Microsoft Azure in Autonomous Driving

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Understand Microsoft’s capabilities and how you can leverage them to build autonomous development toolchain solutions for your customers.

From massive data ingest, storage, train, simulate, build and validate; the immense range of capabilities and sophistication of tools required to build an autonomous vehicle are staggering. See how Microsoft and its partners are leading this with big compute, AI and other solutions.
The Automotive Industry is at a Transformational Moment

The industry is being transformed by a combination of key technology and business model trends:

<table>
<thead>
<tr>
<th>Technology</th>
<th>By 2030...</th>
<th>As a result, automakers need to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>~100% of new cars projected to be</td>
<td>Transform into mobility service providers with a suite of integrated</td>
</tr>
<tr>
<td></td>
<td>connected, up from ~25% today</td>
<td>and intelligent connected car services</td>
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<tr>
<td>Autonomous Driving</td>
<td>~10-15% of new cars projected to be</td>
<td>Own AV technology to provide mobility services and preserve their</td>
</tr>
<tr>
<td></td>
<td>fully autonomous</td>
<td>market position</td>
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<tr>
<td>Vehicle Sharing</td>
<td>~32% of miles driven on new cars will</td>
<td>Invest in vehicle sharing and fleet management services to prepare</td>
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<td></td>
<td>be in shared rides</td>
<td>for a world with fully autonomous vehicles</td>
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<tr>
<td>Electric</td>
<td>~25% WW by 2025 and 100% of passenger</td>
<td>Own EV technology and avail charging services to enable customer</td>
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<tr>
<td></td>
<td>vehicles in China and India will be</td>
<td>demand</td>
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<tr>
<td></td>
<td>electric by 2030</td>
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</table>
Accelerate your Transformation with Microsoft

Our approach to automotive

- Complements OEMs and suppliers – not compete
- Ensures your data is always under your control
- Guarantees the brand and customer experience belongs to you

Our focus areas

- Connected Vehicle
- Autonomous Development
- Smart Mobility
- Marketing, Sales, Service
- Connected Factory
- Emerging
Automotive Priority Solution Areas

Our focus areas

Connected Vehicle
- Telematics and predictive services
- Location based services
- Infotainment
- AD Toolchain on Azure

Autonomous Development
- Massive Data Ingestion
- Simulation
- Data Mgmt. and Training Components

Connected factory
- Customer 360
- Digital marketing
- CRM
- Contact Center
- Dealer Management Services

Smart mobility
- Data Marketplace
- Fleet management
- Urban Mobility

Marketing, Sales, Service
- Smart Factory
- Intelligent Supply Chain and Logistics

Emerging
- Blockchain
- Azure Kinect
- Quantum Computing
Autonomous Driving

Accelerating the dev/test workflow with Intelligent Edge and Cloud
OEM System Engineering Process

Engineering Development
- Regional Architecture (s)
- Feasibility Study/concept Exploration
- Concepts of Operations
- System Requirements
- High-Level Design
- Detailed Design
- Software/Hardware Development Field Installation

Product Validation
- System Validation Plan
- System Verification Plan (System Acceptance)
- Subsystem Verification Plan (Subsystem Acceptance)
- Unit/Device Test Plan
- Unit/Device Testing

Manufacturing & Service
- System Validation
- System Verification & Deployment
- Subsystem Verification
- Operations and Maintenance
- Changes and Upgrades
- Retirement/ replacement

Lifecycle Processes
- Development Processes
- Time Line

Decomposition and Definition
Integration and Reconfiguration
Document/Approval
OEM Product and Services Lifecycle

Autonomous Driving Development

Connected Vehicle

Microsoft Connected Vehicle Platform
Azure IoT platform and Cortana Intelligence Services

AD Development  Test  Validation  Production  Ownership Lifecycle
AD Dev/Test: E2E Workflow & Partner Ecosystem

DATA INGEST & CURATE | TEST | TRAIN | SIMULATE | BUILD | VALIDATE

Test Vehicle | Ingest/Store | Process, Sample, Reduce | Sensor/Algorithm Testing (Open Loop) | Train | Integrate | Build

Tag | Render/Convert | Replay | Simulate | Control Logic Validation | Generate Code | Test-Drive

F(x) | Software in the loop

DATA INGEST & CURATE

Test/Train/Simulate

Build/Validate

F(x)

Software in the loop

Hardware in the loop

Azure Express Route

Azure Compute

Databricks & HDInsight

Azure IoT Edge

Azure Storage, Data Lake Gen2

Azure Batch AI

Azure Machine Learning

Kubernetes

Azure Data Box

Cycle Cloud

Cognitive Services

Azure Key Vault, AAD
Key Industry Ecosystem Engagements

- Cloud and Analytics partner for ACM, an autonomous and smart mobility test facility
- Leveraged by all OEMs, tier ones and technology startups
- Engaged with ACM to influence standards

- Open source AD Platform
- 200+ Member Consortium
- Microsoft is the cloud provider for Project Apollo worldwide with the exception of China

- OpenADx
- Interoperable Eclipse Framework
AD Dev/Test: End-to-End Workflow
Multiple options to filter and ingest PBs daily, regardless of fleet type or location

<table>
<thead>
<tr>
<th>Express Route</th>
<th>Devices</th>
<th>Azure Edge</th>
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<tbody>
<tr>
<td>Private, secure, predictable connections</td>
<td></td>
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<tr>
<td>100+ carrier partners</td>
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<tr>
<td>10 Gbps+</td>
<td></td>
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<tr>
<td>Disk Import</td>
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<tr>
<td>Data Box Disk</td>
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<tr>
<td>Data Box</td>
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<tr>
<td>IoT Edge</td>
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<tr>
<td>AI Toolkit</td>
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<tr>
<td>Databox Edge</td>
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Partner-based solutions

- In-car data storage
- Express Route partner
- Data delivery partner
- Garages/drop-off hubs
- Network acceleration
Massively scalable object storage for unstructured data

**Scalable**
- Foundational service for Microsoft
- >40 million transactions per second
- Multi-PB accounts

**Performant**
- 50+Gbps account throughput
- Continued enhancements under development

**Secure & Compliant**
- Client & Service Encryption
- AAD Integration + ACLs
- Broad & deep compliance portfolio

**Durable**
- Multiple redundancy options
- Strong consistency, data integrity
- Policy: Versioning & WORM locks

**Cost Effective**
- Integrated storage tiers
- Lifecycle management
- Rich metrics

**Partner-based Solutions**
- Data management
- Lifecycle management policies
- Unique policy/regulatory requirements
- Hybrid services: Data replication and tiering, protocol support

Massively scalable object storage for unstructured data
Data Curation

Data selection and transformation, PII data redaction, annotation and training data preparation

Partner-based Solutions

Sensor data fusion tools
Data extraction
Labeling and annotation
Data analysis
Data anonymization
Workflow orchestration and managed services

Microsoft Services

Blob  Cognitive Services  Services Logic  Apps Functions  HDInsight  Search  Databricks  Cosmos  DB Batch
AD Dev/Test: End-to-End Workflow
Verification and validation of training algorithms and sensors via open loop testing

Partner-based Solutions

- Open loop testing tools (ex. ADTF)
- Simulation tools for sensor and algorithm validation
- Comprehensive test management framework
- Workflow management services

Verification and validation of training algorithms and sensors via open loop testing
Partnership Opportunities

- Custom AI model development using TensorFlow, Chainer, PyTorch, CNTK, and other major frameworks
- Compute PaaS training service for custom pipelines, tool integration, & services
- Rich job monitoring and control experience, hyper-parameter tuning, batch testing & scoring

Training

- Your Data with Any AI Tools
- Training with Scale-Out GPU Clusters on Demand
- Intelligence In your Apps and Data Services

Reduce Training Job Run-time with ChainerMN on Azure

With InfiniBand, Scaled to 128 GPUs – job run-time shrunk by a factor of >100x
Simulation

- Simulation as a managed service
  - Photo realistic Sensor Simulation
  - Object level Scenario Simulation

Partnership Opportunities

- Customer specific customizations
  - Support latest and accurate sensor models
  - Parametric control of environment
  - Integration of vehicle dynamics
  - Deriving scenarios from real world data

Billions of miles required: Only possible via simulation, run at scale

Microsoft Services

- GPU Compute
- Batch
- Blob Storage
- Kubernetes Service
- Cosmos DB
- Databricks
- HDInsight
- Simplygon
AD Dev/Test: End-to-End Workflow

- Test Vehicle
- Ingest/Store
- Render/Convert
- Process, Sample, Reduce
- Sensor/Algorithm Testing (Open Loop)
- Tag
- Replay
- Simulate
- Train
- Integrate
- Build
- Control Logic Validation
- Performance Simulation
- Generate Code
- Test-Drive
- Software in the loop
- Hardware in the loop

DATA INGEST & CURATE
TEST | TRAIN | SIMULATE
BUILD | VALIDATE
HIL and SIL Validation

Embedded system validation via hardware-in-loop and software-in-loop

Microsoft Services

Blob storage  Batch  GPU VM  Active Directory  Container service

Partner-based Solutions

- Comprehensive test management framework
- HIL solutions
- System validation tools
- Workflow management services
- Managed services