

THE OHIO STATE UNIVERSITY

LOWNO CAP AND BUS TESTING

CURRENT CAPABILITIES & EXPANSION PLANS

David Cooke
10/11/2019



THE OHIO STATE UNIVERSITY
CENTER FOR AUTOMOTIVE RESEARCH

The Ohio State University



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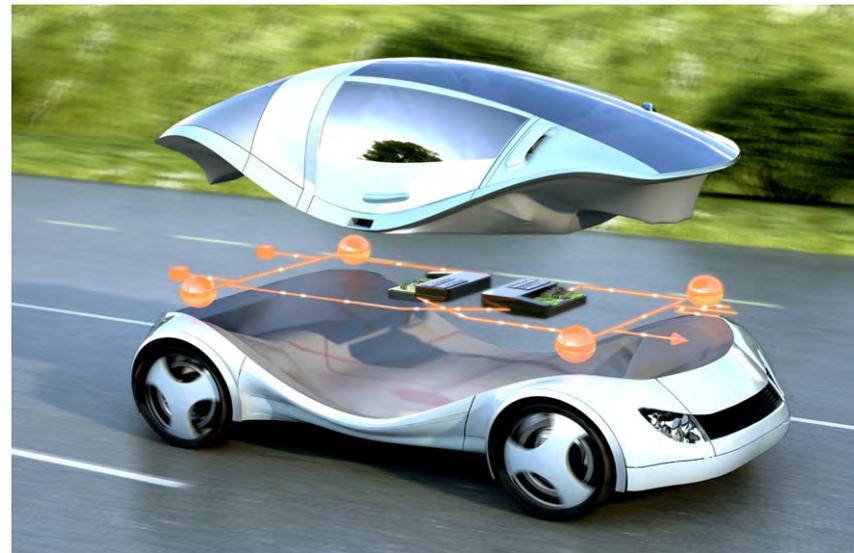
- More than **5000** researchers
- **18** colleges and schools
- **66,000+** students across all campuses
- Nearly **\$1B** in annual research expenditures
- Ranked in the **Top 20** US Public Universities
- Ranked **fourth** among all U.S. universities in industry-sponsored research, with more than half of that research conducted in the College of Engineering
- The breadth, scope and excellence of our research programs make Ohio State a **leading force of innovation and change** – locally, nationally and globally



Center for Automotive Research

REINVENTING MOBILITY AT CAR

- Advanced powertrain and vehicle electrification for improved efficiency
- Increased vehicle intelligence, connectivity and autonomy
- Safety and Security
- NVH and Drive Quality
- New mobility solutions and business models, smart cities, urban logistics





SPONSORED RESEARCH

- CAR supported **\$21 million** in new awards last year alone.
 - **107** active projects, pulling in **60** different investigators
- Our sponsors:



CAR is located on a 50,000 square foot complex on the West Campus of The Ohio State University



Advanced propulsion systems research facilities

- Energy storage systems laboratory
- Chassis dynamometer laboratory
- Advanced traction drive powertrain laboratory
- BEV, PHEV, and HEV test beds
- Hydrogen, Stage 2 Electric, and CNG refueling stations on site

Autonomous vehicle fleet

- Traffic data-collection research vehicle
- Communication and coordination research vehicle
- Vehicle-to-vehicle (V2V) and vehicle autonomy laboratories
- Driving simulator laboratory
- DENZO V2V and Embedded System Laboratory
- OSU-CITR indoor testbed



CHASSIS DYNAMOMETER LABORATORY

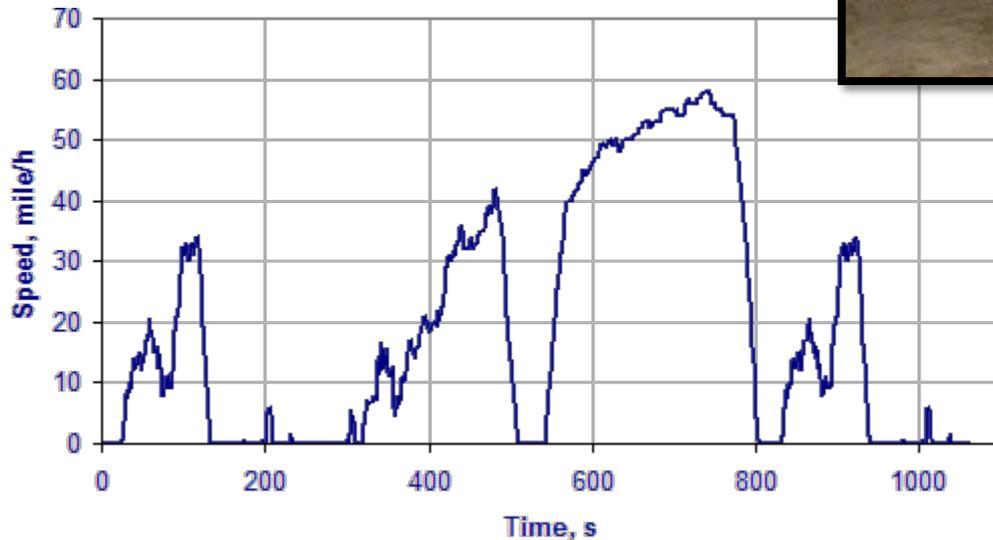


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Real-world route performance with
terrain and environment impacts

Electric range verification

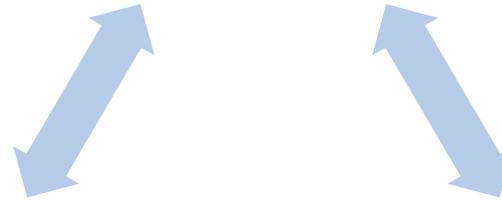
Fuel efficiency evaluation





pack lifecycle determination
In-use pack performance evaluations

Battery
Cycling



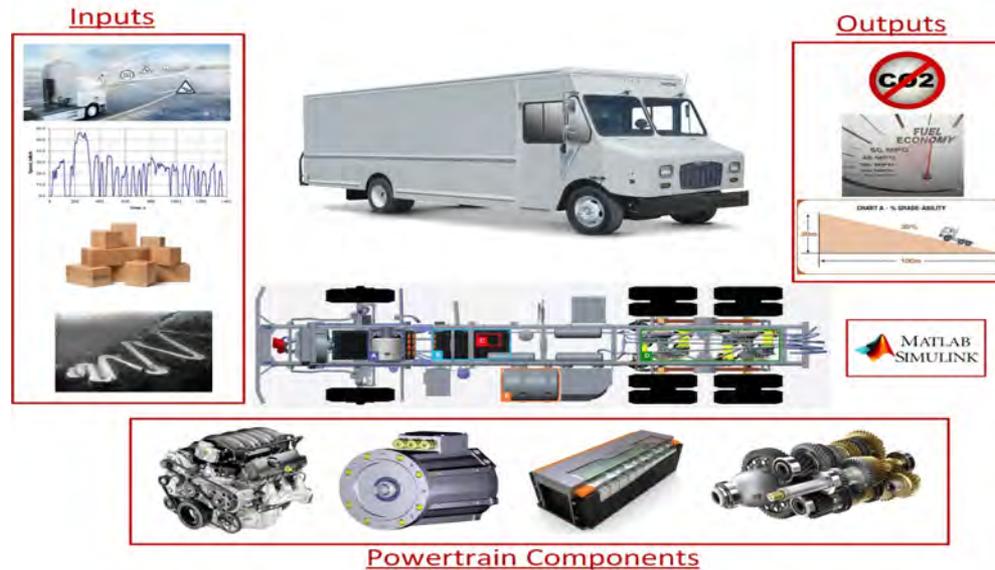
grid storage
charging infrastructure
powertrain testing

BMS/HIL

High
Voltage

Battery management evaluation
State of Charge/Health determinations
Hardware/Battery efficiencies

Fleet Planning – DOE Extended Range Electric Vehicle Architectures



Route Analysis and Optimization





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industries



- **Opened in 1974**
- **Most Comprehensive Independent Proving Ground in North America - 4,500 acres, 800+ Clients**
- **Operated by TRC Inc. (501c3)**
- **Managed by The Ohio State University**
- **Home to NHTSA's only Vehicle Research and Test Center (VRTC)**



PROVING GROUND TRANSIT FACILITY HIGHLIGHTS



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Bus Durability Course

Dynamic Testing Area

SMARTCenter
Autonomous
Development

Main
Campus

24/7 Service Support
Bays

7.5 Mile
Oval

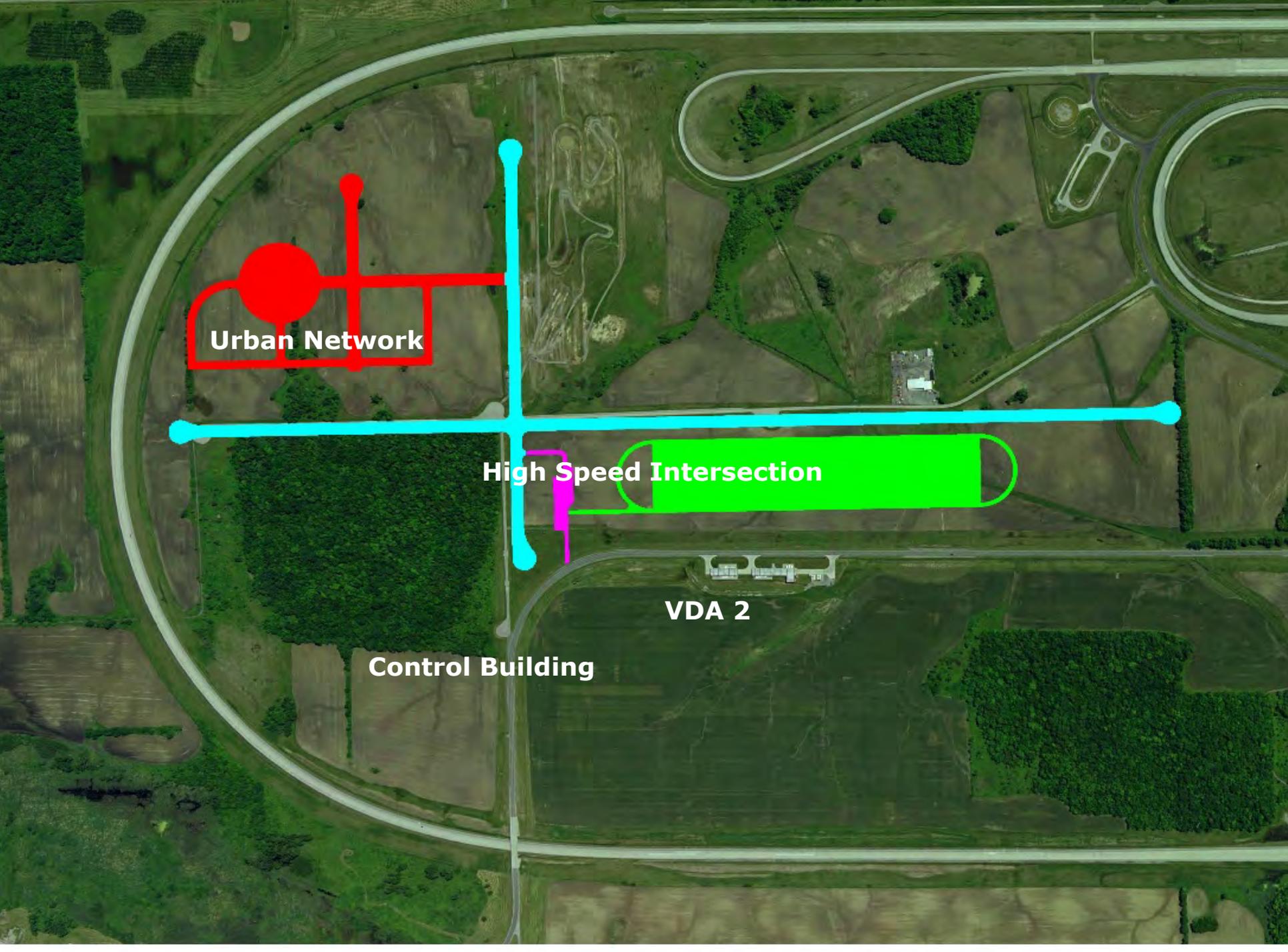
North Campus

- Security Entrance
- Conference Center
- Crash Barrier and Sled





Control Building





SMART MOBILITY ADVANCED RESEARCH AND TEST CENTER



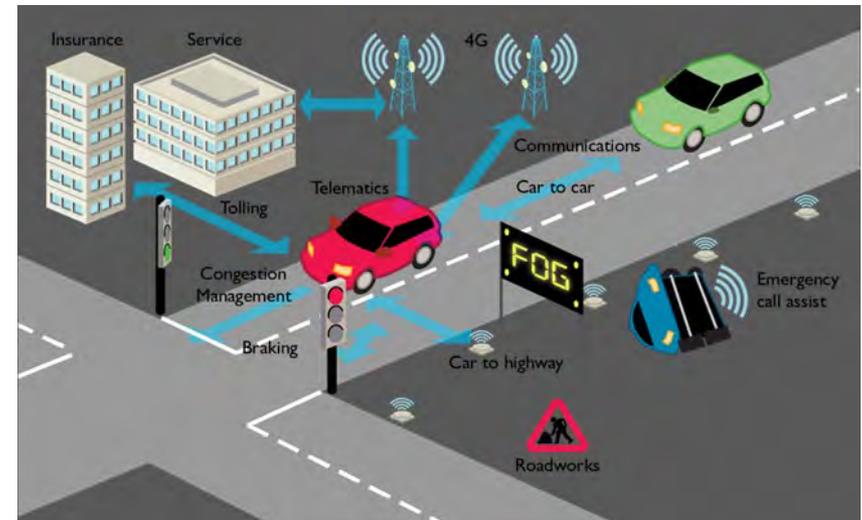
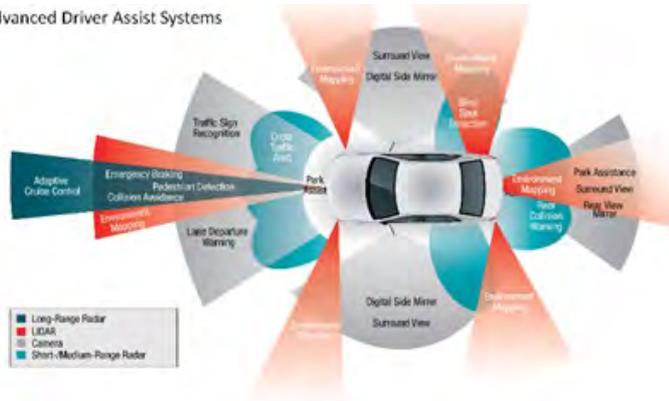
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Controlled Track Testing

- Develop test procedures and carry-out comprehensive test plans
 - Scenario based competencies
 - Automation edge case
 - Adverse weather effects
- CV testing
 - Platooning
 - Railroad crossing
 - Work zone TIM
 - Traffic interactions

Advanced Driver Assist Systems



SMART MOBILITY ADVANCED RESEARCH AND TEST CENTER



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Standardized Testing

- Crash Avoidance
 - Lane Departure (LDW, LKS, LC)
 - Automatic Emergency Braking (CIB, DBS, RAEB)
 - Adaptive Cruise Control
 - Blind Spot
 - Traffic Jam Assist
 - Park Assist
 - Traffic Sign Recognition
- Agencies
 - NHSTA NCAP
 - EURO NCAP
 - IIHS
 - RCAR



CURRENT FEDERAL TRANSIT BUS TEST PROGRAM



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Area	Description	Detail	Status	Capital Expense
0	Test Bus Check-In		Ready	No
1.1	Maintainability	Accessibility of Components and Subsystems	Ready	No
1.2	Maintainability	Servicing, Preventative Maintenance, and Repair and Maintenance During Testing	Ready	No
1.3	Maintainability	Replacement and/or repair of selected subsystems	Ready	No
2.0	Reliability	Documentation of breakdown and repair times during testing	Ready	No
3.1	Safety	A double-lane change	Ready	No
3.2	Safety	Bus braking performance test	Ready	No
4.0	Performance	Dynamometer-based acceleration, gradeability, and top speed test	Ready	No

CURRENT FEDERAL TRANSIT BUS TEST PROGRAM



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Area	Description	Detail	Status	Capital Expense
5.1	Structural Integrity	Structural Distortion	Ready	No
5.3	Structural Integrity	Static towing test	Ready	No
5.4	Structural Integrity	Dynamic towing test	Ready	No
5.5	Structural Integrity	Jacking test	Ready	No
5.6	Structural Integrity	Hoisting test	Ready	No
5.7	Structural Integrity	Structural durability test	Performed	Yes
6.0	Energy Economy	Energy consumption test for battery electric busses using and appropriate operating cycle	Ready	No
6.0	Fuel Economy	Fuel consumption test using an appropriate operating cycle	Ready	No
7.1	Noise	Interior noise test	Ready	No
7.2	Noise	Exterior noise test	Ready	No
8.0	Emissions	Dynamometer-based emissions test using transit driving cycles	Performed	Yes

OSU TIMELINE FOR BUS TESTING PROGRAM IMPLEMENTATION



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OSU'S COMMITMENT TO MANAGING A LONO BUS TESTING CENTER



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OSU and TRC is fully committed to supporting the development of capabilities and the installation of capital equipment required for an FTA bus testing center.

OSU and TRC are developing a comprehensive funding plan which includes Federal, State, and University funding sources.

Our Advanced Transit Mobility Center is intended to house both the FTA Bus Testing and CAP programs on campus while supporting our industrial partners during development of the next generation of transportation solutions.



Survey Methodology

- Anonymous open ended interviews averaging 1-hour in length to identify existing components on current LoNo busses which need improvement
- Discussion directed towards issues of:
 - Maintenance/Reliability
 - Efficiency
 - Noise
 - Cost

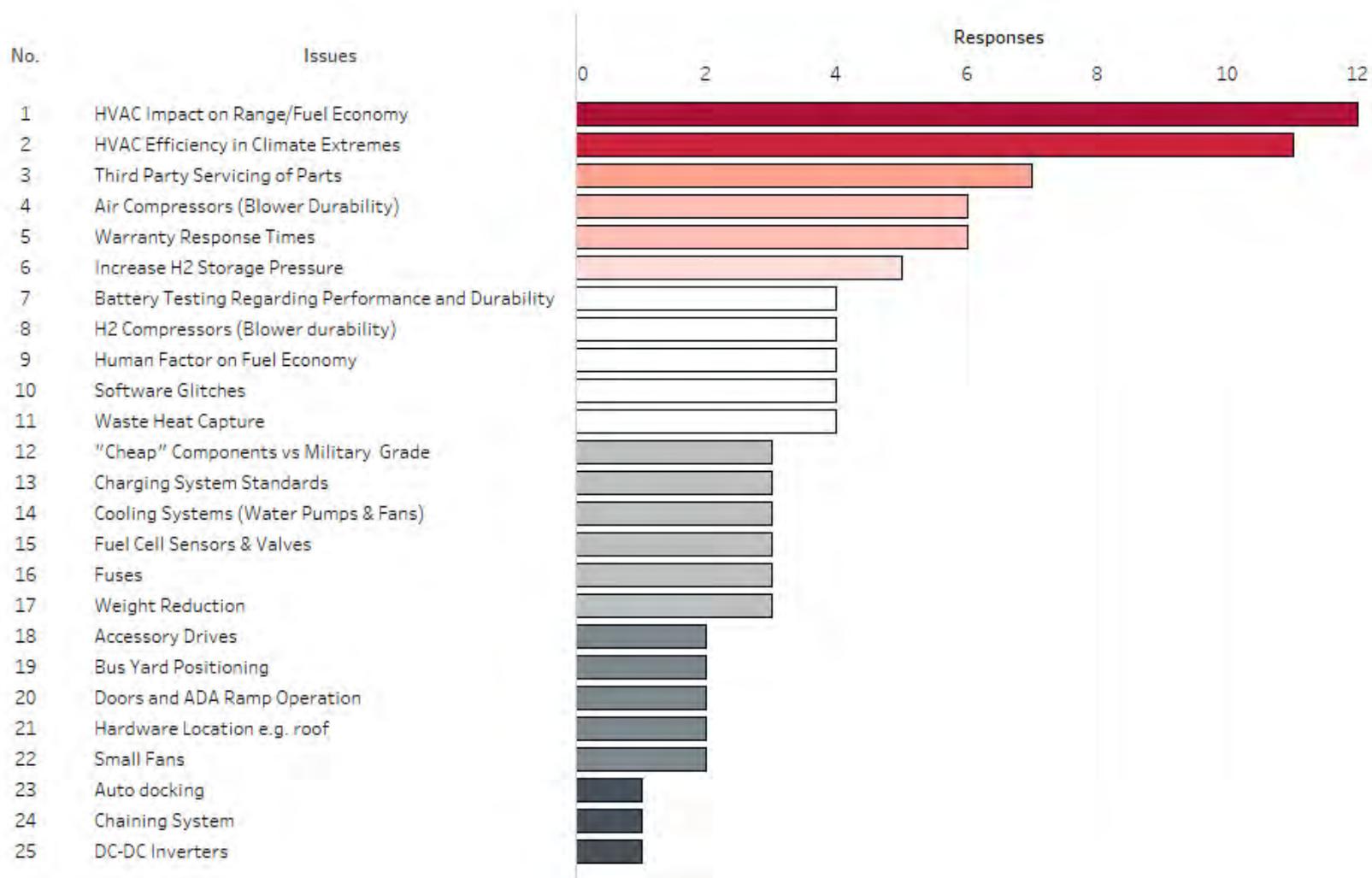
Goal: Identification of technological issues which are preventing transit agencies from fully utilizing their LoNo busses

OSU INDUSTRY SURVEY RESULTS



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OSU and TRC believe the future of the Transit Industry is LoNo.

Possible bus testing program adjustments to meet this future include:

Developing Test Protocols for Energy Storage (Battery) and Powertrain Durability

Specific test procedures for battery electric and fuel cell busses

Developing Test Protocols for Connected and Automated Testing



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