Pilot Systems
Vehicle Operating Information System
VOIS™

Presenter

Jack Szpytman – Principal Applications Engineer

35 years of experience in Powertrain Product Development, Hybrid and Electric Vehicle Program Development, and Test and Validation

- Technical Leadership in Powertrain ECU Development

- Extensive Expertise in Automotive Product Testing and Validation

- Product Development expertise throughout the Product Life Cycle

- BSEE Kettering, MSEE Purdue, MSEM Univ. of Michigan

This presentation is available to you on request. Contact information is on the last slide.

Managing Partners

Roger D. Berry

35 years of experience with Powertrain Engineering, Emissions, and Controls Systems

- **1980** Led the development team of Ford Motor Company's first computer-controlled fuel injection system.

- **1982** Co-founded Intelligent Controls Inc. – 300-person engineering firm specializing in powertrain engineering and control systems.

- **1996** Sold Intelligent Controls, Inc. to Cosworth Technology; Started Pilot Systems International, LLC

- BS Mechanical Engineering, Oregon State University

President

Mike Pryce

- *25 years experience with Hardware and Software Systems for Automotive*

- **1989** Led the development of multi-million dollar, End-Of-Line, test systems utilized world-wide by a major OEM.

- **1994** Business unit leader of 100-person technical staff developing hardware and software systems for automotive OEM's in Europe and North America

- **2004** Became co-owner of Pilot Systems International, LLC

- BS Computer Science, Lawrence Technological University

Pilot Systems International - Overview

Location:
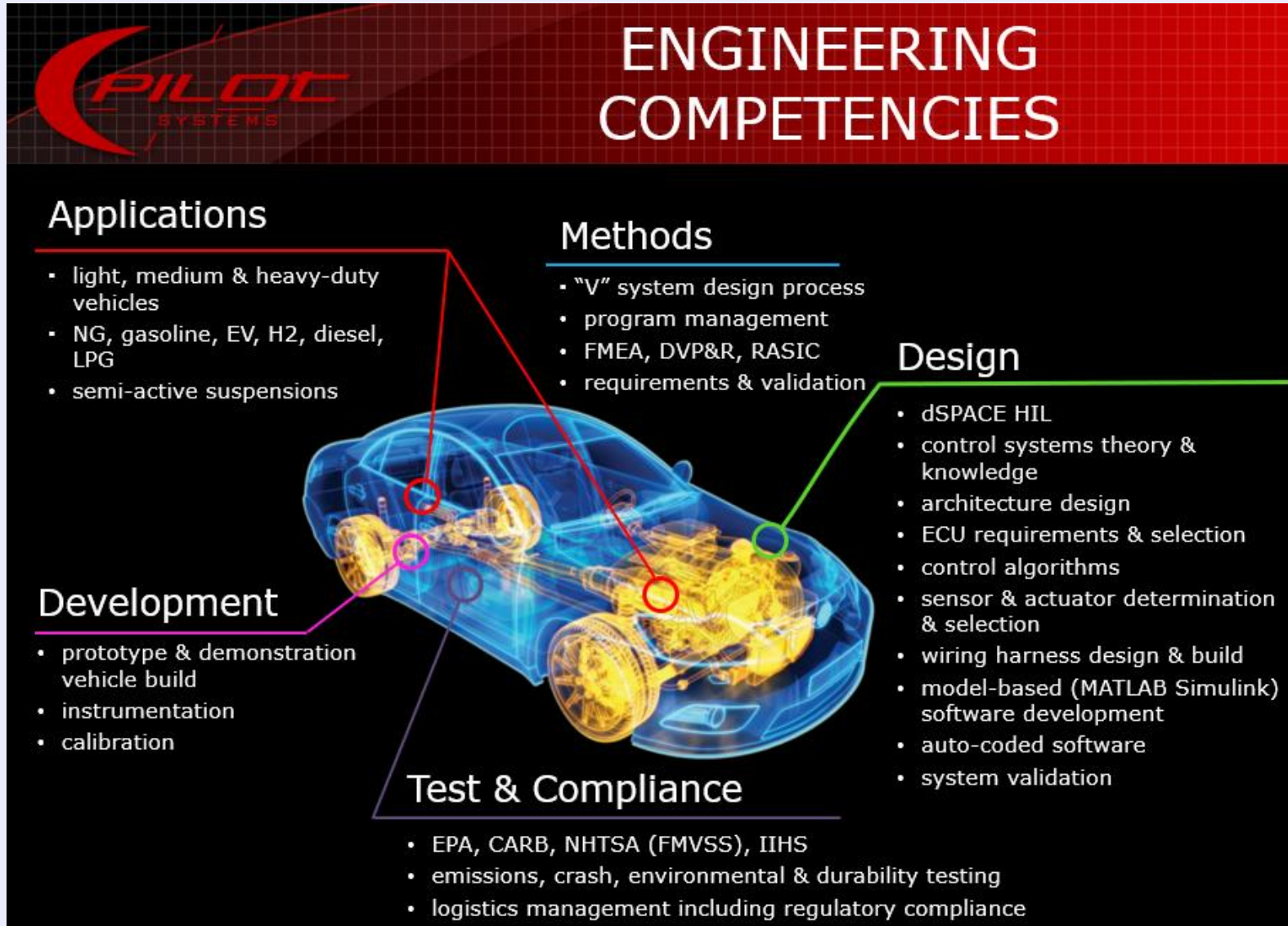
Farmington Hills, MI USA

Company:

20 core professionals.

Extended network of hundreds of industry-leading professionals.

20-year track record of delivering; quality, on-time, on-budget.

We look at the world as a SYSTEM ™

Pilot Systems International, LLC

ENGINEERING COMPETENCIES

Applications
- light, medium & heavy-duty vehicles
- NG, gasoline, EV, H2, diesel, LPG
- semi-active suspensions

Methods
- "V" system design process
- program management
- FMEA, DVP&R, RASIC
- requirements & validation

Design
- dSPACE HIL
- control systems theory & knowledge
- architecture design
- ECU requirements & selection
- control algorithms
- sensor & actuator determination & selection
- wiring harness design & build
- model-based (MATLAB Simulink) software development
- auto-coded software
- system validation

Development
- prototype & demonstration vehicle build
- instrumentation
- calibration

Test & Compliance
- EPA, CARB, NHTSA (FMVSS), IIHS
- emissions, crash, environmental & durability testing
- logistics management including regulatory compliance

Genesis of VOIS

DOT Project Goal: Improve evacuation strategies for large populations

- DOT / FEMA approaches LIFT to improve emergency evacuations.

- LIFT requests Pilot develop concepts

- Pilot / ZKxKZ collaborate.

- Pilot creates concept to fill the information gaps.

- Pilot refers to this concept as Vehicle Operating Information System or VOIS™

Photo of Vortex roundabout, Annandale, Va. courtesy of ZKxKZ

Vortexroundabouts.com

The Information Gap

- On-board sensors cannot detect the extended environment.

- Critical local details also undetectable by on-board systems.

- State-of-the-art AV systems may be adequate for non-interactive vehicle situations.

- Roundabouts have many hard to evaluate details in their environment.

A Challenging Intersection for an Autonomous Vehicle

VOIS: Vehicle Operating Information System

- Quick, real-time decisions key to safe driving.

- AV algorithms must make better decisions.

- Information gap: humans are better at collecting ...

- Roundabouts are particularly difficult for AVs.

- Most OEM effort is to improve on-board sensors and algorithms.
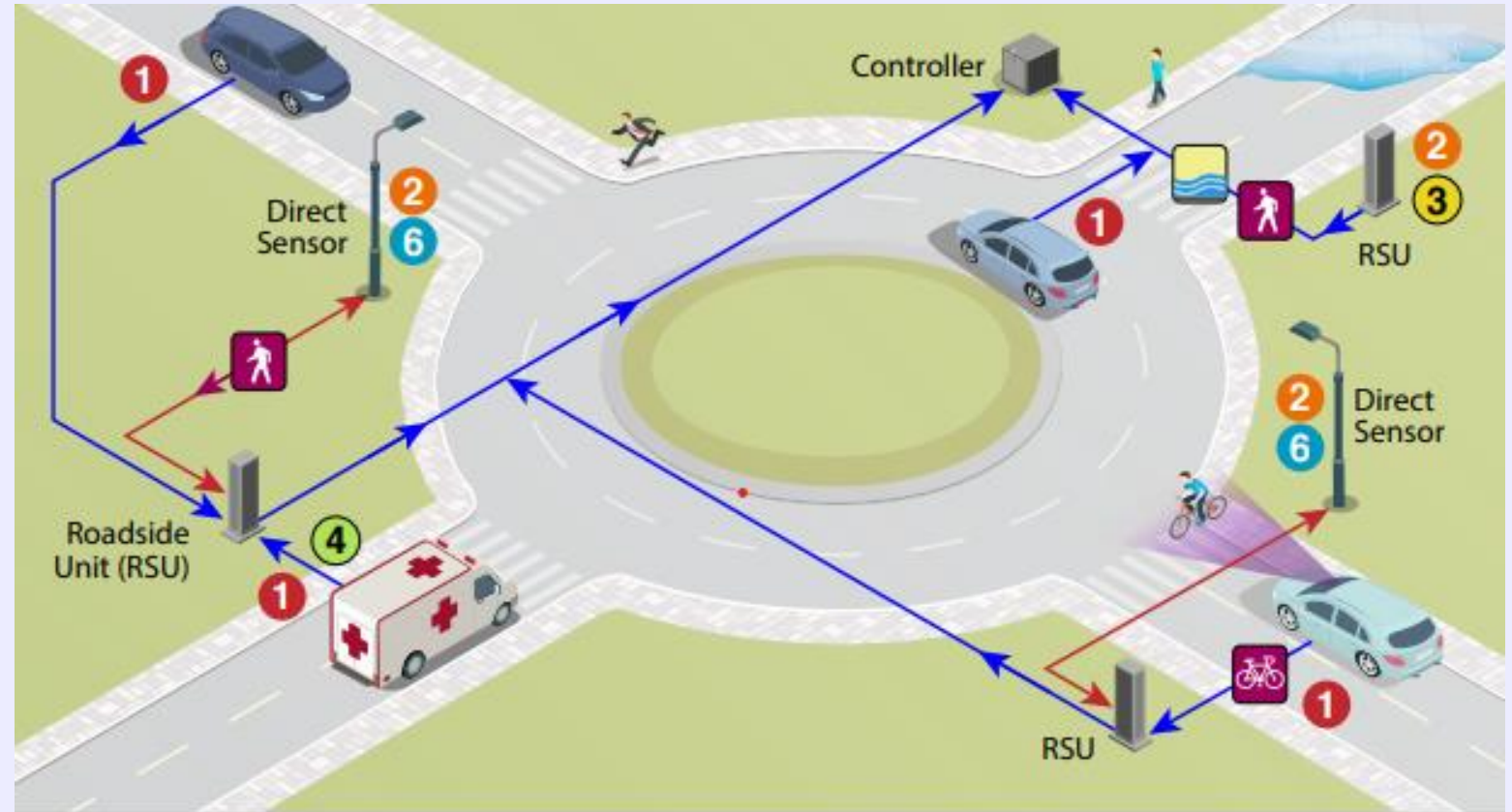
Enhancing on-board perception with off-board information from VOIS


| Perception	Planning	Drive
- On-board systems: limited environmental perception. - Human drivers can perceive more.	- AVs also need enhanced environmental information. - Roundabouts are particularly difficult. - With VOIS, AVs can develop an enhanced navigation strategy.	- VOIS yields safer and higher confidence vehicle actions.

Additional information not available to AVs

Seven broad categories of information provided by VOIS

1. Road Restrictions, Layouts and Geometry
2. Road Conditions
3. Traffic Flow
4. Individual "Entity" Characteristics
5. Weather
6. System Status
7. Legal and Regulatory Information
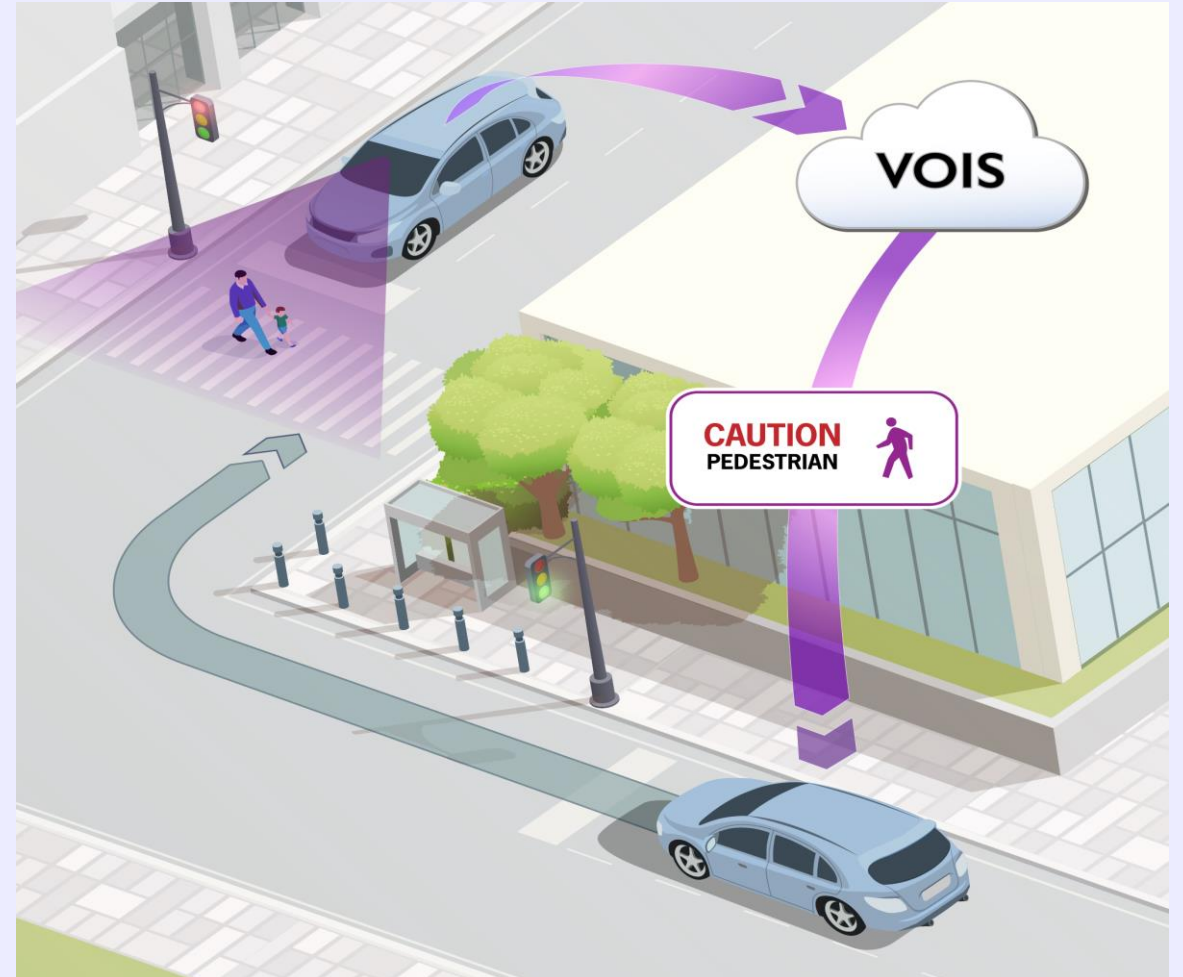
VOIS

- OEM goal: True Level 4 and 5 Autonomous Vehicle operation.

- Realizing AV potential: off-board information must be available to AVs.

- VOIS provides information that exceeds human perception capability.
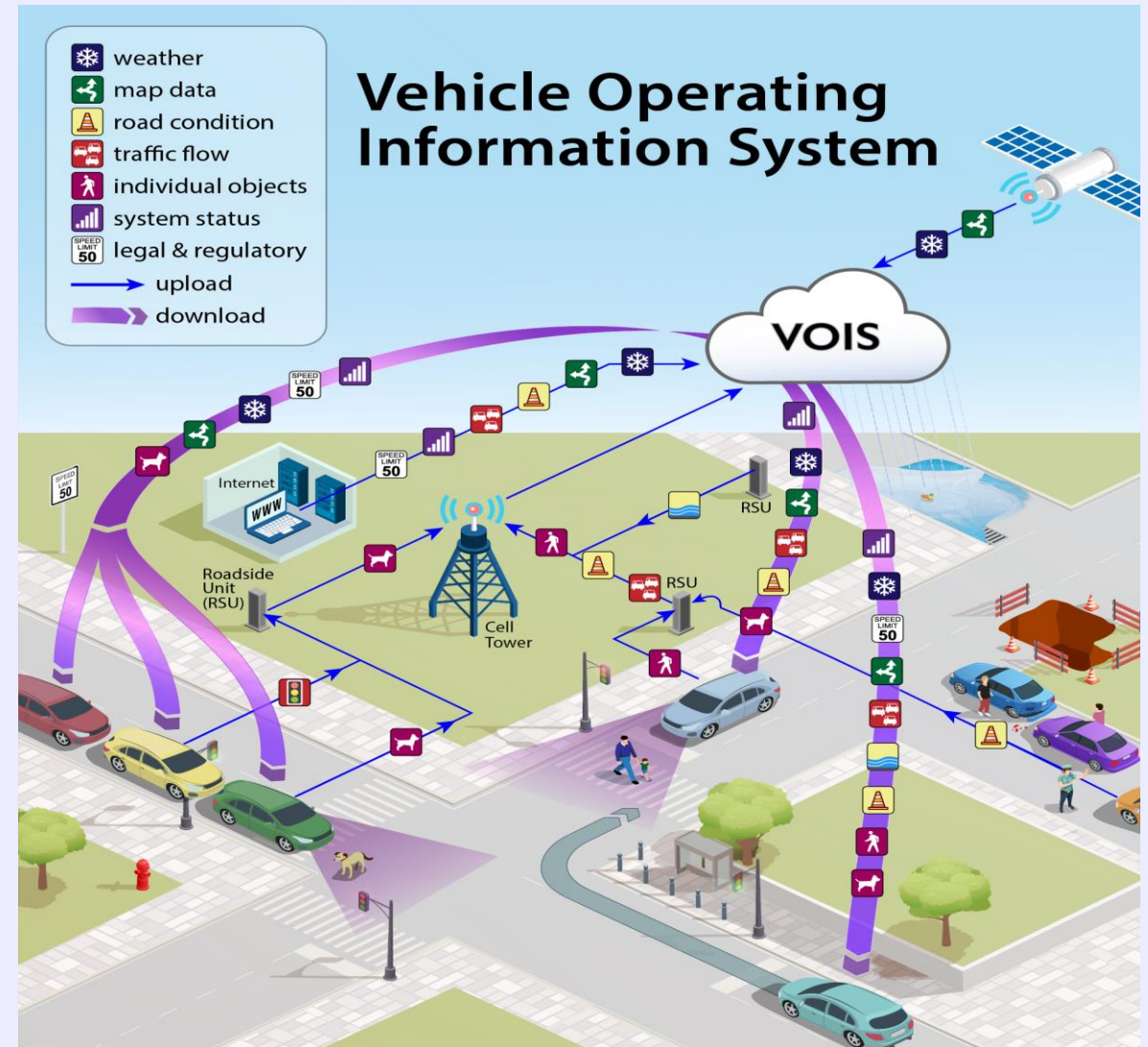
Massive Investment in AV Development

$85B in AV investment by 2017.

- Brookings Institute: "Gauging Investment in Self Driving Cars"
- AI, Software, Machine Learning, Sensors, Guidance Systems, Microprocessors, etc.

Level 4 and Level 5 introduction timelines are pushing out.

- MES Insights: "Why are Companies Investing so much in Autonomous Vehicle Technology?"

"Stumbling Blocks": significant technical hurdles have not been overcome.

Some of the toughest hurdles are addressee by VOIS

Investment in VOIS

With $85B total investment in AVs and technology, there are three principal areas of investment:

- Perception
- Planning
- Action

Perception: One-sixth of total for off-board -

$14B available for VOIS engineering and development

Pilot's VOIS Team:

- 1200 engineers, 3-yr development
- $360M investment

Return On Investment

- AV estimates: revenues of $800B to $1T, per year, by 2030

- Pilot VOIS IP revenues estimate: $420M per year, starting ~ 6 years after initial investment.

- Typical IT margins are 50%.

- Target EBITA: $210M, 6 years after initial investment.

VOIS: Key Research

- Pilot Systems International, LLC: proven record of successfully engineering emerging automotive technologies.
- Significant research performed by Pilot on VOIS.

Pilot as a leader, a collaborator and a catalyst for VOIS implementation

Segments with best opportunity for VOIS partnership

- Traffic Management System Providers

- Government Agencies

- Sensor Developers and Manufacturers

A Partnership with Pilot will lead to more effective deployment of AVs.

Summary:

- AVs and society are looking for environmental and transportation improvements.
- VOIS will make AVs significantly more feasible.
- VOIS will make navigating the highway infrastructure 'more intelligent'.
- VOIS reduces mobility challenges.
- Significant industry investment confirms that significant business opportunities exist.

VOIS ...

The AV World is listening for solutions.

Pilot is working to give a major AV solution a loud clear VOIS.

Thank You !

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For additional information:
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References

Slide 13: Massive Investment in AV Development
Brookings Institute Report : https://www.brookings.edu/research/gauging-investment-in-self-driving-cars/
MES Insights Report: https://www.mes-insights.com/why-are-companies-investing-so-much-in-autonomous-vehicle-technology-a-931134/