Automated Driving Systems for Rural America

Prof. Daniel V. McGehee
Director
National Advanced Driving Simulator

SIP – adus Workshop - Tokyo
November 2021

IOWA | National Advanced Driving Simulator

アイオワ大学　工学部　教授
博士　　ダニエル　マクギヒ
National Advanced Driving Simulator 所長

Rural Roadways are Under-Represented in AV Testing and Demonstrations

Urban-centric AV testing will lead to urban-centric solutions

19% of Americans live in rural areas, but . . .

**50%** of traffic fatalities occur on rural roads
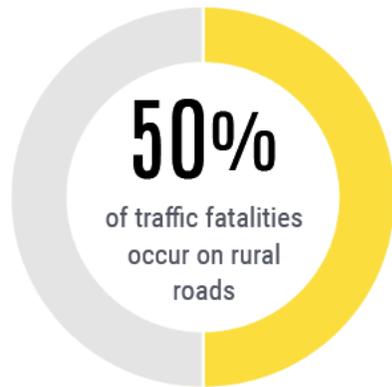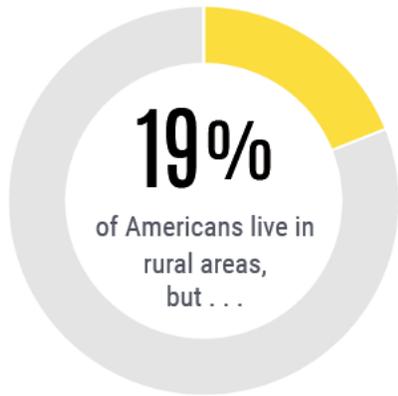
US Census Bureau and FHWA Statistics

IOWA

Mobility-Impaired Populations Need More Options

- 1 in 5 adults over the age of 65 live in rural America

- Older adults are projected to outnumber children by 2035

https://www.census.gov/library/stories/2019/10/older-population-in-rural-america.html

For the first time in US history, older adults are projected to outnumber children by 2035

Projected percentage of population

22.8%

Adults 65+

23.5%

Children under 18

19.8%

15.2%

Projected number (millions)

49.2   73.6

78.0   76.4

94.7   79.8

2016   2035   2060
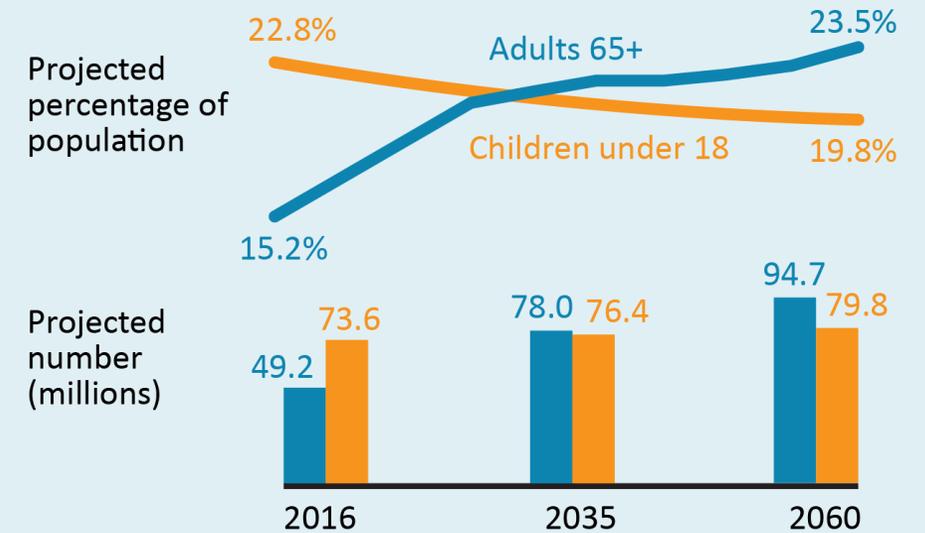
ADS Vehicle

- 2020 Ford Transit 350 HD Chassis

- Buy American Act

- Mobility-friendly vehicle

- Always monitored by safety driver and co-pilot

- Built to support higher levels of automation

- ADA compliant

AUTONOMOUSTUFF

IOWA

National Advanced Driving Simulator

Accessibility

ADA compliant

Equipment

1. GPS antenna
2. DSRC antenna
3. High-definition cameras (2)
4. Velodyne Lidar (on front, sides, and rear of vehicle)
5. Webcam video camera (front and rear)
6. Mobileye collision avoidance system
7. Vaisala mobile detector: road, surface, and weather data
8. Long range radar (front and rear)

Video: Safety Driver Display
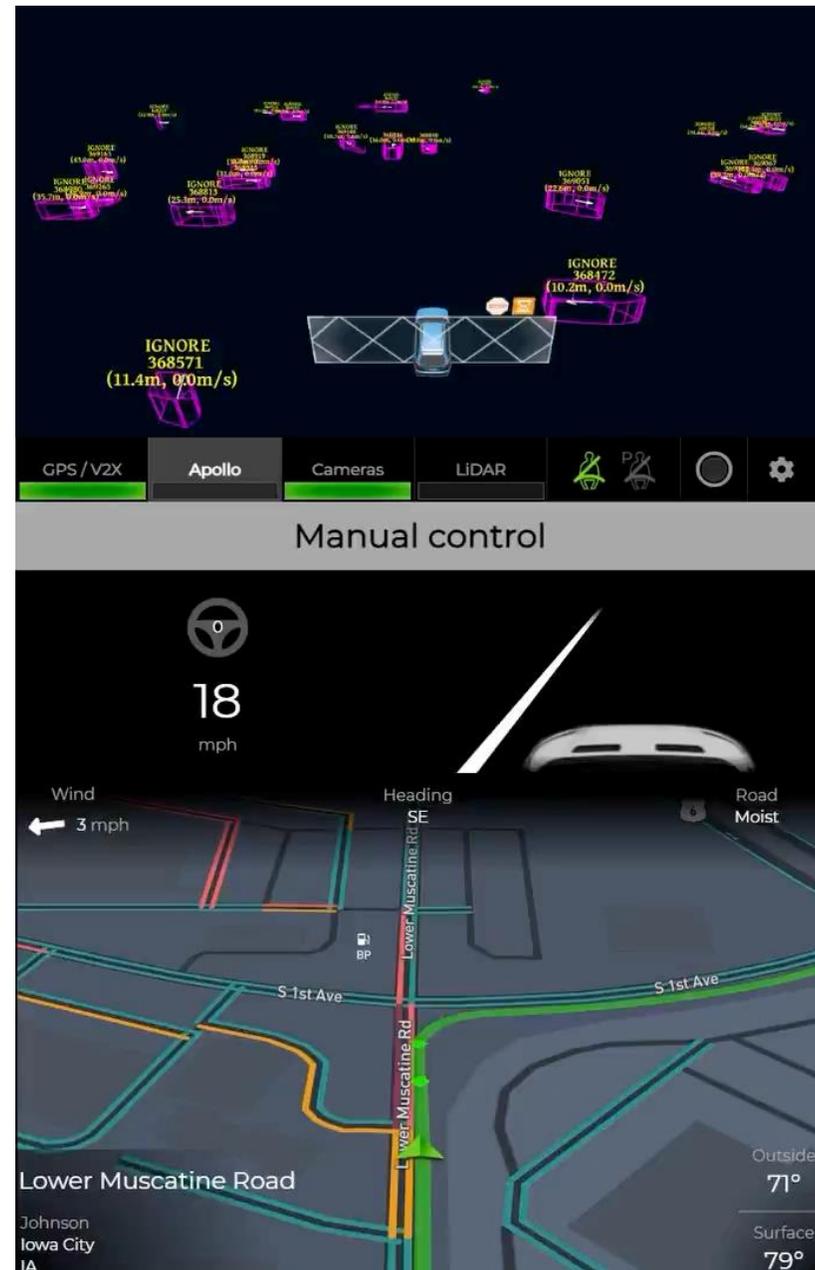
Route

→ 47-mile loop, driven clockwise

→ 4 stops
- Iowa City Marketplace
- Hills Community Center
- Riverside Casino
- Kalona Public Library

→ Different road types
- Marked, unmarked, unpaved

→ Driven all 4 seasons

→ Different times of day

→ Mapped in high-definition

→ Construction along route

MANDLI COMMUNICATIONS

Left Turn Across Traffic

Signalized Intersections w/ SPAT Device

Paved and Curvy Road Without Lane Markings

Gravel Road

Iowa City Marketplace

1 h 13 min
46.9 miles

On-Ramp

Divided 2-Lane Highway

Off-Ramp

Hills Community Center

Main Street

Undivided 2-Lane Highway

Riverside Casino & Golf Resort®

Soft Shoulders

Kalona Public Library

IOWA

Riders from Local Communities

Older adults

- Age 65 and over
- May have a driver's license with or without restrictions

Mobility-impaired adults

- Age 25 and over
- Need the aid of a walker, cane, or wheelchair

Visually-impaired adults

- Age 25 and over
- Vision between 20/70 - 20/200

IOWA

National Advanced Driving Simulator

Data to be Collected
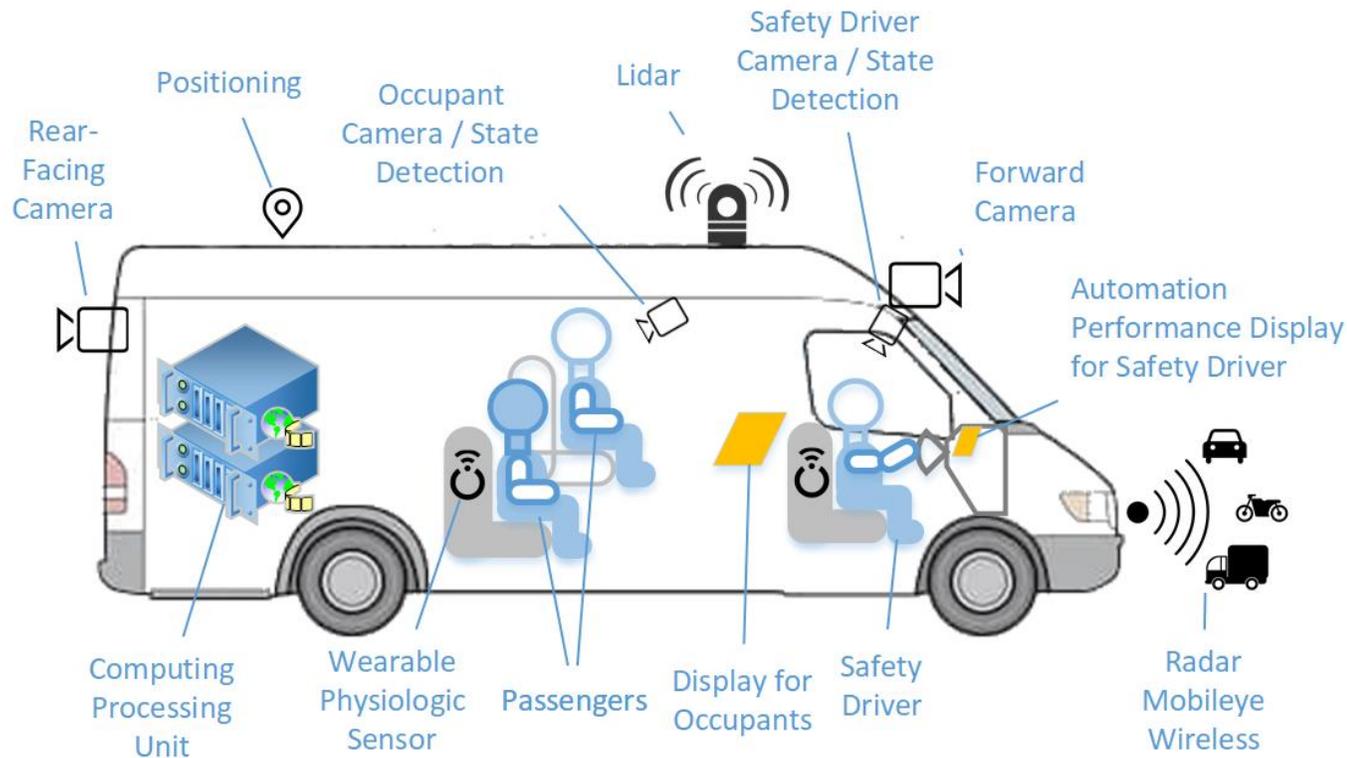
→ Video data from driver and passengers
  - Driver performance/workload
  - Driver/passenger state detection

→ Questionnaire data from the riders regarding trust and acceptance

→ Physiological data from riders and safety driver regarding stress/anxiety

→ Automation performance data
  - Impact of environment

Hypothesis: Trust and acceptance will be gained through experience with the AV

Questionnaire Data

Pre- and post-drive:

- Trust
- Reliability
- Anxiety
- Safety
- Intention to use
- Perceived usefulness

Biometric Data (Empatica)

Baseline data collected pre-drive (10 minutes)

- Data from temperature sensor
- Data from the electrodermal activity sensor
- Blood Volume Pulse (BVP) data from photoplethysmograph
- Data from 3-axis accelerometer sensor
- Inter-beat interval extracted from the BVP signal
- Average heart rate extracted from the BVP signal

Ratings of Anxiety

- Asked at various points throughout the drive
- A monitor at front of shuttle will continuously display the status of the automation (i.e., manual or automated control)

I would trust a highly automated vehicle to drive on gravel roads

How concerned are you about an automated vehicle's ability to interact with non-self-driving vehicles?

IOWA

National Advanced Driving Simulator

Video Data

→ Forward view

→ Rear view

→ 4 synced video streams

  • Driver and co-pilot face, hands, torso

  • Passenger's face/torso

→ Time-stamped

→ HD resolution (1080P)

Access to raw video data requires data usage agreement

Data Sharing Approach

Vehicle / ROS Bag Data → Indexed Relational Database Data → Cloud → Access Portal → Data To Users

IOWA

National Advanced Driving Simulator
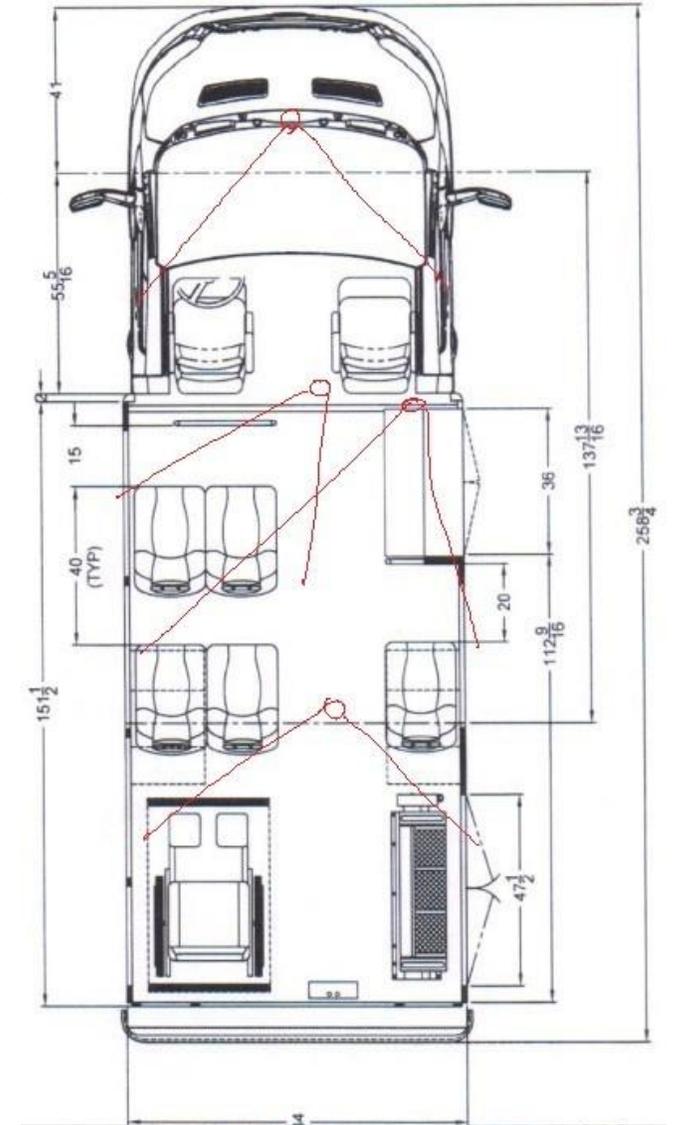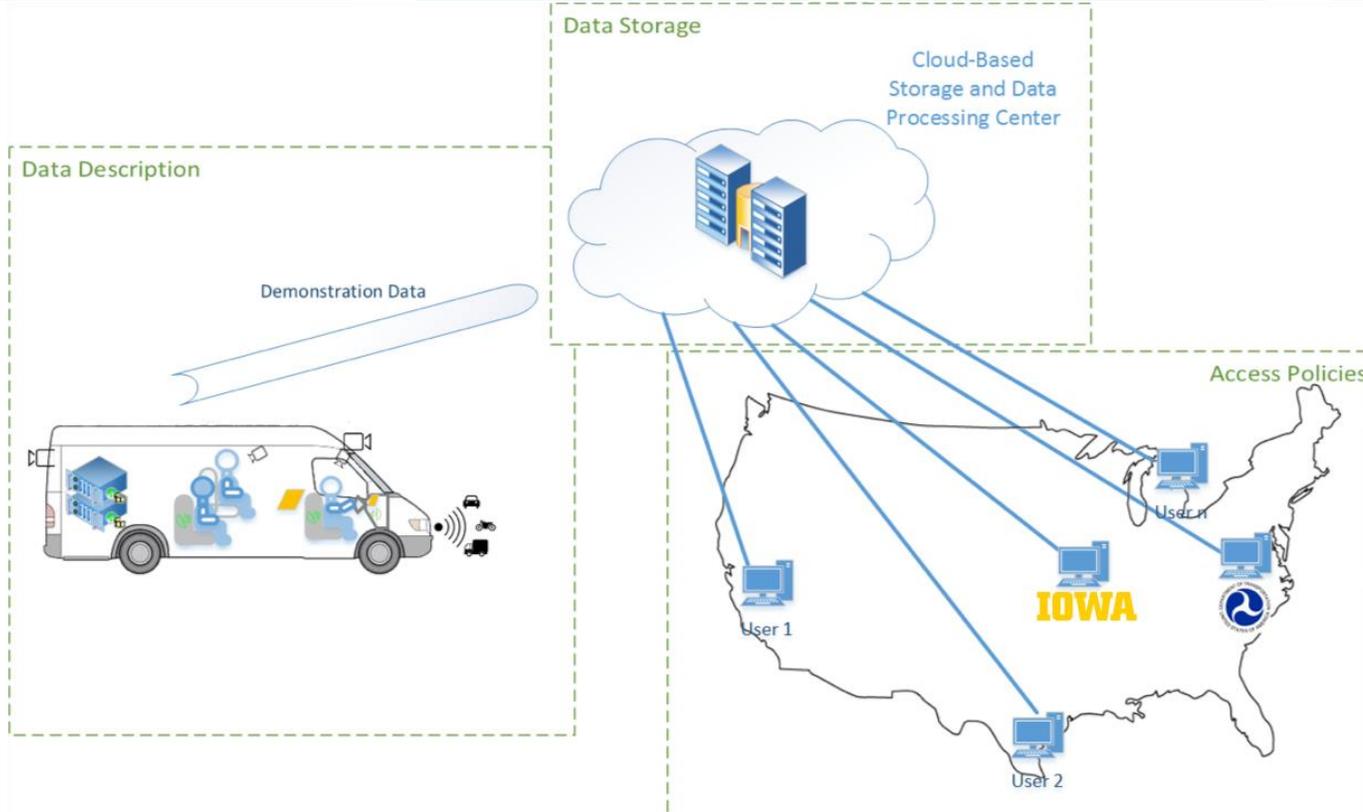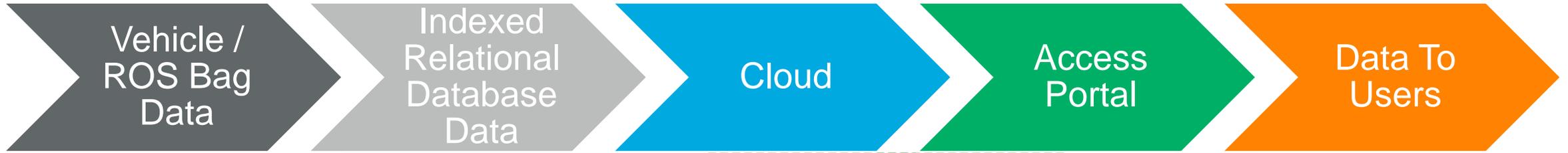
Lessons Learned & Issues for Consideration

- AVs are complicated, expensive, and fickle
- Sometimes perceived as "too safe"

- Marketing hype and buzzwords cloud understanding
- Public fear of the unknown

Funding for solutions targeted to solving critical use-cases

IOWA | National Advanced Driving Simulator

ADSforRuralAmerica.uiowa.edu

Omar Ahmad, project manager
omar-ahmad@uiowa.edu
319-335-4788