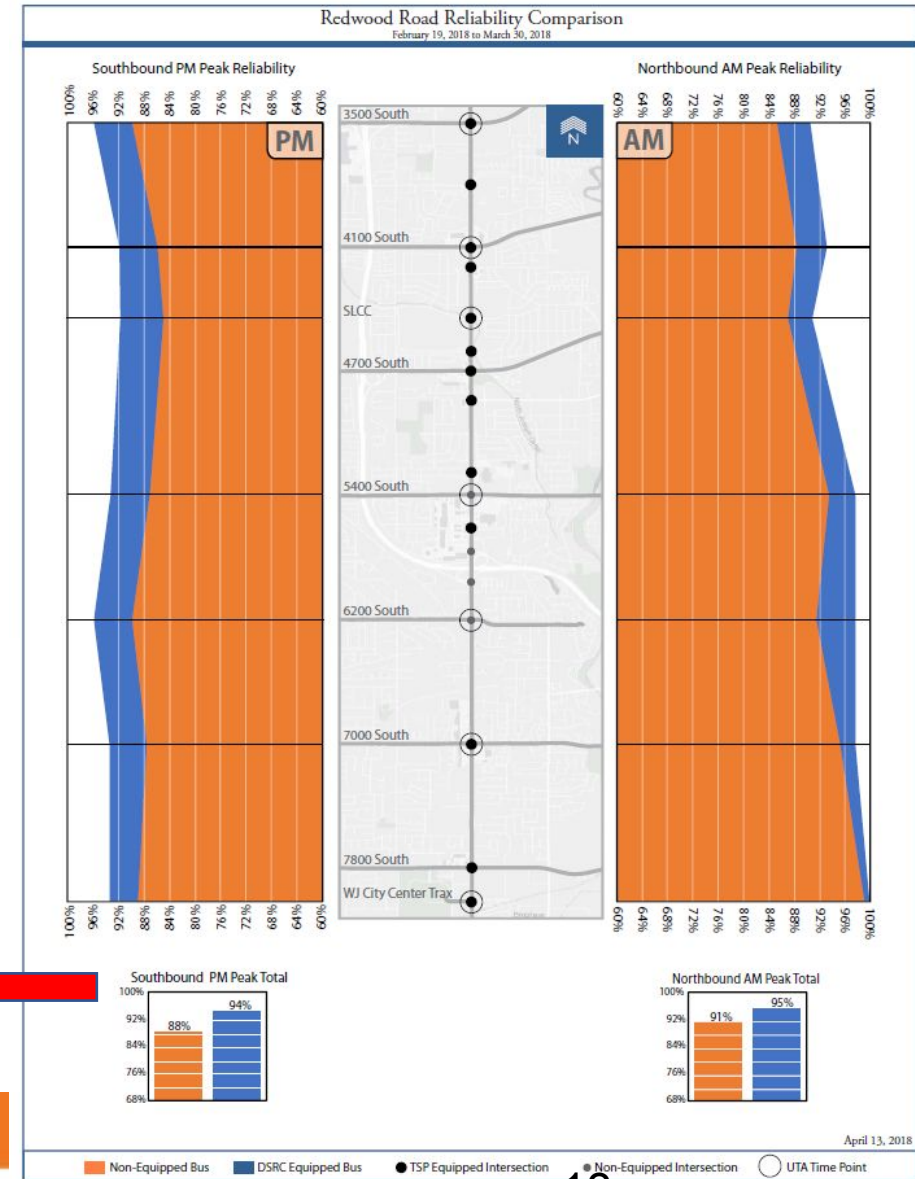
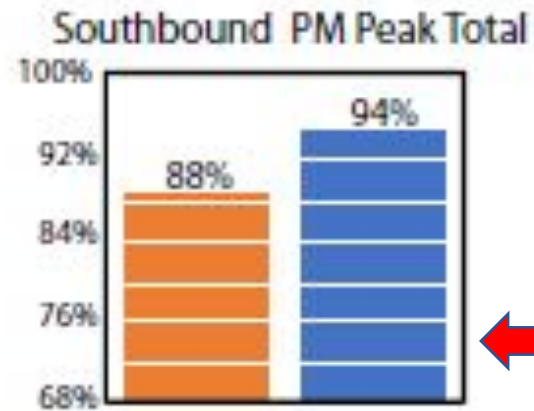
	id	tstamp	code	param
3	7116	2018-02-14 18:59:13.5000000	171	2
4	7116	2018-02-14 18:59:13.5000000	112	1
5	7116	2018-02-14 18:59:40.4000000	113	1
6	7116	2018-02-14 18:59:53.7000000	172	2
7	7116	2018-02-14 18:59:54.6000000	115	1

*Econolite ASC/3 & Cobalt*

*Intelight MaxTime*

# Operational Results (Preliminary)

- Operational Since Nov 2017
- Transit Schedule Reliability
  - Improvement: 88% to 94% (Southbound)
  - Similar Results for:
    - Northbound Peak
    - Southbound Average
    - Northbound Average



# Additional Deployments

## Provo-Orem BRT Project

- 47 Intersections
- Intersection Variety – skews / curves
- MMITSS-Utah
- Two DSRC Brands



## Snow Plow Pre-emption Project

- Salt Lake Valley – 4 to 5 corridors
- Up to 120 Intersections

