CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION

Economical Acquisition of Intersection Data to Facilitate CAV Operations and Hardening to Improve System Integrity

Richard Ajagu and Samuel Labi

Presentation to the CCAT Accessibility Focus Group

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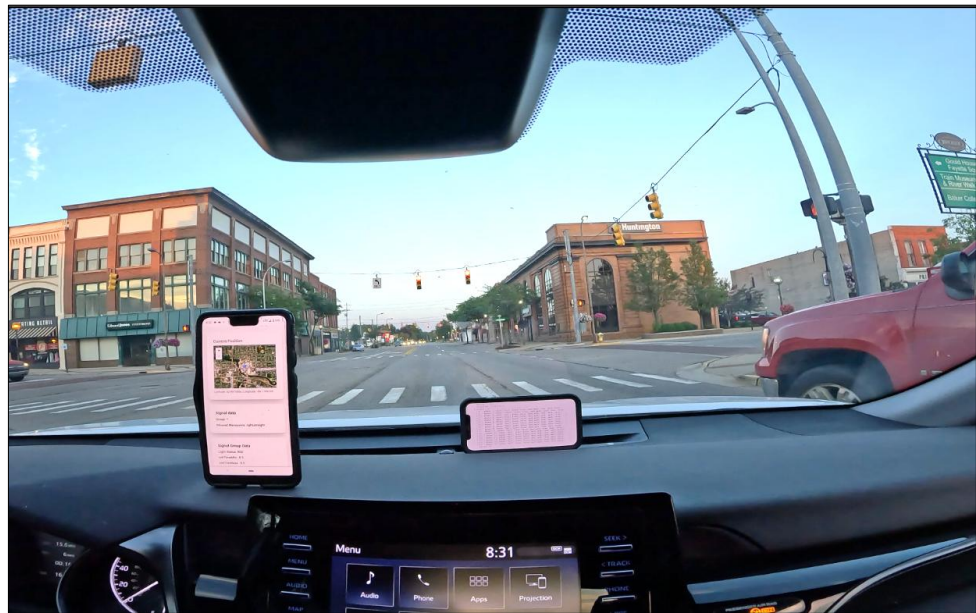


PURDUE UNIVERSITY

Contents

- State of Infrastructure
- Project
- Information Physical Flow
- Data Diode
- Edge Device
- New Systems Engineering Methodology

IoT, Connected World

- Connectivity is everything
- CV and CAV
- V2V, V2I, V2X
- Smart Cities
- Traffic Flows, Intersection Data

DSRC, RSUs

Overall Costs of Typical Intersection Data Projects

•A study in Gwinnett County, Georgia, estimated the cost to equip 20 intersections with DSRC at $309,000, which averages to about $15,450 per intersection.

•Another estimate for 10 intersections in the Seattle area ranged from $70,000 to $80,000, or $7,000 to $8,000 per intersection.

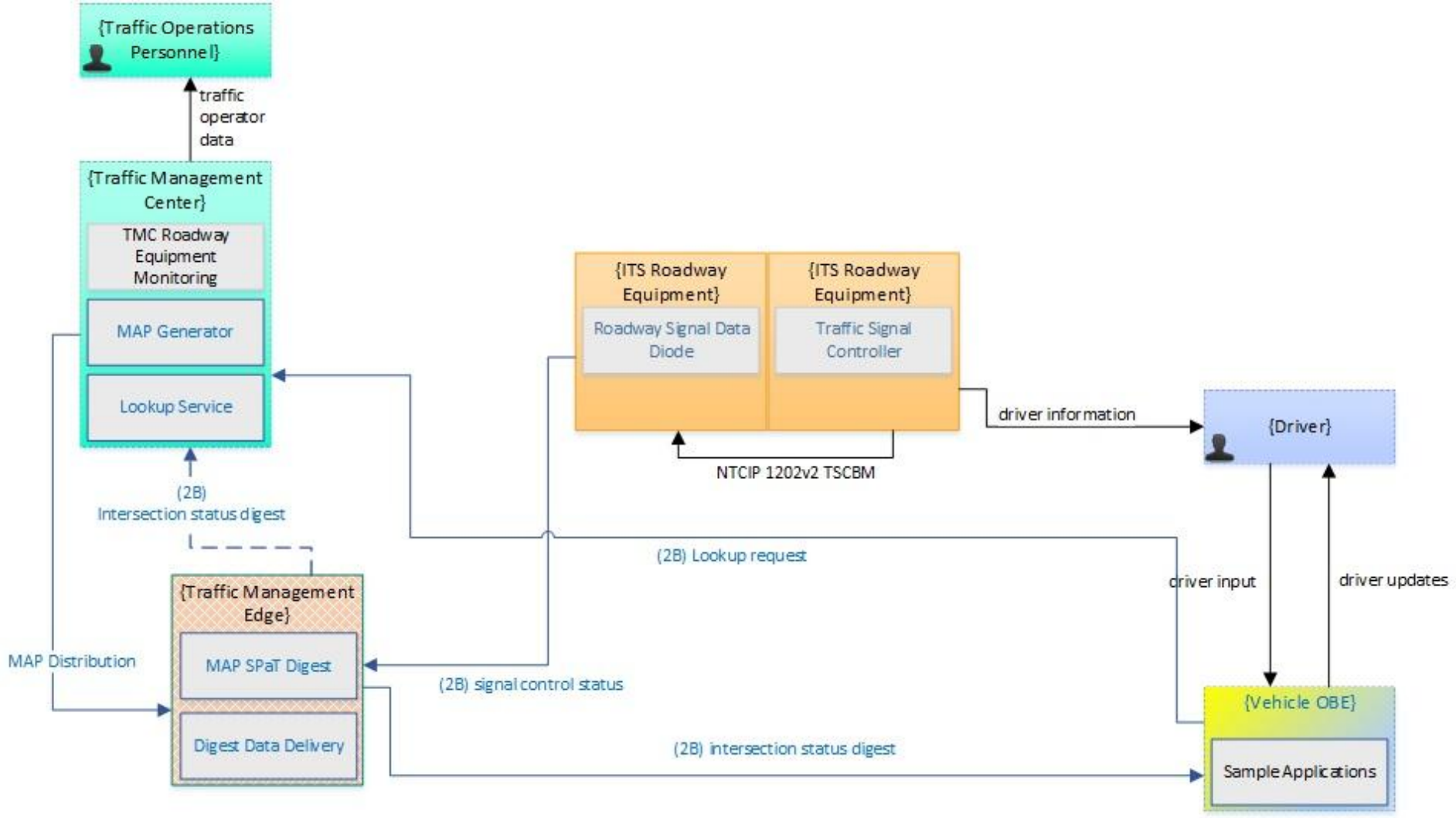
Intersection Control: NEMA Cabinet

Project Goals

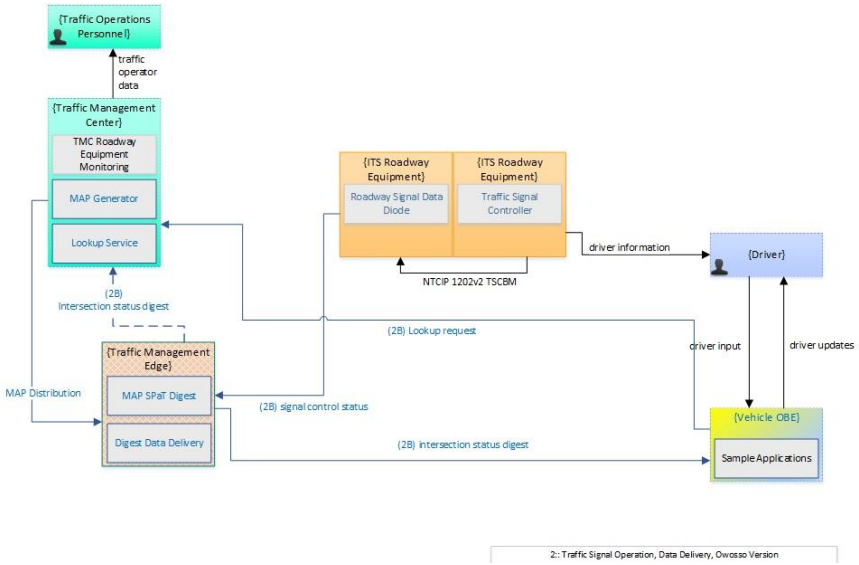
The major contributions of this research will include:

- (1) new system partitioning that uses unidirectional data movement from the infrastructure to simplify the implementation in order to establish a base for future updates to allow bi-directional data movement,
- (2) investigation of the use of the Cubicon design methodology to reduce the cost to design physical and functional objects while maintaining an understanding of the design to assure existing infrastructure integrity,
- (3) demonstrating the ability of CubeProtocol to maintain a deterministic digital twin of traffic signal controllers with very efficient, high-integrity data movement, and
- (4) evaluation of the system data delivery performance to test the technology claims of up to a 10X cost reduction against equivalent data performance to what DSRC is capable of doing

Information Flow: Physical View

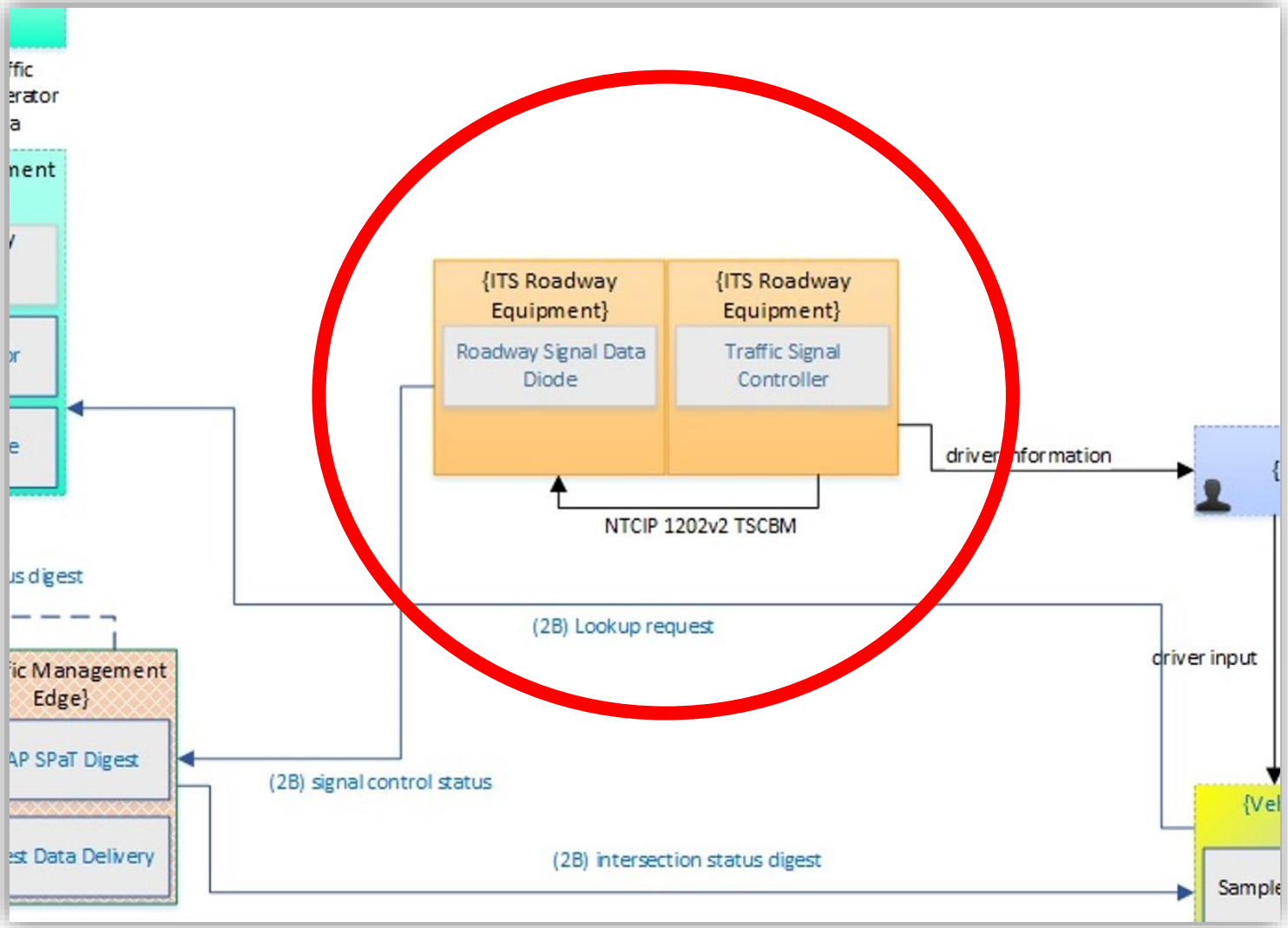


Physical View: Components



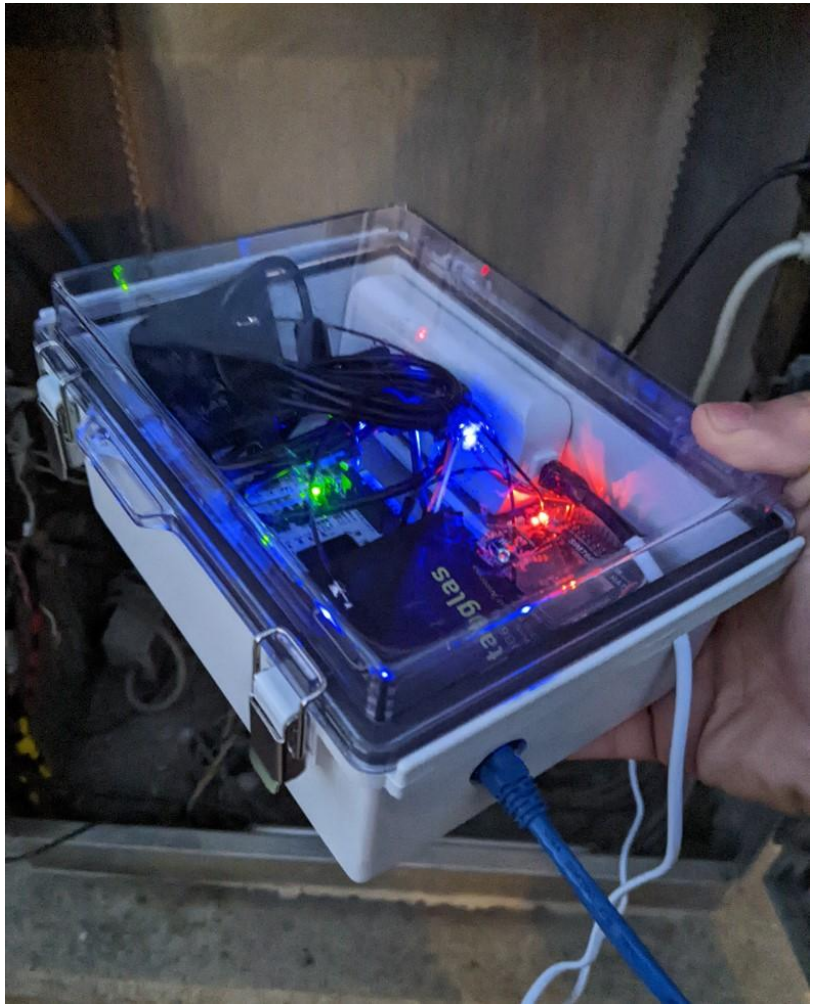
- **Driver**
- **Vehicle OBE**
- **ITS Roadway Equipment**
- **Traffic Management Edge**
- **Traffic Management Center**

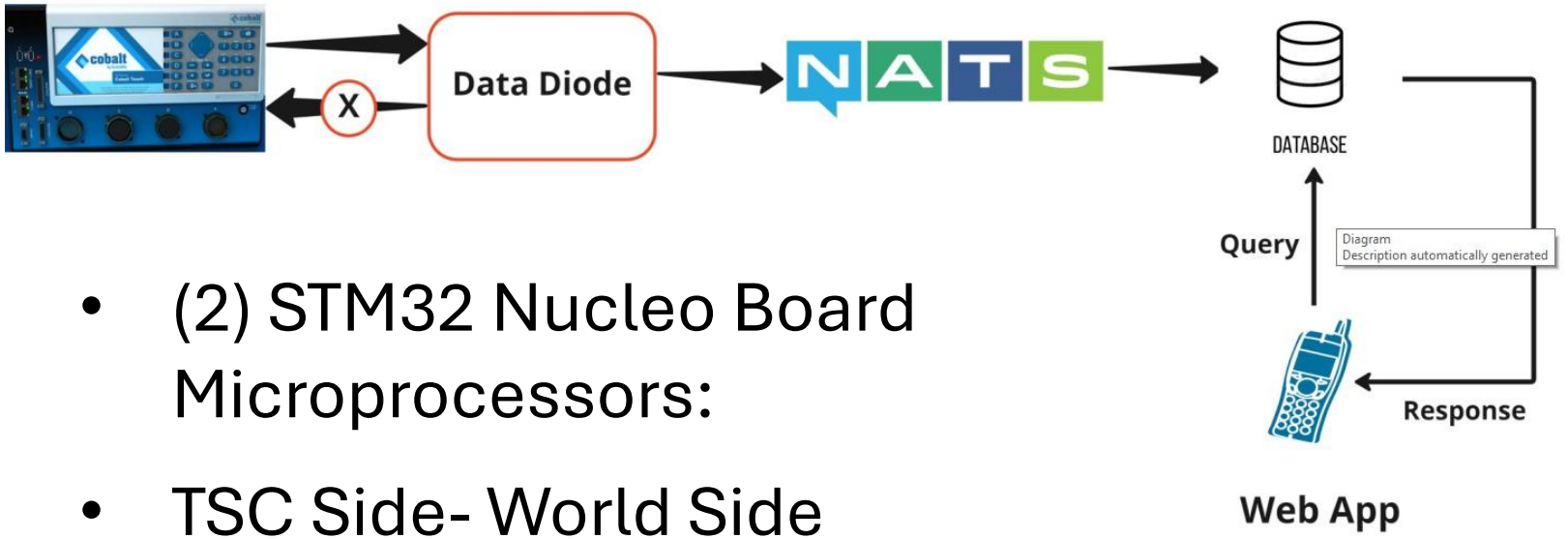
Data Diode



- One-Way Data Flow
- Input: NTCIP 1202v2 TSCBM (Encoded Data String)
- Filter TSCBM for SPaT
- Output SPaT & MAC
- Low Cost

Data Diode





- (2) STM32 Nucleo Board Microprocessors:
- TSC Side- World Side
- Ethernet COnnection
- LTE Cellular Modem
- Patch Antennas

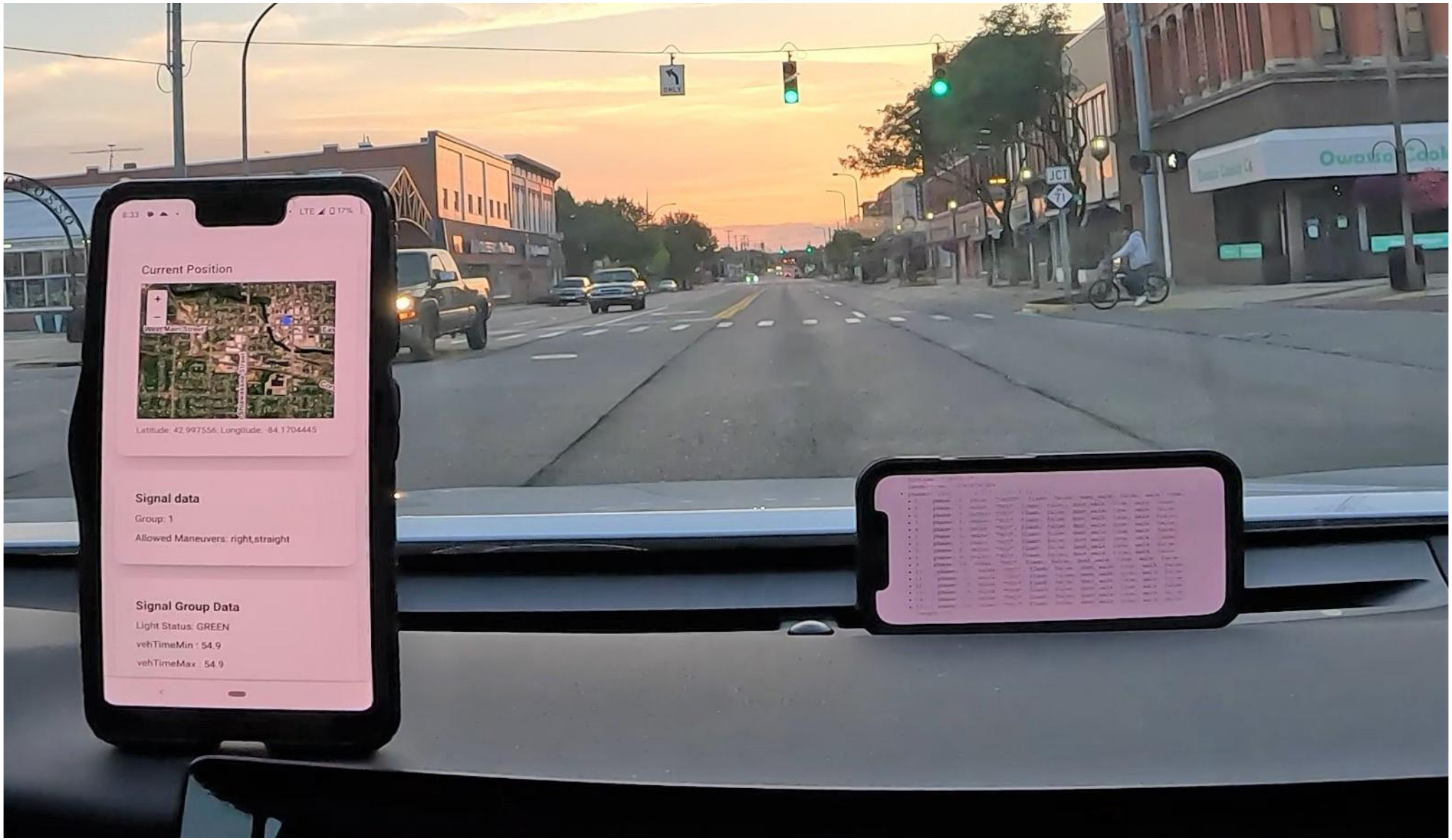
Data Diode MDOT Bench Testing -> Field Testing

Lansing, Michigan: MDOT Demonstration/Bench

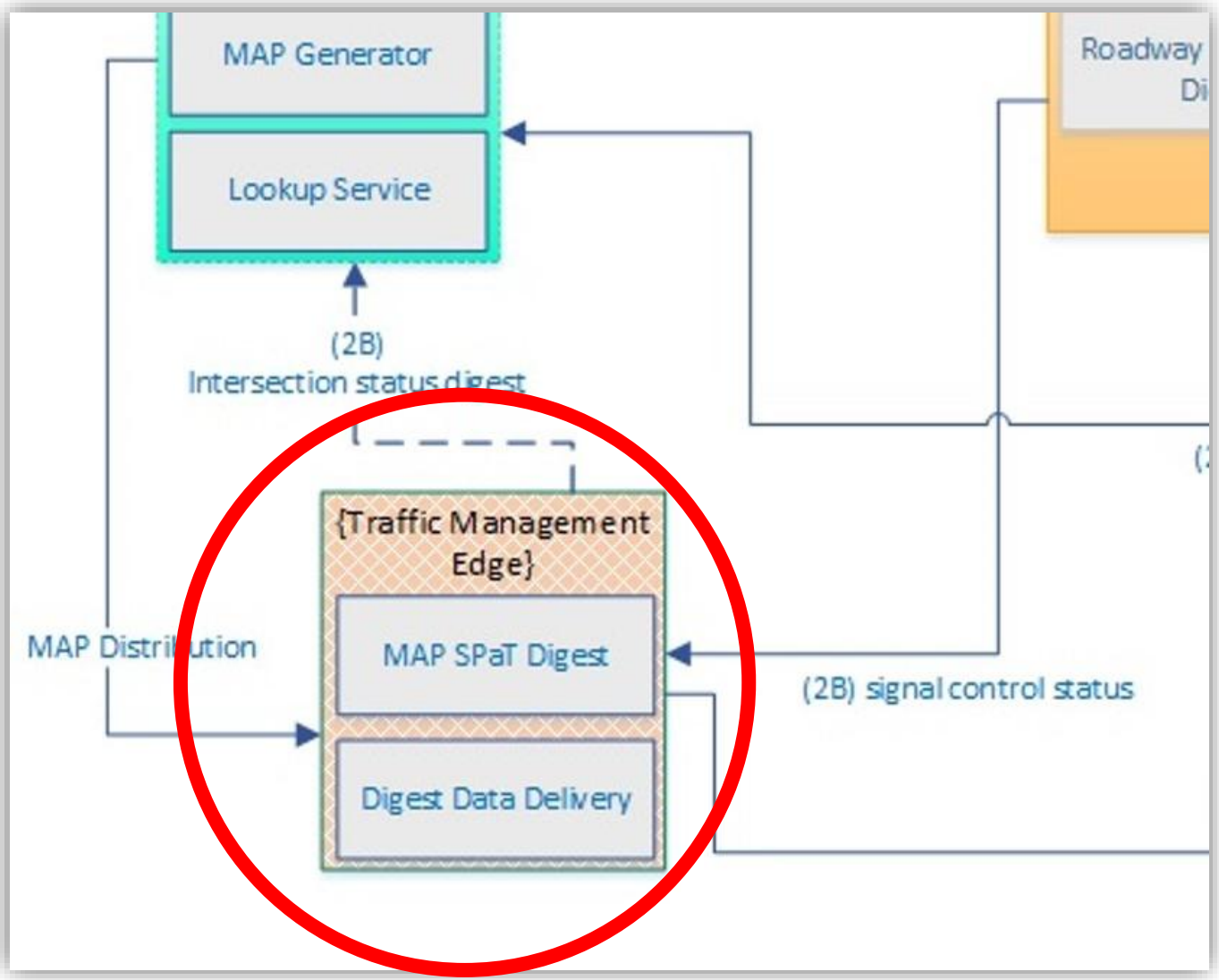
Safety, connectivity, longevity

Owosso, Michigan: Field Test

Physical Test:

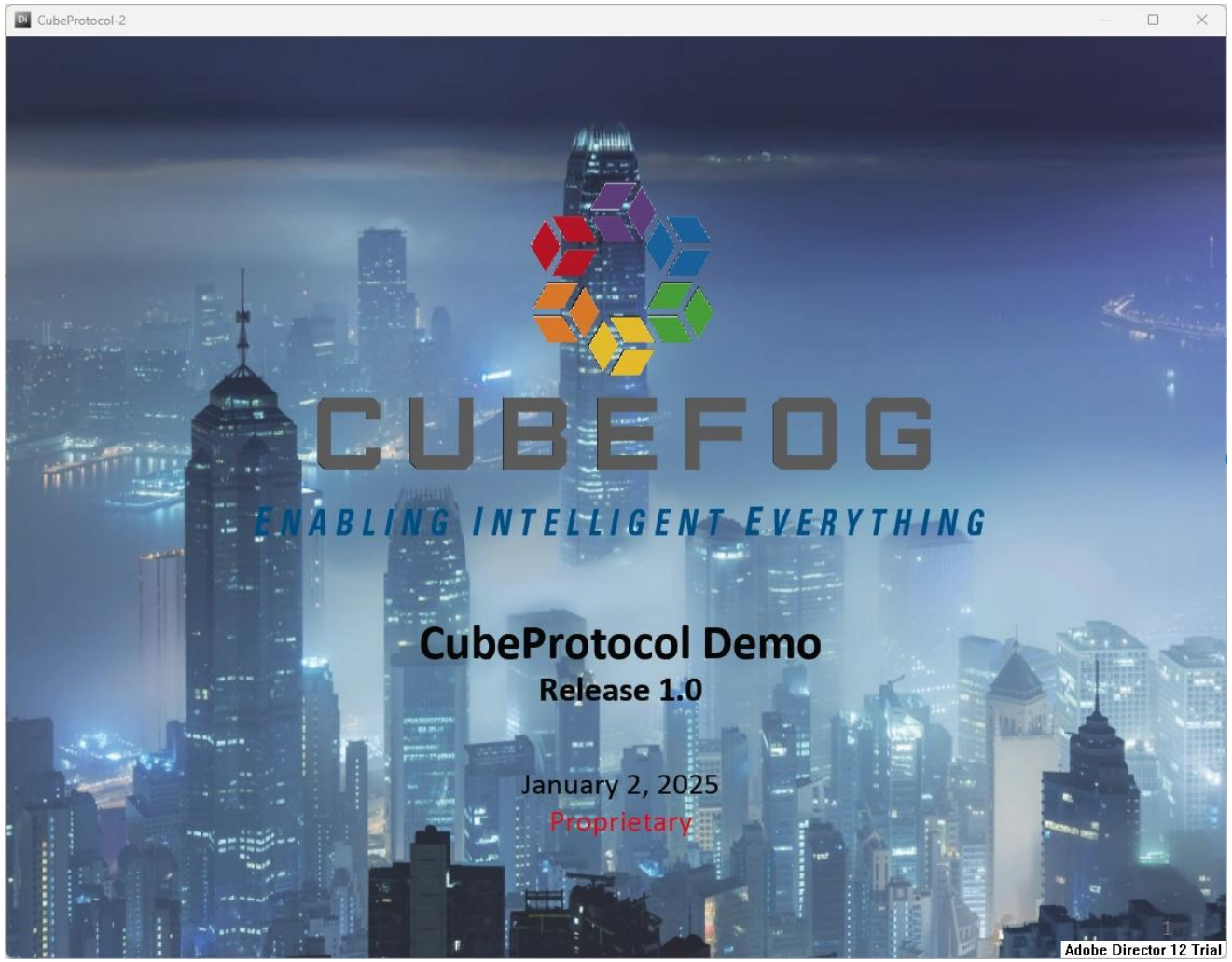


Edge Device



- Edge Device Server (Handle Data Structures)
- SPaT + MAP (Digital Twin of Intersection)
- Data Flowing to Edge Device (100ms)
- Create Digest for All Intersections
- Queries from Connected Vehicles & Devices
- Ideal: Low Level, “Run on the Bare Silicon”

Edge: Cubefog System Design Methodology



- Highly Efficient, Maintain Integrity, Resistant to Alteration
- No OS, Exploits that come w/them
- UseCase: IoT, Intelligent Transportation Extremely Large Distributed Systems
- High System Integrity w/Very Efficient Data Flows
- Made for Embedded Systems: Flash & Run 30yrs
- Subject Matter Expert: Make Diagram to Capture Desired Behavior – create and run directly

Upcoming

- Design Behavior Models for DataDiode, MAP/SPaT Digest
- Implement CubeProtocol
  - Low-Level Language: Go
- Build and Bench-Test Evaluation Objects
- Deploy in the Field and gather Data
- Evaluate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