



FHWA/MDOT/UMTRI Integrated Mobile Observations 2.0 (IMO)

Michigan Department of Transportation

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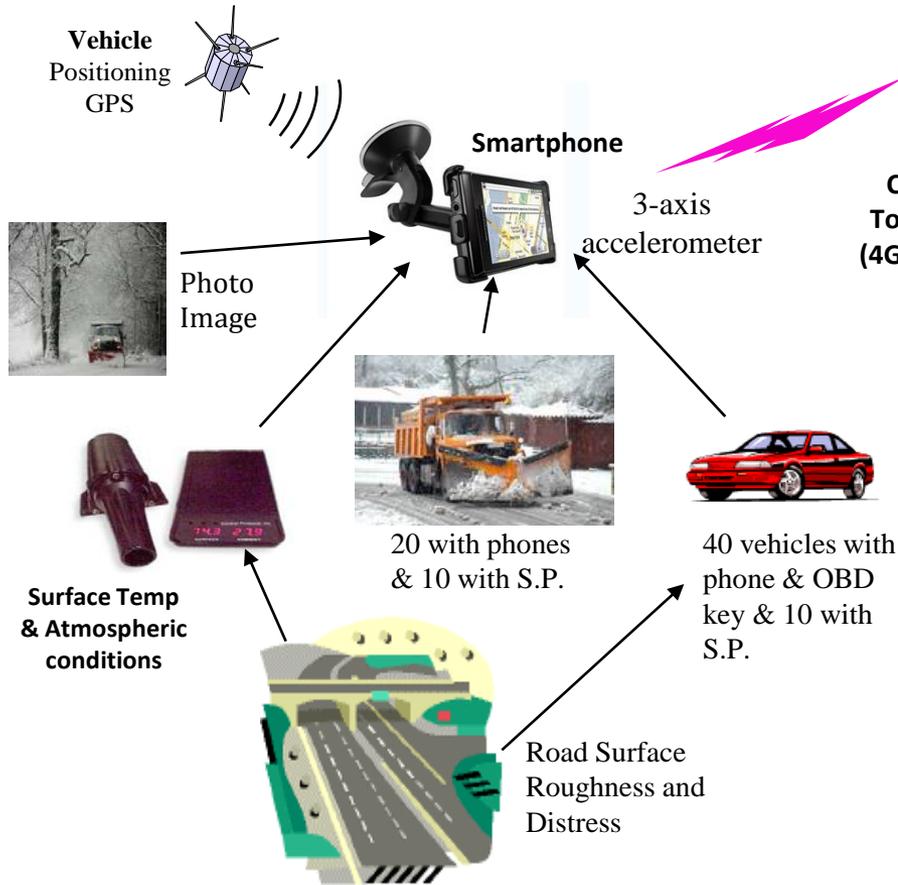
Bruce Belzowski



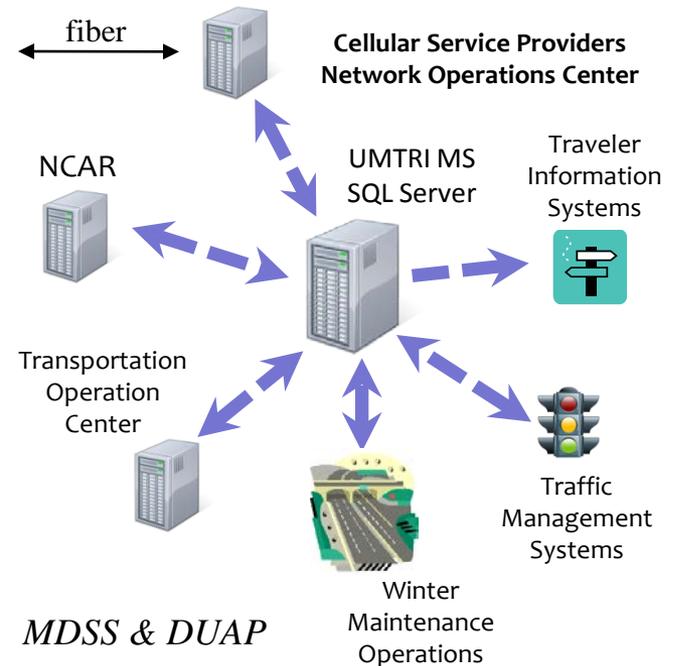
FHWA/MDOT/UMTRI IMO 2.0 Architecture

Michigan I-94 Corridor

MDOT Vehicles - FHWA Data Collection



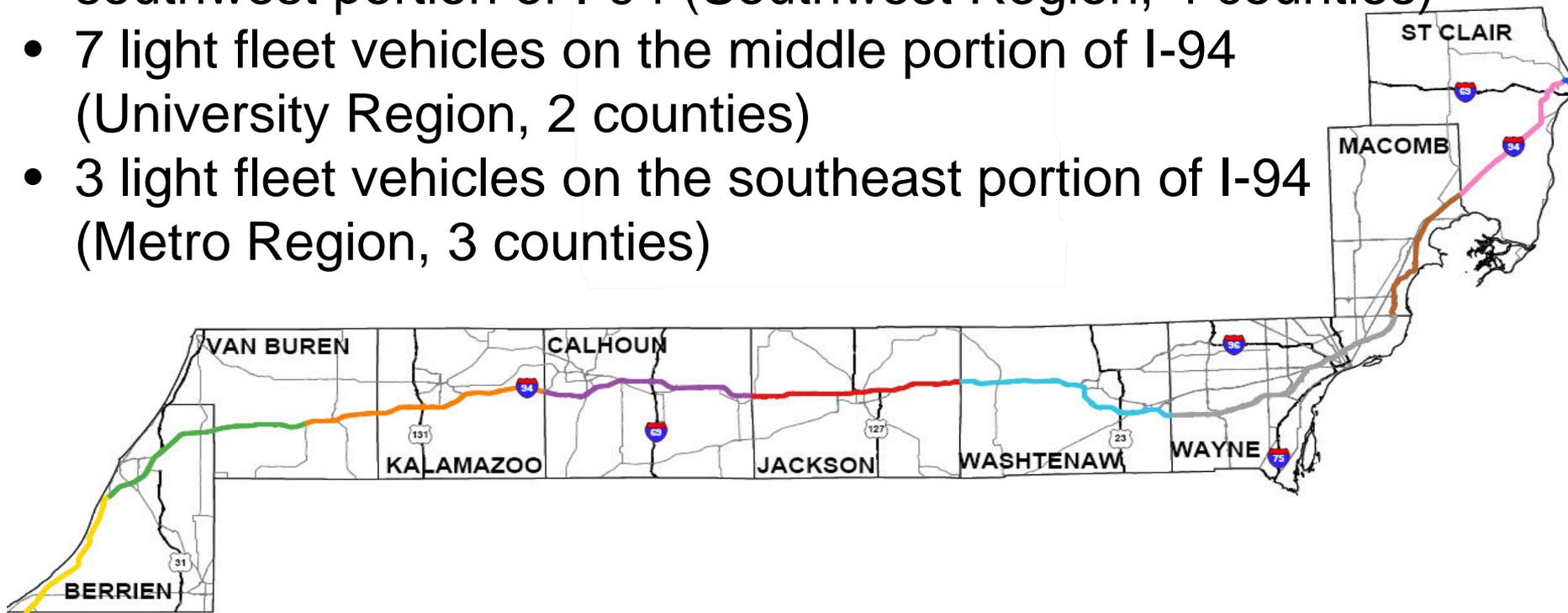
Data Users: UMTRI, NCAR, MDOT MDSS & DUAP & TOC/Navteq & RITIS/Atkins



MDOT Fleet Vehicles for IMO 2.0



- Vehicles traverse portions of I-94 on a regular basis
- 20 snowplows and 30 light fleet vehicles on the southwest portion of I-94 (Southwest Region, 4 counties)
- 7 light fleet vehicles on the middle portion of I-94 (University Region, 2 counties)
- 3 light fleet vehicles on the southeast portion of I-94 (Metro Region, 3 counties)

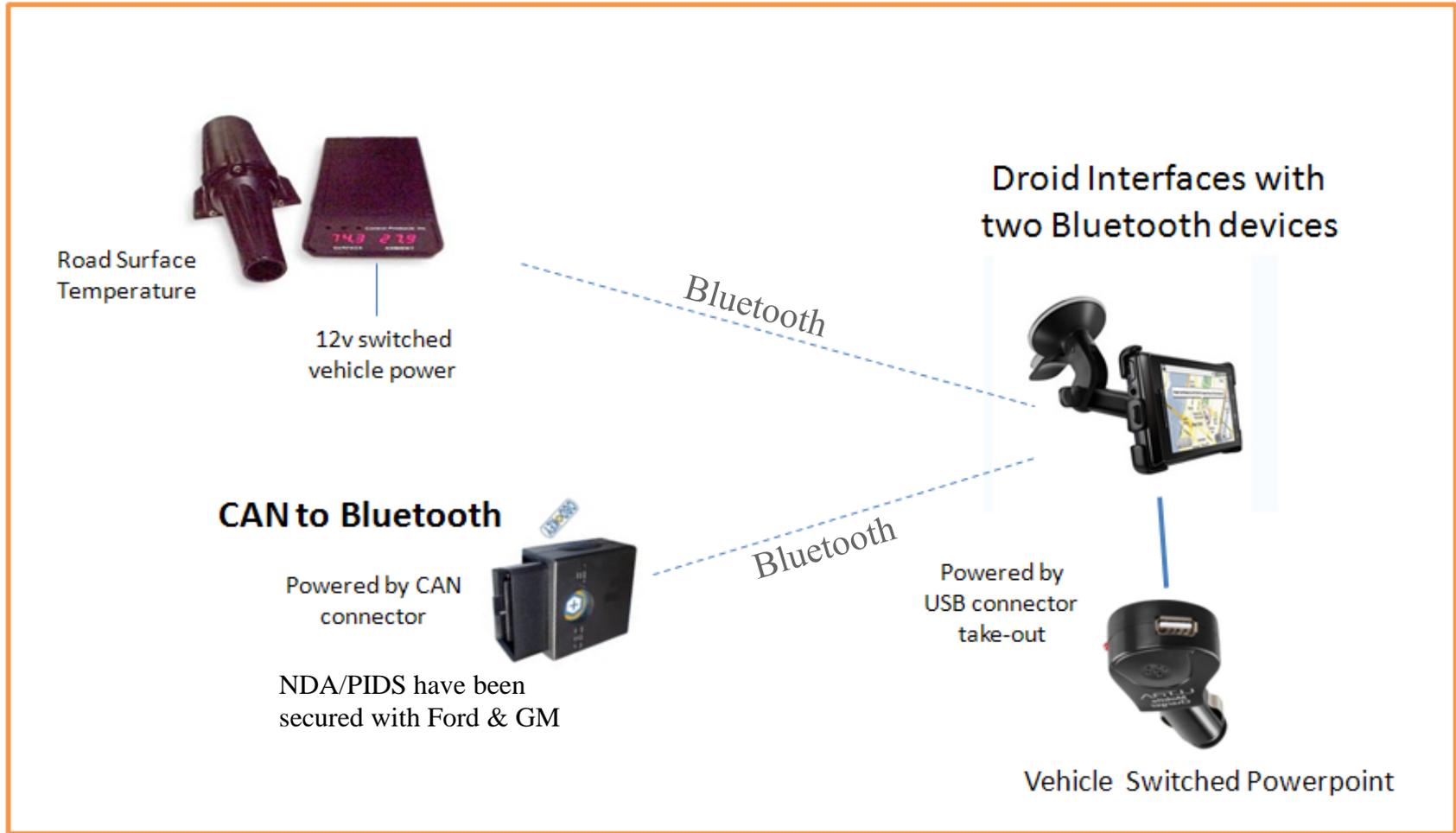


DataProbe App on Droid Smartphone



- DataProbe: Android application runs on Droid phones.
- Has Bluetooth, a USB port and a 3-axis accelerometer
- Droid mounted in a windshield docking station
- DataProbe can work alone or in combination with other data sources
- DataProbe gathers one set of data every second
- Five minutes (300 seconds) of data is collected in a data file and prepared for sending
- When the Droid has a cellular connection made (4G/3G), DataProbe sends available files (1MG) to UMTRI virtual servers.
- Collected to date: 135,000 vehicle miles of data (over 25 GB of data)

System Components



DataProbe Data Sources

<u>SIGNAL</u>	Surface		
	Droid	OBKey	Patrol
Position	X		
speed	X		
direction	X		
altitude	X		
distance	X		
veh dynamics	X		
roughness	X		
imaging	X		
VIN		X	
RPM		X	
Throttle Position		X	
ABS		X	
Trac Control		X	
ambient temp		X	
barometer		X	
pavement temp			X
humidity			X
dew point			X
Number of vehicles	(60)	(40)	(20)

- Flexible configuration
- Near real time data access with cellular services
- Not all CAN networks have desired data
 - Varies by model year and car line
- Surface Patrol requires hardware installation

Mobile Device and OBD Install



- Droid in WMT's is mounted to ceiling (left)
- Droid in light fleet is mounted to dash (center left)
- Light fleet vehicles have OBD key (lower left)
- Display contents will vary based on system configuration/mode (below)



Surface Temperature Sensor Placement



- Surface temp sensor on sedans mounted on engine fire wall (left ex. of pilot trunk install)
- Surface temp sensor on WMT's mounted between air tanks (below)
- Humidity sensor mounted on front lip of trunk decklid (below)
- Sensor data broadcast via serial Bluetooth adaptor



Roadway Camera Images

- Images (jpg files) taken with the Droid camera of the roadway
- Images can be triggered manually, on ABS lockup, or remotely
 - Optionally, a single or three image sequence can be captured
 - Three image sequence separated by two seconds between them
- All images are sent to servers within five minutes



Pushing Messages to Driver

- Operations center may send text message to driver of fleet vehicle for 10 second display
- Current display data is replaced with incoming text
 - Example text:
 - - “Call the office when available”
 - - “Redeploy to Exit 112”
 - - “Take photos of problem area”
- No driver physical interaction required to get text display
- Display annunciation (“beep”) heard when text received

Web Portal for Sending IMO Messages and Images

DATAPROBE FLEET COMMUNICATIONS

Message to be sent:

SEND

Region	Location	Driver	Year	Model	Config	In Service	Req Photo	Send Message
SWS	SOUTH HAVEN GARAGE	Mark Grazioli	2006	F250	BC			
SWS	PLAINWEL GARAGE	Tom Simpson	2008	F250	BC	X		X
SWS	COLOMA GARAGE	Hussain Ibrahim	2008	F250	BC			
SWS	KALAMAZOO GARAGE	Scott Geiger	2008	F250	BC			
SWS	COLOMA TSC	Keith Williams	2010	F250	BC	X	X	
SWS	COLOMA TSC	Ron Jackson	2009	SIERRA	BC	X		
SWS	JONES GARAGE	Rich Antuna	2009	SIERRA	BC			
SWS	FENNVILLE GARAGE	Mark Grazioli	2005	F250	BCS			
SWS	KALAMAZOO TSC	Tom Simpson	2006	F250	BCS			
SWS	JONES GARAGE	Hussain Ibrahim	2006	F250	BCS			
SWS	MARSHALL GARAGE	Scott Geiger	2006	F250	BC			
SWS	COLOMA TSC	Keith Williams	2006	F250	BC	X		
SWS	MARSHALL GARAGE	Ron Jackson	2008	Intern	BS	X		
SWS	REGION MAINTENAN	Rich Antuna	2008	Intern	BS			

Operator types messages, selects vehicle, then clicks SEND

SEND

Operator selects images to be taken then clicks SEND

Vehicle fleet details maintained by administrator/operator

Identifies which vehicles are currently in-service

Data Management and Distribution

- Data files (csv) sent to UMTRI servers are tested for validity
 - Files are stored on a secure University of Michigan Virtual Server with access to files limited to specific UMTRI, Intersog, and MDOT staff
- Non-valid files received at UMTRI are not re-transmitted
 - Containing errors (CRC checking)
 - GPS data without three or more satellites
 - Vehicle speed over file duration never over 0 mph (vehicle setting stationary for more than 5 minutes)
- Valid files are sent via FTP to Connected Vehicle servers
 - NCAR
 - Meridian (MDSS)
 - DUAP (Mixon-Hill)
 - Navteq (DMS Travel Times)
 - Atkins (RITIS 4DX: User Delay Cost I-94)

Risk Severity Summary

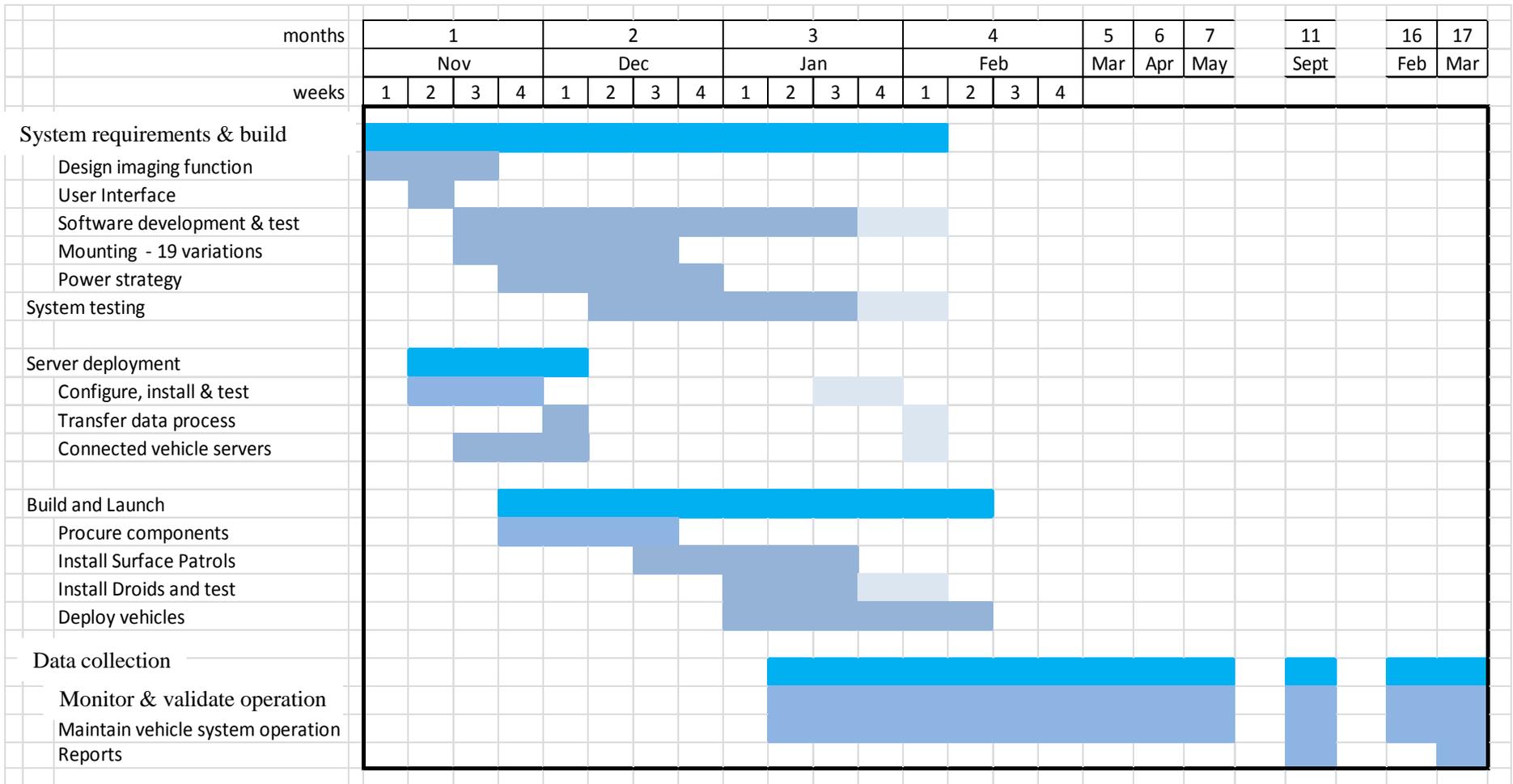
Top 3 Issues:

- **Bluetooth interface to Surface Patrol**
- **Lack of GM CAN PID support**
- **Random interaction between car and OBD device**

Applications

- Weather and road condition data into MDSS
- Real time road quality monitoring
- Fleet monitoring and management (miles, hours, routine maintenance, etc.)
- Targeted individual messages (augments DMS)
- Provide travel times and incident updates
- Remote imaging and physical monitoring of environment
- Visibility monitoring (snow, fog, rain, etc.)
- Emergency detection (ABS lockup & differential wheel speed reports)
- Slippery surface notification
- Weather ground truth augments ESS (surface temperature, dew point, etc.)
- Vehicle/device health monitoring (are devices installed on vehicles working?)
- Vehicle diagnostics
- Performance Management
- Regain Times

Summary IMO 2.0 Schedule



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