

Virtualization Project

**Vertical Market Segment:
Automotive**

Team 1
Mohit Patil
Yingqi Mou





“MY Car” Company Background

1. “MY Car” is a self-driving car development, manufacturing and operation company (subsidiary of traditional automotive manufacturing company)
2. On-premise data center and data storage, traditional network connection
3. 1091 employees
4. Revenue[1] and Expense[2]:

MY Car's annual revenue is currently \$360M per year.

MY Car's Operating expenses in Research and development \$ 73M per year

Sales, general and administrative \$29M per year

Total operating expenses \$102M per year

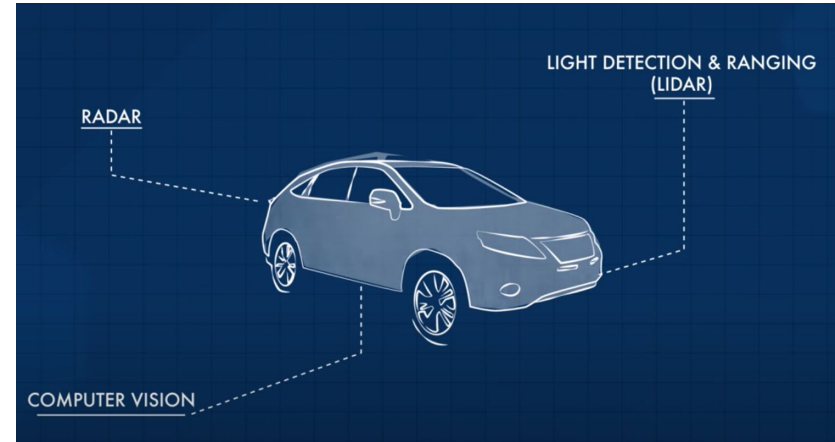
[1] <https://growjo.com/company/Zoox#revenue-financials>

[2] <http://d18rn0p25nwr6d.cloudfront.net/CIK-0001045810/b569a167-655a-491f-b584-4e3c71064537.pdf>

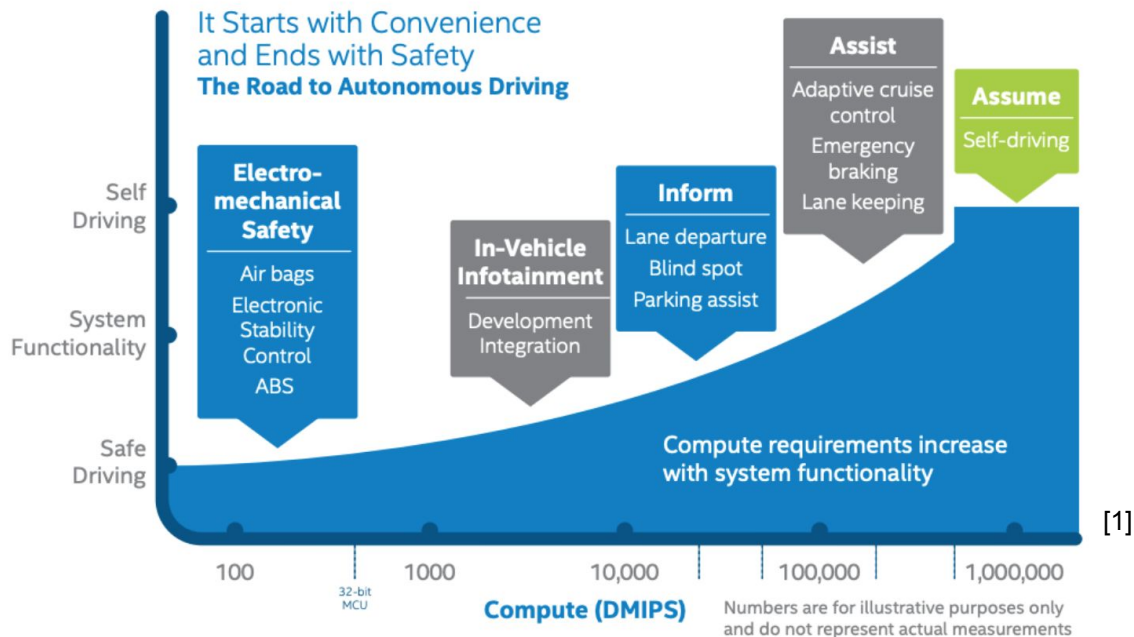


Self-driving Car Business Need

1. Reinforcement learning calculation for providing the best route and operation for cars -- requires **high computing power in the centralized servers**
2. **Sufficient and scalable data storage** for newly collected data from vehicles to do reinforcement learning -- storage need is for for both development and for future operation)
3. Data collection and transmission from all automotive car -- requires data security, high network bandwidth, stability for **network connection**



High computing power



[1] <https://www.intel.com/content/www/us/en/automotive/driving-safety-advanced-driver-assistance-systems-self-driving-technology-paper.html>



Existing Devices

1. **Server:** 10 * On-Premise Servers: Hewlett Packard HP N4000 (rp7400)
2. **Storage:** 5 * Dell EMC SCv3000 1.92TB SSD SAS Read Intensive 12Gbps 512 2.5in Hot-plug AG Drive
3. **Network:** Cisco Traditional network connection
4. **Server Operating system:** Linux
5. **Workers Laptop Operating system :** Linux or Microsoft Windows
6. **Office Suite(for non-R&D departments):** Microsoft Office

HP N4000 (rp7400)

CPU	1-8 PA-8500/ 1-8 PA-8600/ 1-8 PA-8700 360-750 MHz
Caches	1.5-2.25 MB L1
RAM	32 GB
Design	Stretch
Drives	2 SCSI
Expansion	12 PCI
Bandwidth	System 4.2 GB/s CPU 17 GB/s Mem 8.5 GB/s I/O 6.4 GB/s XBAR 15.3 GB/s
I/O	SCSI 3 serial 100E 100E console

Business Model

- Manufacturing autonomous driving cars
- Collecting data from self driving cars
- Applying Reinforcement learning on the collected data for better decisions
- Self-driving car operation (IoT development)



[1]

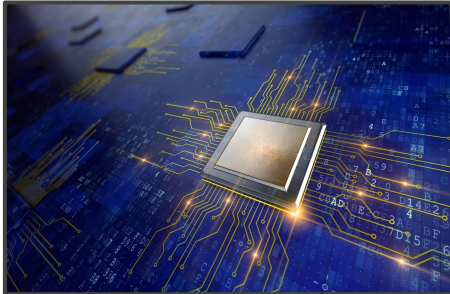
Existing Challenges

From expense perspective:

- Old IT infrastructure maintenance cause increased OpEx and lacking manpower
- Server, network and storage equipment update will bring in new CapEx

From technical perspective:

- Insufficient computing power with old CPUs
- Data storage with low I/O speed and scalability issues
- Traditional network connection, low data transmission speed





What type and how it helps?

From expense perspective:

- Old IT infrastructure maintenance cause increased OpEx and increased manpower
Solution: Migrate to virtualization, thus **no need for datacenter management** anymore
- Server, network and storage equipment update will bring in new CapEx
Solution: **Pay as you go**, no need to buy / update / maintain equipments anymore

From technical perspective:

- Insufficient computing power with old CPUs
Solution: Choose Virtualization plan with **sufficient Core** numbers
- On-premise data centers with low I/O speed and scalability issues
Solution: Choose High I/O **on demand** virtualized storage plan
- Traditional network connection, low data transmission speed
Solution: Update to fast and stable speed transmission plan

VMware



Business Model

1. Virtualization: Cloud Foundation Components

Cloud Foundation delivers a natively integrated software-defined data center stack that includes the core infrastructure virtualization, **vSphere, vSAN and NSX**.





2. Cloud Services: VMware Cloud on AWS

VMware Cloud on AWS brings VMware's enterprise-class SDDC software to the AWS Cloud with optimized access to native AWS services. Powered by VMware Cloud Foundation, VMware Cloud on AWS integrates **VMware's compute, storage and network virtualization products** (VMware vSphere, VMware vSAN and VMware NSX) along with VMware vCenter Server management, optimized to run on dedicated, elastic, bare-metal AWS infrastructure.



Cost Structure and Price (Cloud Foundation)

- vSphere + vCenter : \$3,595 + \$6,175 + \$899 + \$1,544 = \$12, 213 [1]
- NSX: VMware NSX Advanced per Processor = \$4,495.00 [2]

vSphere Editions			
Product Title	License Price	1 Year Support & Subscription	
 vSphere Standard	US \$995.00	Basic	US \$273.00
		Production	US \$323.00
 vSphere Enterprise Plus	US \$3,595.00	Basic	US \$755.00
		Production	US \$899.00
vCenter Server Editions			
Product Title	License Price	1 Year Support & Subscription	
 vCenter Server Foundation	US \$1,535.00	Basic	US \$560.00
		Production	US \$664.00
 vCenter Server Standard	US \$6,175.00	Basic	US \$1,297.00
		Production	US \$1,544.00

[1] https://www.vmware.com/reusable_content/vsphere_pricing.html

[2] <https://www.virtualizationworks.com/NSX.asp>



Advantage and Disadvantage (Cloud Foundation)

Advantages

- Forms ecosystem from manufacturing to operation
- Data Security
- High speed data transmission

Disadvantages

- Higher Cost than Microsoft
- Hard to migrate original data center / data into new services
- Complicated datacenter management architecture (needs time to learn vCenter, SDDC, etc.,)



Cost Structure and Price (VMware Cloud on AWS)

- VMware Cloud on AWS

Number of Hosts: 3+

- VMware SDDC software: vSphere, vSAN, NSX-T, vCenter Server
- High Availability, SLA, Multi-Cluster
- Applicable for **on-demand, 1 year and 3 year subscription purchase**
- An option to buy this service via the web using a credit card is available only in N. Virginia, Ohio, N. California, Oregon, Canada(Central), Frankfurt, Ireland, London, Paris, Stockholm, Singapore, Tokyo, Mumbai, Sao Paulo, and Seoul AWS regions.
- By paying for the service using a credit card, you will be charged a nonrefundable fee of US\$2,000 or equivalent in your applicable non-USD currency, at upon deployment of your first SDDC. Subsequent SDDCs provisioned will not be subject to this charge.
- Credit card payment option is available to purchase a single SDDC with up to 3 hosts



Cost Structure and Price (VMware Cloud on AWS)

Host Specifications	i3.metal	r5.metal
Cores / host	36	48
Memory / host (GiB)	512	768
Storage	NVMe (3.6 TiB cache plus 10.7 TiB raw capacity tier)	EBS Only
EBS	-	\$0.12/GiB/Month
Elastic vSAN	-	\$2.28/host/hour
Pricing		
On-Demand (hourly)	\$9.226325 / hour	\$11.264773/ hour
1-year Subscription	\$57,318.94 / 1 year	\$64,595.92 / year



Advantage and Disadvantage (VMware Cloud on AWS)

Advantages

- One Suite for anything needed (buy one plan and get vSphere, vSAN, NSX on AWS)
- Release the burden of Datacenter Management
- High speed data transmission
- High Availability, SLA, Multi-Cluster

Disadvantages

- Involves 2 different providers for virtualization implementation
- Higher Cost than Microsoft
- Hard to migrate original data center / data into new services



Other Advantage of VMware

Data Security and Privacy

Telemetry data, especially in a user-driven context, can be sensitive and require solid privacy and security considerations. Type and frequency of data collected needs to be customizable as well as encrypted end-to-end. Some data required for predictive analysis must not be displayed or made available to third parties because that could allow the profiling of a user's behavior. **To address security and privacy challenges, the AirWatch platform is built with industry-standard FIPS 140-2 algorithms and relies on a strong privacy engine,** which enables the customization of collected and stored data types.

[1] <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/solutions/industry/vmware-solution-connected-car.pdf>



Other Advantage of VMware

VMware ESXi and NSX

VMware ESXi combined with software lockstepping and NSX is the ideal underpinning for AUTOSAR (AUTomotive Open System ARchitecture) runtime, adding **easy portability, fault tolerance, isolation** among virtual machines, and network security, without the need to change the application.

[1] <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/solutions/industry/vmware-solution-connected-car.pdf>



Ecosystem

VMware can provide solutions from manufacturing to operation support to autonomous cars

- vSphere ESXi - Create Virtual Machines for the centralized computing system
- vCenter - data center and IT infrastructure management
- Future Scalability - vMotion
- NSX - software defined network, sufficient data transmission speed
- Connected Vehicles Platform - for operation



Level of Support - VMware Connected Vehicles

VMware provides an end-to-end IoT management solution for monitoring, managing and securing all your things - from car to the cloud.

VMware Connected Vehicles Features:

1. Set up
2. Monitor
3. Manage
4. Secure



In a word, VMware Connected Vehicles enables manufacturers to deliver more innovative products and experiences to drivers. And more applications and personal services in the car.

[1] <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/solutions/industry/vmware-connected-car-vision-business-brief.pdf>

[2] <https://www.vmware.com/solutions/industry/automotive/iot.html>



Level of Support - VMware Connected Vehicles

Vision: Powering new automotive business models through the secure and efficient sharing of data and intelligence between vehicles, users and vendors via the cloud

Security: Innovative segmentation-based approaches to security in data centers, vehicle head units and wireless networks that minimize business risk and protect drivers.

Software over-the-air: Secure collection, analysis, management and delivery of real-time data transmitted over-the-air between drivers, vehicle head units and vendors

Data collection & analysis: Maximum value from connected car data supported by the software-defined data center, secure public cloud infrastructure, cloud-based data management and intelligent in-vehicle device agents.

New business models: Driving new revenue streams through data recycling, shaping the in-vehicle user experience on demand, driverless transport services, and more.

[1] <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/solutions/industry/vmware-connected-car-vision-business-brief.pdf>

Microsoft



Microsoft History in Cloud

- “**Windows Auto**” initially released on Dec 4, 1998
- This is widely used as AutoPC in automotive industry
- **Microsoft Azure** formerly known as Windows azure initially released on Feb 1, 2010
- Microsoft announced **Microsoft connected vehicle platform** by replacing earlier Connected vehicle strategy in year of 2016
- Public preview went live in early year of 2017 [1]
- MCVP platform presented at **IAA, Frankfurt Auto Show** in 2019 late year [2]
- Ready to deploy MCVP built services in March, 2020 [3]

[1] <https://www.zdnet.com/article/the-first-cars-using-microsoft-connected-vehicle-platform-at-scale-are-coming/>

[2] <https://azure.microsoft.com/en-us/blog/microsoft-s-connected-vehicle-platform-presence-at-iaa-the-frankfurt-auto-show/>

[3] <https://techcrunch.com/2017/01/05/microsoft-launches-a-new-cloud-platform-for-connected-cars/>



Business Model and Platform

- **Microsoft Connected Vehicle Platform** is all about getting vehicles to connect to Microsoft cloud services like Azure, Office 365 and more on the back-end.
- This new platform enables the delivery of services like telemetry, command-and-control, and OTA updates to drive software-defined in-vehicle experiences
- **Azure cloud** global footprint is leveraged to deliver a consistent platform with both scale and high availability, Global connectivity, and Secure & authenticated access
- **Microsoft technology** used in platform includes IoT, Security & Connectivity, Edge services which creates automotive grades and cloud-based data pipeline for secure hyperscale communication



Microsoft Connected Vehicle Platform features

- **In Vehicle Experience**
 - Provides all different experience through digital webOS Auto which uses emergence of persuasive voice assistant offered to the drivers and passengers
- **Autonomous Driving**
 - Underlying Machine learning models which drives the car or provide assistance to driver
 - Integrates navigation intelligent services such as HD maps and traffic as containerized service to take additional location context
- **Advanced navigation**
 - Architecture which enables to send navigation and diagnostic data from vehicles to azure cloud. This data can be used to generate data-driven insights
- **Connectivity and over the air updates (OTA) (In vehicle Infotainment)**
 - Infotainment apps can be used in real time and connected through WiFi hotspot
- **Telematics and Prediction Services**
 - Provides vehicle lifecycle management which accurately process forecast vehicle

[1] <https://azure.microsoft.com/en-us/blog/microsoft-s-connected-vehicle-platform-presence-at-iaa-the-frankfurt-auto-show/>





Cloud Security




- **Microsoft Intelligent Security Association** uses Upstreams security for detection, investigation and remediation for threats targeting connected vehicles and smart mobility services.
- **Upstream's AutoThreat Intelligence** is the world's first automotive cyber-threat intelligence center.
- It collects, analyzes, and disseminates threat intelligence specific to the automotive industry, ranging from OEMs, Smart Mobility companies, service providers, and connected fleets.
- **Upstream's C4 (Centralized Connected Car Cybersecurity)** is the first cloud-based cybersecurity solution designed for OEM's, VSOC (Vehicle Security Operations Center) teams, and fleet owners and managers, to protect connected vehicles and smart mobility services from cyber-attacks or misuse at rest and in motion.



Data Storage and Ingestion

- Microsoft offers **Network based (online)** and **offline appliance** based scenarios for data ingestion and has tiered storage model hot, cool and archive which facilitates cost-effective scalability and performance

	
Data Box Gateway <ul style="list-style-type: none">Virtual device provisioned in your hypervisorSupports storage gateway, SMB, NFS, Azure blob, files	Data Box Edge <ul style="list-style-type: none">Local Cache Capacity: ~12 TBIncludes Data Box Gateway and Azure IoT Edge.

			
	Hot	Cool	Archive
	Frequently accessed data	Less frequently accessed data	Rarely accessed data
Cost	Lowest transaction cost	Lower capacity cost	Lowest capacity cost
Access time	Immediate (ms)	Immediate (ms)	Hours



Services in Ecosystem

- **MVCP platform Services**
 - Vehicle provisioning
 - Two-way network connectivity
 - Continuous over-the-air updates of containerized functionality,
 - Support for command-and-control
 - Hot, warm, or cold path for telematics
 - Extension hooks for customer or third-party differentiation.
- **Part of Azure Cloud Services**
 - Hyperscale
 - Global availability
 - Regulatory compliance.



Advantages

- Global cloud infrastructure.
- Azure high performance computing service
- Robust security, compliance and privacy measures.
- Innovative artificial intelligence (AI) capabilities.
- End-to-end analytics solutions.
- Leading, innovative technologies
- Partner ecosystem support.

VMware vs Microsoft





Comparison between the 2 providers

Item	VMware	Microsoft
Data Storage	NvMe (3.6 TiB cache plus 10.7 TiB raw capacity tier)	2948 GB Temp Storage
Data Security	Connected Vehicles Platform	Microsoft Security Intelligent Association partnering Unistream
Computing Power	I3 (36 cores & 512 GiB Memory per host)	NV48 v3 (48 Cores, 448 GB RAM per host)
Cost	\$9.226325 / hour	\$6.768/hour

Microsoft Virtualization Adoption





Microsoft

Points taken into consideration :

Function	Solution
AI/ML/Computer Vision and Voice	Azure AI platform/ Cognitive Services
Storage	Azure Blobs/ DataLakes / SQL Azure
Web servers	Azure VM's
Cloud Security	Upstreams Autothreat Intelligence and Centralized Car Cybersecurity
Computing Power	Azure InfiniBand Network (Mellanox 200Gb/s HDR)
Overall Cost	Lesser compare to VMware
Prototyping (Cameras, Connectivity)	Azure IoT



Virtualize Data Center

- **Existing On Premise Data Center Servers**
 - Hewlett Packard HP N4000 (rp7400)
- **Upgrade to Virtual Machine Data Servers**
 - Microsoft Hyper-V R1 Windows Server 2019
 - Supports NX and DEP
 - Supports CMPXCHG16b, LAHF/SAHF
 - Better Scalability compare to vSphere Active VM per host 1024 and Virtual CPU/VM 64
 - Comprehensive Security through Windows Active directory

Processor	3.8Ghz 64-bit
Memory	512GB RAM
Storage	Local Disk SSD 256 TB
Virtual CPUs	16
Nodes	28
Network File System	SMB 3.0



Azure Virtual Machines

- **Autonomous Vehicles** requires virtual machines to be highly capable of doing faster calculations in terms of navigation, graphics rendering and reinforcement learning
- **N-Series GPU** enabled virtual machines is ideal for compute and graphic intensive workloads which provides high-end remote virtualization, deep learning and predictive analysis
- For **NC24 24 Core, 224 GiB RAM, 1440 GiB temporary storage, 4X K80 GPU** cost around \$1156 per month
- Two **Virtual Machines Series NC and NV** specifically focused on high performance computing & machine learning and powerful remote virtualization workloads respectively

Instance	Core	RAM	Temporary storage	GPU	Pay as you go with AHB
NV4as v4	4	14 GiB	88 GiB	1/8th MI25 (2GB VRAM)	~\$170.09/month
NV8as v4	8	28 GiB	176 GiB	1/4th MI25 (4GB VRAM)	~\$340.18/month



Azure Storage Services

- **Autonomous vehicles** create massive amount of data 20-100 TB everyday and this data ingestion requires to compute complex calculation
- Generated data needs to be stored and processed faster on high latency and throughput
- Few advantages of using Azure storage -
 - **Scalable** - Greater than 40 Million transaction per second
 - **Performant** - 50+ Gbps account throughput
 - **Durable** - Multiple redundancy with strong consistency and data integrity
 - **Cost-effective** - Integrated storage tiers
 - **Secure & Compliant** - Client and Service encryption

[1] https://autonomous-driving.org/wp-content/uploads/2018/10/Microsoft_Azure-in-Autonomous-Driving.pdf



Virtualize Storage

- **Existing Storage**
 - Dell EMC SCv3000 1.92TB SSD SAS, Read Intensive 12Gbps 512 , 2.5 in Hot-plug AG Drive
- **Storage Improvement plan with Price cost**
 - **Blob Storage** - Scalable object storage for unstructured data

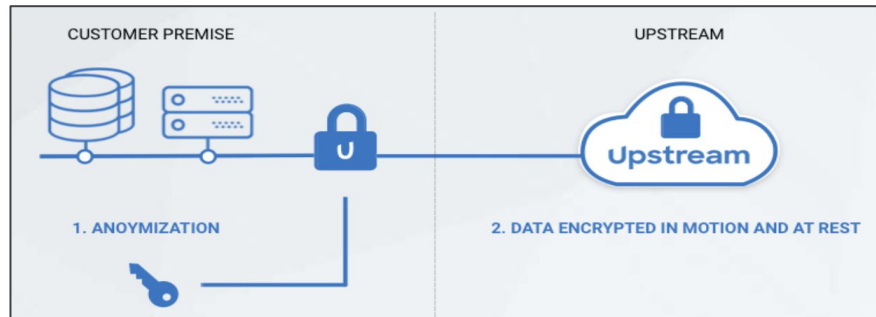
	Hot	Cool	Archive
First 50 TB/month	\$0.0184/GB	\$0.01/GB	\$0.00099/GB
Over 500 TB/month	\$0.0177/GB	\$0.01/GB	\$0.00099/GB

- **HPC Cache** - File caching for high performance computing

Instance	Cost
Cache disk (1GB/hour)	\$0.0004
Throughput (2GB/hour)	\$\$7.87

Virtual Cloud Security

- Partnered with UpStream Security to provide solutions on **Cloud based automotive cybersecurity** such as detecting threats, data anonymization and encryption
- Data driven detection platform which analyzes vast amount of data to protect entire connected vehicle environment
- **Solutions to Problems**
 - Analyzing data using Machine learning (to detect abnormal behavior)
 - Protecting against multiple attacks through WiFi or Bluetooth
 - Data encryption and Anonymization





Azure IoT

- **Azure IoT** will be utilized to **store and ingest the data in real time** from Vehicle cameras, Sensors like lidar (Light detection and ranging) and Radar (Range detection and ranging) [1]
- This real time data can be analyzed to decipher the valuable insights such as **monitor live location of vehicle** and **plan for optimized routes**
- Here, we are going to use Azure IoT edge hub services for real time data ingestion and processing pipeline for messages.
- Azure IoT has **3 standard editions S1, S2, and S3** which cost at \$25, \$250 and \$2500 per unit respectively for 4KB message size [2]

[1]-<https://www.fev.com/en/coming-up/press/press-releases/news-article/article/efficient-data-management-for-autonomous-driving-fev-accelerates-development-time-with-microsoft-az.html>

[2]-<https://docs.microsoft.com/en-us/azure/architecture/example-scenario/data/realtime-analytics-vehicle-iot>

Benefits (Tech/Business)



High Computing Power

- **Microsoft Azure's high-performance computing** and deep learning has below integrated solutions for autonomous development :
 - **Cloud Workstation & Rendering**
 - **HPC Simulation and Analysis**
 - **Deep Learning and AI Training**
- These solutions will help us our company to reduce the amount of **time to train, teach and deploy** updated autonomous models
- **Azure InfiniBand network** cables will provide extremely low latencies, high data throughput which is most important in Autonomous vehicle decision making



Azure AI Platform/Cognitive Services

- An Integration with **Azure AI platform** can help in developing the AI models for **Auto-labeling technology** which provides the scalable solution to pre-process the data
- The main role Azure plays here, to **improve productivity** and **reduce costs with auto scaling compute** and **tune hyperparameters faster**
- Our company can focus on developing the AI and Azure will take care the scaling of AI training jobs
- One of the other advantage is we can save the labor cost and time-to-label considering the competitive market

[1] <https://www.microsoft.com/en-us/ai/ai-platform>

[2] <https://azure.microsoft.com/mediahandler/files/resourcefiles/5467086f-7c5a-4106-8615-7f5e4ad217fd/microsoft-ai-platform-whitepaper.pdf>

Virtualization Plan (Implementation Strategy)





Microsoft Cloud Adoption Framework for Azure

Define strategy - Define a cloud strategy to drive adoption efforts that unlock business value.

Plan - Convert the aspirational goals of cloud adoption strategy into actions

Ready - Prepare the cloud environment for planned changes.

Adopt - Migrate workloads to the cloud and modernize them to meet your customer needs.

Govern - Establish cloud governance to maintain a well-managed cross-cloud environment.

Manage - Follow the cloud operations principles to run reliable cloud environments.

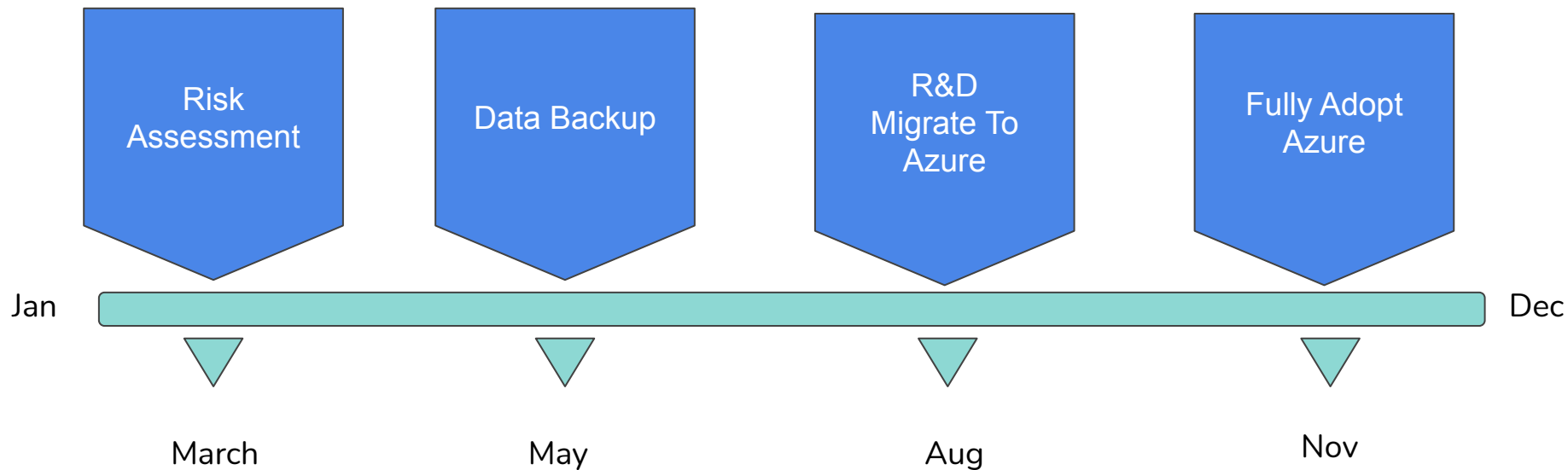


Implementation Plan

1. **Business Goal** - Meet business need for computing power, data storage and transmission; Reduce CapEx and OpEx
2. **Decision Framework** - Develop a decision framework to systematically examine use-case scenarios for adopting cloud computing
3. **Risk Assessment** - Data lost and how well and fast can cloud service be adopted by employees in different departments.
4. **Migration Activities** - Define how R&D, operation, sales teams migrate to use different products - IaaS, PaaS and SaaS



Roadmap

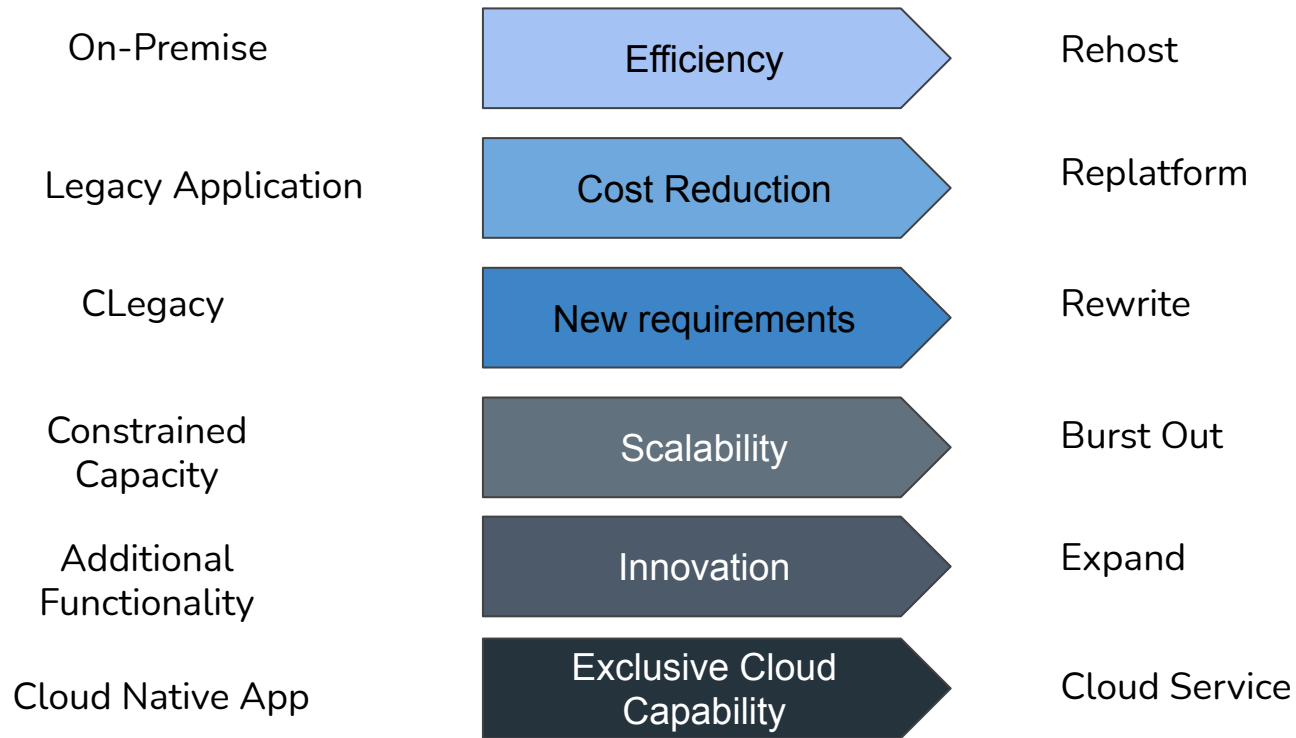


Conclusion



Cloud Adoption Benefits

- **Lift and Shift** on premises computing to IaaS public or private host



Thank you!



BACKUP SLIDES



Cloud Security Definition (VMware)

Cloud security is a broad term encompassing the technology and best practices designed to protect data and information within a cloud architecture. Cloud security ensures data privacy, security, and compliance around data stored in the cloud. Because of cloud computing distributed and dynamic nature, there are unique considerations when it comes to securing data within the cloud.

Cloud security includes the security controls and process improvements that strengthen the system, warn of potential attackers, and detect incidents when they do occur.

[1] <https://www.vmware.com/topics/glossary/content/cloud-security>



VMware Connected Car

VMware provides a car - cloud data transmission, and data processing, management suite.
Forms an ecosystem **from manufacturing to operation.**

Use cases¹:

Improve Driver Safety and Comfort, Provide Better Insurance, Enable Smarter Manufacturing,
Offer Proactive Services, Improve Fleet Management

[1] <https://www.vmware.com/solutions/industry/automotive/iot.html>



Microsoft for Startup Autonomous Driving

- This program which aims to accelerate the growth of startups working on autonomous driving
- Microsoft partnered companies which provides the innovative use of reinforcement learning and neuroscience to deliver complex L4 driving scenarios and Linker Networks
- This startup program helps to take reliability to a whole new level through their AI-based auto-labeling technology helping the industry build smarter, safer vehicles