



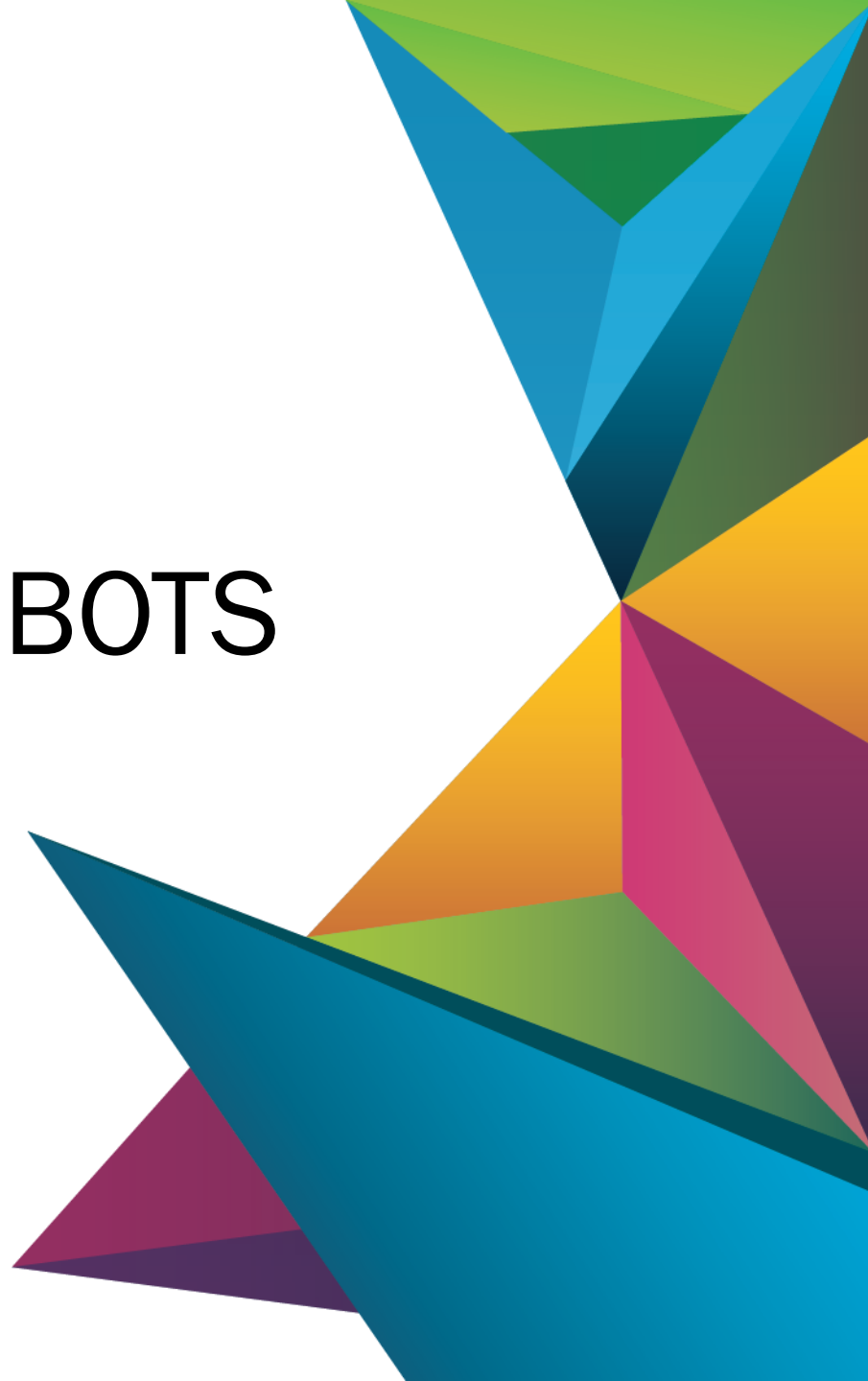
# FIELDING AUTONOMOUS ROBOTS LEVERAGING THINGWORX

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6/9/2016

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# AGENDA

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- ❑ ASI Introduction
- ❑ Autonomy and Robotics
- ❑ Current Industry Challenges
- ❑ Leveraging Thingworx Platform with Autonomous Robots
  - Marketplace Apps



- Founded 16 years ago
- Ground vehicle robotic specialists
- Agile Scrum Development
- More OEM partnerships than any other robotics company
- Robotics Business Review Global Top 50

Robotics Business Review



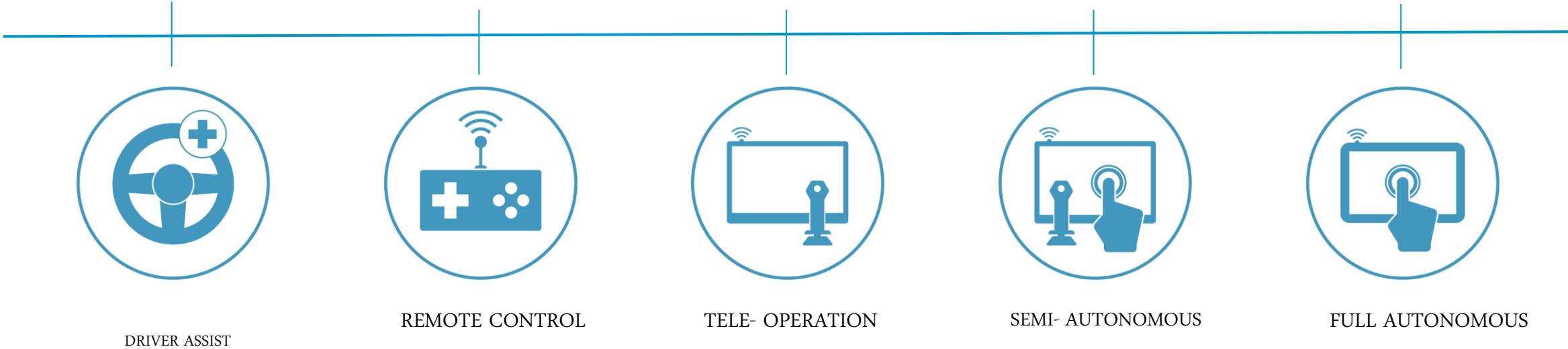
# ASI LOCATION



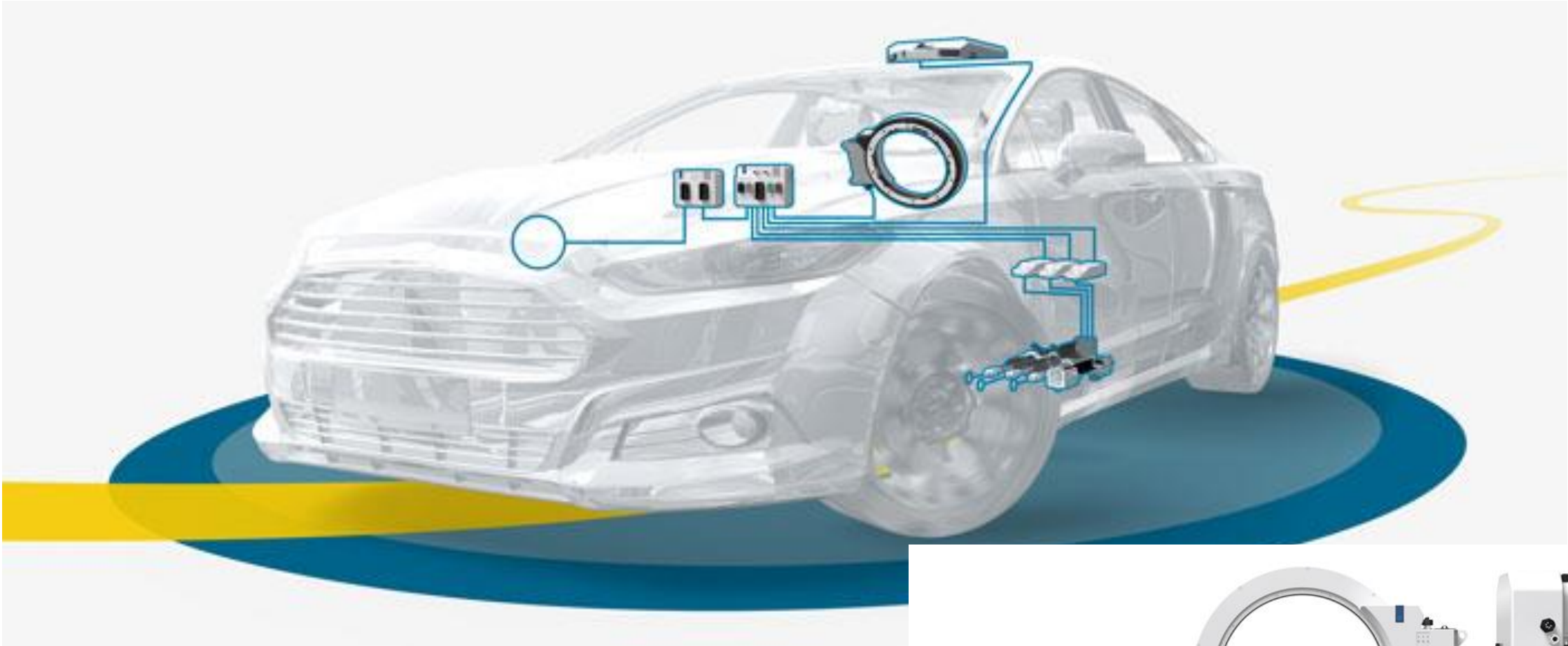
# autonomy

*noun*, | au·ton·o·my | \ò-'tä-nə-mē\

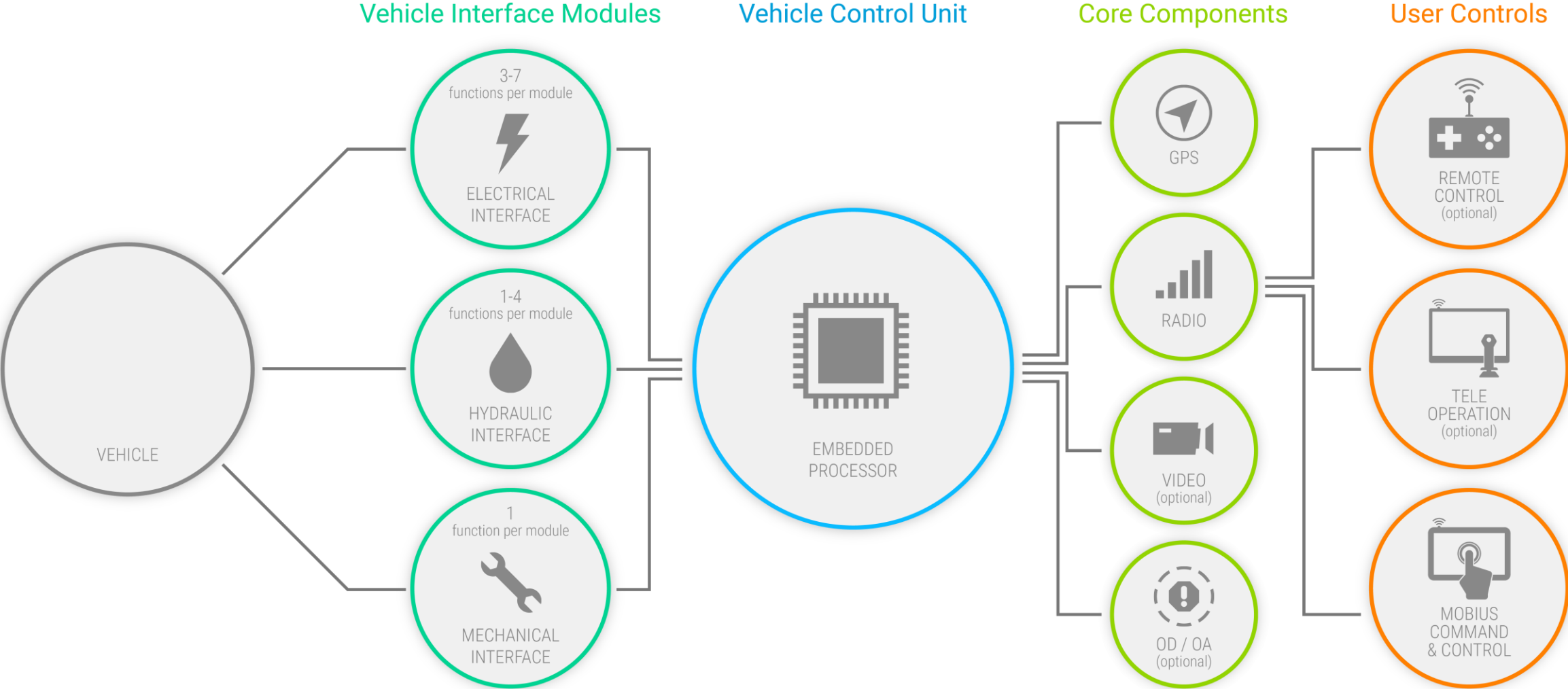
# LEVELS OF AUTOMATION



# NAV KIT

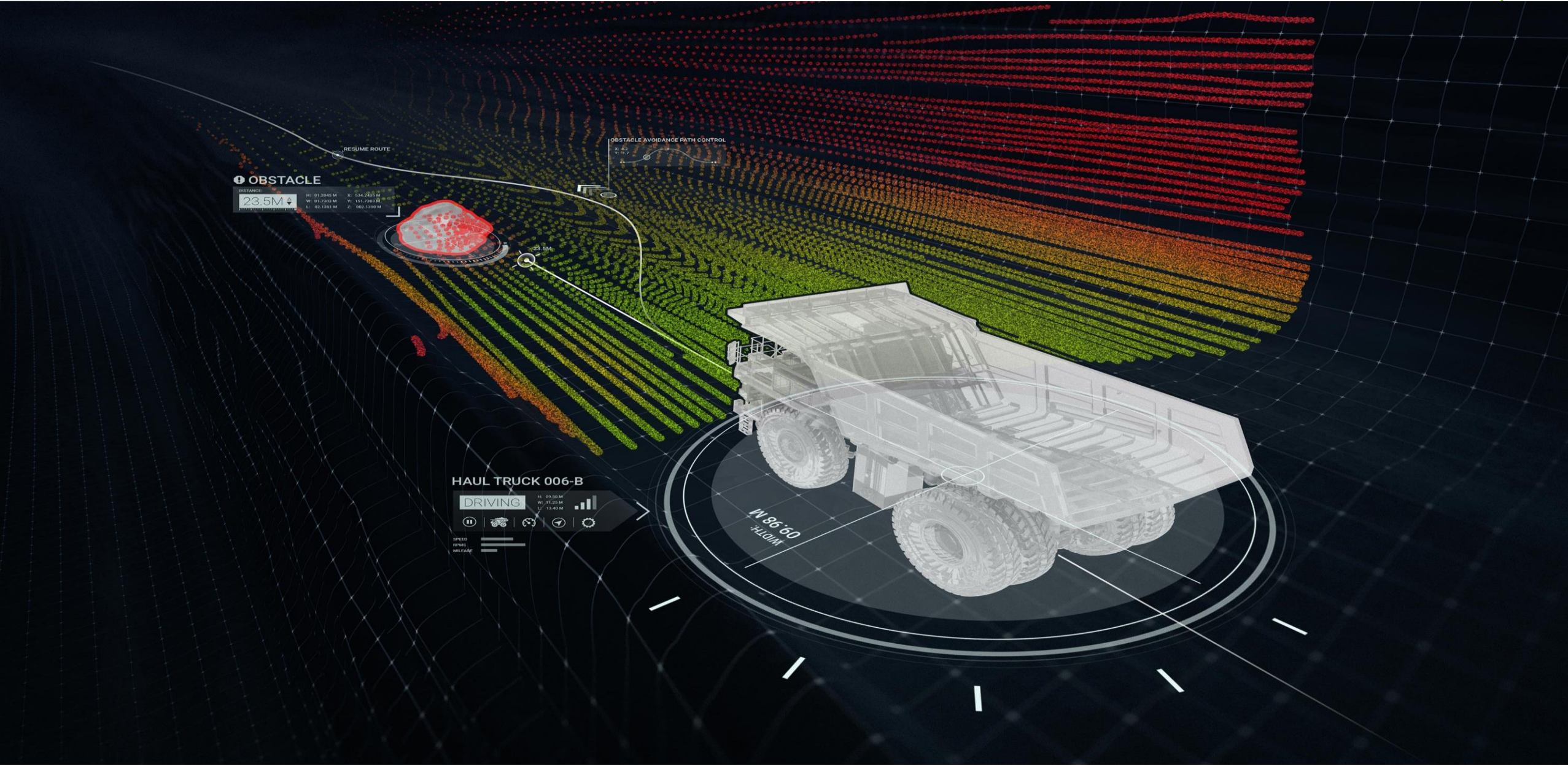


# NAV KIT – SYSTEM DIAGRAM





# ENVIRONMENTAL AWARENESS - VANTAGE



# MOBIUS COMMAND AND CONTROL



The screenshot displays the LIVEWORX 16 command and control interface, which is divided into several functional areas:

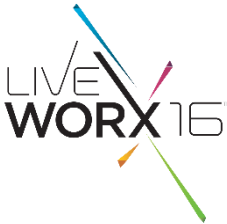
- VEHICLES Panel:** A list of vehicles is shown, including "LEVI BAKER 1" and several "Haul Truck" and "Articulated A35G" units. The "Haul Truck T284 001" is currently selected and highlighted in blue.
- Speedometer:** A large circular gauge displays a speed of 36 KPH. Below the gauge are buttons for "A" and "N" (likely for gear selection).
- Map:** A top-down map view shows a large green rectangular area, possibly a field or work zone, with a purple harrow pattern overlaid. A yellow tractor icon is positioned on the map. A "START" button and a dropdown menu (currently set to "Standard") are visible in the top right of the map area.
- Vehicle Details Panel:** A detailed view of the selected vehicle shows a speedometer at 0.00 MPH, a fuel gauge, and a battery level indicator showing 12V. Below these are buttons for "A" and "N".
- Location Panel:** A panel titled "South Farm" provides location data for Petersboro, UT, including coordinates: LAT: 32.1710467, LONG: -95.2889440, X: 223.740m, and Y: 251.713m.
- Navigation and Controls:** A central navigation pad with a compass rose and directional arrows is present. A vertical toolbar on the left contains various icons for system functions.

# INDUSTRY CHALLENGES

- Lack of agreed standards and protocols
  - Automotive industry taking the lead
    - CAN & Open CAN
  - ISO bus in Agriculture
  - Military sponsored
    - JAUS
    - Interop V2
  - Open Source
    - ROS (Robotic Operating System)

- Making autonomous systems safe
  - Functional Safety
    - Real time operating system for critical systems
    - Failing safe
  - Obstacle detection & environmental awareness
    - Known and unknown obstacles
  - Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication
  - How to handle human variances

# INDUSTRY CHALLENGES - LEGAL AND MORAL DILEMMAS



OR



# LEVERAGING IOT & THINGWORX

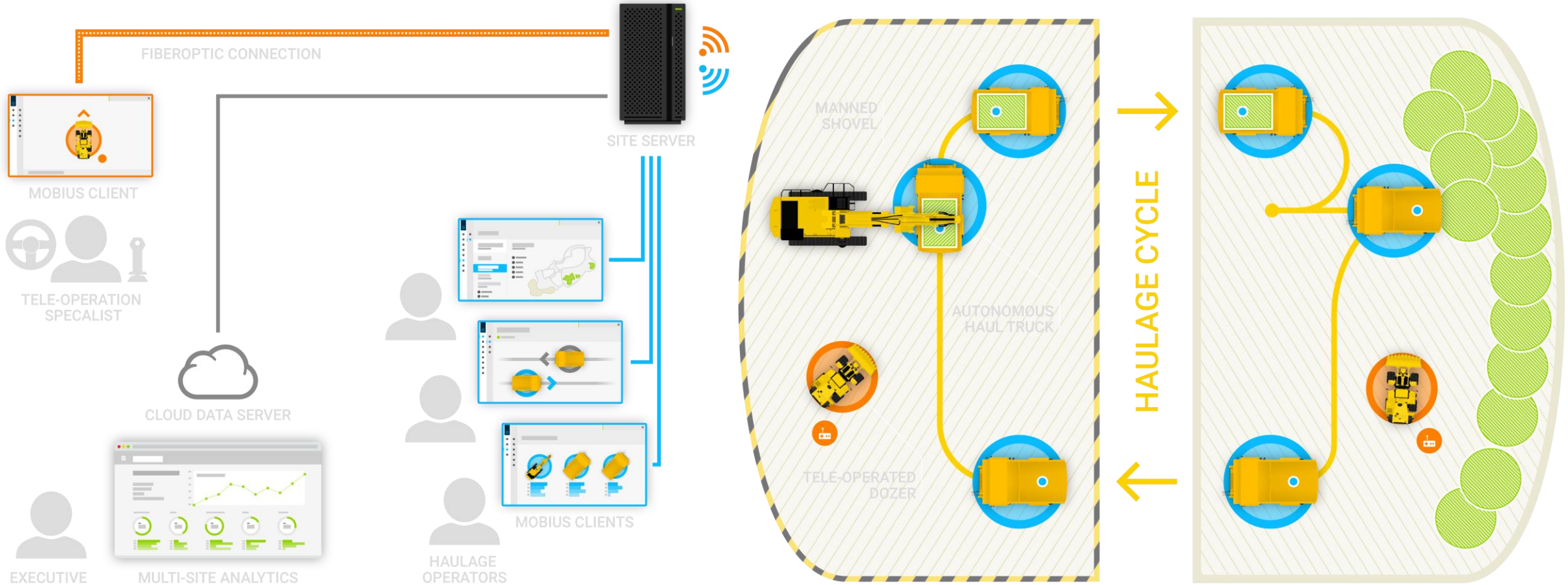
# TYPICAL AHS / TELEOPERATION DIAGRAM

## Off Site / Remote Location

## On Site infrastructure

## Load Zone

## Dump Zone





# MOBIUS DIAGNOSTICS



Levi Baker



## Zaldivar Mine

11 Users : 152 Assets

Status:

Online - Some vehicles need attention.

TEST ENTIRE SITE

**CRITICAL**

DOZER 002 VEHICLE AI FUSE 4 BLOWN

2 min ago

**WARNING**

DOZER 008 AI CPU TEMP IS TOO WARM

15 min ago

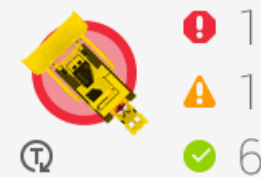
all site trucks dozers shovels drills other

Site



- Mobius server
- GPS
- Radios
- Support

Dozers



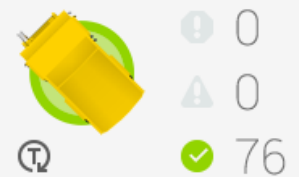
- Dozer 002
- Dozer 008
- Dozer 001
- Dozer 003
- Dozer 004
- Dozer 005
- Dozer 006
- Dozer 007

ADTs



- Truck 001
- Truck 002
- Truck 003
- Truck 004
- Truck 005
- Truck 006
- Truck 007
- Truck 008
- Truck 008

Rigid Haul Trucks



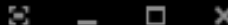
- Truck 001
- Truck 002
- Truck 003
- Truck 004
- Truck 005
- Truck 006
- Truck 007
- Truck 008
- Truck 008



# MOBIUS DIAGNOSTICS – VEHICLE LEVEL



Levi Baker



← Zaldivar Mine  
Dozer 2

Status:  
E-Stopped  
AI triggered

TEST VEHICLE

**CRITICAL**  
DOZER 2 VEHICLE AI  
FUSE 4 BLOWN  
2 min ago

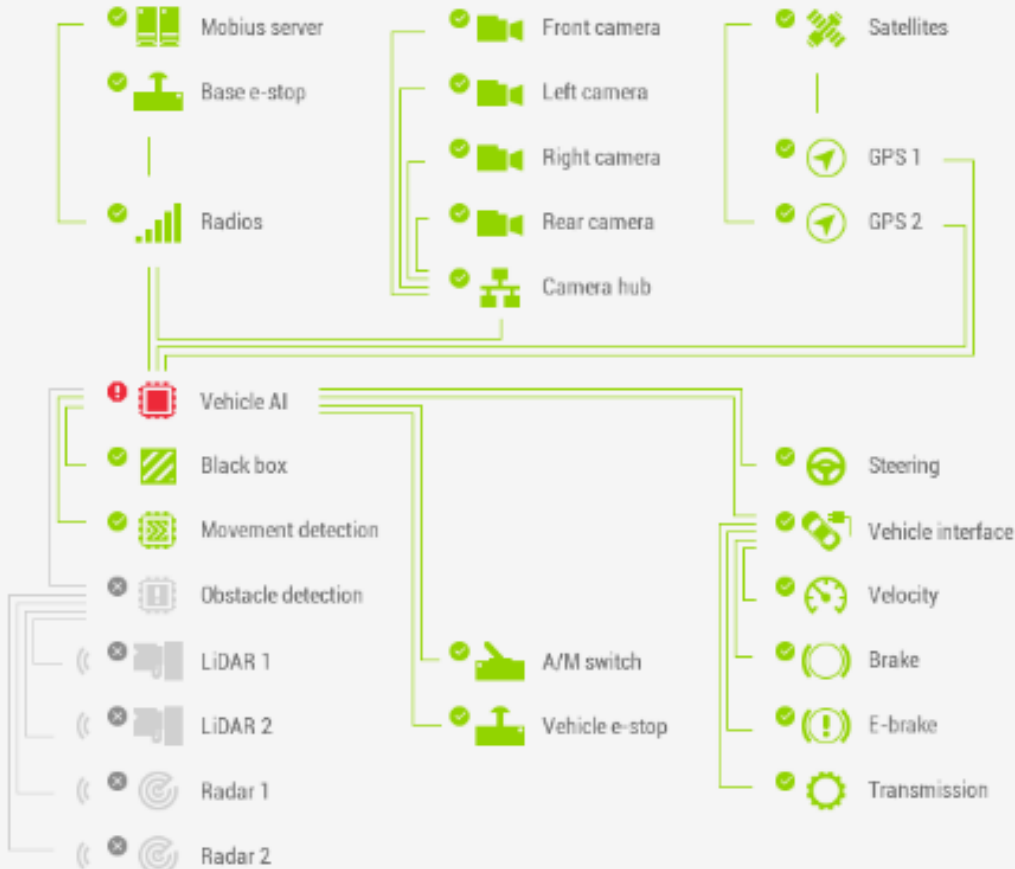


0.00 MPH  
1000 RPM

200°F  
ENGINE TEMP

24V  
BATTERY

Advanced...



# MOBIUS DIAGNOSTICS – VCU LEVEL

Levi Baker

## Zaldivar Mine

Dozer 2 : Vehicle AI

Status:  
Fully operational.

**TEST COMPONENT**

You have no notifications for this component.

20% CPU  
14° CPU TEMP  
10° TEMP  
200 Kbps ETHERNET

Advanced...

### Replacable parts:

- Fuse 1: 10A GPS power
- Fuse 2: 5A Radio power
- Fuse 3: 4A Vehicle interface power
- Fuse 4: 5A LiDAR power
- Fuse 5: 4A Actuators power
- Fuse 6: 10A Aux power
- Fuse 7: 4A Aux power
- Micro SD card: OK
- IMU  
Motion detection sensor: OK

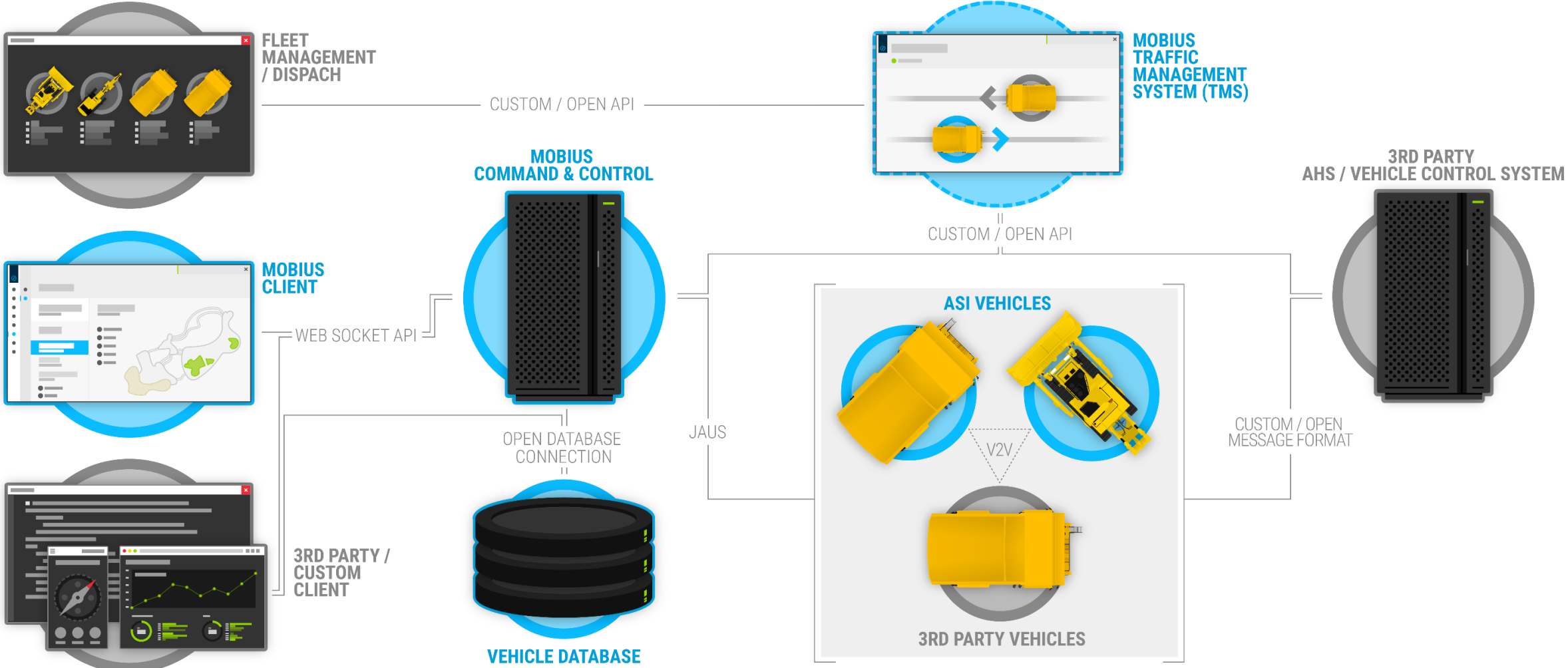
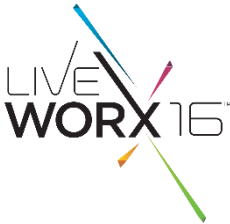
### Software components:

|                            |             |
|----------------------------|-------------|
| Vehicle AI software        | 5.0.15485.0 |
| Black box software:        | 1.0.14856.0 |
| Motion detection software: | Configured  |
| Vantage software:          | 2.3.01293.1 |

**CHECK FOR UPDATES**

- Restart vehicle AI
- Reset firmware

# TYPICAL MINING SYSTEMS DIAGRAM



## Tesla Tests Self-Driving Functions with Secret Updates to Its Customers' Cars

The Internet connection built into every Tesla gives the company a unique advantage in the race to develop autonomous vehicles.

by Tom Simonite May 24, 2016

- “Since introducing this hardware 18 months ago we’ve accrued 780 million miles,” said Anderson. “We can use all of that data on our servers to look for how people are using our cars and how we can improve things.” Every 10 hours Tesla gets another million miles worth of data, he said.
- “We will often install an ‘inert’ feature on all our vehicles worldwide,” said Anderson. “That allows us to watch over tens of millions of miles how a feature performs.”

# A ROBOTIC FUTURE?



- Automation (Robotics) is proven and accepted
  - Lower cost input
  - Increase availability and productivity
- Innovation is exponential
  - Standards alignment is critical for sustainability
  - IoT is driving cooperation and interoperability for data
- Standards bodies and industry teams forming working groups to tackle interoperability for data access and control messaging

- IoT is an enabler for monitoring and measuring vehicle and system performance and effectiveness
  - Aggregating and delivering information
  - A Robotic App Exchange?
- ASI is migrating to cloud based analytics and control by leveraging the Thingworx platform.

The image features several colorful geometric shapes, primarily triangles and lines, scattered across the white background. A large, multi-colored triangular shape is prominent on the right side, composed of various shades of blue, green, yellow, and purple. Several thin, colored lines (blue, pink, green, orange) radiate from the center towards the top and bottom edges. The text 'LIVE WORX 16™' is centered in the upper half, with 'LIVE' in a thin, outlined font and 'WORX 16™' in a bold, solid black font.

# LIVE WORX 16™

TAKE A FRESH LOOK AT THINGS

[liveworx.com](http://liveworx.com)