The *Utah Connected* Program

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Webinar #1 – July 19, 2023

Thanks!

- Ivan Marrero, FHWA Utah Division
- FHWA and their ATCMTD Grants Team and local FHWA Office
  - These webinars are brought to you through ATCMTD funding
- Lisa Zundel, UDOT Traffic Management Director
- Muriel Xochimitl and the XFactor Team
- To all the presenters – UDOT, UTA, and our consultants
  - Panasonic, Narwhal, Wall Consultant Group, Duraline, Optasense, and VSI Labs
- To all of you – on this webinar, future webinars, and who will view these recorded webinars later

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Webinar Goals

- Promote information sharing
- Share lessons learned
- Foster collaboration
- Support and encourage deployment efforts by other agencies

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UDOT Transportation Technology Group

- Formed in 2016
  - Efforts previously located within the Intelligent Transportation Systems Group
- Within UDOT's Traffic Management Division
  - Close coordination with signal operations, ITS, freeway operations , etc.
- Focused mostly on transportation operations technologies
  - Connected vehicles
  - Automated vehicles
  - Sensor technology (LiDAR, DAS, etc.)
- Four people. . . And a lot of consultant support

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UDOT Transportation Technology Goals

- Safety
  - Reduce crashes / save lives
  - UDOT's Strategic Goal: Zero Crashes, Injuries and Fatalities
  - Provide information to: driver, vehicle, control room operator
  - Focus on vulnerable road users
- Mobility
  - Improve transportation options and reliability for all users
  - UDOT's Strategic Goal: Optimize Mobility

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UDOT Transportation Technology Goals

- Safety
- Mobility
- Achieve Full Situational Awareness
  - Know what is going on across our entire network
  - Includes innovative sensors – like DAS and LiDAR
- Prepare for CV-Equipped Production Vehicles
  - Full CV safety benefits require that OEMs install compatible systems
  - Be at the forefront of CV deployment and encourage broad deployment

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ATCMTD Program

ATCMTD

- Advanced Transportation and Congestion Management Technologies Deployment
  - Established by the Fixing America's Surface Transportation (FAST) Act
- Fund the development and deployment of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment
- 58 projects funded since 2016 from almost 300 applications

ATCMTD "*Utah Connected*" Grant

- Announced in April 2019 (From a FY18 Notice of Funding Opportunity)
- Awarded in Sept 2019
  - $3,000,000 federal / $3,120,800 state match (as amended)
- Essential component of UDOT's development and expansion of innovative technologies

ATCMTD "*Utah Connected*" Grant

- Three focus areas:
  - Connected Systems – Real-time Full Situational Awareness
    - Data Ecosystem ← Webinar #2
    - Fiber Sensing (Distributed Acoustic Sensing) ← Webinar #5
  - Connected Vehicles – Solutions for Safety and Mobility
    - Transit Signal Priority
    - Snowplow Preemption ← Webinar #4
    - Curve Speed Warning (CSW)
    - Spot Weather Impact Warning (SWIW) ← Webinar #3
  - Connected People – Autonomous Shuttle Deployment
    - ~~Automated Vehicle Shuttle Lessons Learned~~
    - Automated Vehicle Road Readiness Study ← Webinar #6

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Connected Vehicle Data Ecosystem

Intelligent Highways:
Full Situational Awareness

The “Big Picture” around transportation technology in Utah

https://youtu.be/Z91IL9PDbmw

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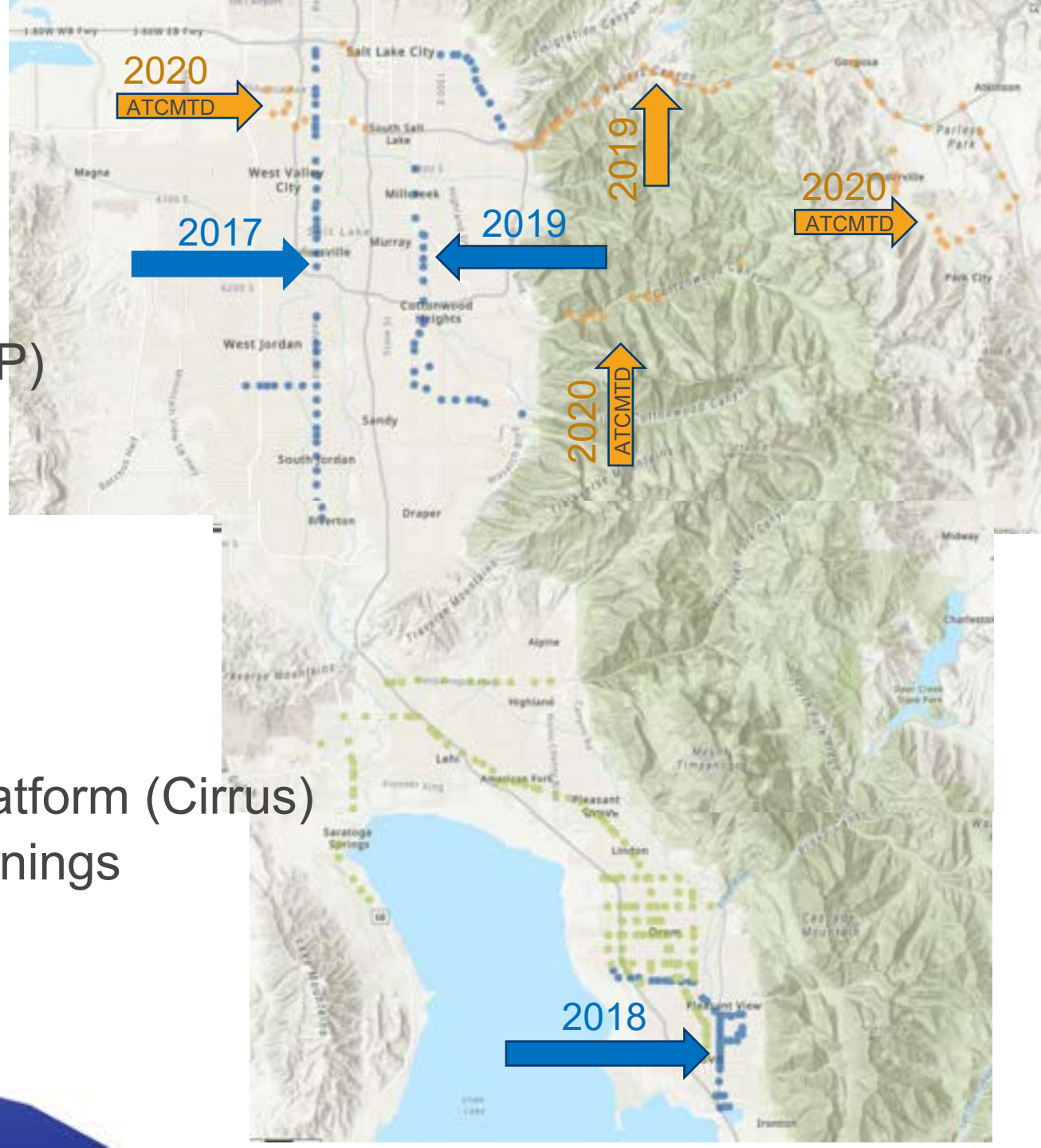
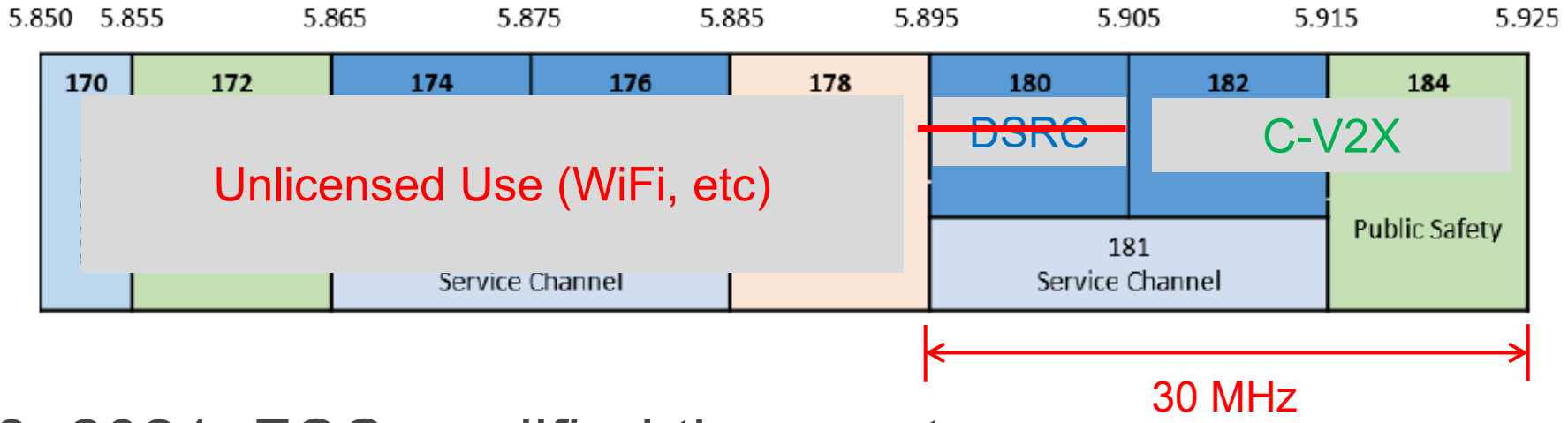
Connected Vehicle Deployments

CV Deployments

- 2017 - 2019
  - DSRC RSUs & OBUs
  - Support Transit Signal Priority (TSP)
  - Support Snow Plow Preemption
- 2019
  - Dual Mode (CV2X & DSRC)
  - Vehicle Insights (from BSM)
- 2020 (ATCMTD)
  - Cloud-based “Data Ecosystem” platform (Cirrus)
  - Curve Speed & Spot Weather Warnings
  - Security Credentials on messages



Changes to the Spectrum



On May 3, 2021, FCC modified the spectrum:

- Give the lower 45MHz to unlicensed use (Wi-Fi)
- Formally allow C-V2X (LTE-V2X) into the spectrum, pending final Rules
  - Previously allowed in the spectrum only through “experimental license”
- Move DSRC (temporarily) to upper 30MHz (by July 2022)
- Phase out DSRC entirely (by about mid 2024 - tbd)

Moving Forward with Connected Vehicles

Regulatory Certainty

- It has been decided: we have 30 MHz & C-V2X
  - Note: C-V2X / LTE-V2X is NOT 5G
  - Note: C-V2X / LTE-V2X is NOT telematics
- Need Final Operating Rules - FCC 2nd Report & Order
  - Broadcast power limits everyone can live with
  - Permit process
- Need Waivers from the FCC to operate CV2X in the near term
  - Joint Waiver issued April 2023 – 14 specific parties (incl. Utah and Virginia)
  - Other waiver requests still pending

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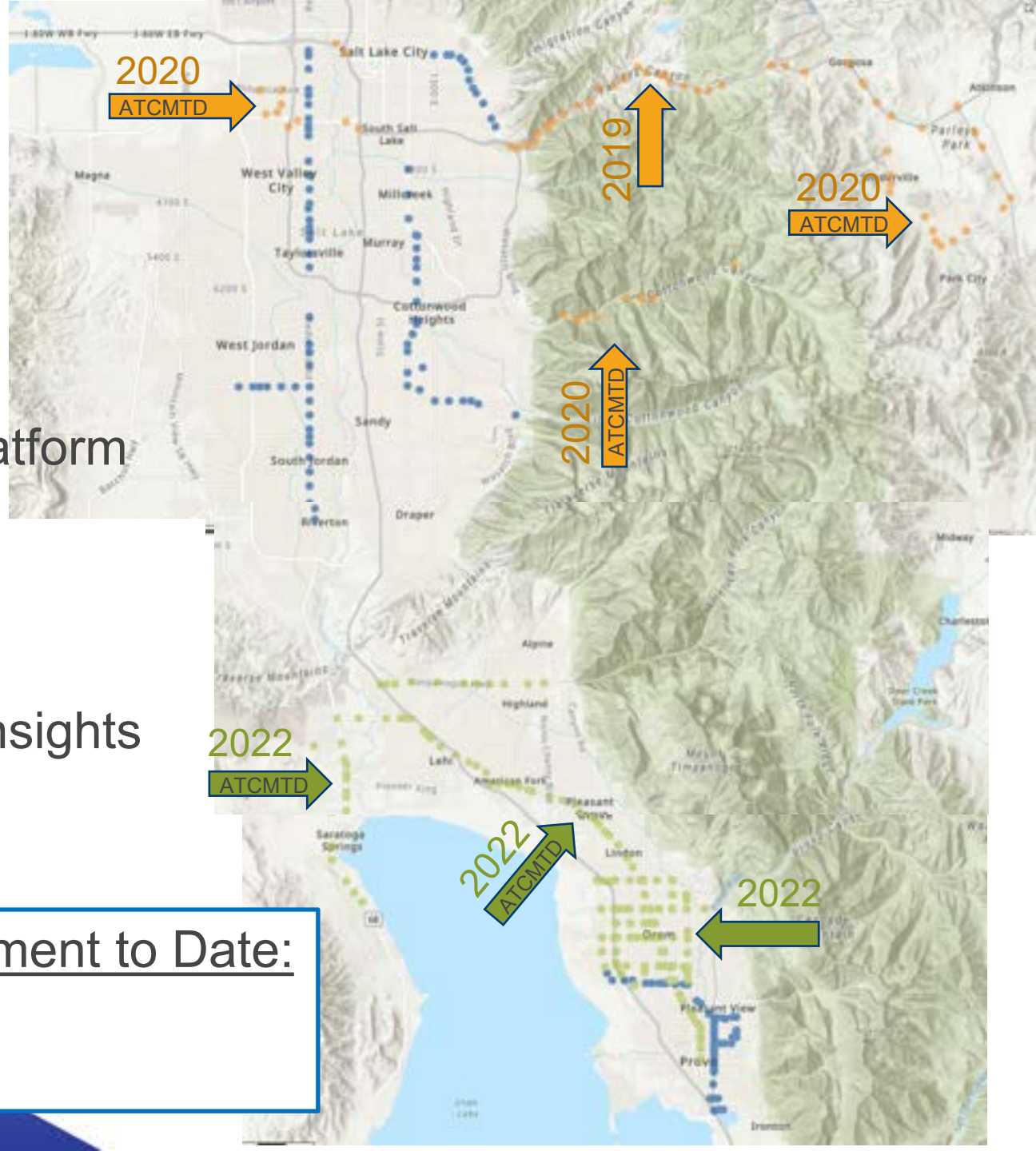
CV Deployments

- 2019
  - Vehicle Insights (from BSM)
- 2020 (ATCMTD)
  - Cloud-based “Data Ecosystem” platform
  - CSW and SWIW
  - Security Credentials on messages
- 2022
  - “Enclave”: Preemption & Vehicle Insights
- 2022 (ATCMTD)
  - TSP & Preemption

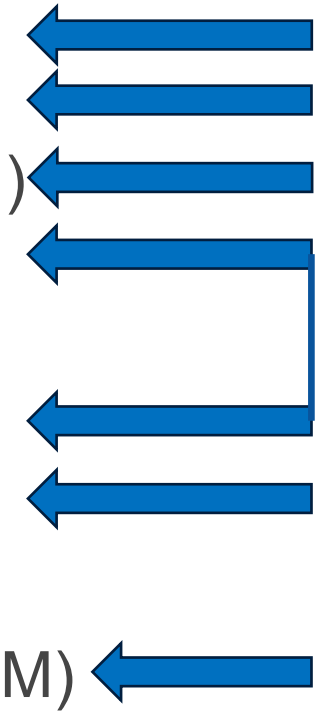


Total Deployment to Date:

- 338 RSUs
- 272 OBUs

Standardized Messages Being Used

- Signalized Intersections:
  - Signal Phase and Timing (SPaT)
  - Intersection Geometry (MAP)
  - GPS Correction Message (RTCM)
  - Signal Status Message (SSM)
- Vehicle-Generated:
  - Signal Request Message (SRM)
  - Basic Safety Message (BSM)
- Roadside Locations:
  - Traveler Information Message (TIM)



Supports Many Intersection Applications

Used For Higher Location Accuracy

TSP & Preemption

Vehicle Insights

Curve Speed & Spot Weather Warnings

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In theory, there is no difference
between theory and practice.
In practice, there is.
- Yogi Berra

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Lessons Learned

- A lot of progress has been made in the past four years
  - FCC 1st Report and Order – resolution in spectrum (like it or not)
  - Connected Intersection (CI) Guidance – uniform deployment guidelines
    - Implementation Guide: CTI 4501 v01.00, June 2022 (will be revised in 2024)
    - Validation Report: CTI 4502 V01.00, Feb 2022
    - Performance Assessment – Crash Avoidance Metrics Partnership, Dec 2022
    - CI Guidance Document: Connected Vehicle Pooled Fund Study, Dec 2022
    - CI Test Plan: Connected Vehicle Pooled Fund Study, Mar 2022
    - V2I Day One Deployment Guide: 5GAA, pending release in Oct 2023
    - MAP Preparation Guidance: Connected Vehicle Pooled Fund Study, Dec 2022
    - MAP Creation Tool: USDOT

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Lessons Learned

- A lot of progress has been made in the past four years
  - Hardware has matured
    - Roadside Unit Standard: CTI 4001 v01.01, Sept 2022
    - Updated standards for signal equipment and cabinets (NEMA TS-10, NTCIP 1202, etc)
    - Certification for C-V2X devices
  - Initial C-V2X Waivers have been granted – establishing power limits
  - Security certificates are available
    - Standards: IEEE 1609.2, Mar 2023
    - Need more structure in the SCMS system
  - C-V2X hardware is ready for deployment

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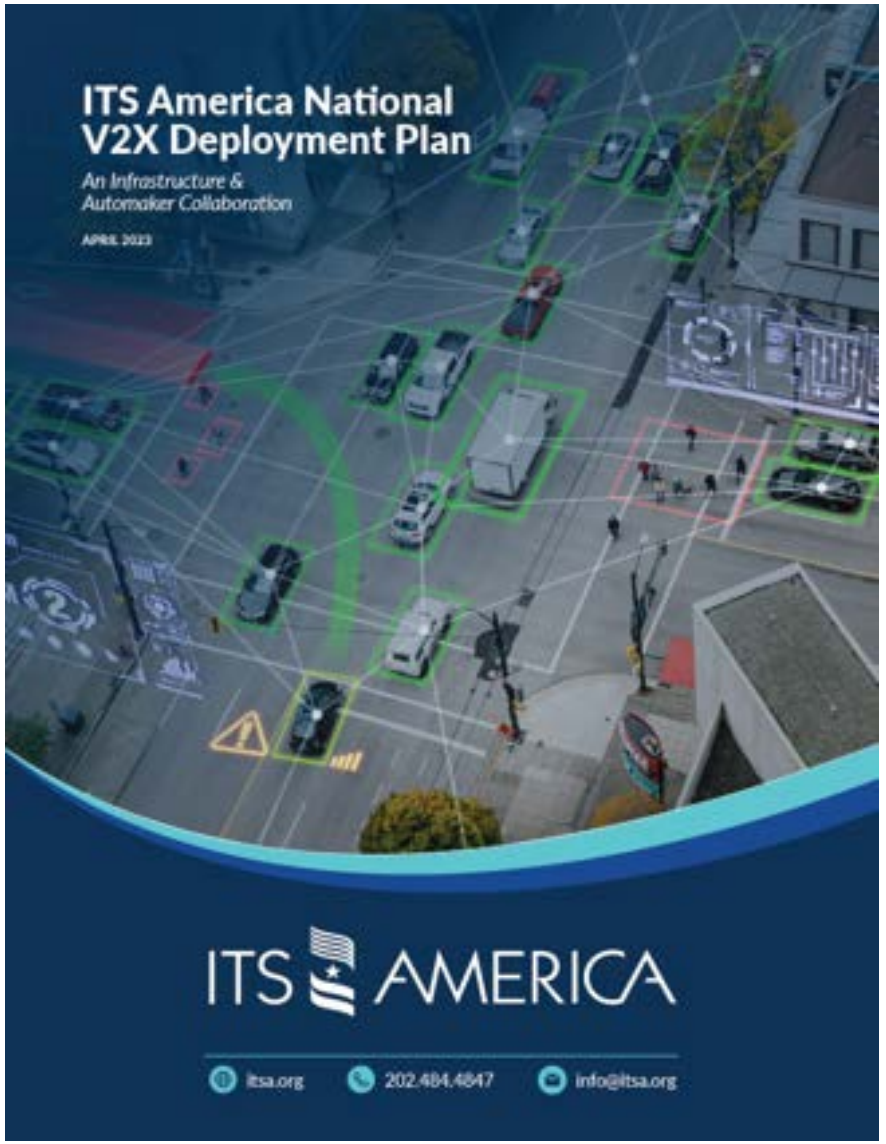
Lessons Learned

- A lot of progress has been made
  - Guidance for V2X deployment by agencies

https://itsa.org/advocacy-material/its-america-national-v2x-deployment-plan/

  - A broader National Deployment Plan coming from the USDOT in 2024



Lessons Learned

- Deployments can bring short term results
  - Transit Signal Priority:
    - Improved reliability by 6%
    - Decreased schedule deviation by 19%
  - Snowplow preemption
    - Reduces corridor plowing time significantly
    - Removes snow and ice more quickly

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Lessons Learned

- Deployment takes time
  - Procurement, Testing, Delivery, Installation, Integration = 25 months
  - Funding cycle & project location selection adds more time
- Agencies should get started now

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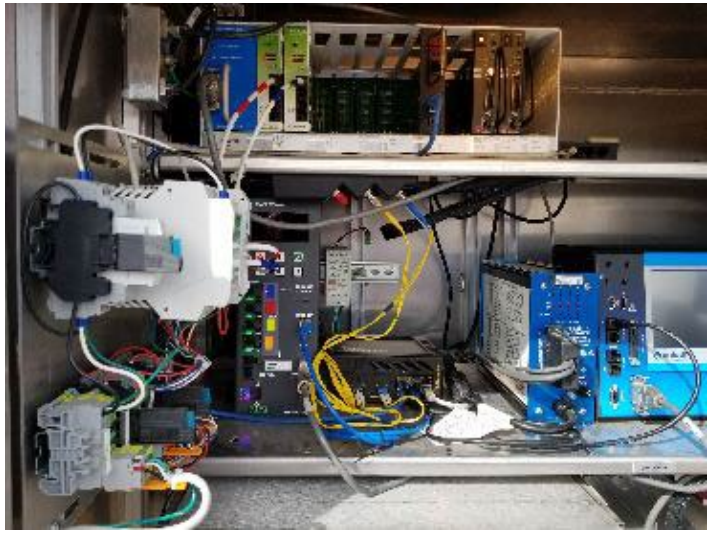
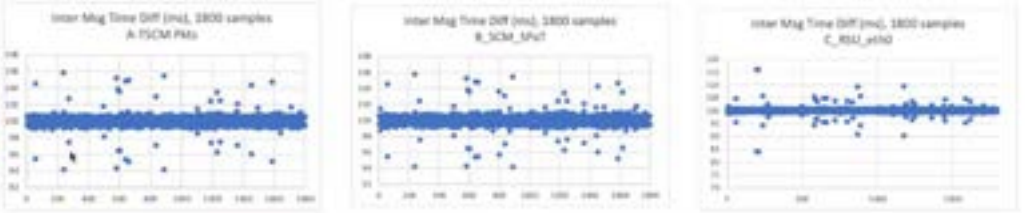
Lessons Learned

- Still working on some issues
  - Synch devices in signal cabinet
    - Getting all devices on the same clock
  - SPaT Broadcast Consistency
  - MAP Accuracy and Verification
  - SCMS Features
    - Misbehavior detection
  - Refining the use of RTCM
  - Need to build trust with automakers
    - Information is accurate, consistent, reliable, and secure



SPaT Analysis of Periodicity
Inter Message Time Interval

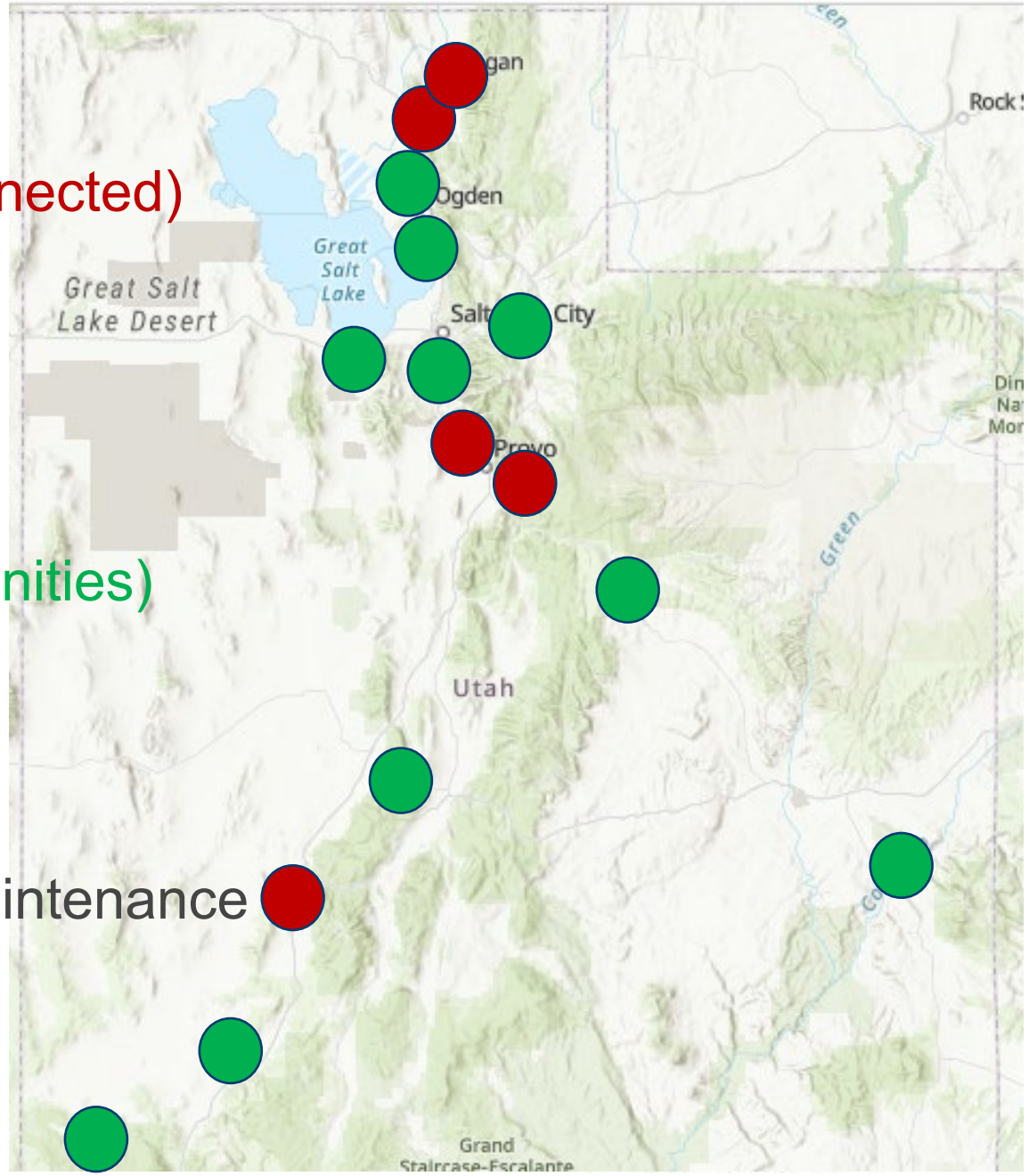


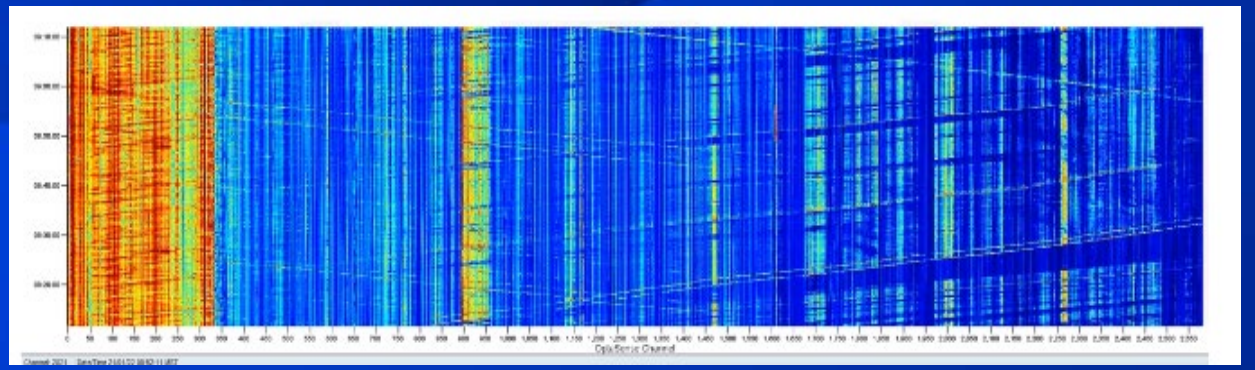
Future Deployments

- 2023 / 2023
  - Additional TSP / Preemption corridors
- 2023 – 2024 (ATTAIN)
  - Replace DSRC RSUs and OBUs with C-V2X

Future Deployments

- 2024 (ATCMTD 2020 - Utah Broadly Connected)
  - Another “enclave” site
  - Additional TSP / Preemption Corridors
  - Rural safety applications (VSL, etc.)
  - Intersection safety applications
- 2025 (ATTAIN – Utah Connected Communities)
  - RSUs in many cities & towns
  - Preparing for production vehicles
- 2023-2025
  - Institutionalize V2X Operations and Maintenance

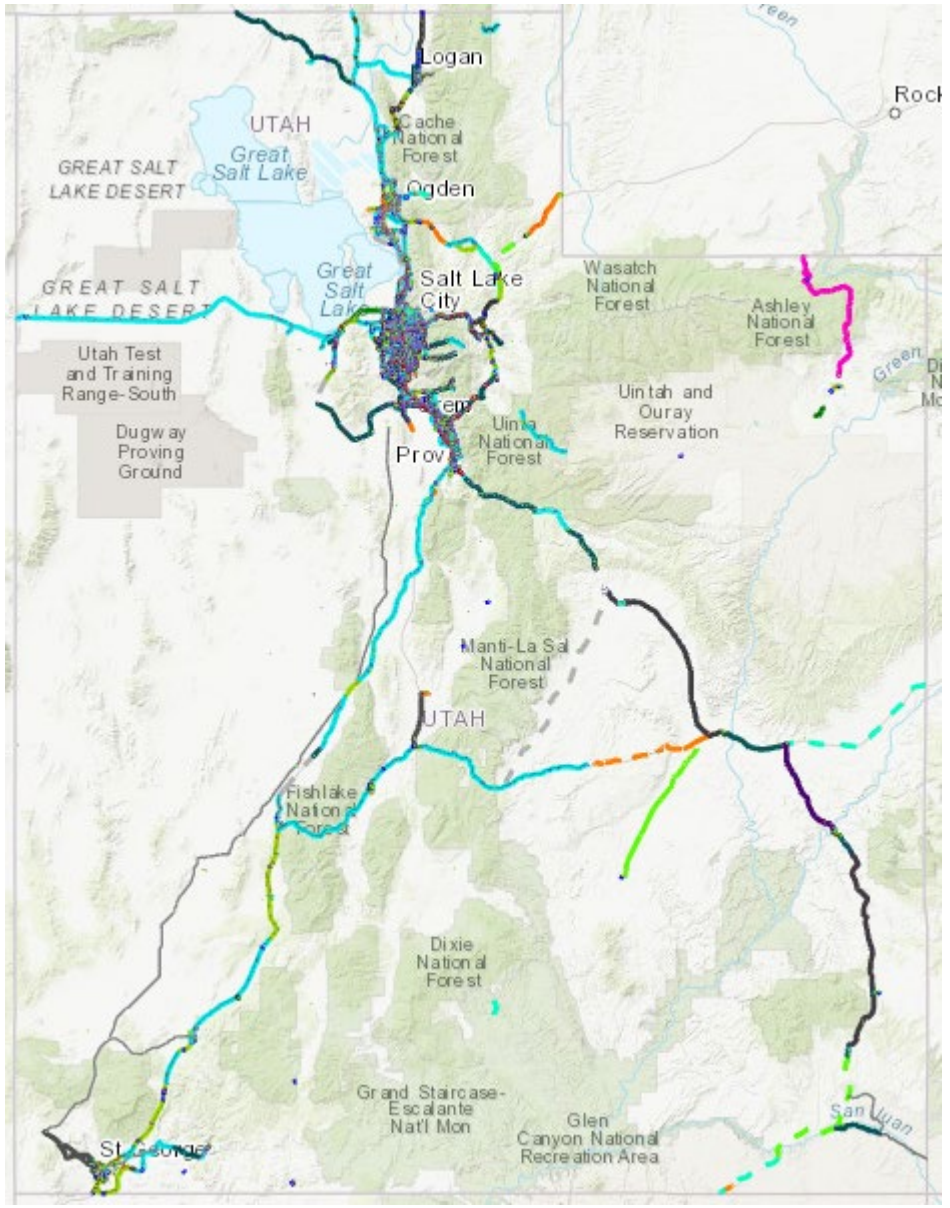




Distributed Acoustic Sensing

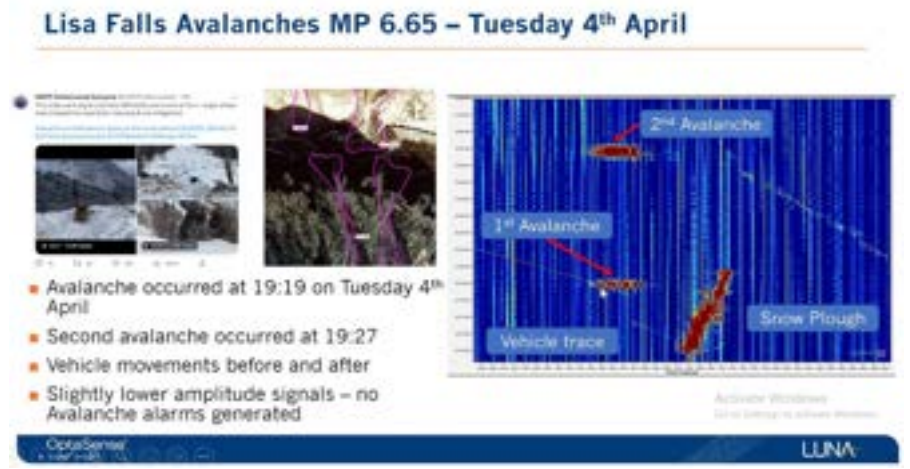
Distributed Acoustic Sensing

- UDOT has fiber across the state
  - Connect to signals & ITS devices
- Using existing fiber to sense events along the road



Distributed Acoustic Sensing

- Fiber senses ground vibrations
  - Measure speeds and travel times
  - Sense impact events
    - Crashes
    - Rockfalls
    - Avalanches
  - Team spent considerable time tuning the algorithms
  - Fiber placement is critical



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Automated Vehicle Road Readiness

Automated Vehicle Road Readiness

- More than half of new cars have forward-facing cameras
  - Lane Keep Assist (LKA)
  - Automatic Emergency Braking (AEB)
  - Adaptive Cruise Control (ACC)
- Effectiveness depends on visibility of our lane markings
- We wanted to know:
  - How good are our lane markings?
  - Are they compatible with these camera technologies?
  - What kind of improvements are needed?

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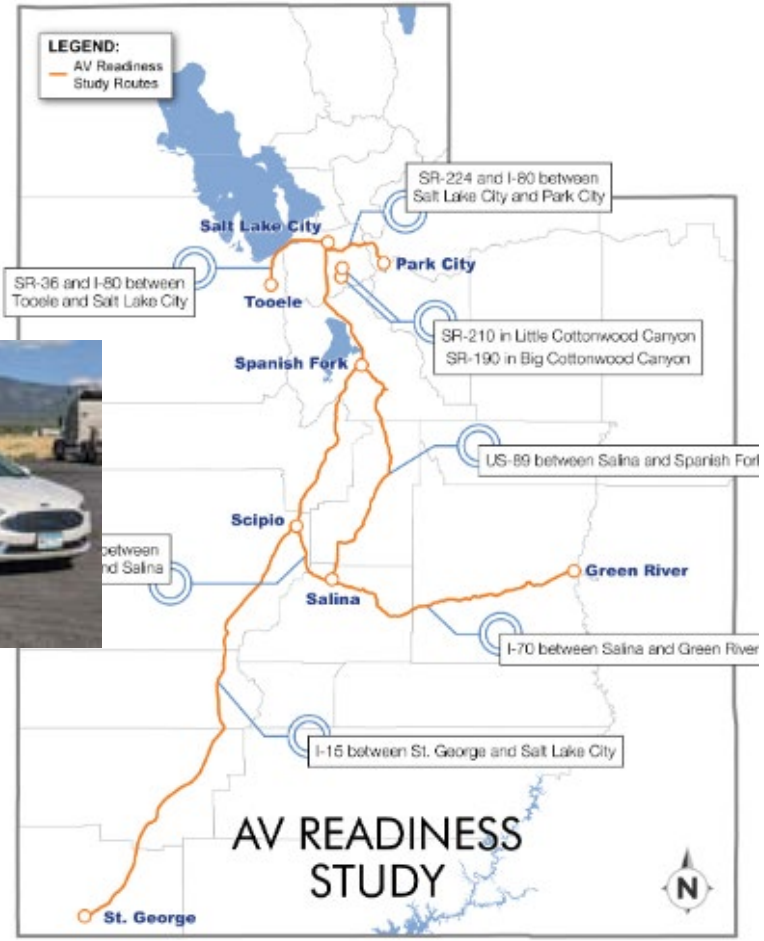
Automated Vehicle Road Readiness

- Surveyed 1400 miles of UDOT roads
- Processed data to assess pavement marking effectiveness
  - Daytime and nighttime surveys
  - Identified problematic issues
- Most markings were adequate



Questions / Discussion

https://transportationtechnology.utah.gov/