



# Connected Work Zone Devices

Connected Work Zone Devices Peer Exchange  
November 16, 2022

# Connected Work Zone Devices

- Smart Arrow Boards
- Connected Temporary Traffic Signals
- Other Connected Devices (experimental)
  - Portable Rumble Strips
  - Sequential Flashers
  - Worker Presence



# Smart Arrow Boards

How did it all start?

- 1994(?) Iowa DOT/MnDOT joint meeting in Albert Lea, MN



# Smart Arrow Boards

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- Crazy talk after dinner



# Smart Arrow Boards

How did it all start?

- 1994(?) Iowa DOT/MnDOT joint meeting in Albert Lea, MN
- “Wouldn’t it be great to broadcast the location of an arrow board to motorists so that they had early warning of a lane closure?”



# Smart Arrow Boards

How did it all start?

- 1994(?) Iowa DOT/MnDOT joint meeting in Albert Lea, MN
- “Wouldn’t it be great to broadcast the location of an arrow board to motorists so that they had early warning of a lane closure?”
- Technology was unavailable
- Kept plugging the idea over the years
- Got used to strange looks from colleagues



# Smart Arrow Boards

- 2014 Iowa DOT wanted to create a research-grade Work Zone Database.
  - Where and When did we have lane closures last year?
- Work Zone Data Initiative got started about the same time
- Now it was time to push the SAB idea again
- Only took 20 years



# Smart Arrow Boards

- 2015 Iowa DOT developed a Traffic Critical Projects (TCP) program
  - Identify projects that had potential for Safety and Mobility concerns and use appropriate mitigation strategies to minimize impact
  - State-wide IWZ deployment contract
  - Traffic Management Center began collecting data from all temporary IWZ devices
  - InTrans (ISU) was the work horse for data collection and analysis





# Smart Arrow Boards

## Requirements

- Functional without additional effort by workers
- Able to modify older equipment to function as SAB
- Simple communication protocol to minimize data stream



# Smart Arrow Boards

- 2018 (four years later) Iowa began development of a communication protocol and specification for state-wide deployment.



# Smart Arrow Boards

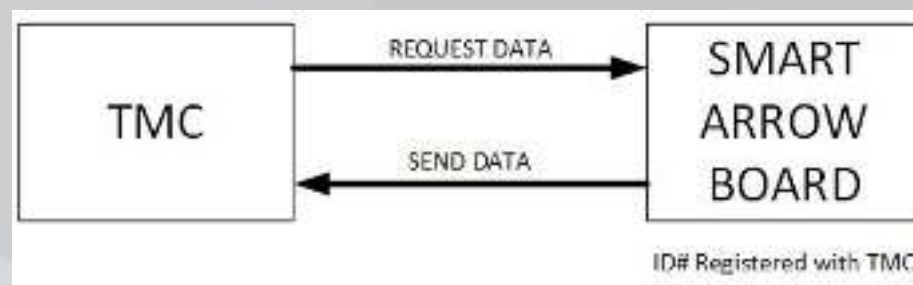
- Remote monitoring of
  - Location,
  - Orientation, and
  - Operation mode
- Two options for data communication
  - Option 1 – data received from intermediary server
  - Option 2 – data polled directly from Arrow Board



# Smart Arrow Boards

## Option 2

- Original concept was for TMC to pull information directly from the arrow board, no third-party data management.
- Similar to remote sensors and dynamic message signs
- Must be registered with TMC



# Smart Arrow Boards

## Option 1

- After discussions with manufacturers developed second communication protocol.
  - Arrow Board communicates with third-party (manufacturers) servers.
  - TMC polls data from intermediary third-party server



# Smart Arrow Boards

- Arrow board should update SABP on pattern change within 2 minutes
- Device should update SABP within 2 minutes if moved 500'
- Device should provide a health check every 30 minutes
- SABP should contain all arrow boards that fall within the State of Iowa border including a 1-mile buffer.



# Smart Arrow Boards

- Info at the Work Zone Reference Library
  - <https://iowadot.gov/workzonereferencelibrary>
  - <https://iowadot.gov/workzonereferencelibrary/docs/Specifications-Requirements.pdf>



# Smart Arrow Boards

- Specification

## 2528.03, Construction, (Traffic Control)

### F. Arrow Boards.

#### 1. Operation.

- a. When indicating a right or left lane closure, operate in a sequential chevron mode.
- b. When indicating a traffic split, operate in a flashing double arrow mode.
- c. When indicating caution, operate in an alternating diamond mode.

#### 2. Remote Communications.

When using an Arrow Board for stationary work zones on the Interstate System, remote communication capabilities meeting requirements of [Article 4188.10, F](#) are required.

#### 3. Type and Size.

Type C Arrow Boards as defined in Part 6 of the MUTCD are required for all applications.

#### 4. Testing and Configuration.

On Interstate projects, at least 1 week before Arrow Board is deployed to a project, a testing and configuration process shall be performed with the Engineer.





# Smart Arrow Boards

- Specification

## 4188.10 Arrow Boards.

### A. General.

Arrow Boards shall be approved per [Materials I.M. 486.12](#).

### B. Power System.

1. Solar power system shall charge and maintain batteries automatically without intervention, designed for year round deployment in Iowa assuming minimal solar charging during winter months.
2. No component shall create a shadow on any portion of solar panels.
3. Battery box shall be locked.



# Smart Arrow Boards

- Specification



October 20, 2020

Office of Construction & Materials

Matls. IM 486.12

Supersedes October 21, 2014

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## **INSPECTION, ACCEPTANCE and COMMUNICATION PROTOCOL of ARROW BOARDS**

### **GENERAL**

Arrow boards must meet the requirements found in the Manual on Uniform Traffic Control Devices (MUTCD - 2009) Part 6F.61 and Iowa DOT Specification Article 4188.10. Approved Products are listed in the Materials Approved Products Listing Enterprise (MAPLE).

### **APPROVAL PROCEDURES WHEN 4188.10.F APPLIES**


#### **Approval Request Submittal Form**

When an Arrow Board vendor is requesting the Department to evaluate its ability to meet 4188.10.F, the vendor shall submit a device for testing and complete the form "Connected Temporary Traffic Control Device Approval Request Form" found here:  
<https://iowadot.gov/workzonereferencelibrary/docs/Smart-Arrow-BoardForm.pdf>



# Smart Arrow Boards

- Approval Request Form



## Connected Temporary Traffic Control Device Approval Request Form

Manufacturer:

Device Description (i.e. Smart Arrow Board):

Model No. and Firmware Version (if applicable):

Software Version (if applicable):

Does the device use option 1 (JSON) or option 2 (direct connection) of the [Smart Arrow Board Protocol \(SABP\)](#):

☐ Option 1 (JSON)

☐ Option 2 (direct connection)

**If the device uses option 1, provide the following details**

API/URL to compliant Smart Arrow Board Protocol (SABP):



# Smart Arrow Boards

Manufacturers need to request approval for:

- Equipment originally built to meet Specification 4188.10
- Retrofit kits that modify older equipment to meet specification 4188.10

Approval is not required for combinations of arrow boards and retrofit kits. Manufacturers of retrofit kits are expected to explain what equipment is compatible with the retrofit kit



# Smart Arrow Boards - Testing

1. Make sure device is off and at the start location
  - Make sure it is off and the data feed represents this
2. Right Chevron
  - Turn the chevron to right and wait at least 5 minute so the data is archived
3. Left Chevron
  - Turn the chevron to left and wait at least 5 minute so the data is archived
4. Move 500'
  - Move the arrow board at least 500' (try to minimize as much as possible)
5. Wait 5 minutes after 1st move
  - Wait 5 minutes to see if the location is refined



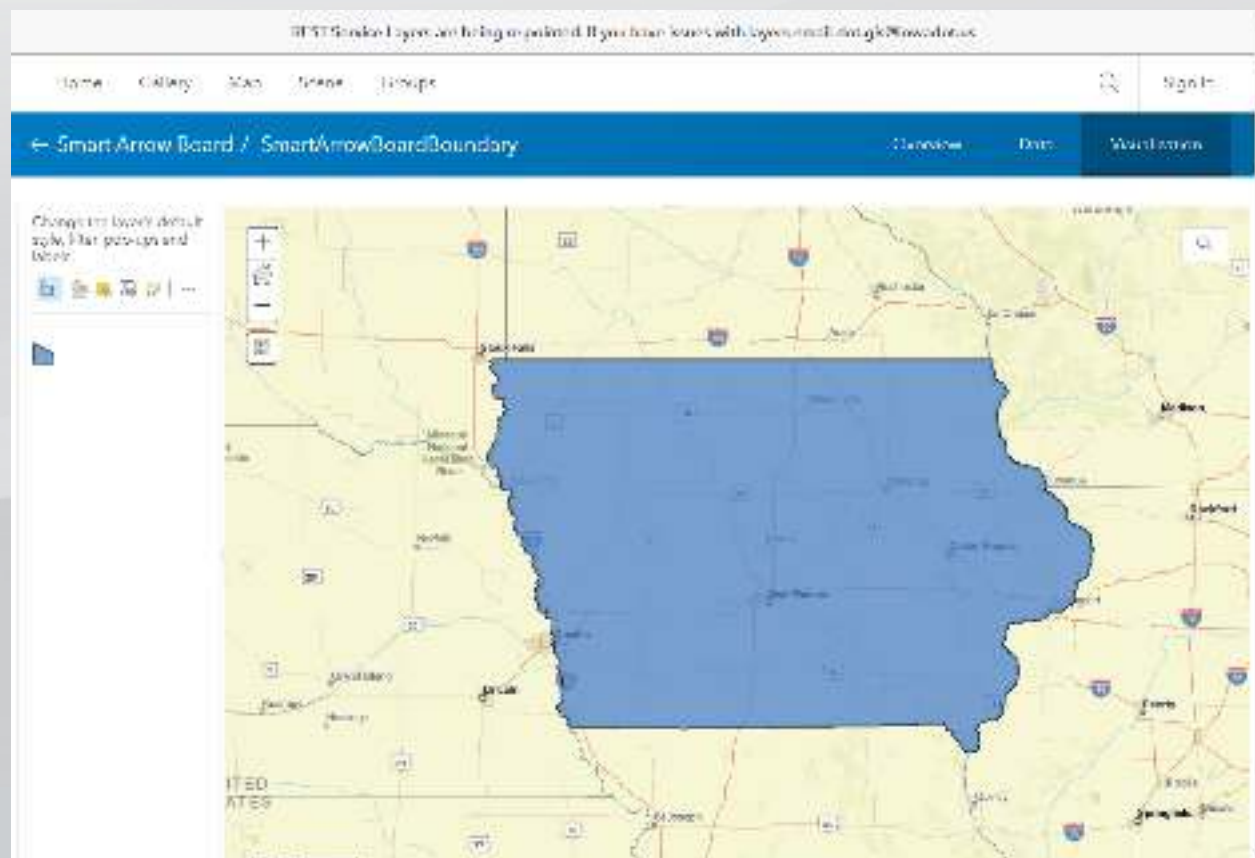
# Smart Arrow Boards - Testing

6. Move 500' again
  - Move the arrow board again at least 500' (try to minimize as much as possible)
7. Wait 5 minutes after 2nd move
  - Wait 5 minutes to see if the location is refined
8. Right Chevron again
  - Change to right chevron to make sure the device location and information is updated
9. Wait 1 hour (if on roadway wait as long as possible)
  - Wait 1 hour to see how much the check-in occurs
10. Turn Device Off
  - Turn the device off and record information



# Smart Arrow Boards

- Smart Arrow Board Boundary



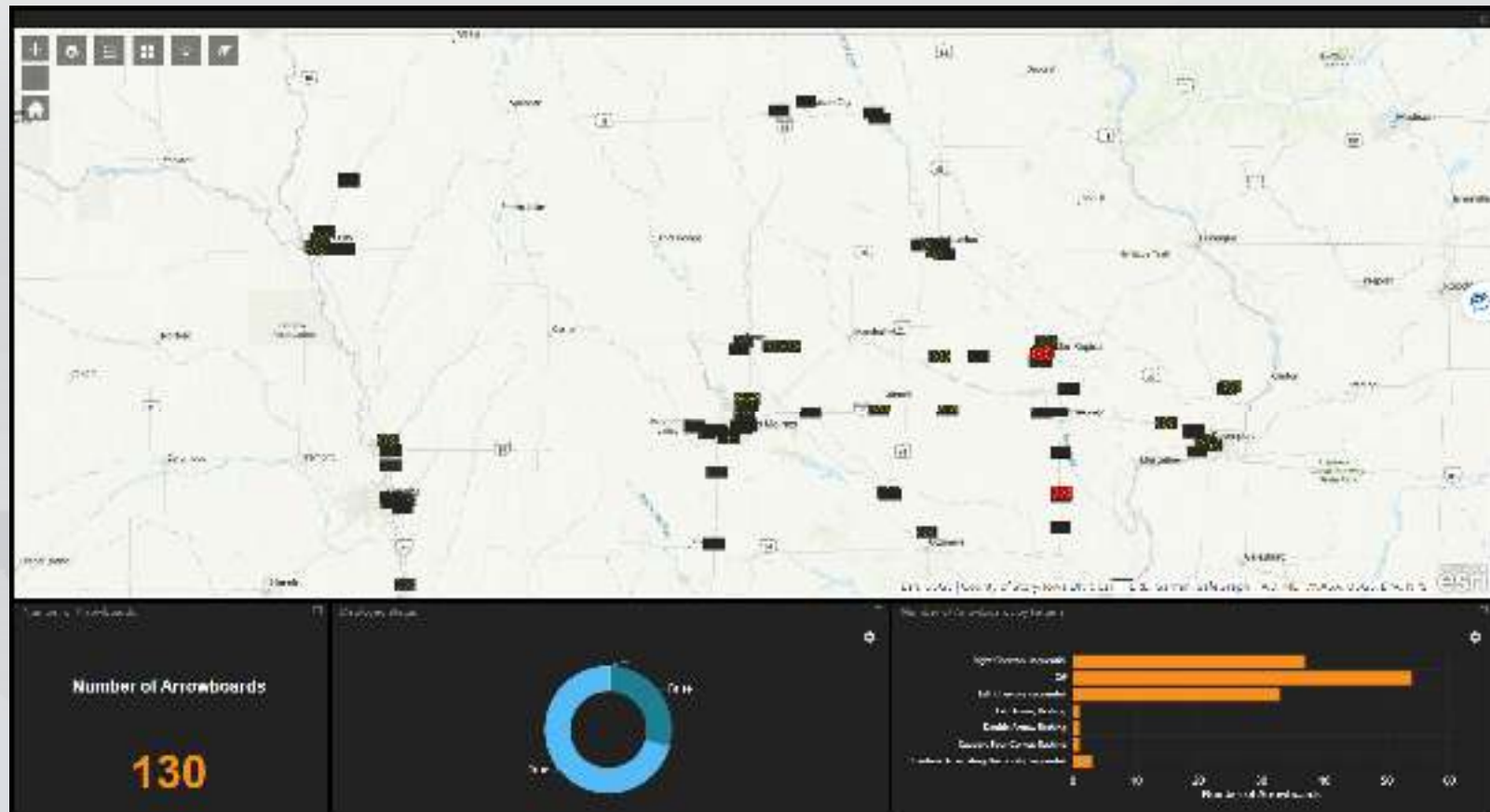
# Smart Arrow Boards

- 2021 require SAB on all interstate lane closures
- 2022 require SAB on all primary lane closures
- 2023(?) convert all DOT Maintenance mobile units
  - DOT chose to use existing AVL system to collect arrow board data





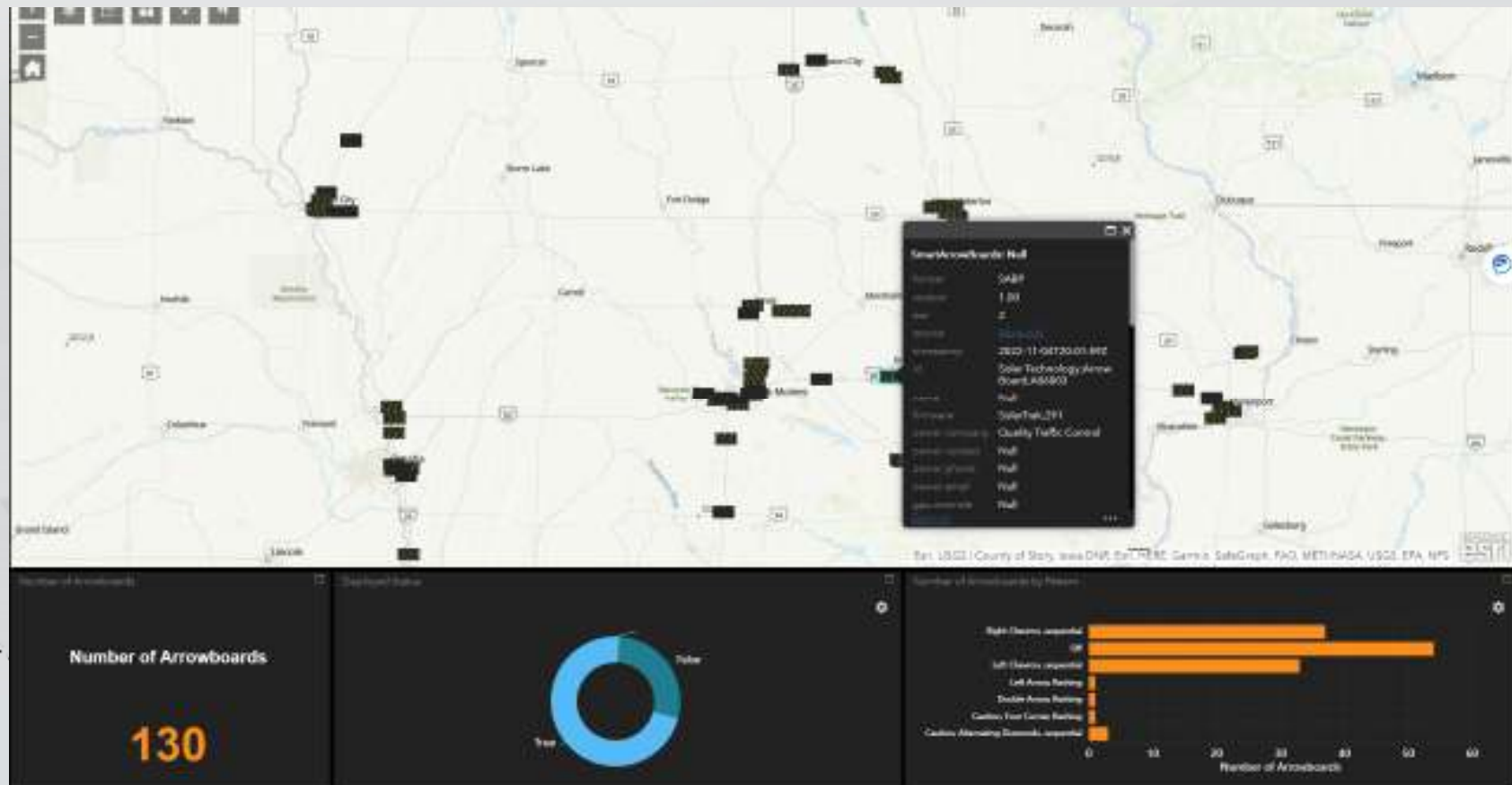
# Smart Arrow Boards



SAFETY RESPECT INTEGRITY TEAMWORK LEADERSHIP



# Smart Arrow Boards

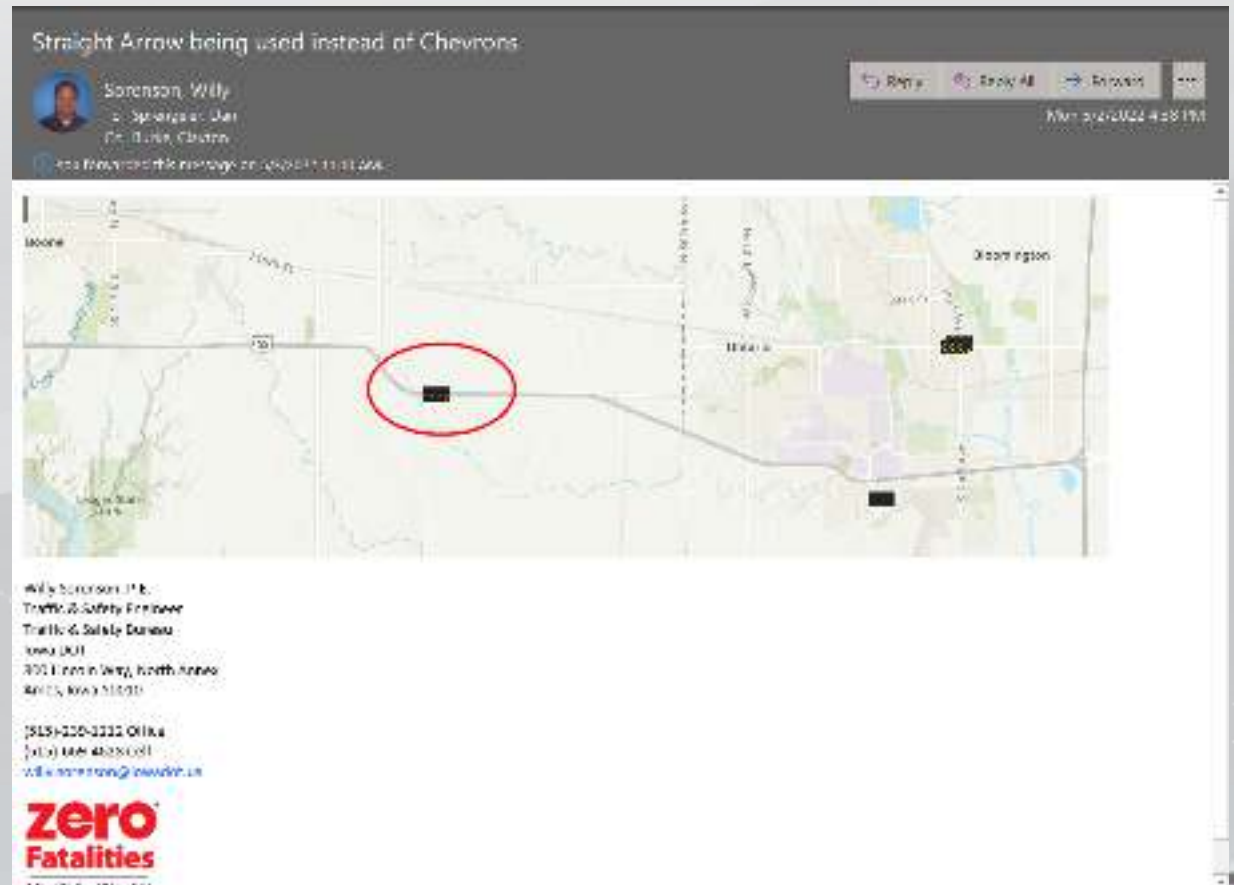


SAFETY RESPECT INTEGRITY TEAMWORK LEADERSHIP



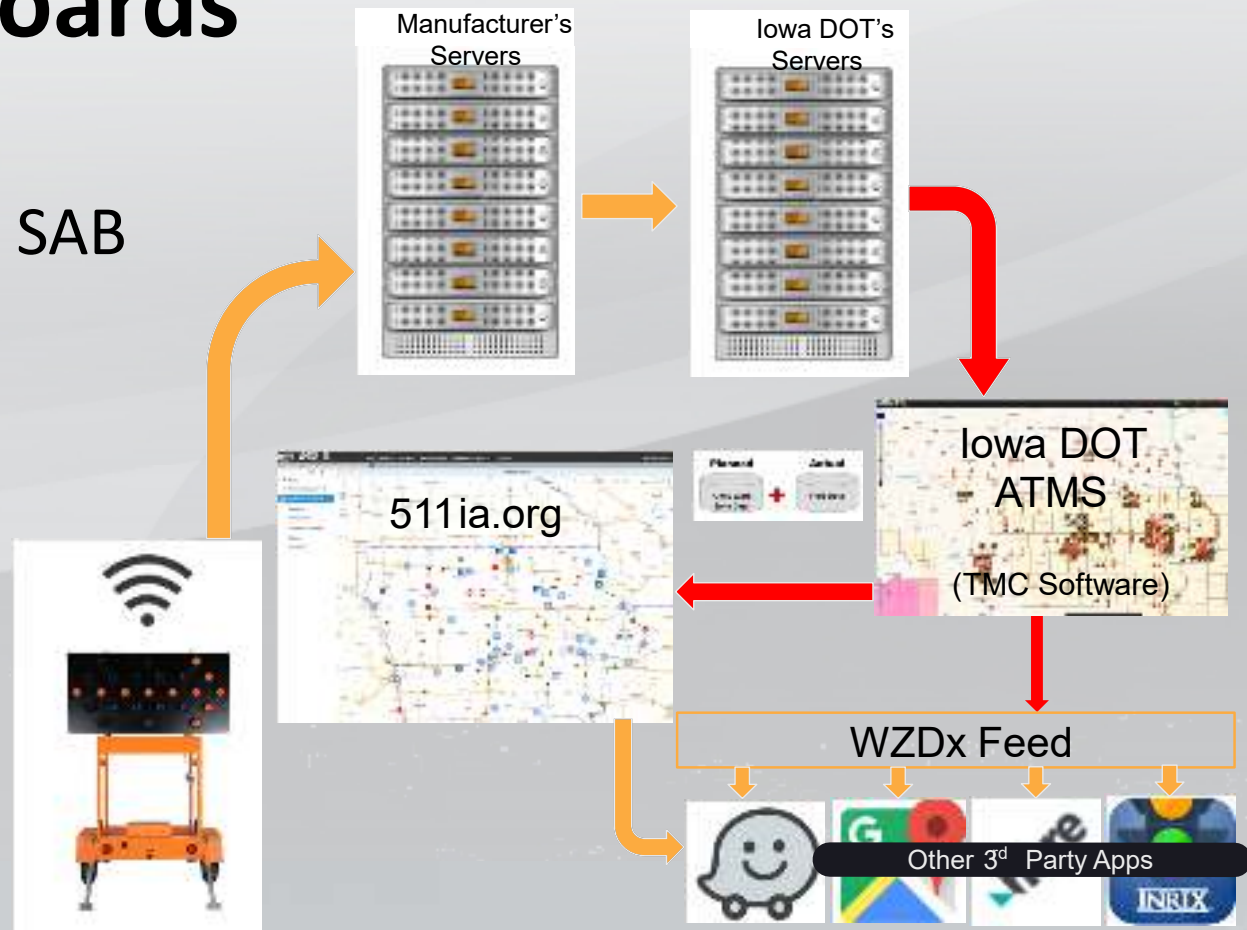
# Smart Arrow Boards

- On my way home noticed arrow board with wrong operating mode
- Contacted contractor and it was fixed in less than an hour



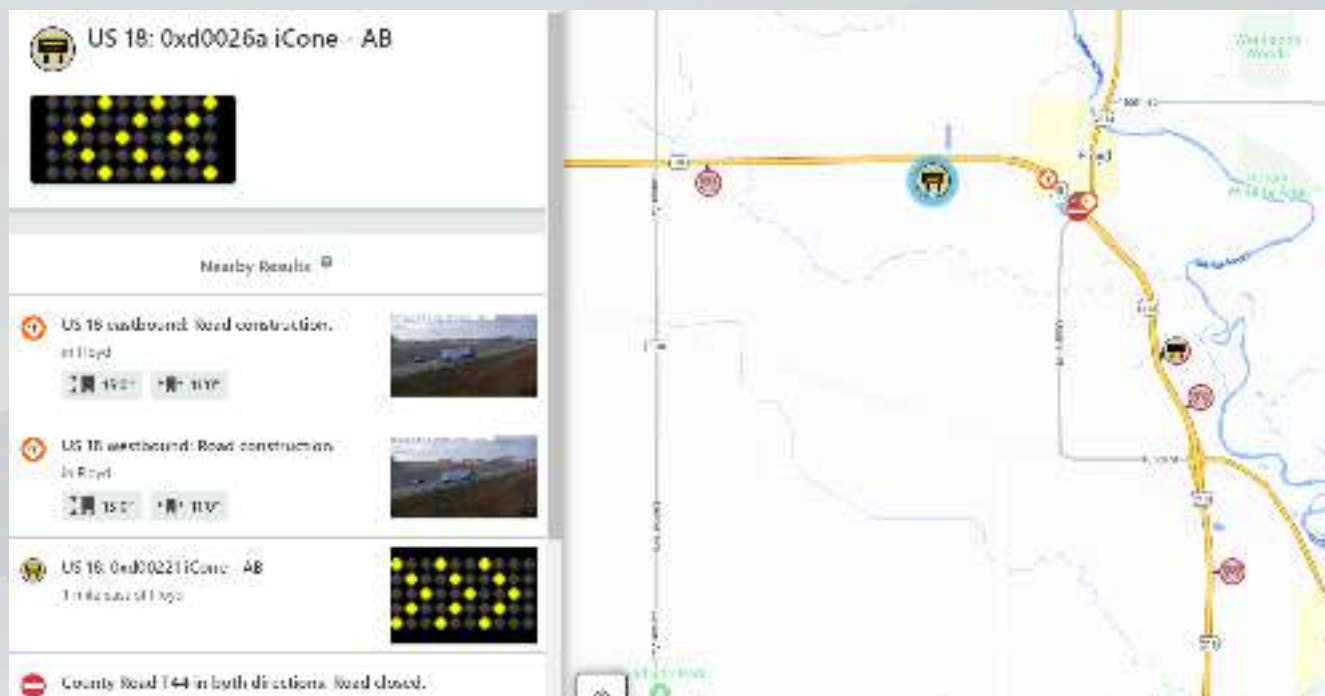
# Smart Arrow Boards

- Fall 2022 began integrating real-time SAB location into 511ia.



# Smart Arrow Boards

- 511ia Screen Shot



# Connected Temp Traffic Signals

- 2021 Developed protocol for CTTS
- Received manufacturers comments
- Iowa DOT became aware of WZDx protocol effort for Connected WZ Devices
- Decided to wait until new protocol was finished.
- Expect to share specification for CTTS early 2023
- Delayed CTTS deployment until 2024



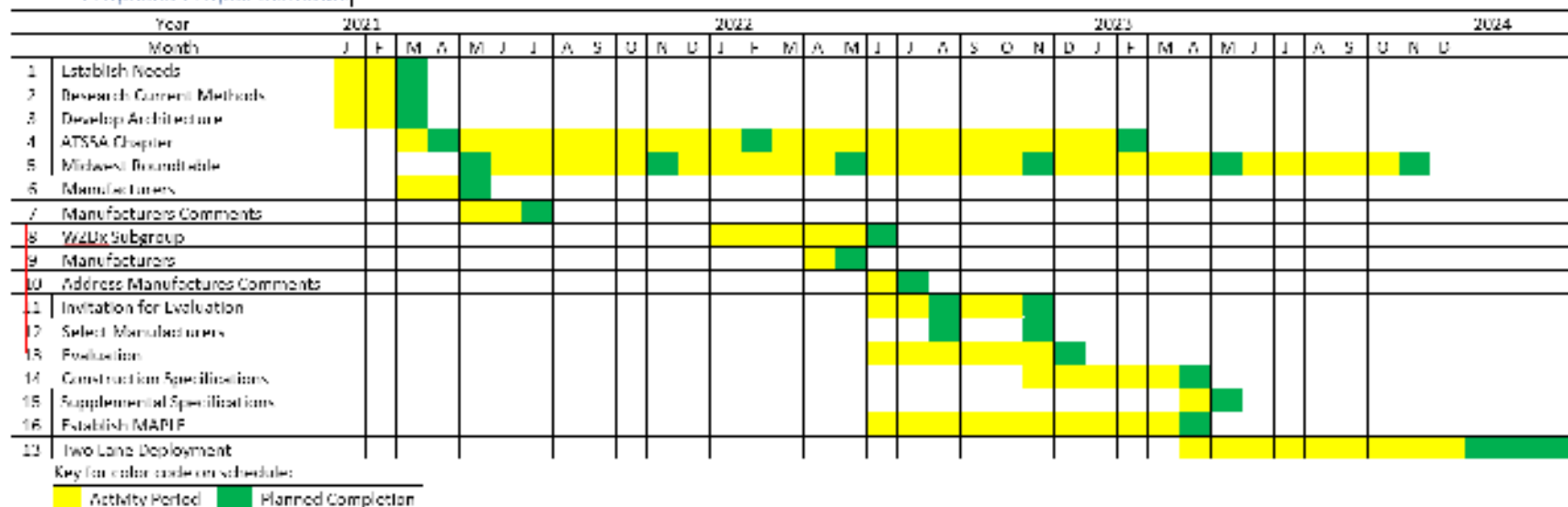


# Connected Temp Traffic Signals

- CTTS Deployment Schedule

Connected Temporary Traffic Signal Deployment Plan Iowa DOT  
DRAFT March 24, 2021 Revised January 5, 2022

## Proposed Project Schedule



SAFETY RESPECT INTEGRITY TEAMWORK LEADERSHIP



# Connected Temp Traffic Signals

Remote monitoring of:

- Location
- Orientation
- Traffic Signal Operation Mode





# Connected Temp Traffic Signals

2023

- Draft new specification for temporary traffic signals
- Assess existing contractor inventory
- Ability to retrofit existing signals w/o communication capability
- Develop approved products list for new signal systems and retrofit kits.



# Connected AFAD's

- Currently Iowa does not require AFAD's
- Reduce the use of flaggers
  - Temporary Signals
  - AFAD's to move flaggers off the roadway
- IF we start to require AFAD's then they will be connected



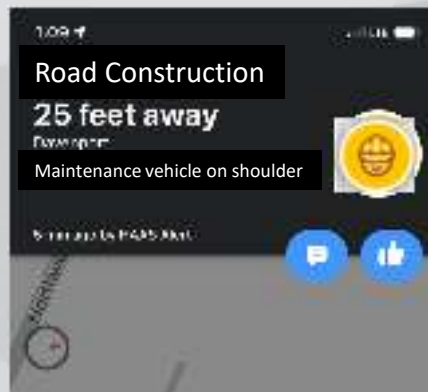
# Other Connected Devices

- Portable Temporary Rumble Strips



# Other Connected Devices

- Sequential Flashers (Pi-Lit)





# Other Connected Devices

- VA Tech Worker Protection System



# Other Connected Devices

- Iowa DOT AVL Data
  - Data feed into ATMS to notify the TMC when and where Maintenance Operations are occurring.



# Other Connected Devices

- Automated Audible Warning System





# Other Connected Devices

- Automated Audible Warning System





# Other Connected Devices

- Automated Audible Warning System



# Thank You

# Questions?

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