Automotive Product & Powertrain Innovations

– Trends, Challenges & Strategic Priorities

（汽车产品及动力系统创新 - 趋势，挑战及战略选择）

天津大学第11届内燃机暑期课堂 – 2020年8月16号

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- **All quoted information in this Presentation is in public domain**
- **This PowerPoint deck contains my own insights and point of view based on my research & prior working experiences. They do not represent views from any OEM companies**
- **Additional information on topics covered today can be obtained from me directly. Email: chuang6@hotmail.co.uk**

自我介绍

我今年56岁，1963年出生于中国长春，现住在英国伦敦东部Essex. 我于2019年7月从福特汽车公司欧洲总部退休。退休前曾任福特全球Transit Connect车型首席工程师(Global Chief Engineer)，中国及亚太地区业务战略总监(Business Strategy Director)和商用车总监 (Commercial Vehicle Director)。

目前，我为汽车行业提供一些咨询服务。2019年10月我被英国巴斯大学Bath University聘请为访问教授，给它们工程业务管理(EBM)硕士生和汽车动力系统 (AAPS) 博士生开了一门必修课 – "汽车工程业务管理，汽车产品创新策略及业务流程". 最近和英国Surrey和Brunel大学计划安排今年10月为工程研究生做EBM方面的访问讲学。

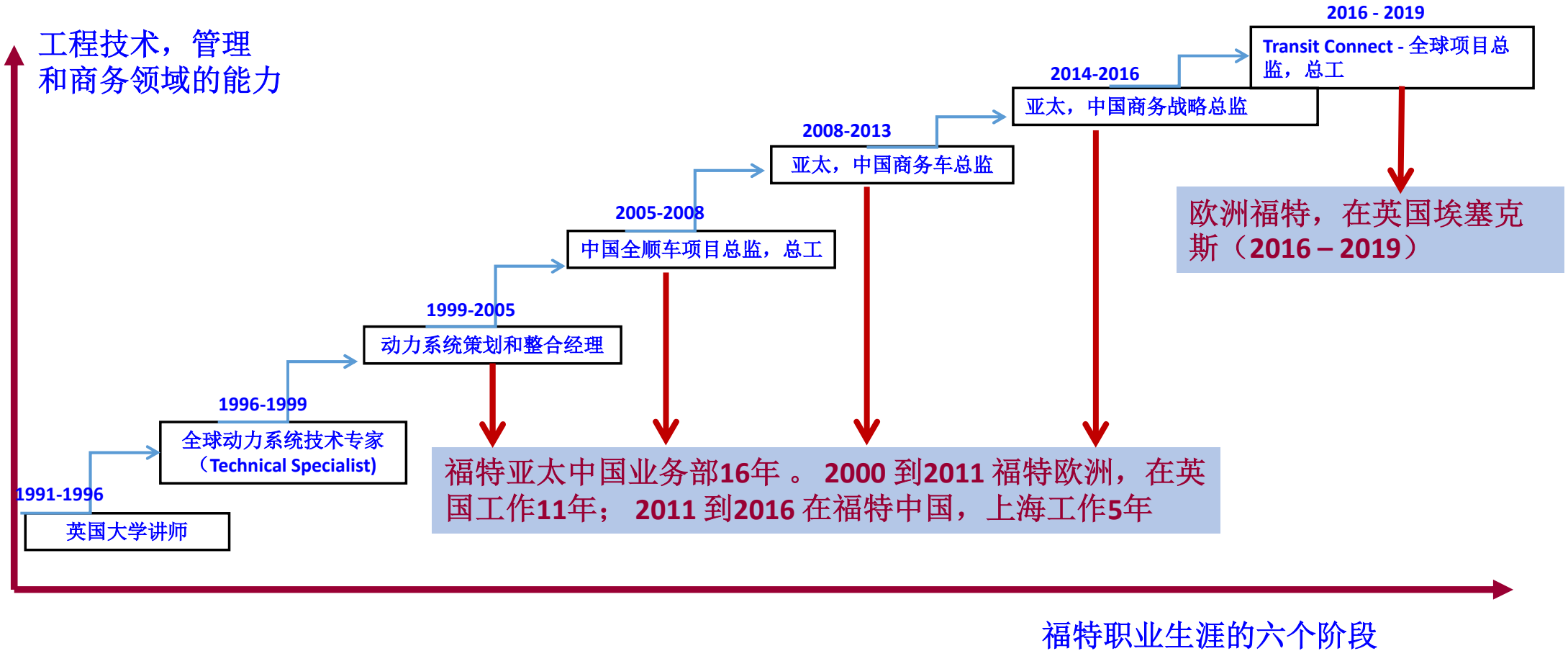
本人教育背景

1981年-1985年：学士 - 天津大学内燃机工程系
1985年-1987年：天津大学汽车内燃机专业研究生（天大保送研究生）
1988年-1991年：博士学位 – 英国伯明翰大学机械工程 （1988年考取并获得中英友好奖学金）
2000年-2002年：英国亨利(Henley Management College) 管理学院MBA （福特公司全额资助）

工作经验

1988年-1992年：英国伯明翰大学汽车发动机博士生
1992年-1996年：英国拉夫堡（Loughborough) 理工大学，汽车工程系讲师，博士导师
1996 年-2019年: 福特汽车公司欧洲总部，Dunton 国际研发中心（英国伦敦东部埃塞克斯Essex)

在福特公司职业生涯 共23年，出任6个不同的职位



6 Large Sections of Specialist Materials – For Engineering Business Management Courses at Universities , Employee Training and Development at OEMs

1. Business, Product Innovation Strategies and Auto Industry Trends
2. Business Processes in Automotive Industry
3. Business Organisations, Joint Ventures, Strategic Alliances and Collaborative Projects
4. Product Development, Project Management & Managing Product Quality
5. Competence, Engineering Management & Leadership
6. Intellectual Property Rights (IPR) & Business Negotiations

Topics To be Covered in this Seminar

- **Introduction**
- **Automotive Product Innovation and Overarching Framework - C.A.S.E**

（汽车产品四化：网联化，智能自驾化，共享化，电气化）

- **Key Issues and Major Challenges in Technology Innovations & Business Models for Connected Autonomous Vehicles (CAVs)**
- **Strategic Priorities for Product Innovations & Strategic Alliances - Ford Examples**
- **Key Takeaways, Q&A**

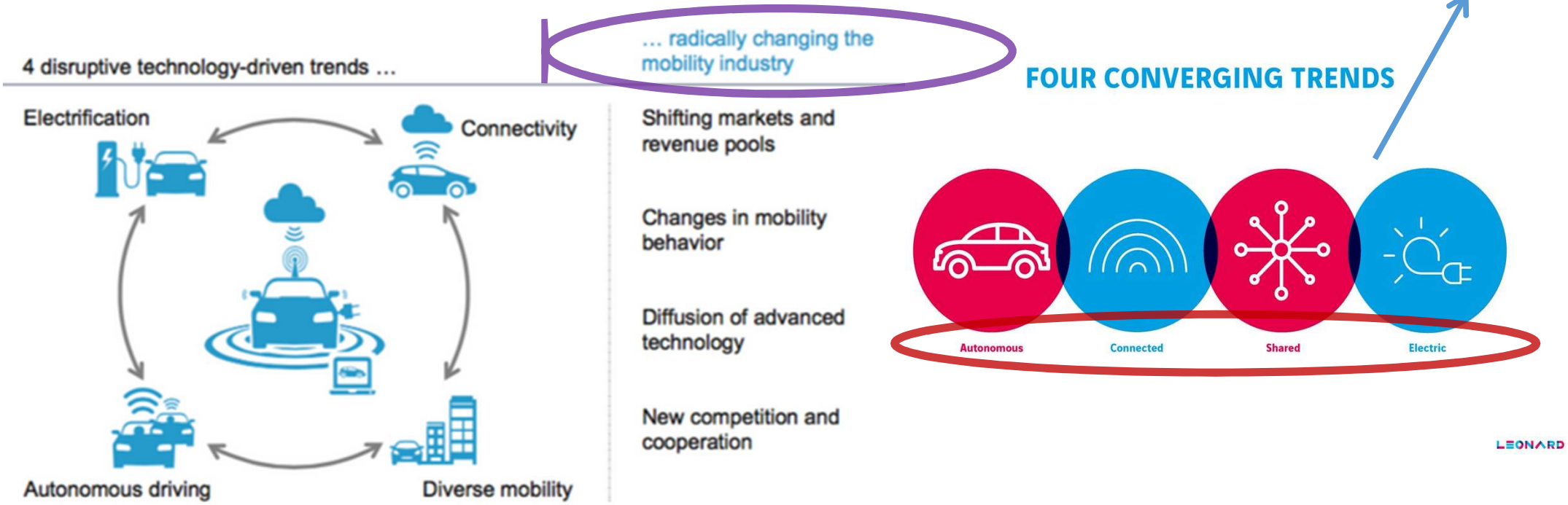
Introduction

- Automotive industry is going through some most profound changes and transformations today driven by emerging new **disruptive technologies （颠覆性技术）** and product innovations
- Digital revolutions, self driving technology using AI and electrified powertrain are the main driving forces for the **remake of the new industry landscape**
- New entrants including internet and technology giants, auto suppliers are all competing with traditional auto OEMs on the increasingly important **mobility space and ecosystems**.

Introduction

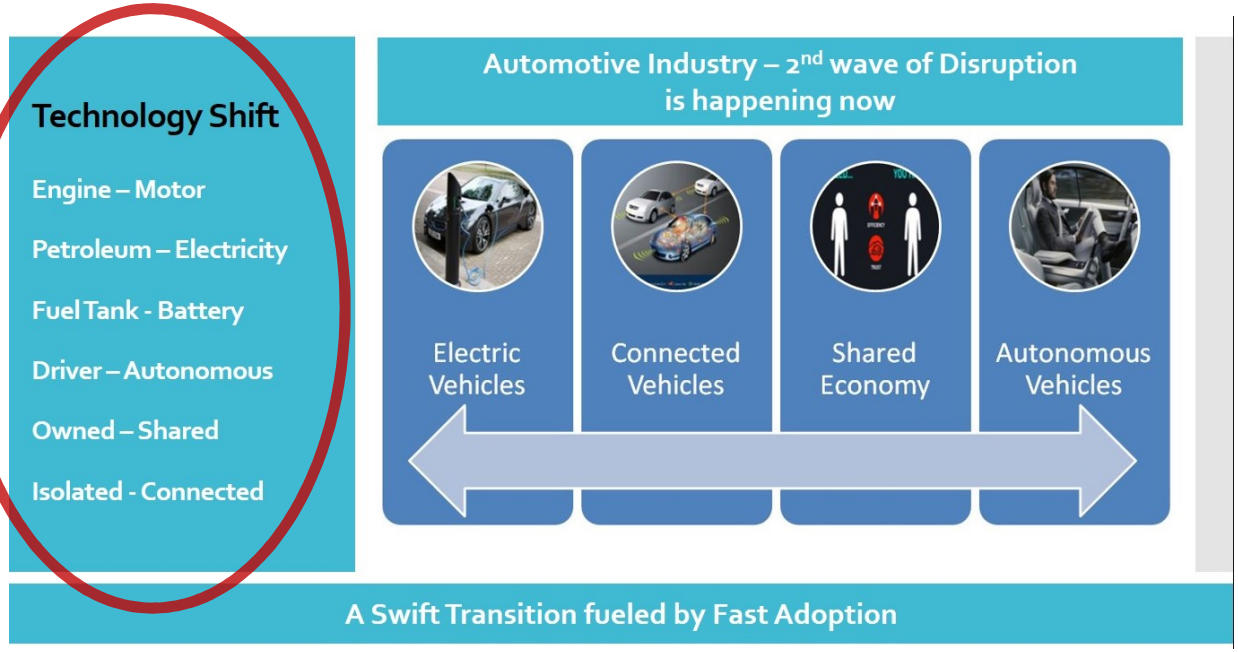
- Large capitals, new start-ups, OEMs and Technology firms' resources are being poured into Connected, Automatous Vehicles (CAV) R&D and mobility related fields in order to gain technology leadership and competitive advantages
- The impact of the new automotive product innovations of CAV are deep and profound on wider automotive related industries. Many new emerging business models and opportunities are driven by **CAV and mobility-on-demand (网联智能按需点播出行业务)**
- New waves of industry collaborations and **strategic alliances** among OEMs, tech companies and suppliers are becoming norms as they need to joint resources and effort to tackle complex technological challenges, reduce R&D and product innovation costs and to minimize business, market and financial risks.

Four Product Innovations Dominates Automotive Industry today – C.A.S.E.



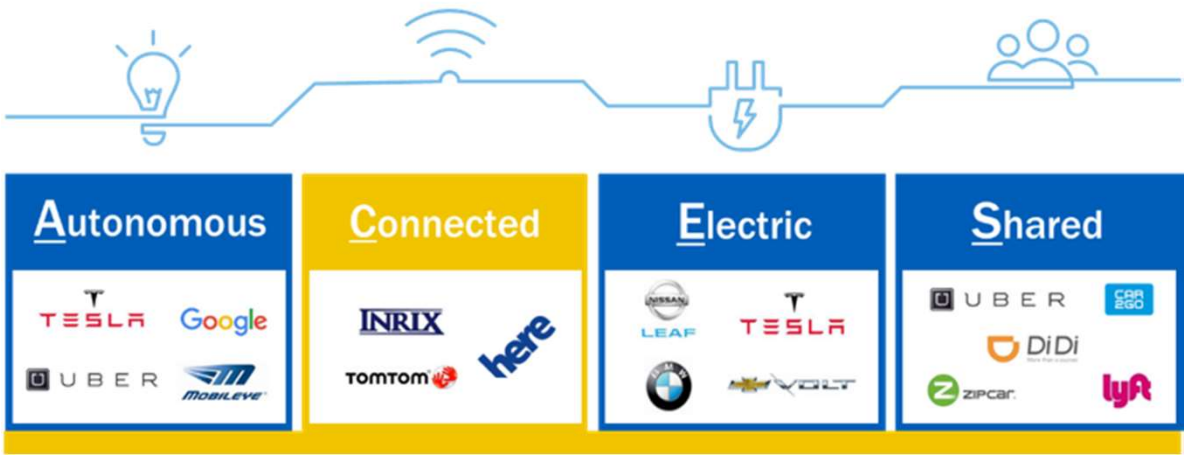
- There are four major disruptive forces that will shape and drive the future trends of automotive product innovations and they form the key pillars of Auto OEM's product innovation strategies – C.A.S.E
- These four technology innovations will **converge** providing new customer experiences, creating new business models, and completely transforming the **automotive industry structure** and its make-up in coming years.

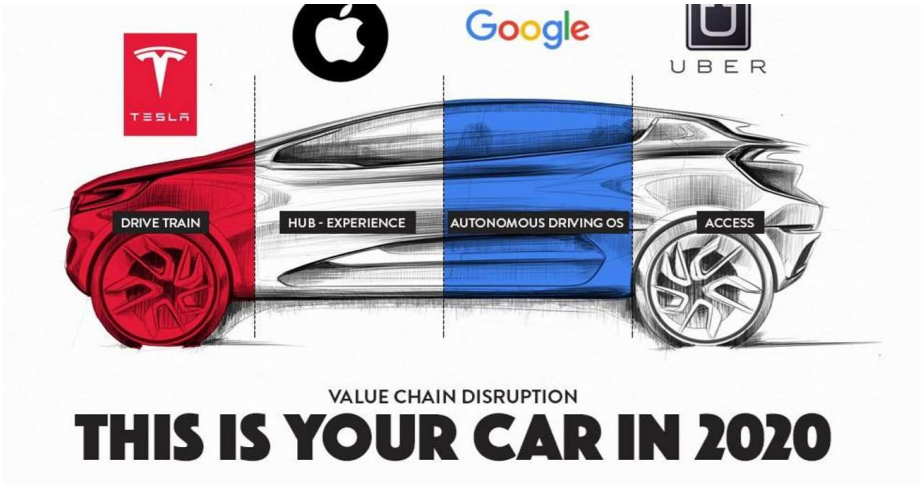
Mega technology development and trend will lead new waves of Automotive alliances in the industry



- Automotive disruptive forces will lead to new waves of strategic alliances cross wider industries so that OEM **can gain technology access, leadership and market dominance in mobility ecosystem space**

Key Global Players in Automotive CASE Product Innovations





- Technology development for these four trends are the key battle grounds for auto OEMs, Suppliers and Tech Companies and Internet giants
- Key players are global companies from US, Europe and China
- Collaborations among OEMs, Tech companies and suppliers become norms to tackle new technological challenges, reduce R&D costs and to minimize market & financial risks.
- New “ABCDE” Car technologies & integration (AI, Broker,Connectivity, Data, Energy/ Electrifications)

Overview of C.A.S.E. Trends and Their Impacts

Overview of C.A.S.E. Trends and Their Impacts

Electrified

Electrified Vehicles

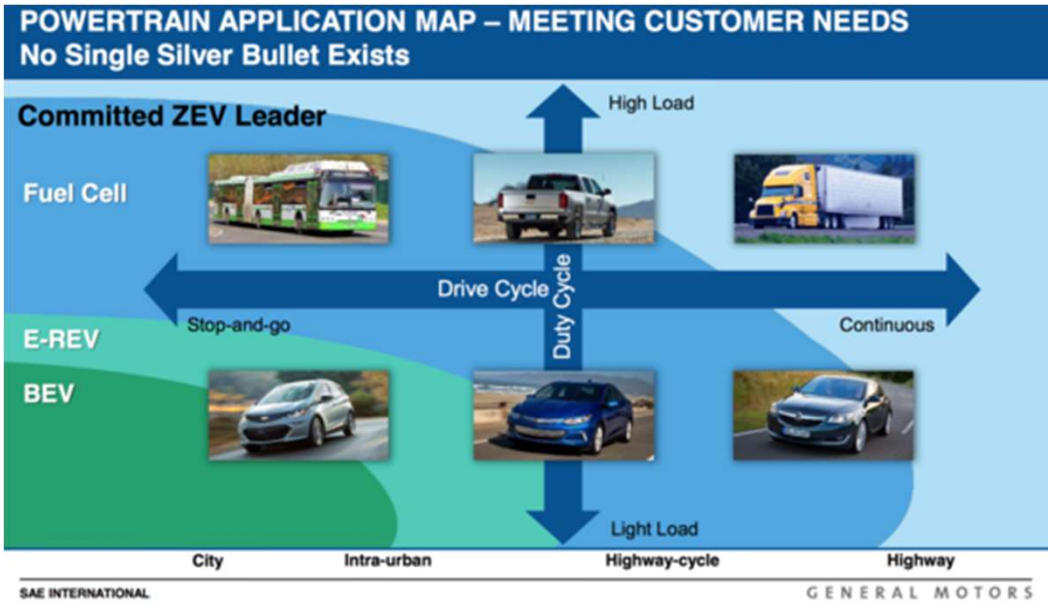
Three main types of electrifications

Electrified

- HEV – Hybrid Electric Vehicles
- PHEV – Plug in HEV
- BEV – Battery EV
- Technology choice is driven by customer drive cycle, usage profile, range requirements and capability demands
- The battery technology, costs and capability improvement are the key drivers for rapid market and customer adoption for BEV.

- Tesla has brought electrification revolutions to the auto industry
- Auto OEMs are catching up fast with their own electrification plans
- The battery technology, costs and BEV capability improvements are the key drivers for rapid market and customer adoption for BEVs.
- IONITY – EU Consortium for high power high speed charging network

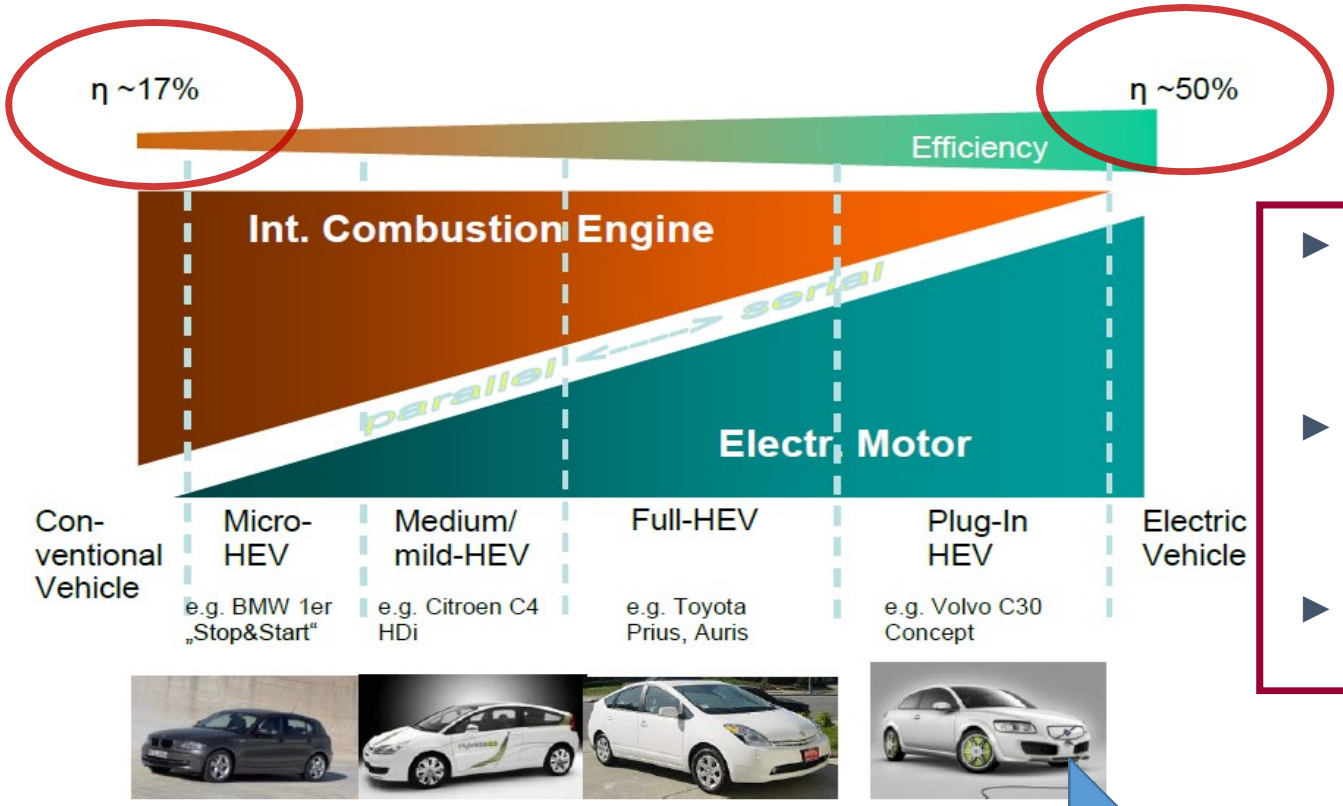
One size does not fit for all – Both Battery and Fuel Cell are needed for EVs



- The wide range of drive cycles and duty cycles require different EV solutions
- Customer demand most effective electrification drive train to meet their needs
- **No single silver bullet**
- Both Japan and South Korean OEMs are pushing for FC adoption in the main stream PV with limited success

- The Battery technology, costs and capability improvement is the key drivers for rapid market and customer adoption for BEV.
- Drive cycles dictate the place of Fuel Cell EV, requiring breakthrough in FC technology and infrastructure maturity.
- **EV "Courses for horses" approaches（量体裁衣, not one size for all）**

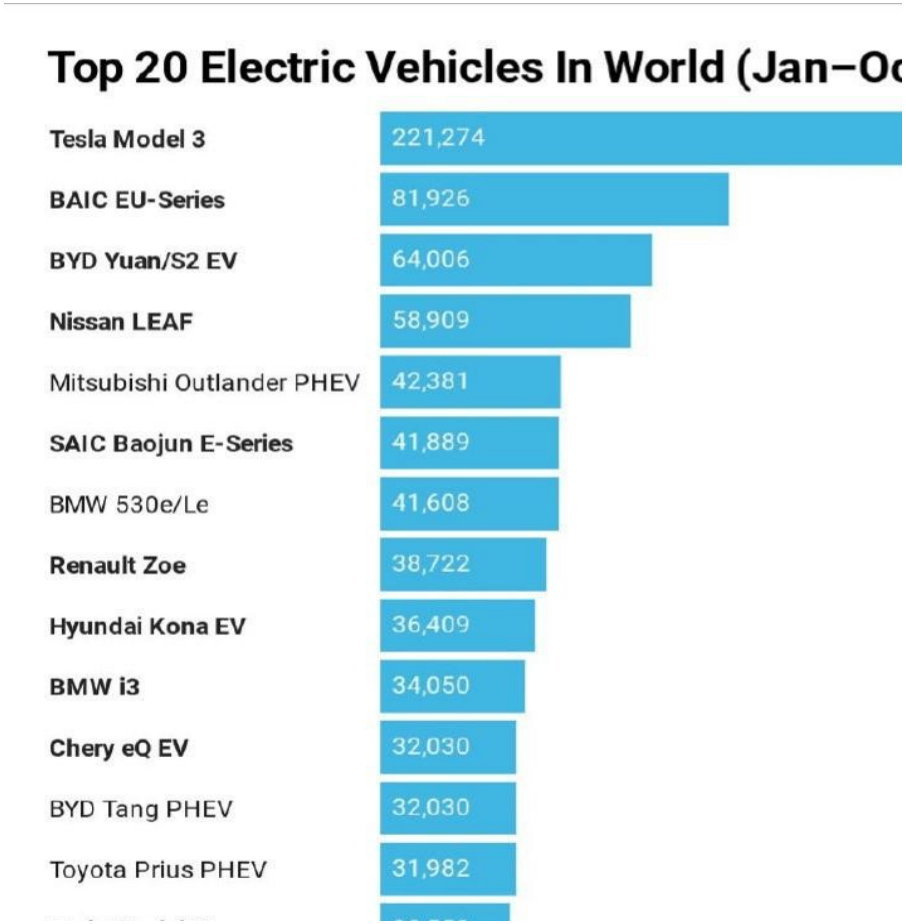
Degree of hybridization



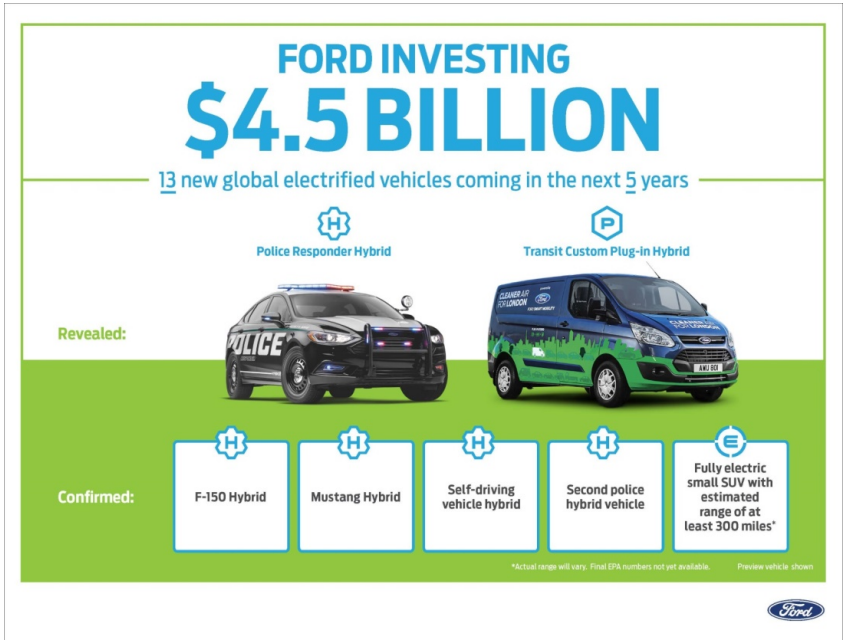
- EVs convert about 50- 60% of the **electrical energy** from the grid to power at the wheels.
- **ICEs only convert about 17%–21% of the energy stored in gasoline to power at the wheels.**
- PHEV tend to use series hybrid

ICE becoming a less dominant power source

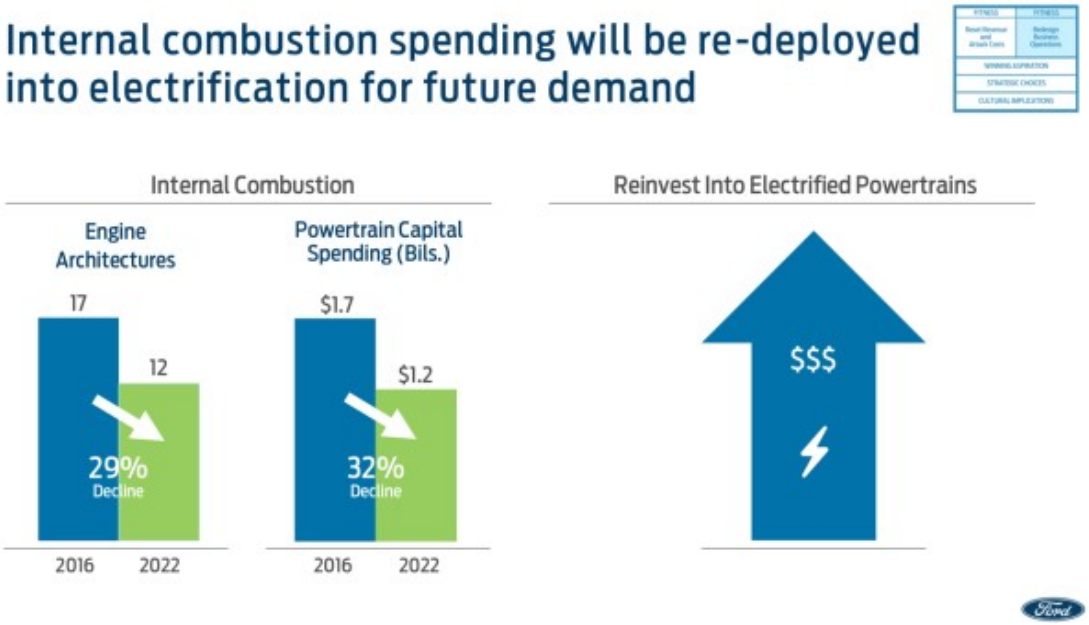
Ford has decided major investment for product migration to EVs



- Ford has been slow and behind major competitors for electrified vehicles.
- Hence recent announcement of major investment in future electrified models and use VW licensed MEB platform

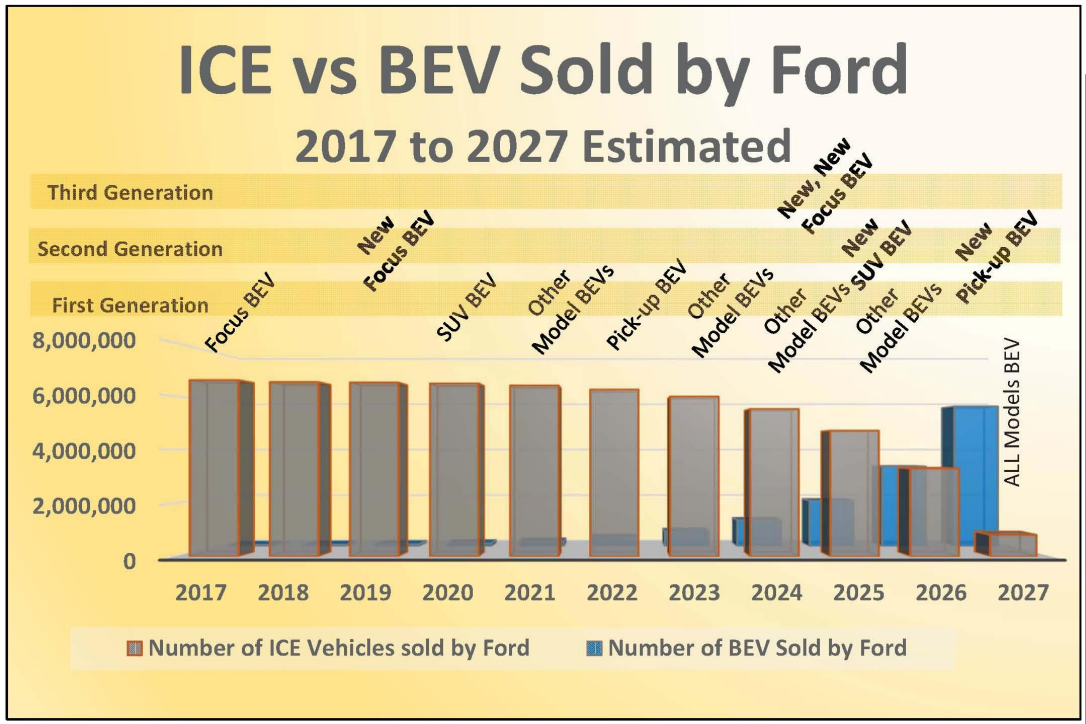


Ford is shifting its capital and focus from ICE to EV powertrain



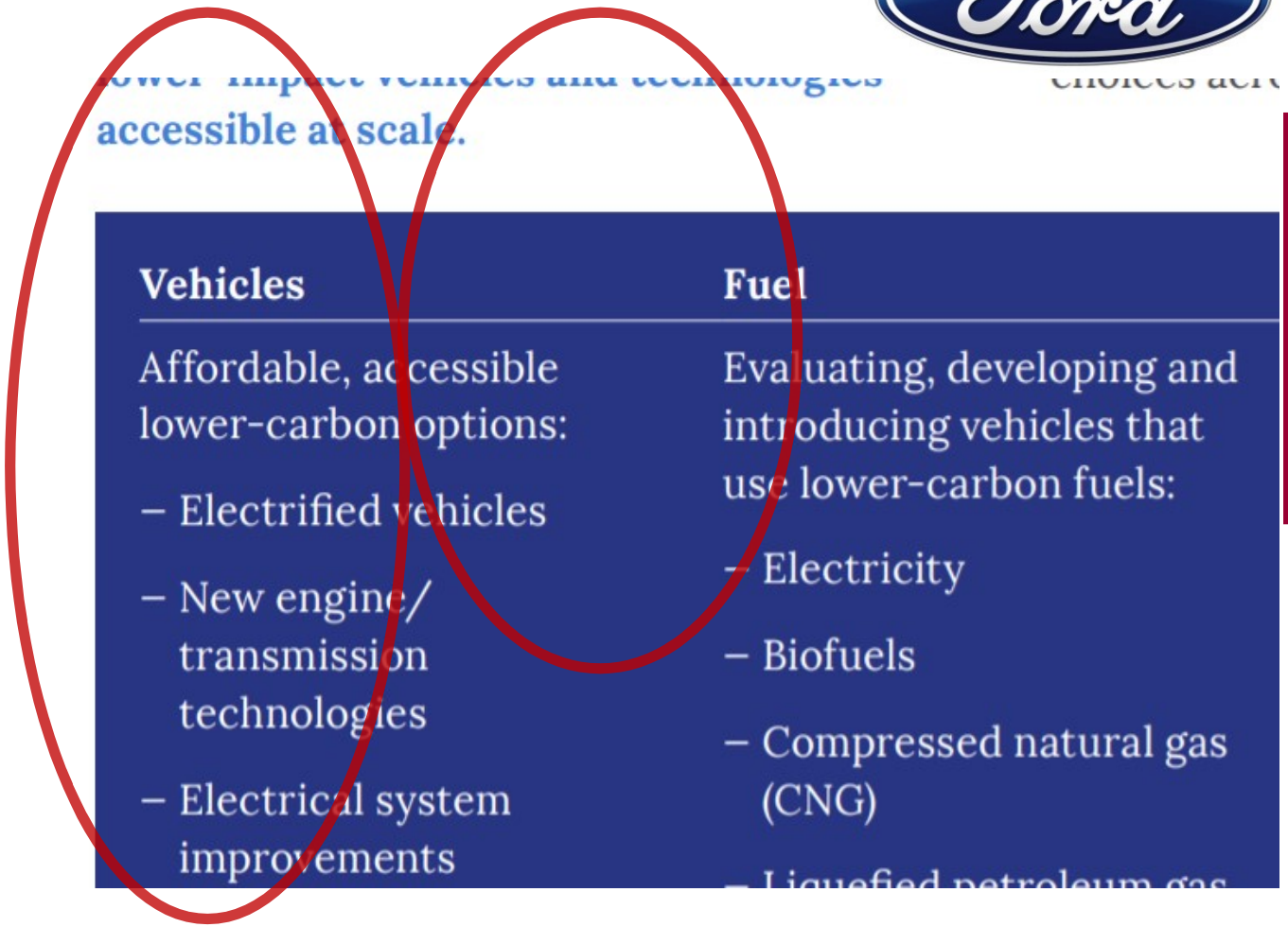
- Ford capital allocation reduction is consistent with Engine/PT architecture and application declines
- The capital is re-deployed for electrified drive train

Ford is catching up with competitions with aggressive BEV launch plan



- Ford Electrification launch plan ensures coverage of all technologies for different user profiles
- BEV is growing rapidly from 2023-2027 to catch up competitions
- **By 2027, Ford ICE will be less than 15% of the total product offering, indicating aggressive powertrain migration plans**

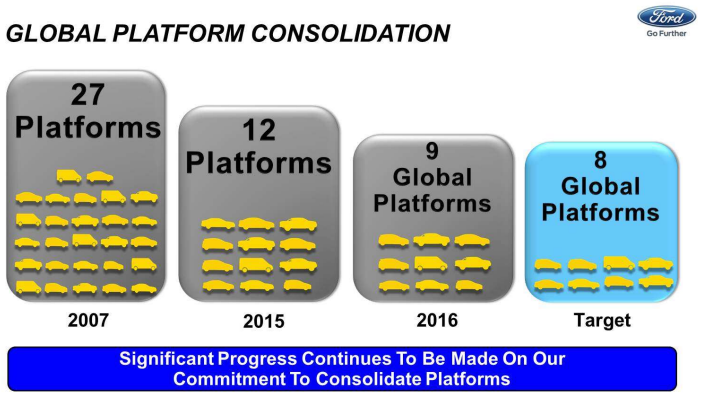
Ford Portfolios approach for electrified PT – how effective?

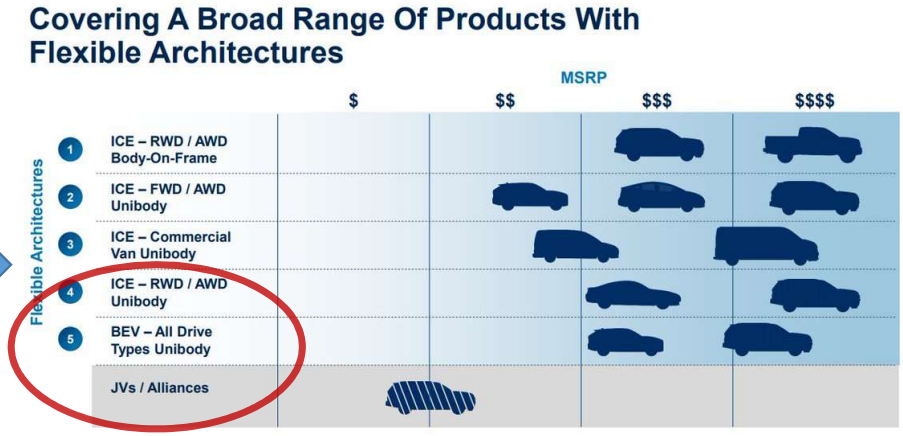


- There is no single way to improve fuel efficiency and vehicle CO2 emissions
- **Ford takes a portfolio approach for the power-train**

Ford Vision of success - flexible modular architecture designs

- 5 Modular architecture will cover all nameplate models in the future

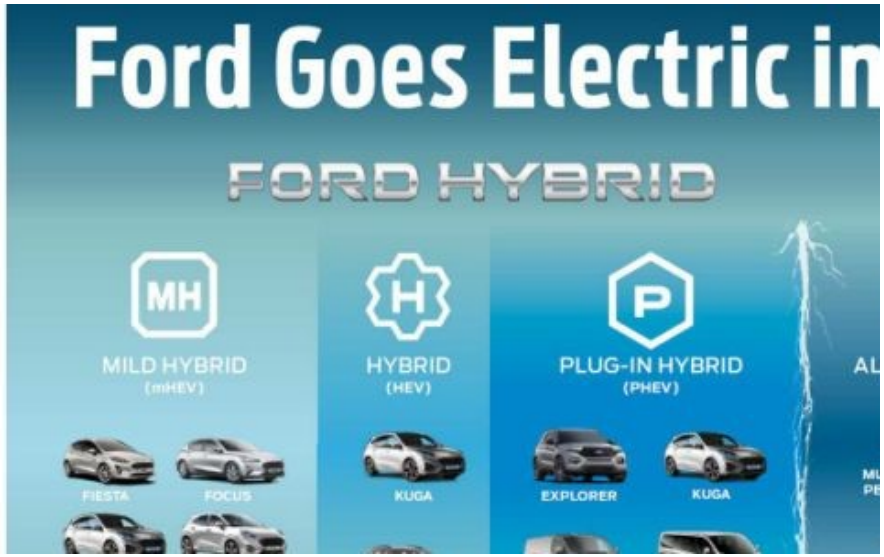




Ford Two prongs EV strategy – to keep parallel internal development and a stake in external technology & expertise

- Ford invested $US500 million **in Tesla competitor and startup Rivian 2019**
- This is for all-electric pickup and SUV for US market.
- **Amazon is another key investor in RIVIAN**
- The all-electric RIVIAN R1T and R1S SUV are built on its proprietary **"skateboard" platform**
- It includes battery pack, drive units, suspension, brakes and thermal management system.
- Ford wants to learn from its BEV platform expertise and may use it for F150 – **to keep BEV architecture options open**
- RIVIAN porotypes feature rugged specs for outdoor life style use

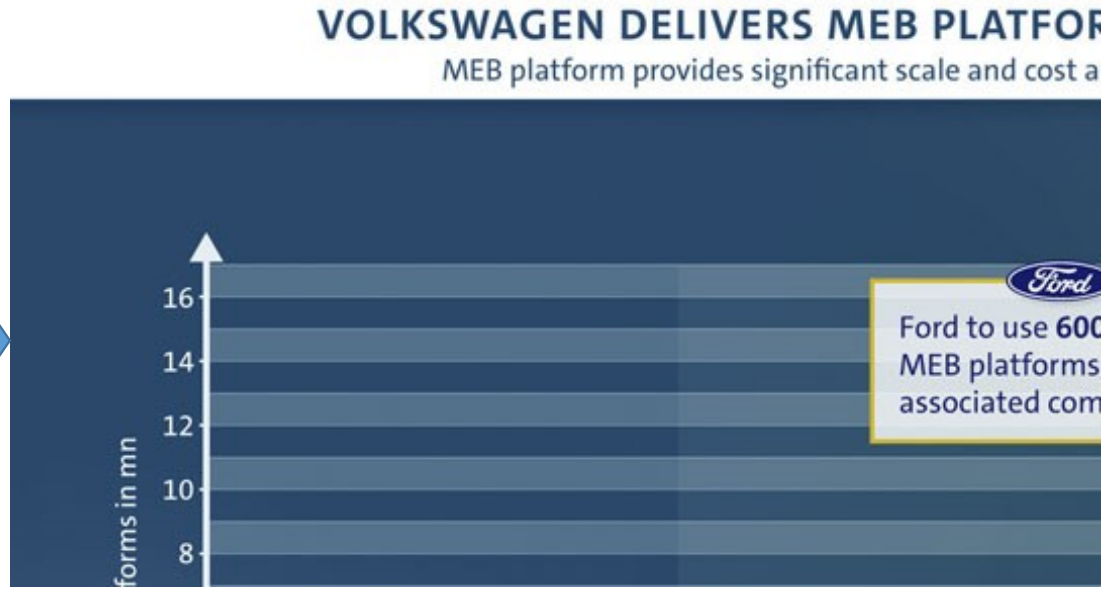
Ford PT and EV plans in Europe



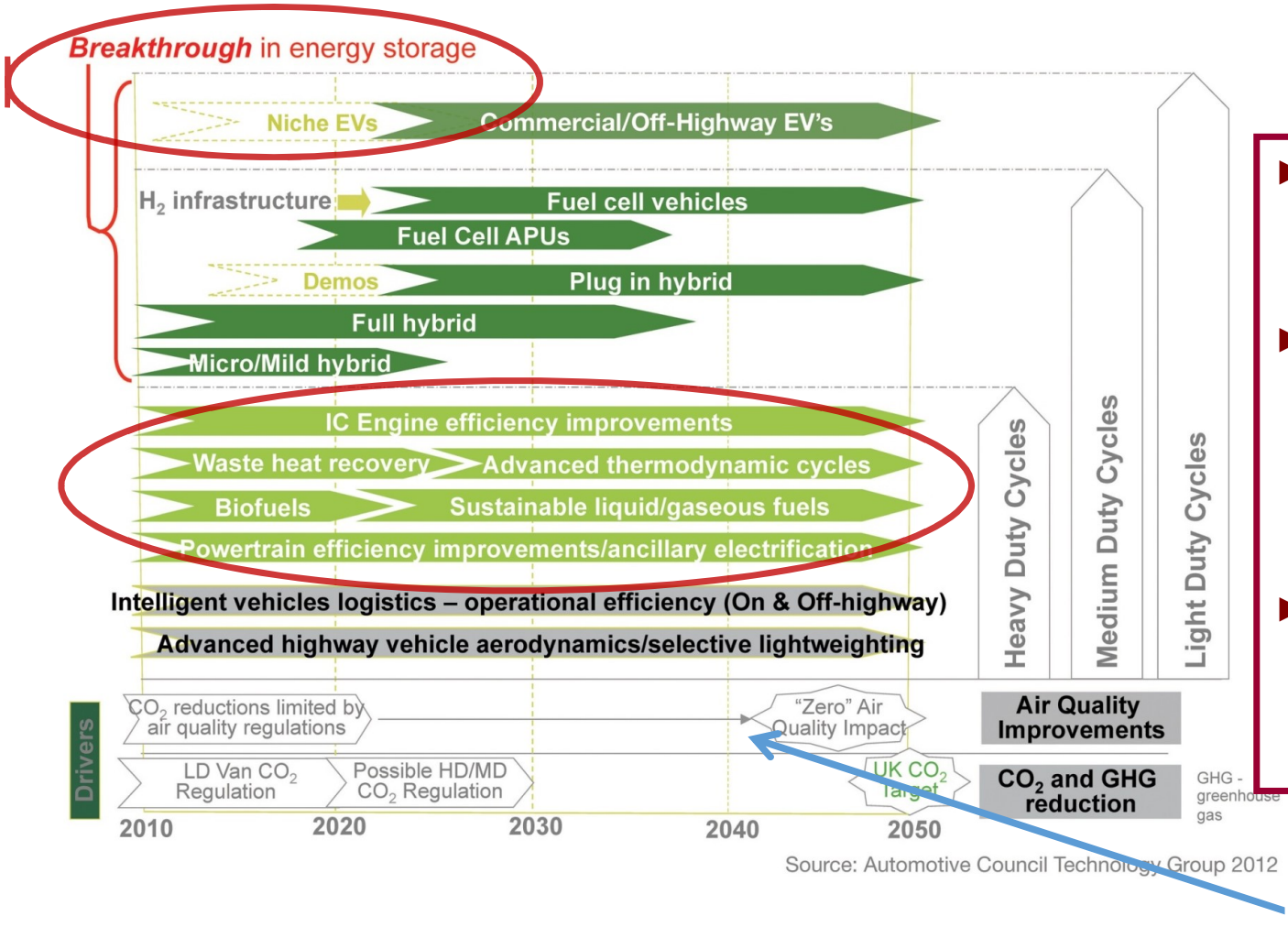
- Ford projection on electrified PV adoption in Europe **– 2022 is the tipping point.**
- This is based on **the battery cost reduction trajectory, expanded charging infrastructure availability and general improvement of range, and capabilities of electrified PV**

Major Initiatives at Ford for Vehicle electrifications

- The parallel BEV strategy of using VW MEB for European BEV products will complement Ford overall global BEV plan
- Ford intent of buying and using licensed MEB Platform from VW will provide a compelling competitive advantages in crowded BEV markets



Automotive Technology Plans –Drivetrain and options



Source: Automotive Council Technology Group 2012

- Automotive technology plans cover transition from ICE to other clean technologies like EV, PHEV, Fuel Cell
- During the transition period, small step such as ICE efficiency improvements and alternative fuels for sector specific likely to to drive immediate results and benefits
- **A ban on selling new petrol, diesel or hybrid cars in the UK will be brought forward from 2040 to 2035 at the latest – Feb 2020 news**

Moved to 2035

Examples of Automotive Technology Priorities and Key Areas of Focus in the next 3-5 Years
- For reducing Ground Transport emissions to drive low carbon transport in UK

CASE STUDY – UK LOW CARBON TRANSPORTATION INITIATIVES

Retrofit & conversion near-term strategy

- **A range of interim solutions like LPG, CNG, SCR, Hydrogen, renewable biofuels and dual fuels - targeting Buses, CV vans & HGV freight fleets.**
- **Opportunities: fleet upfitters, components' suppliers collaborations for scales**

CV 1 Ton and 2 Ton van strategy

- **Backbones of UK delivery & services. Targeting CV electrification 10-20% increase YoY,**
- **Policy and incentives for CV PHEV/BEV Work Programs - collaborating OEM, upfitters, fleet operators for demand pull & supply push. E.g. P**lug-in van grants

Zero emission UK Buses

- **100% UK buses with zero emissions**
- **Showcasing Bus sector BEV shares, retrofit technology & benefits**

Drive Train Technology priorities that will drive low carbon transport in the next five years

Examples of Automotive Technology Priorities and Key Areas of Focus: Next 3-5 Years
- For reducing UK emissions and CO2

Innovative urban mobility solution

- Converging moving people and goods using light ISV (Micro Van “L” plate) – connected, autonomous and shared use
- Supporting emerging new business models in urban transport TaaS/MaaS.
- EV/AV Cargo/People carriers + Last mile AV together with intelligent transport ecosystem

Breakthrough technology for HGV

- R&D and academia,
- Progressive adoption of retrofits/renewable fuels to PHEV or BEV or hydrogen HGV
- Setting ULET standard , recommended technology and funding/incentives

EV Energy supply system readiness

- Testing case: depot-based fleet charging
- Electrified CV Fleet, charging infrastructure provider, electricity supplier and DNO working together for a feasible clean CV fleet ecosystem

PT Technology strategic priorities that will drive UK low carbon transport in the next five years

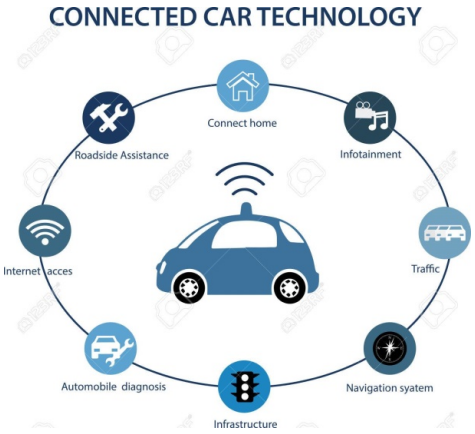
Connected

Connected Vehicles

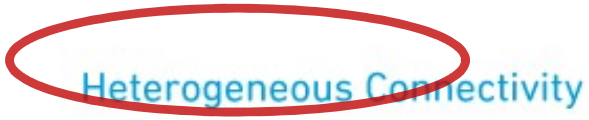
Overview of Vehicle Connectivity

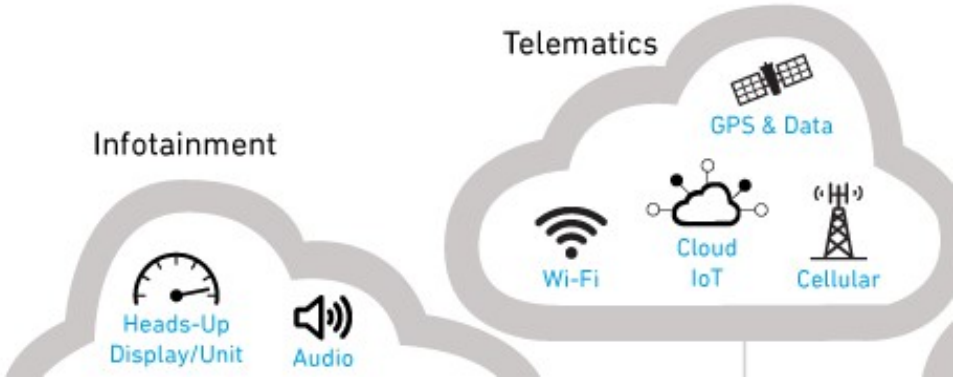
Connected

- Digital revolutions - mobile Internet access WI-FI
- Infotainment – visual, audio: new content access for drivers, Audio, advanced HDU, "mobile phone & computers on wheels"
- Telematics – Live Traffic updates, GPS, SatNAV, diagnostics, roadside assistance, Transport mobility clouds
- V2X – 5G V2V, V2I, V2N, V2H, V2D, V2P etc

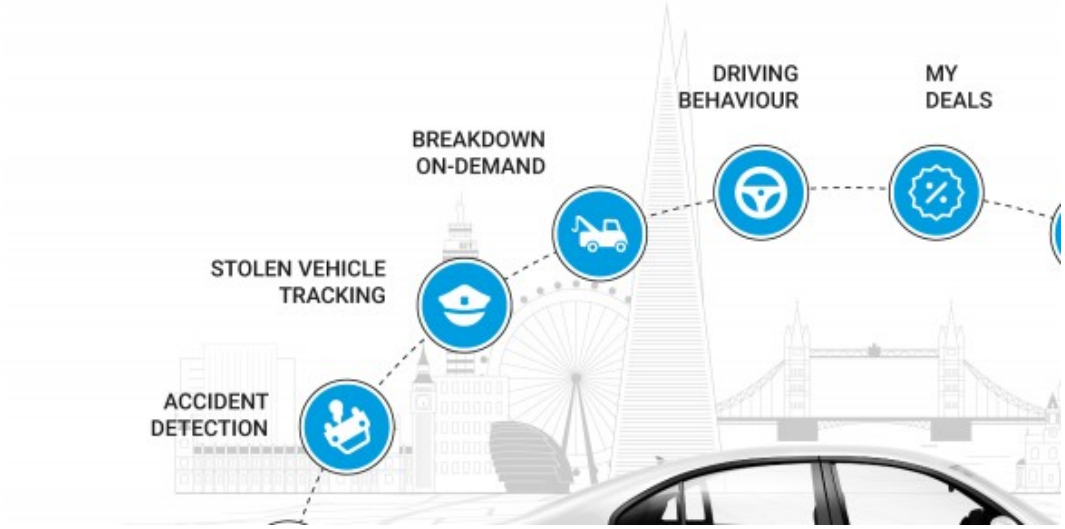


- Vehicles are increasingly connected to each other, to infrastructure and mobility clouds via wireless network
- This provides a foundation for future **Smart Transportation System, Smart City & Smart Energy (4S)**
- Customer experience will be transformed thanks to infotainment, contents delivery and access to other mobile app services.





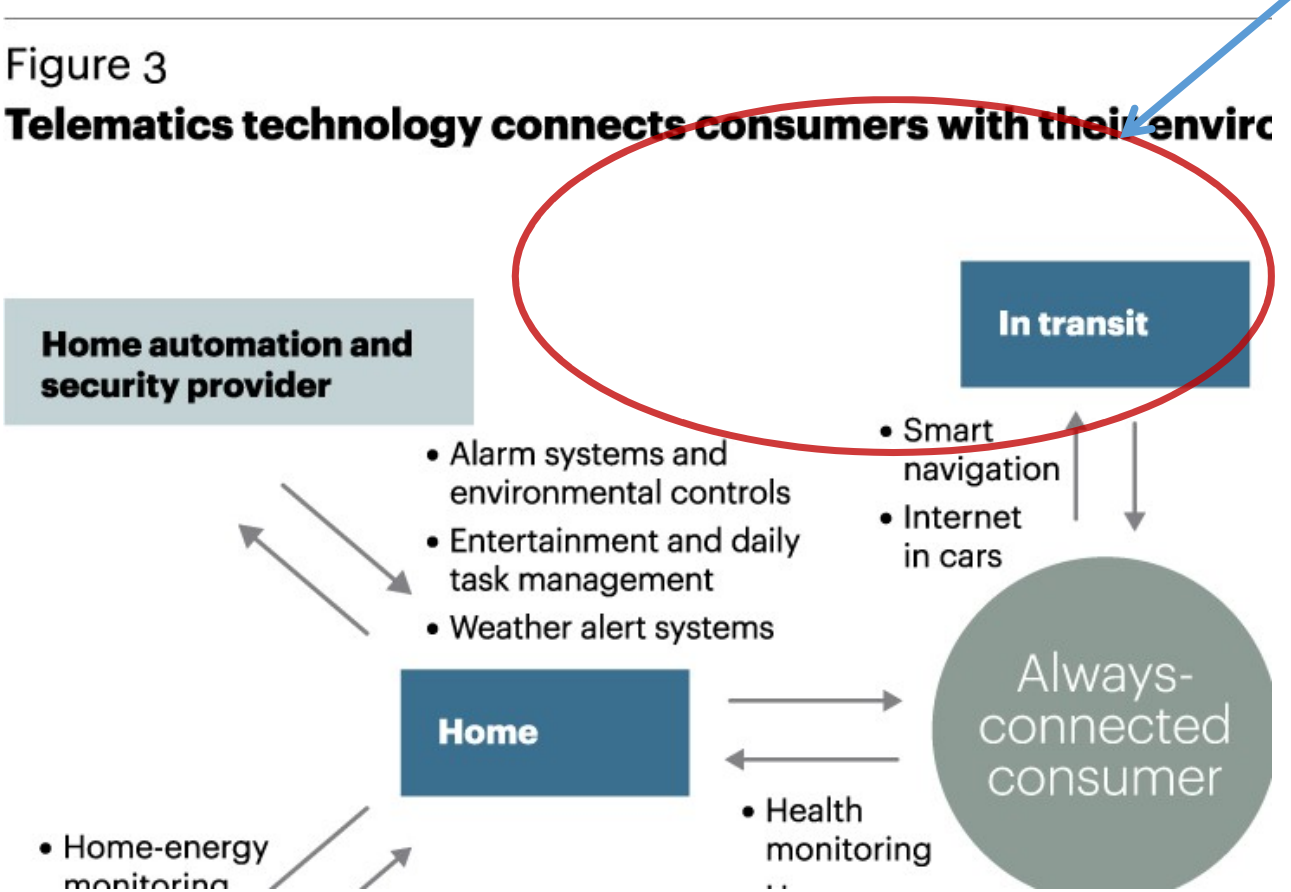
Many Benefits brought by connected vehicles via cellular network(移动通信网）



- Automotive connectivity create significant changes for many parts of **vehicle value chains (汽车产业价值链）** e.g. services, repairs, breakdown, diagnostics & live traffic updates etc.
- Internet content providers and Mobile service providers are likely the biggest winners. What about Auto OEMs?

Connectivity is in every part of our lives today

Vehicle Connectivity



- Automotive connectivity is only one part of always-connected consumers
- With Connected vehicles, consumers are able to integrate their social, home and work activities **on the move.**
- **Dedicated vehicle operating system (OS) and advanced HMI will provide enhanced consumer experiences for always-connected consumers.**

Ford Connectivity Initiatives

Ford Collaborations

- Ford acquired e-scooter Spin - first and last miles solution, Micro-Mobility Revolution
- August 2018, Ford collaborating with Alibaba Cloud - TMC to China
- TMC – Transpiration Mobility Clouds is the first open cloud-based platform that connects the diverse components of urban mobility systems, including connected vehicles, mass transit, pedestrians, city infrastructure and service providers –sustainable transportation network.
- TMC will help journey planning, ride hailing, fleet routing, dispatching, customer interfacing

FCS Connectivity

Ford Commercial Solutions connected vehicle systems

- For company fleets, relays information from built-in modems to a business's internal IT system. Fuel usage, mileage, GPS location, vehicle health and driver behavior being analyzed to improve efficiency
- For law enforcement operators: fuel usage, emissions, vehicle health and driver seatbelt to monitor fleet efficiency and driver behavior

Ford V2X Technology

- Ford is to deploy cellular vehicle-to-everything technology (C-V2X) in US in 2022
- To deploy C-V2X technology in Ford vehicles in China in 2021.
- C-V2X is a wireless communication technology that can "talk" and "listen" to similarly equipped vehicles, people and traffic management infrastructure:
- 5G cellular network, C-V2X enables direct communication between the connected devices, meaning a signal doesn't need to first travel to a cellular tower, allowing V to V direct communications

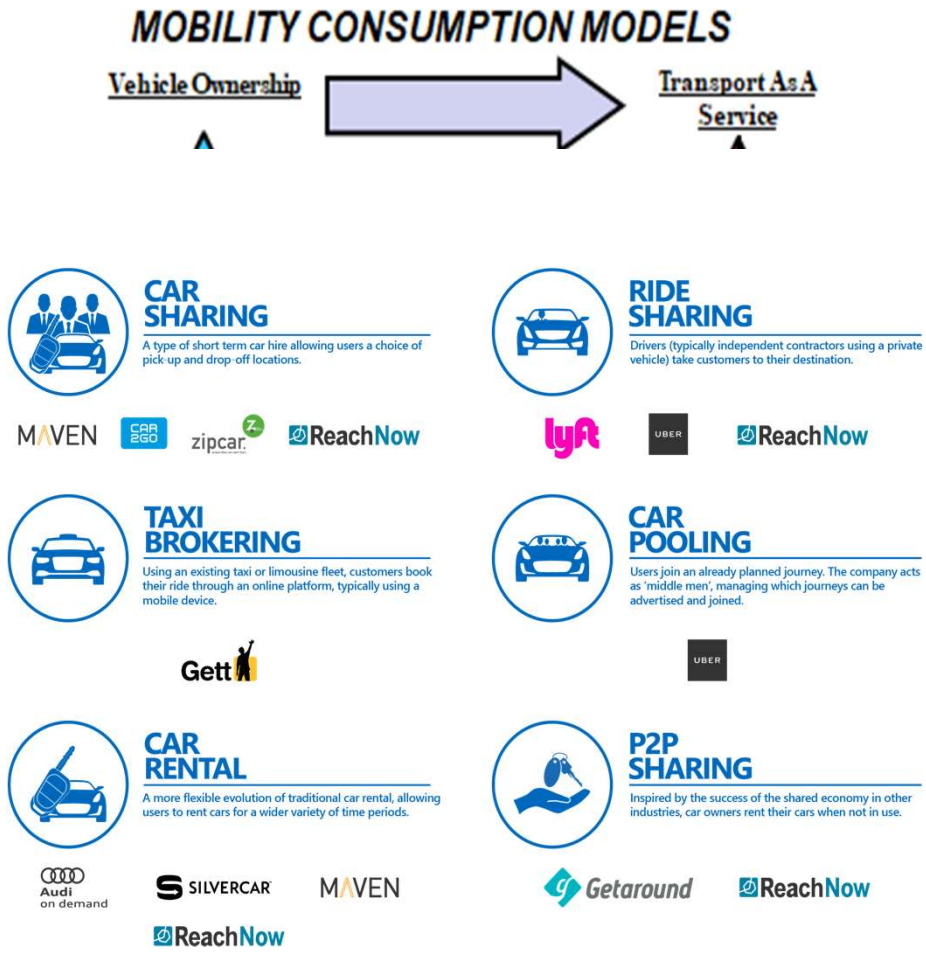
Shared

Shared Use

Mobility consumptions

Shared

- Car-sharing, ride sharing,
- Mobility apps
- Multimodal transport needs
- Auto OEMs shifting from vehicle ownership model to transport service via product innovations and business transformation
- Auto OEMs moving to smart mobility service providers
- Consistent with digital, sharing economy, increasing customer connectivity and to reduce customer mobility pain-points (congestion, parking etc.)



- **Shifting vehicle ownership to mobility services**
- Trends of ride sharing and car sharing
- OEMs want to become future Mobility service providers – business model transformations

Future trend of mobility and ownership model

AV and Shared – Key trend (PwC model)

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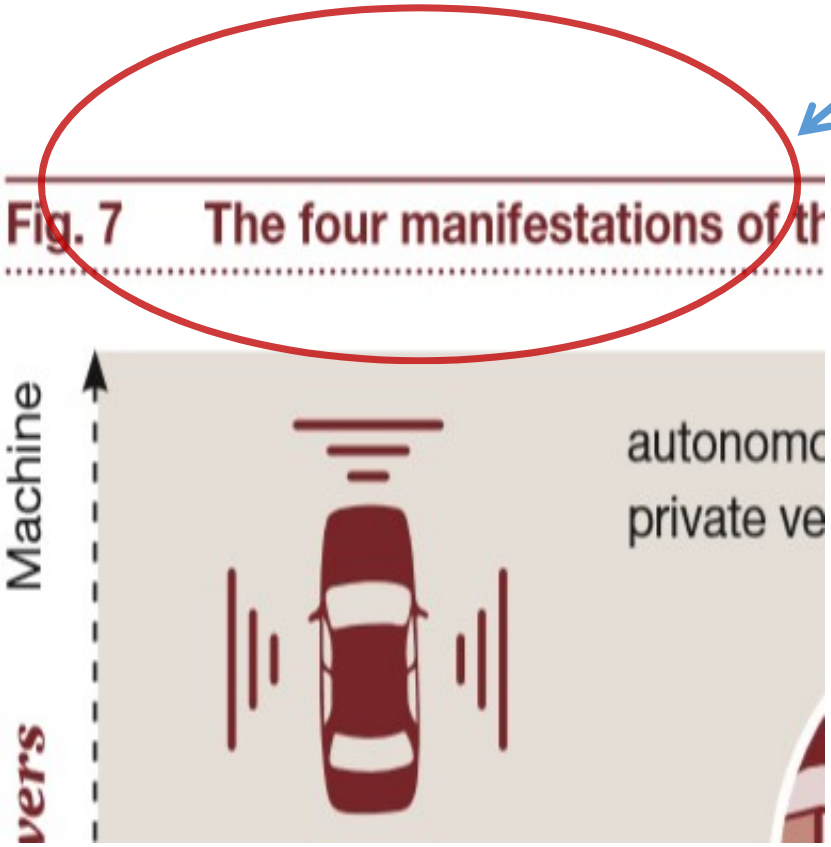


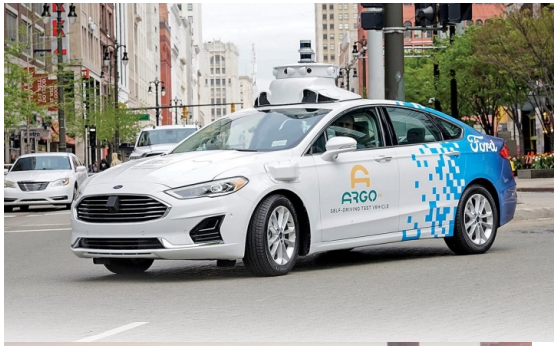
Autonomous

Autonomous Vehicles

Examples of leading Self Driving vehicles

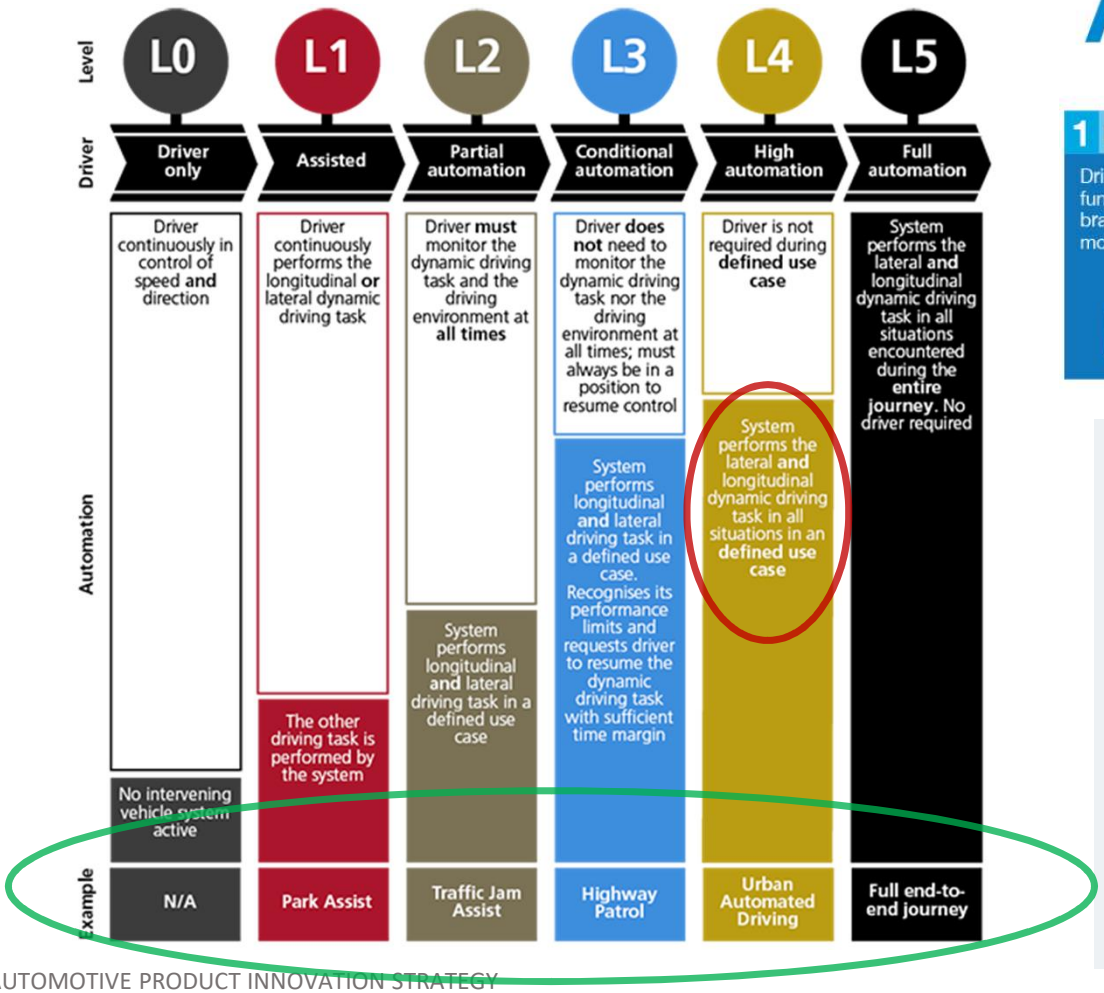
Autonomous

- **Virtual driver**
- **Robot driver**
- **Self Driving system**
- **Vehicle Automations - partial, high or complete automations without human interventions: Level 3-4 definition later slide**
- **CAV – connected autonomous vehicles – key automotive product innovation front**

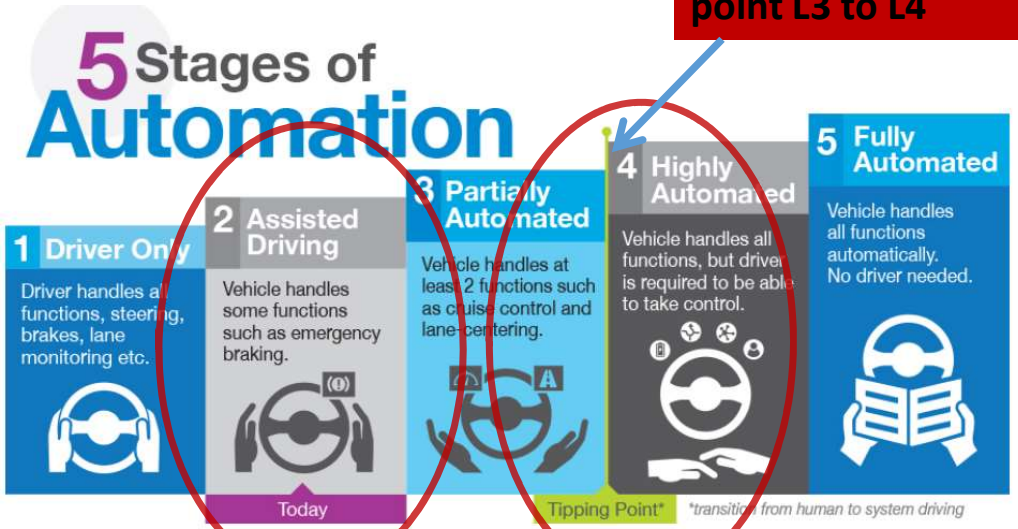


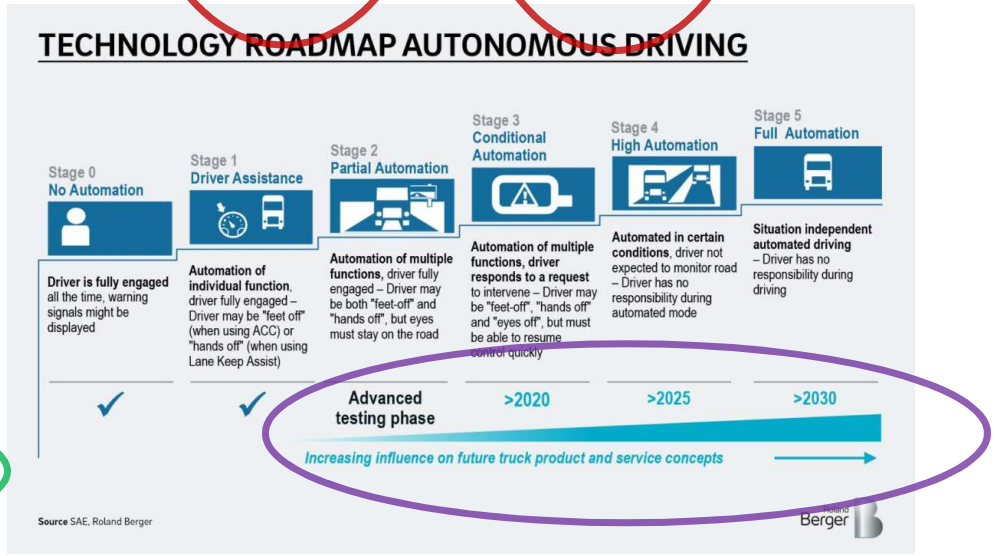
- Waymo leading the way for AV technologies and deployments
- Waymo starts commercial ride-share service in US Phoenix area in 2018 using self-driving vehicle fleet with **Chrysler Pacifica** plug-in hybrid minivans.
- OEMs like GM and Ford have their own AV fleets doing tests and with their launch plans (details in later slides)
- CAV – Connected Autonomous Vehicle technology is the single biggest product innovation challenge in auto industry today

Illustrations of SAE Definitions L1-L5 5 stages of Vehicle Autonomy



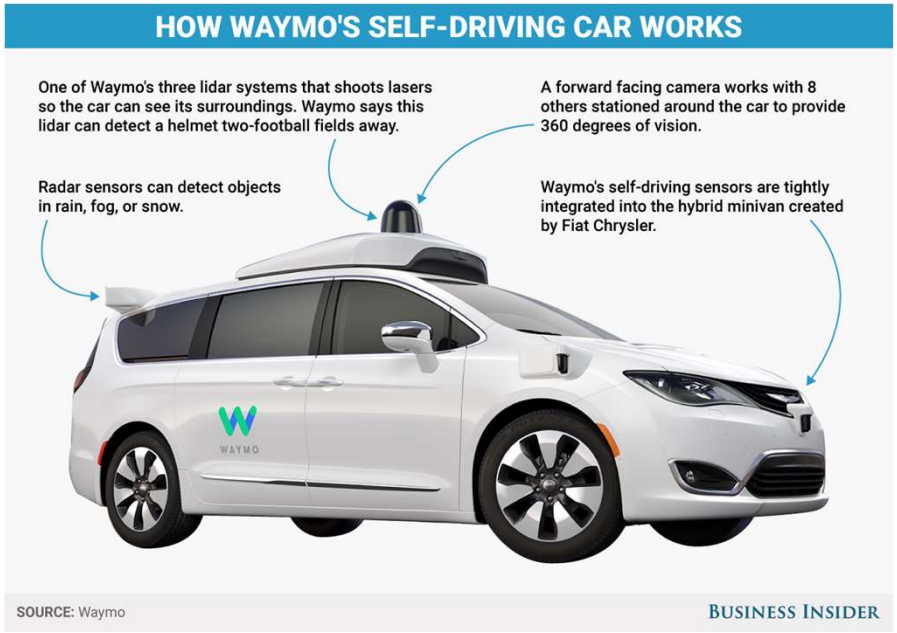
Autonomy tipping point L3 to L4



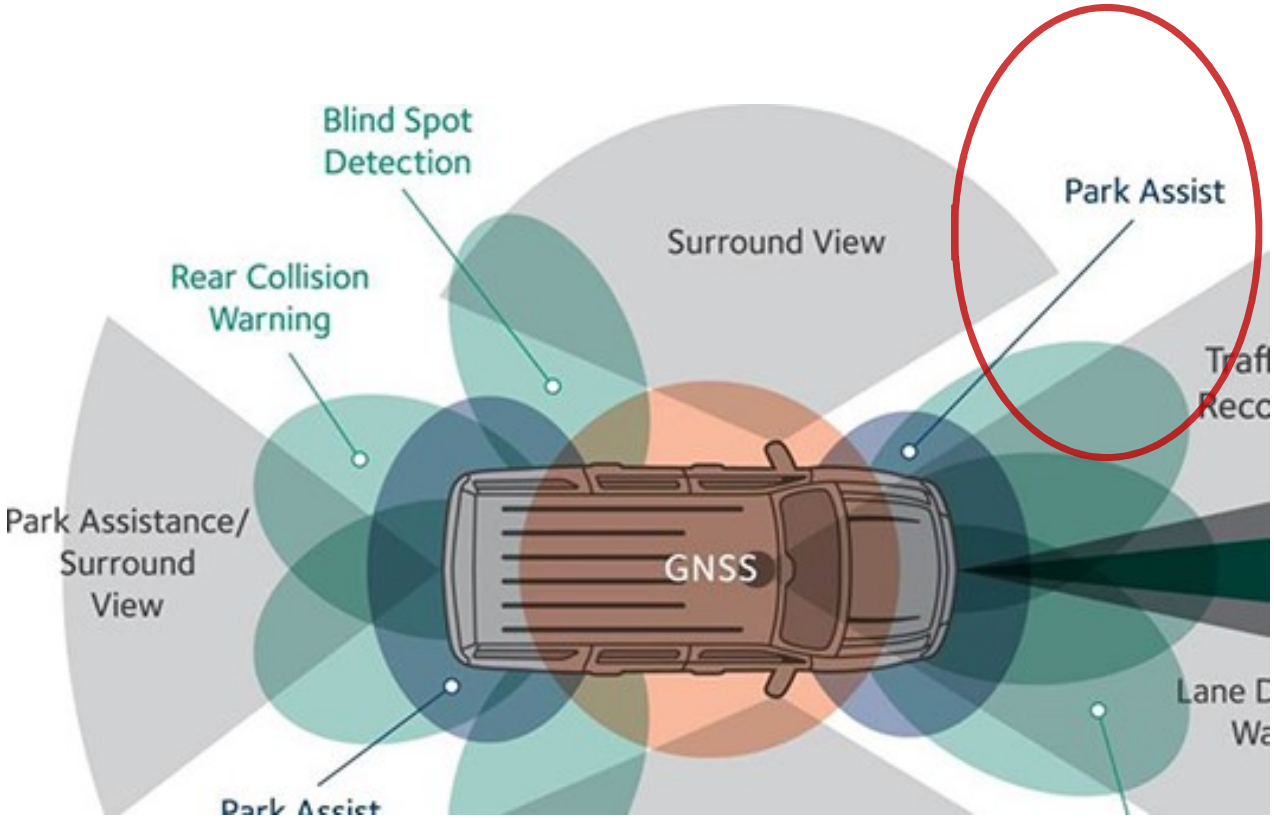


Waymo as the most advanced SDS using their own sensing hardware, algorithms and system integrations

- Waymo makes self-driving hardware developed in-house. These sensors and hardware such as vision systems, radar, and laser-based Lidar (Light Detection & Ranging) allow Waymo to efficiently integrate them with their own software algorithms. Waymo uses their own sensors to detect and identify objects. Fog, rain or dust can limit visibility in these sensors.

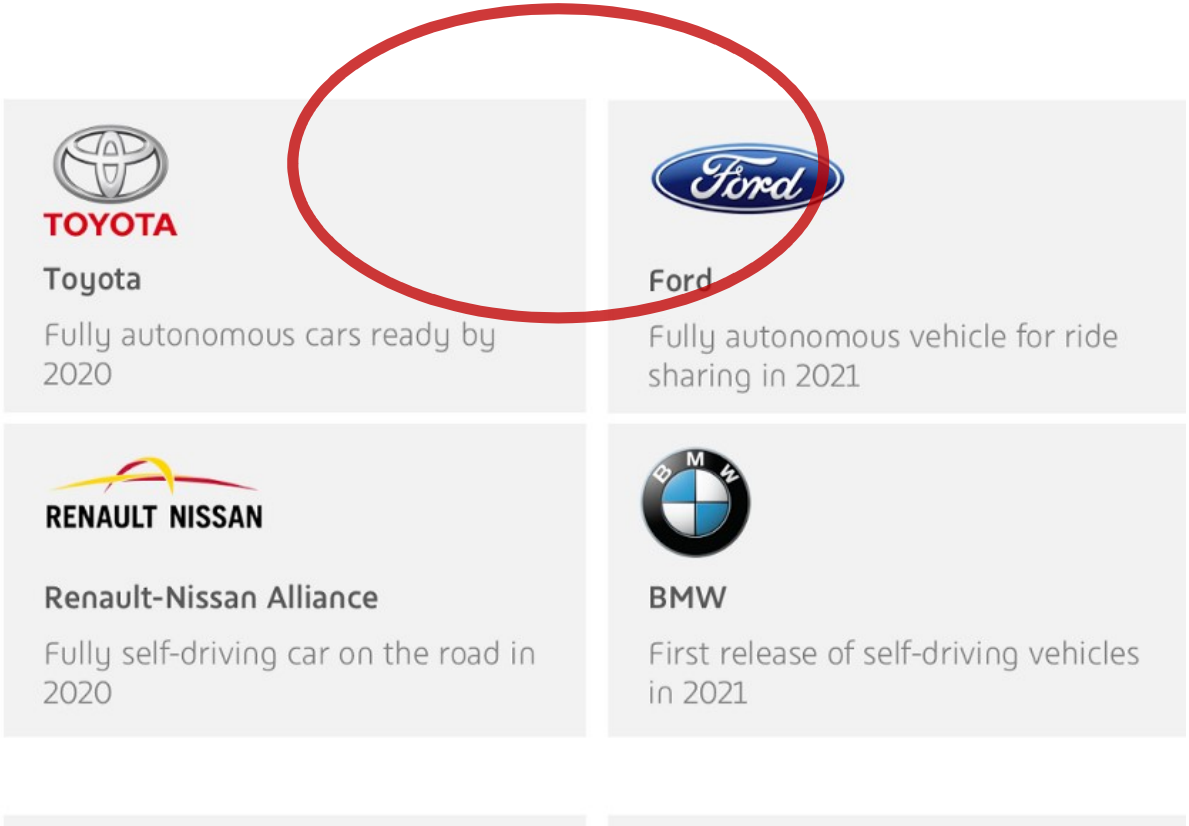


Vehicle autonomy - today's technologies and tomorrow's challenges



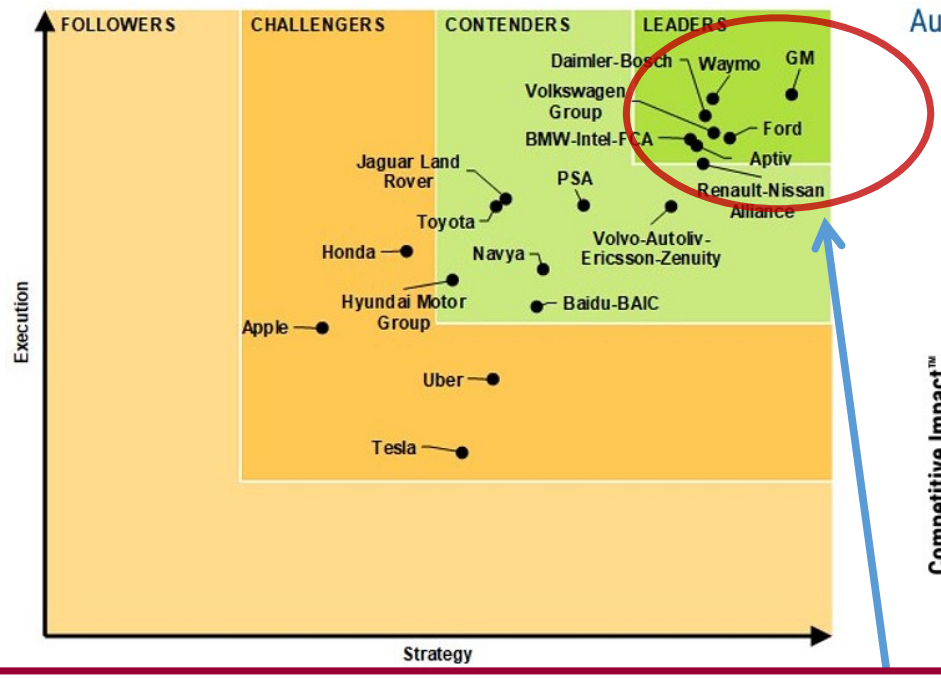
- Radar and Lidar are used to determine the range, angle, or velocity of surrounding objects.
- Most of these automation features are available on today's vehicles
- To achieve L4 and L5, significant software development and machine learning are needed to emulate human behaviors and decision making process during complex situations and environments
- AV ethics or robot driver ethics is an emerging research branch - how does the software coding affect the ethical decision that AV needs to make at an accident-occurring situations?

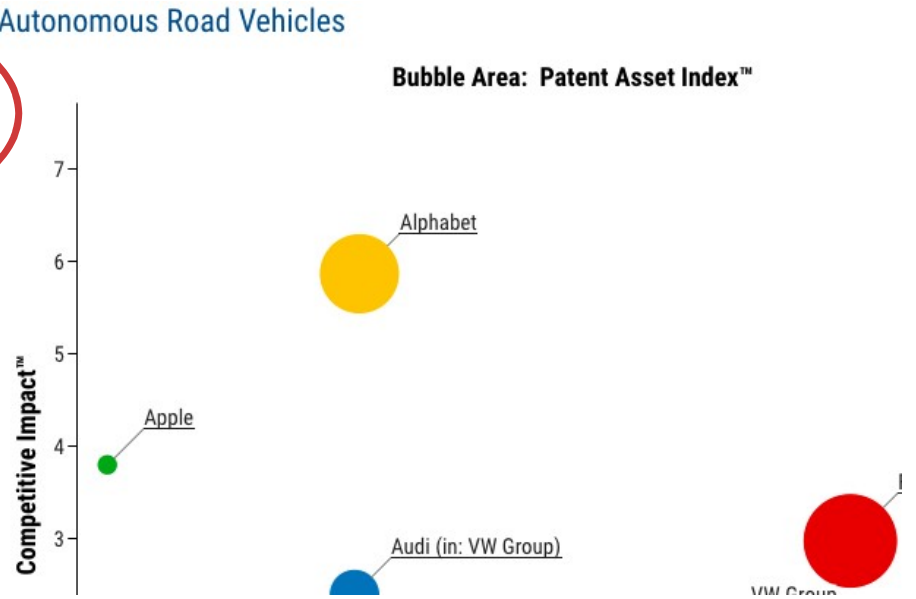
AV Product Debut by global players – OEMs, Tech companies and new entrants: Too optimistic timeline?



- AV Product launch plan by key players.
- Ford 1st debut AV product (Level 4) in 2021 - likely to be a purpose build vehicle for ride-sharing and goods delivery.
- It remains to be seen whether these AV can operate under snowing, heavy rain, difficult driving conditions and complicated environments.
- Potential M&A among SDS companies – Mobileye predicting. Each SDS requiring high level of integration of camera, sensors, machine learning S/W, and HD Mapping etc. It is an end to end system and needs wider applications via M&A for efficiency

AV Competitors relative strength and positioning



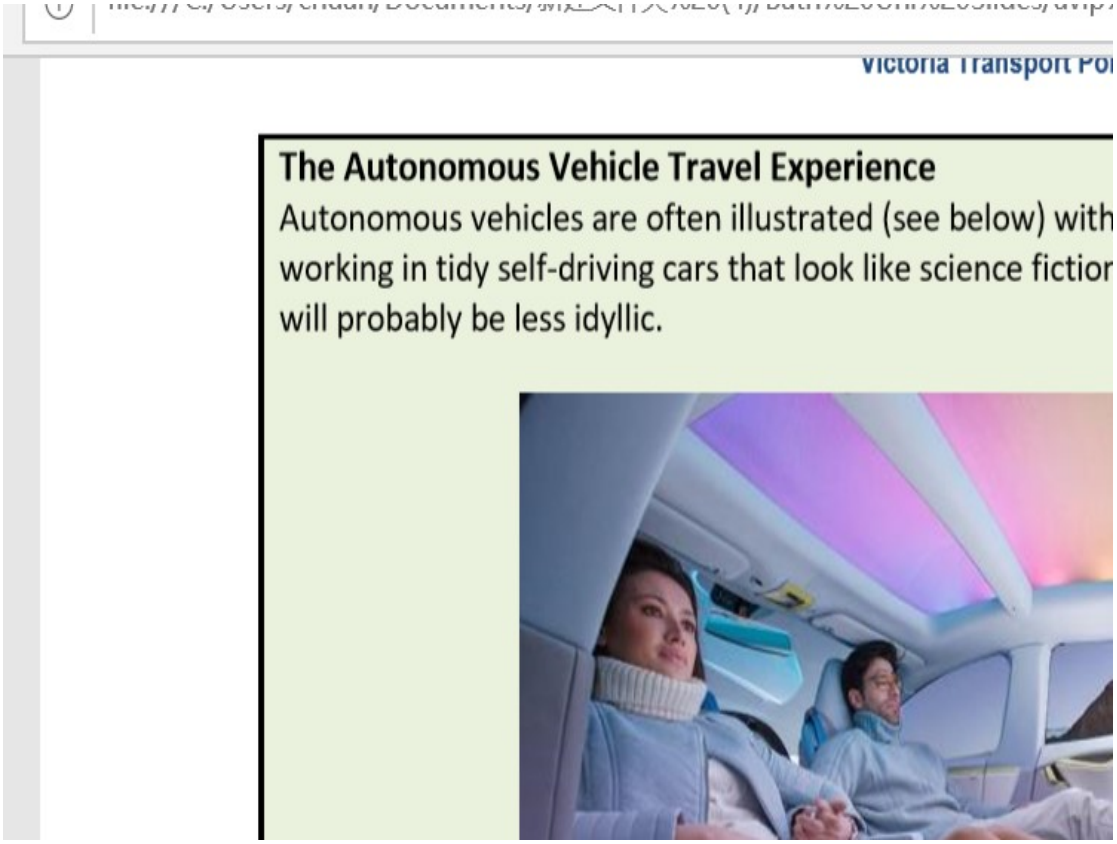


- Ford is one of the top tier companies who are leading Self Driving technology in terms of patent, fleet vehicles, AV strategy and executions
- It is believed that Ford is about 18-24 months behind GM for technology maturity. Can Ford leverage VW alliance and combined resource in Argo to execute a winner AV product in 2021?

Examples of future AVs, dream designs and superior customer experiences

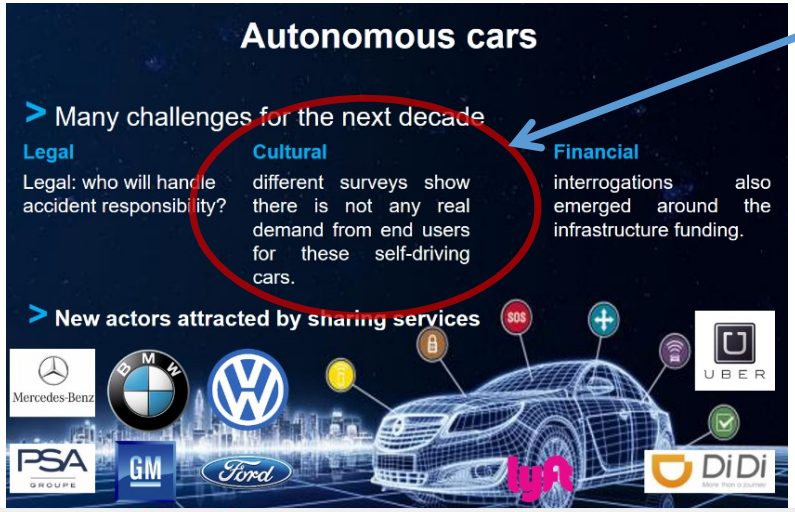
- MB F015 Luxury in Motion - mobile living spaces
- Six display screens that turn the car's interior into a "digital arena" allowing passengers to interact with the vehicle via gestures, eye-movements and touchscreens.
- The car can locate and reach its owner by connecting to their smartphones
- Concept, gimmick?

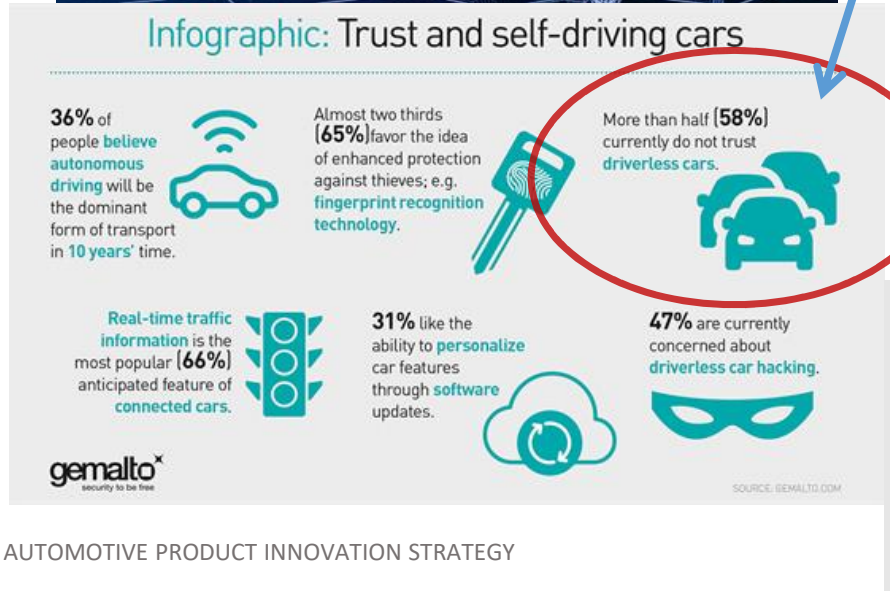
Examples of future AVs, dream designs and superior customer experiences



- The luxury moving space with full internet access and privacy would be used as a temporary office, a quiet place to rest and sleep, or a luxury "hotel" to rent
- New business models being explored in Japan and other Asian cites where private living space has a high premium
- Travelling experiences in AV will be totally transformed

AV Going forward – Key Challenges





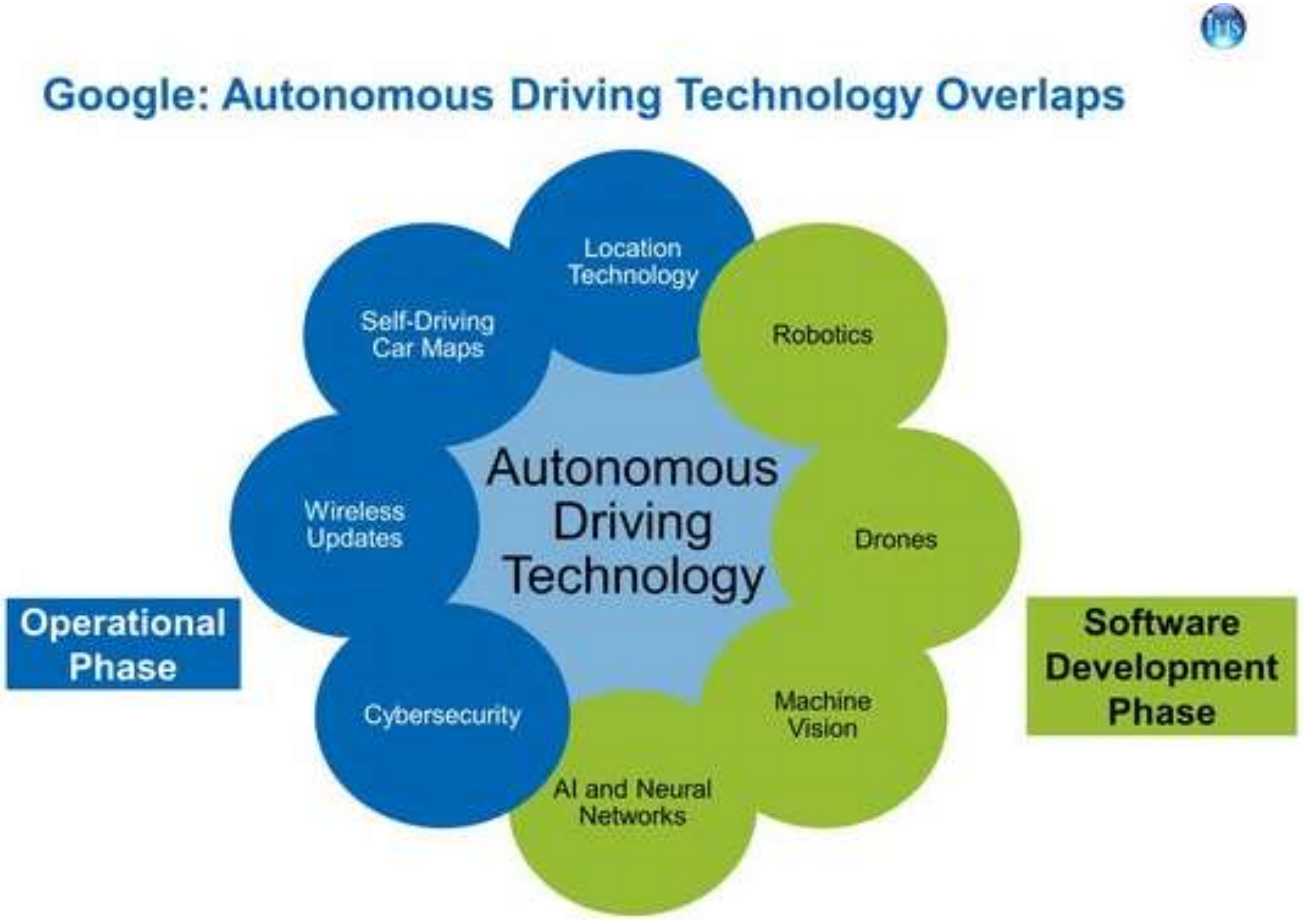
- The adoption rate for AV is uncertain for general public
- Technological hurdles need to be overcome using AI, machine learning. Define design & validation guidelines for software coding, when/what is enough?
- SDS robustness and safety are assured via rigorous testing and fleet validations, design standards?
- Legal framework in place and established for the large scale AV roll-out
- It is envisaged that initial phase of AV will be limited to robot taxi, goods delivery and ride-sharing in a defined use case, driving routes & driving conditions .

complex software then aircraft (Exhibit 9). Producing s
and ensuring that it never fails is virtually impossible. T
failures, including some that cause severe accidents.

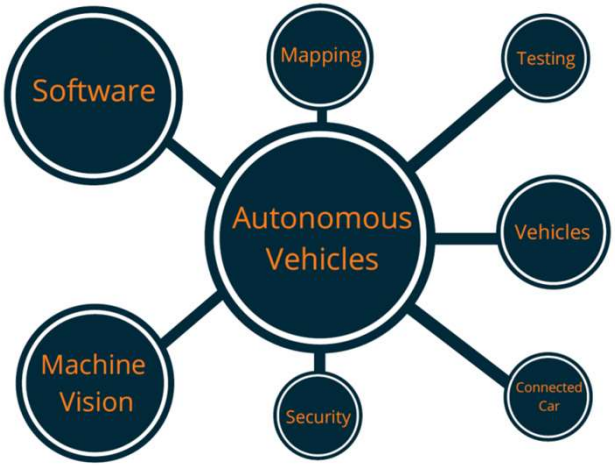
Exhibit 9 **Aircraft and Automobile Software Co**

F-22 U.S.

Google's approach to solve Software, Integration and Operations issues



- Technology leadership is at the heart of AV progress and developments. Machine vision, Learning and SW are keys
- Waymo's roadmap for solving technology, operational challenges - a holistic and coordinated approach for SDS leadership.

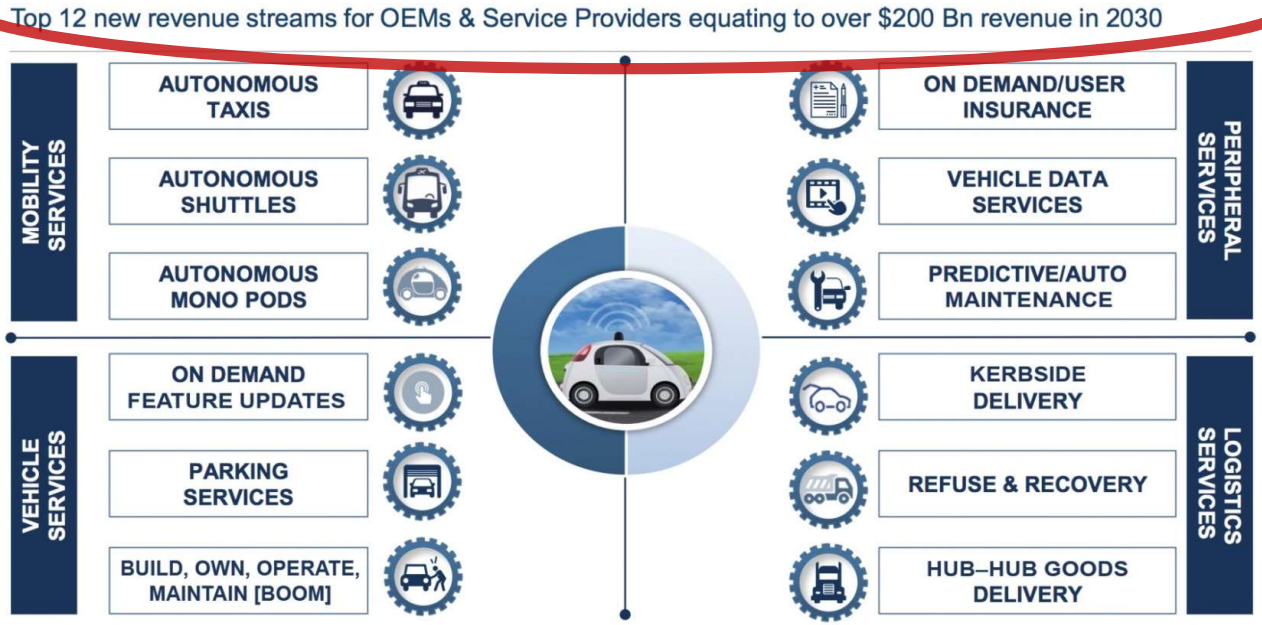


Waymo CEO acknowledges the major challenges ahead for AV

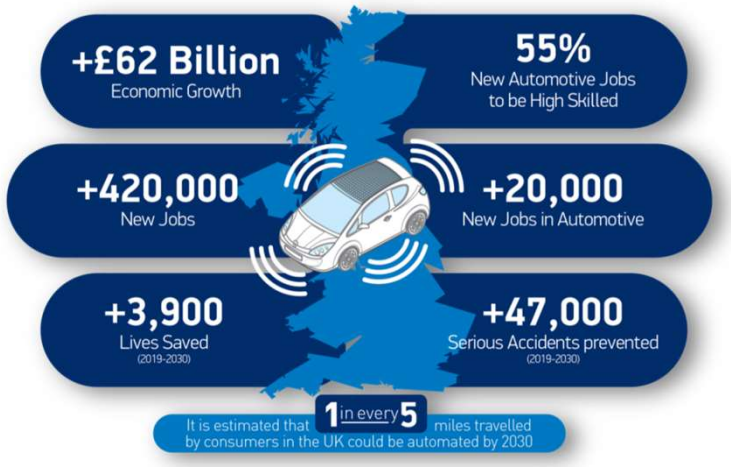
… As for self-driving cars, five years ago some analysts had forecast that the AV market share would approach 80% by 2035. But more recently Waymo's CEO conceded that it could be decades before autonomous cars are routinely seen on roads. **He added that AVs may never be able to drive without human assistance in difficult conditions**, such as bad weather or areas crowded with construction or emergency equipment

Implications & Key take-away

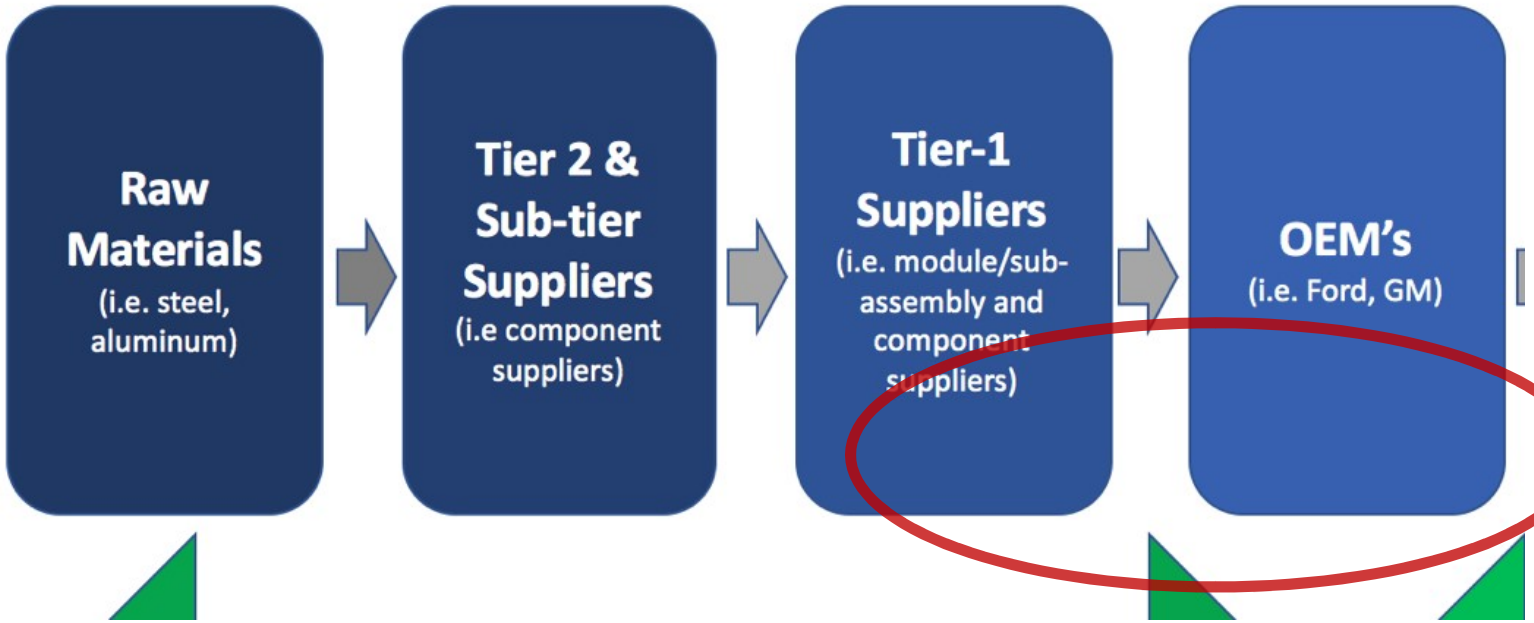
Impact of Auto Innovation of CAV on future "Mobility Economy"



- Auto product innovation Megatrends not only drive total transformation of automotive industry, but also generate increasing economic and business activities and revenues.
- Many jobs will be created by the sector

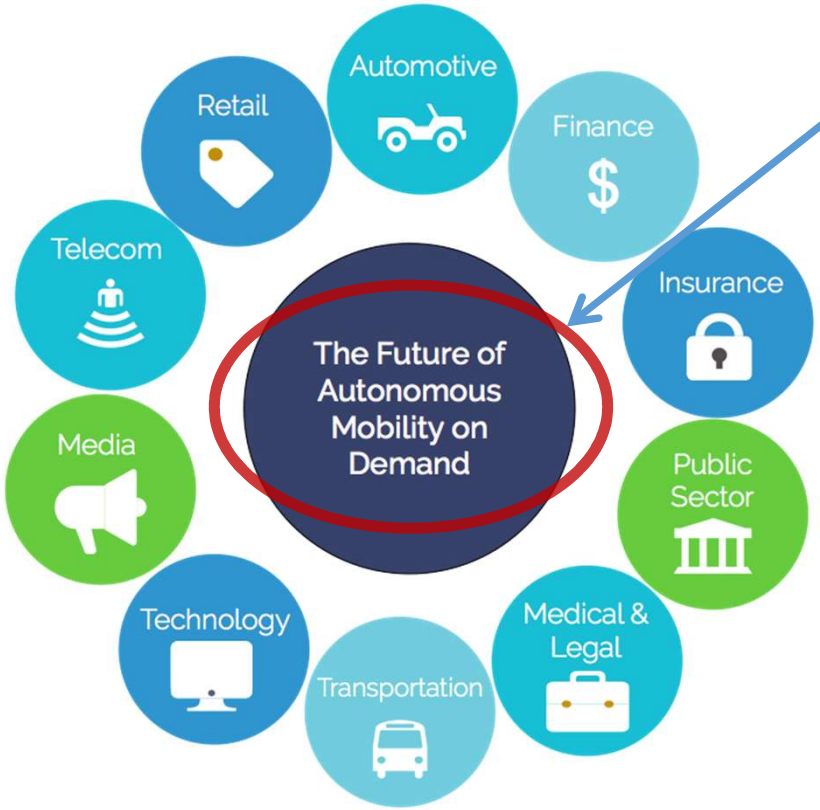


Digital Impacts on Automotive OEMs – Supply Chains and Mobility services



- Transforming Ford - Supplying Mobility in a Digital World
- Reinvent the company for the future, driven by the new age of digitalization and connectivity.

Many Industries will benefit from automotive product innovations and revolutions with CAVs

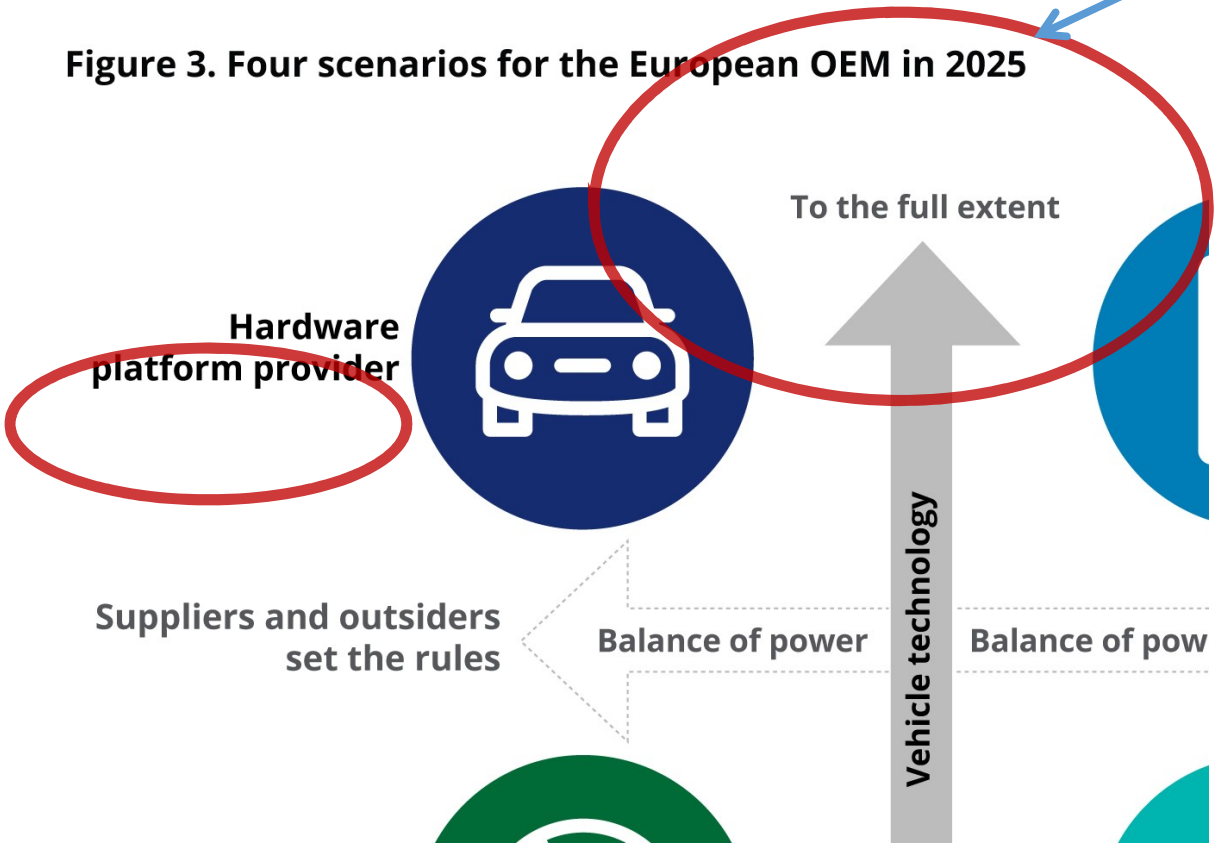


- CAV leads to Autonomous mobility on demand – high stake with immense impacts on wider industries and economy
- Large capitals, new start ups, OEMs and Technology firms' resources are being poured into CAV and mobility related fields in order to obtain technology leadership, advances and future "killer" products and services
- There are many emerging business models, opportunities and additional scopes for auto related industries driven by CAV and mobility on demands
- Auto OEM is only one of many players in the ecosystem

Desired Future Role of Auto OEMs – Technology and Mobility Managers

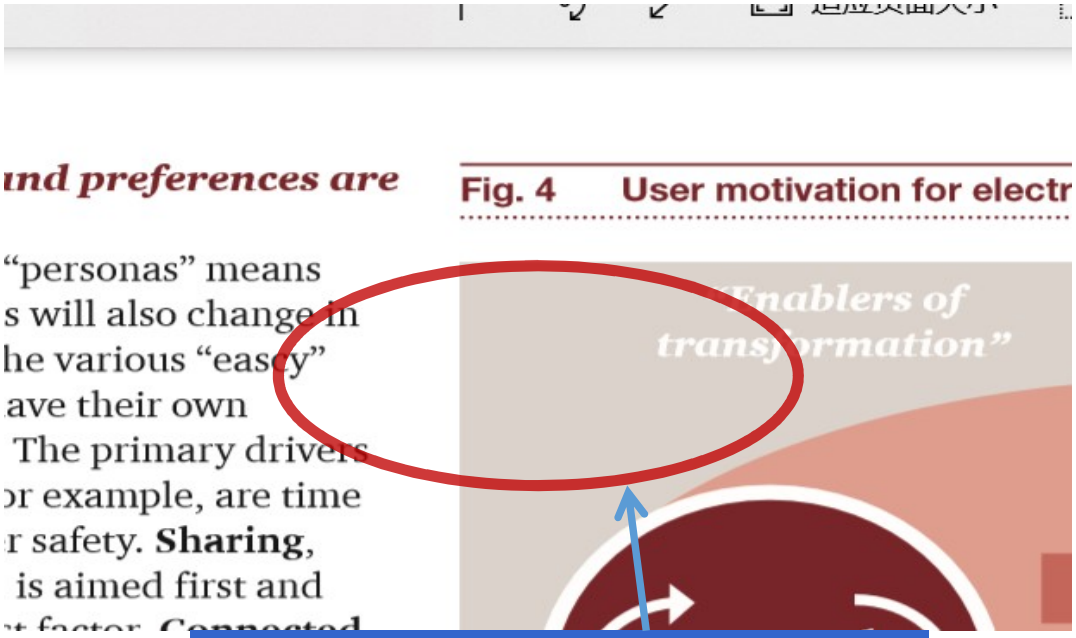
Desired area for Auto OEMs

Figure 3. Four scenarios for the European OEM in 2025



- Traditional Auto OEMs need to catch up with Tech companies with **digital proficiency, internet software skills, sophisticated Algorithm and Coding,** new technological capabilities, AND to restructure their business model at the same time to become dominant players in smart Mobility service arena
- This is why major OEM like GM, VW and Ford are using both in-house engineering and Alliances for key technology innovations for CAV in order to maintain dominant power, avoiding to become a supplier to Tech giants in the future – **this is a multiple prong strategy.**

4 Automotive Product Innovation trends – self re-perpetuating and self-reinforcing growth trends, they will converge



Shared Mobility demand CAV development; CAV push for Mobility applications （PwC Model)

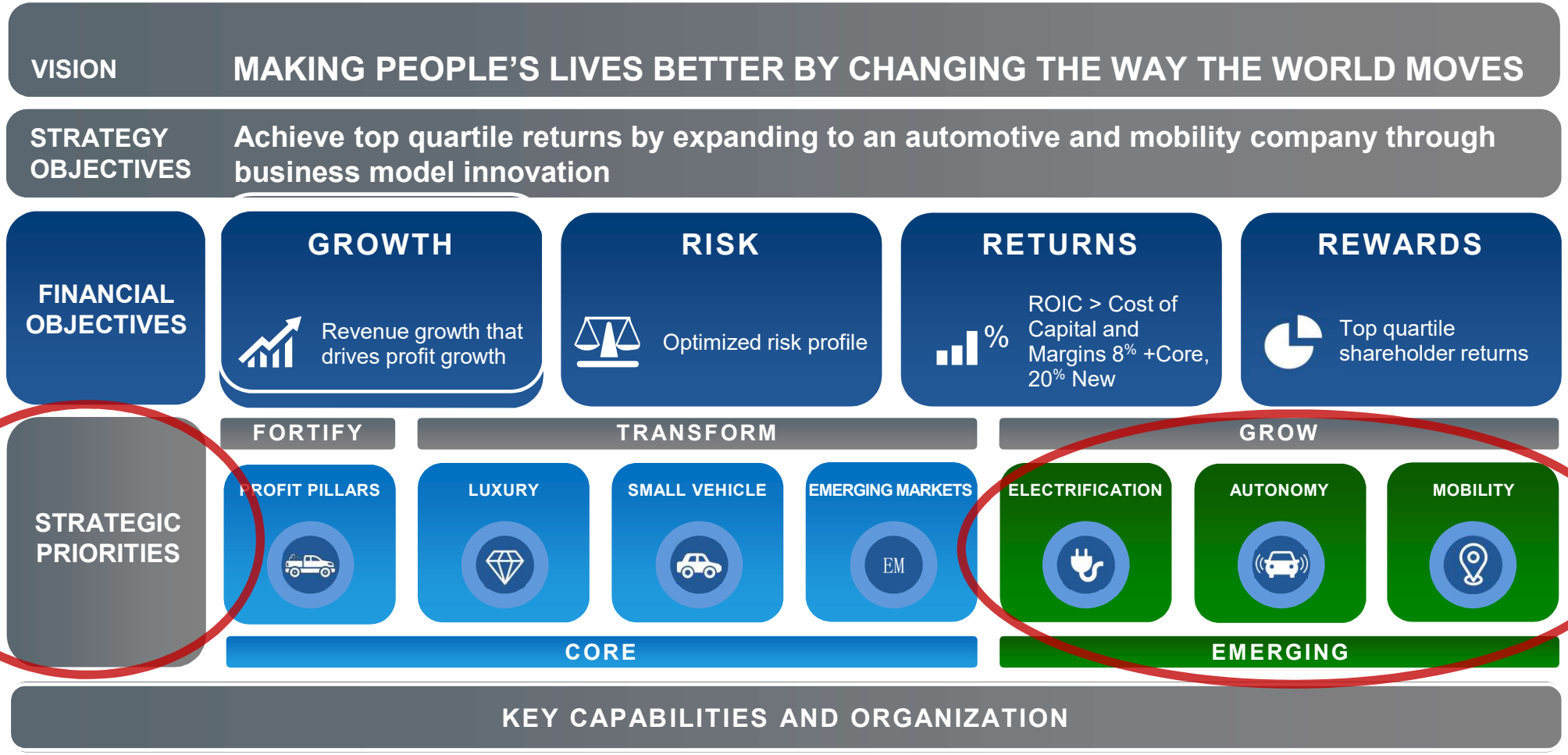
- 4 Auto megatrends will reinforce each other, creating a self perpetuating trend for business growth and broadened scope for social and economic possibilities.
- EVs have less parts and are less susceptible to failure due to simpler power train – this is a significant advantage where vehicles are being shared and used intensively.
- Self-driving cars, 'robotaxis' are easily combined with the sharing concepts
- The future is autonomous shared mobility on demand（按需点播式的自动驾驶分享出行服务）

Reduction of OEM New Product Go-To-Market to 2-3 years

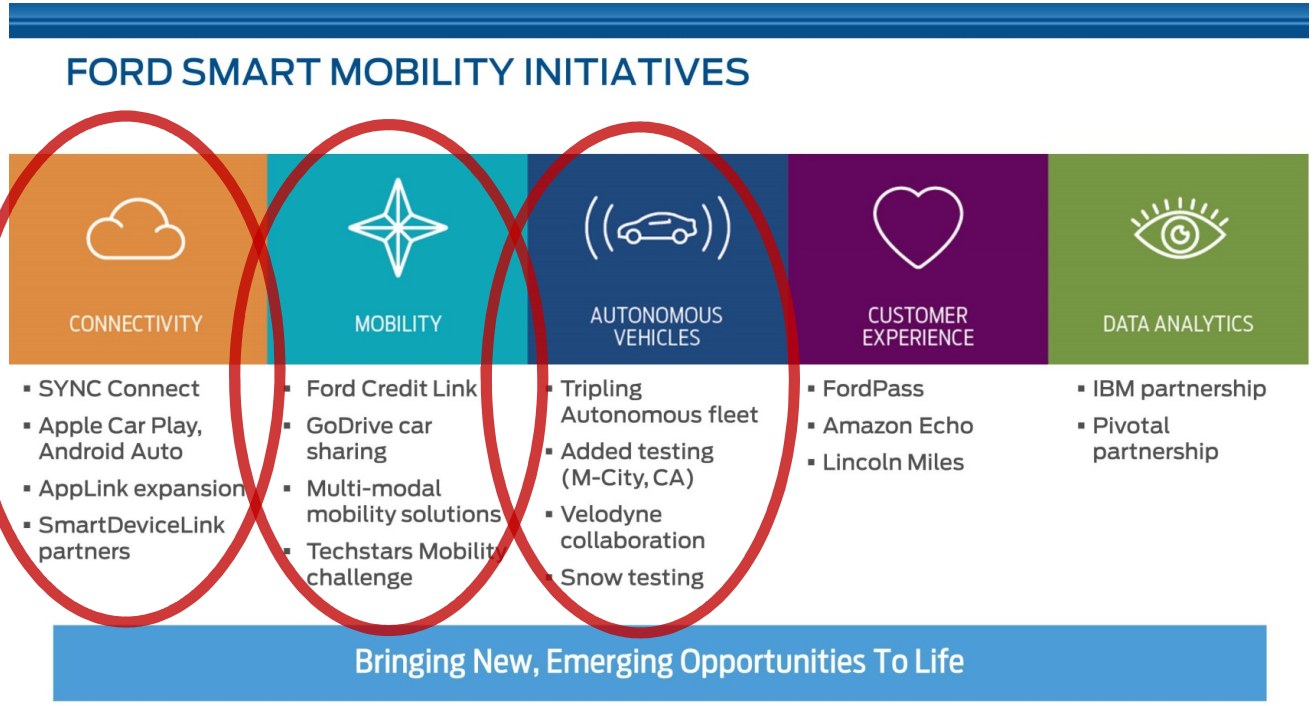
- The new product introduction will be faster due to simplified EV vehicles. BEV production processes are simpler too.
- Auto OEMs are facing polarization and diversity of product offerings
- On one hand, business and market require utilitarian, simple "throw-away" cars for autonomous ride-sharing; on the other hand, they need to offer highly customized individualistic vehicles for differentiations
- OEM Factory digital transformation – more efficiency and productivity with robots and less people

Strategic Priorities & Key Considerations – Ford Motor Company Examples

FORD'S STRATEGIC FRAMEWORK – C.A.S.E AS KEY GROWTH AREAS

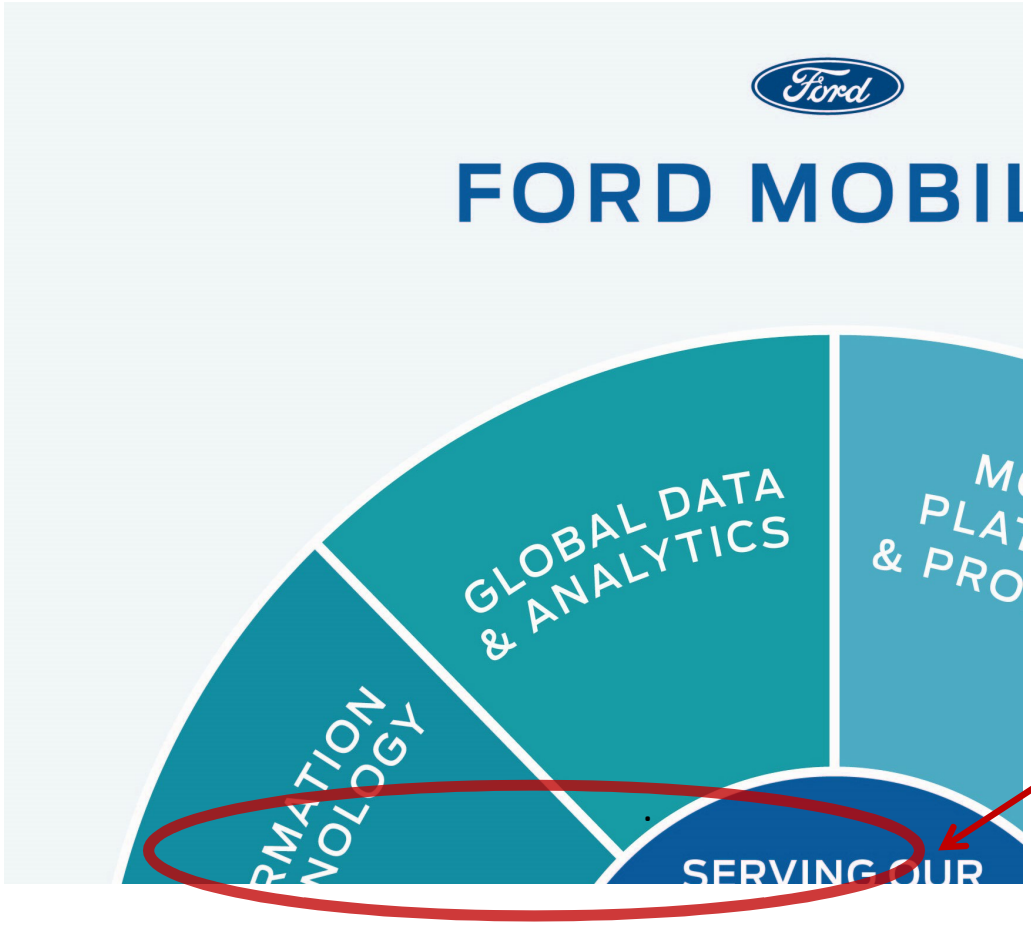


Ford has to evolve its business model to stay relevant



- Digital disruption has forced Ford to reconsider its core business model
- The organization is moving from an auto company to a mobility company.
- To enable this, Ford has created a wholly owned subsidiary, Ford Smart Mobility LLC – developing transport solutions

Ford Motor Company to Ford Mobility Company



- Ford created a new subsidiary company called **Ford Mobility LLC 2016.**
- Ford Smart Mobility LLC designs, builds, grows, and invests in emerging mobility services. It collaborations with start-ups and tech companies.
- Ford wants to become the most trusted mobility brand in the world,
- Transition into the '**Ford Mobility Company'**

Ford AV LLC as an independent company to develop its Self-Driving Technology for Ford vehicles

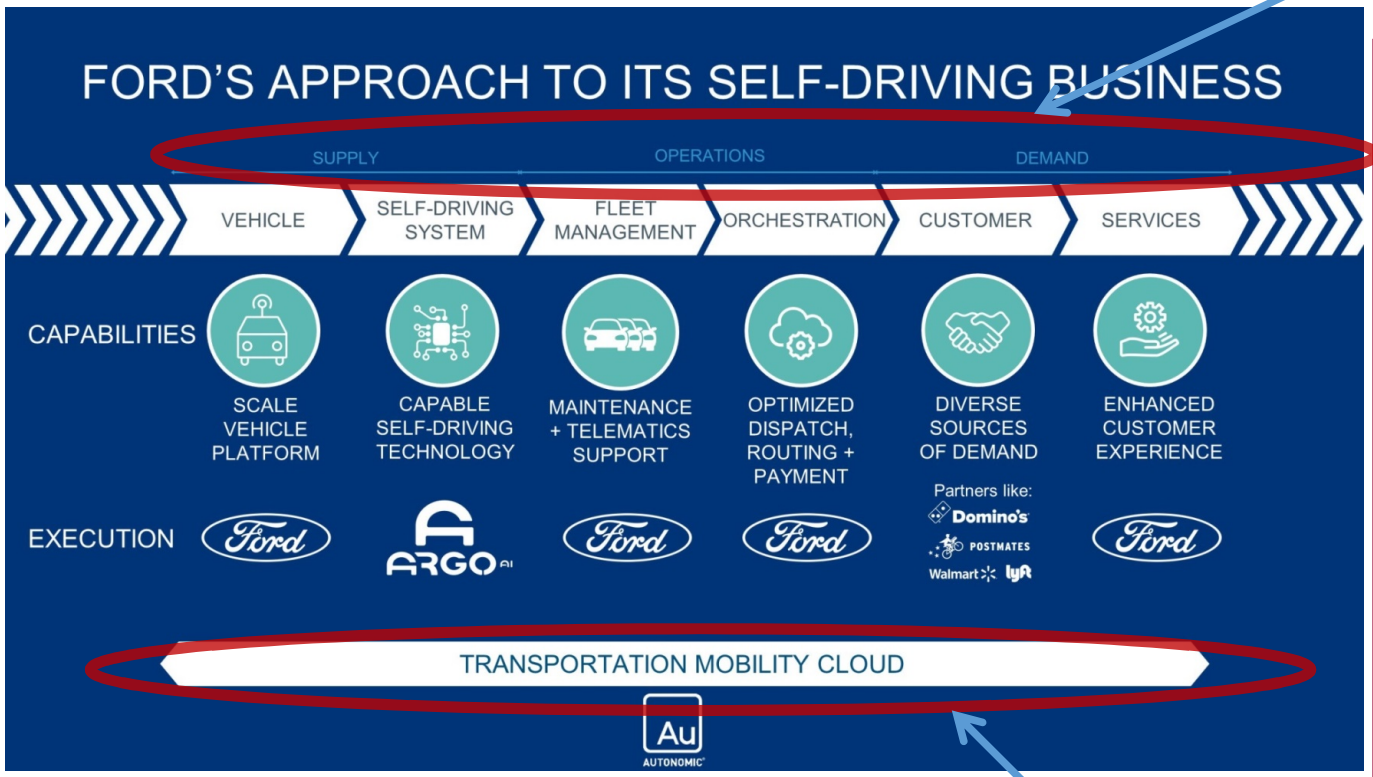
- Ford created a new subsidiary company - **Ford AV LLC in 2018**. It houses all self-driving vehicle efforts including SDS integration, AV research, advanced engineering, Software and App Programming Interface, AV TaaS network development, user experience, business strategy & business development.
- Ford is planning on investing $4 billion in AV development between 2018 to 2023, including its $1 billion investment in Argo AI
- This new organization has its own management structure and compensation so that it can attract the brightest engineers and operates independently from Ford structure

Ford Examples: Key Financial Metrix 2018 FY – Automotive sector

EBIT & Net Income

- FY Auto net income reduced due to lower Europe & China results – next slide
- Large losses in Smart Mobility LLC due to heavy investment in self-driving vehicle development and mobility services

Ford Self Driving Vehicle Business Model & Ford AV value chain strategy - Will it work?

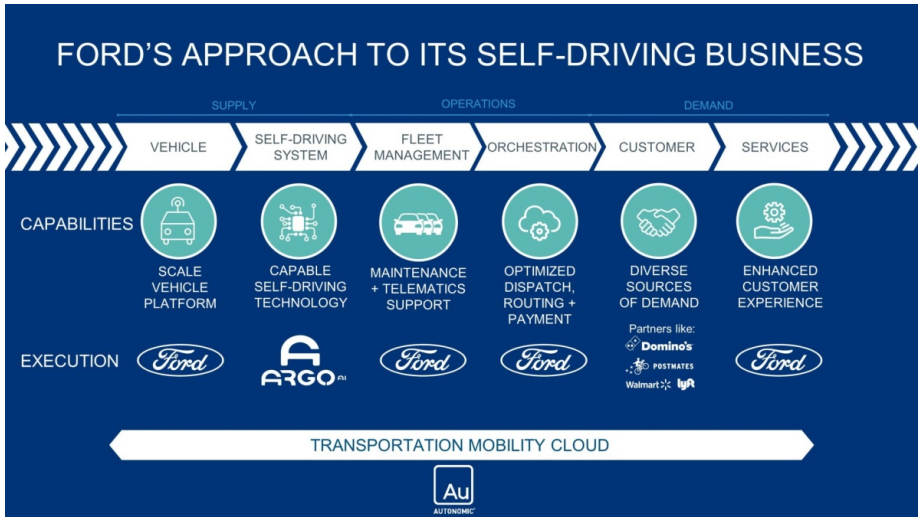


Managing Supply, Operations and Demand very differently

Ford TMC – a key enabler

- Ford AV will focus on ride-sharing and delivery services —at least initially.
- **Develop and manufacture self-driving vehicles at scale at affordable costs**.
- Ford will partner with **third-party ride-sharing and delivery companies** to deploy the AVs – **Out-Sourcing the Demand**
- It will be a unique design optimized for autonomous driving in commercial service.
- Key factor to consider: Accessibility, Affordability and Convenience

Ford Self Driving Vehicle Business Model – Ford AV value chain strategy - Will it work?



- **It will be a hybrid. Because hybrids have advantages over BEV for AV.**
- Hybrids don't require downtime for recharging
- They can power sensors and computer systems without compromising range
- Fleet operators like them - the technology is familiar and proven
- The self-driving-related systems will be fully integrated into the vehicle – designed-in from the start, rather than added to a human-driven model

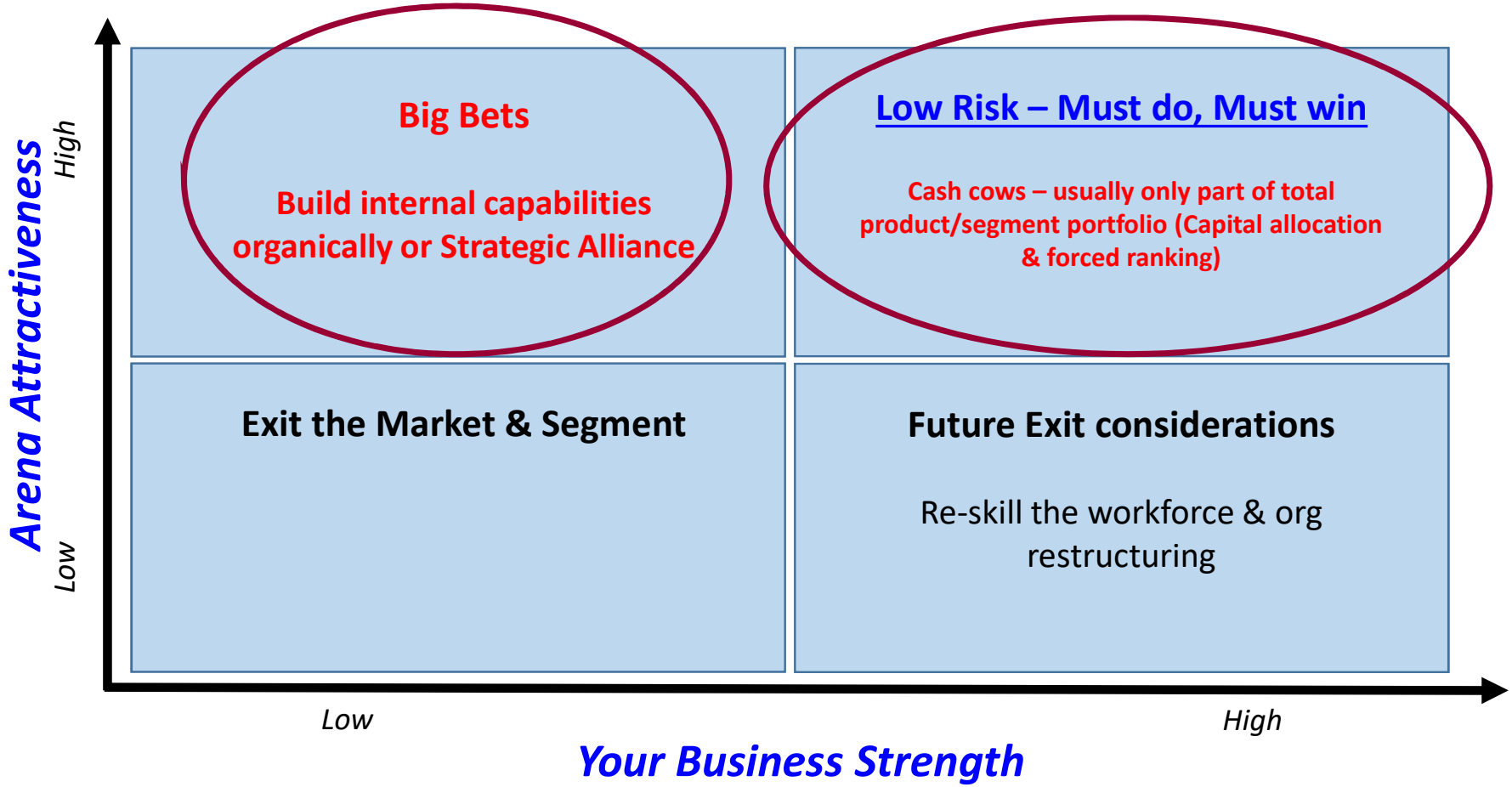
Dural purposes - Need to deliver goods and moving people (ride sharing)

Rise and Fall of Ford Chariot and further Mobility purchase

- Ford acquired Chariot in 2014. Chariot offers on-demand ridesharing via Ford Transit shuttles, looking to supplement public bus routes and local trains. Chariot uses commuter routes that are not well served by existing solutions.
- It shuts down in 2019 due to its poor market and financial performances. But Ford learns a lot for routing, dispatching & customer interfaces – will be used for Ford Commercial Solutions, its fleet telematics and data arm.
- Ford admits that running a profitable transportation business is hard
- Ford Smart Mobility LLC, acquired San Francisco-based scooter rental firm **Spin** in 2019 - **Shared electric scooters.** Is the experiment going to work this time?

Strategic Arenas Framework in Practice & Key Considerations –

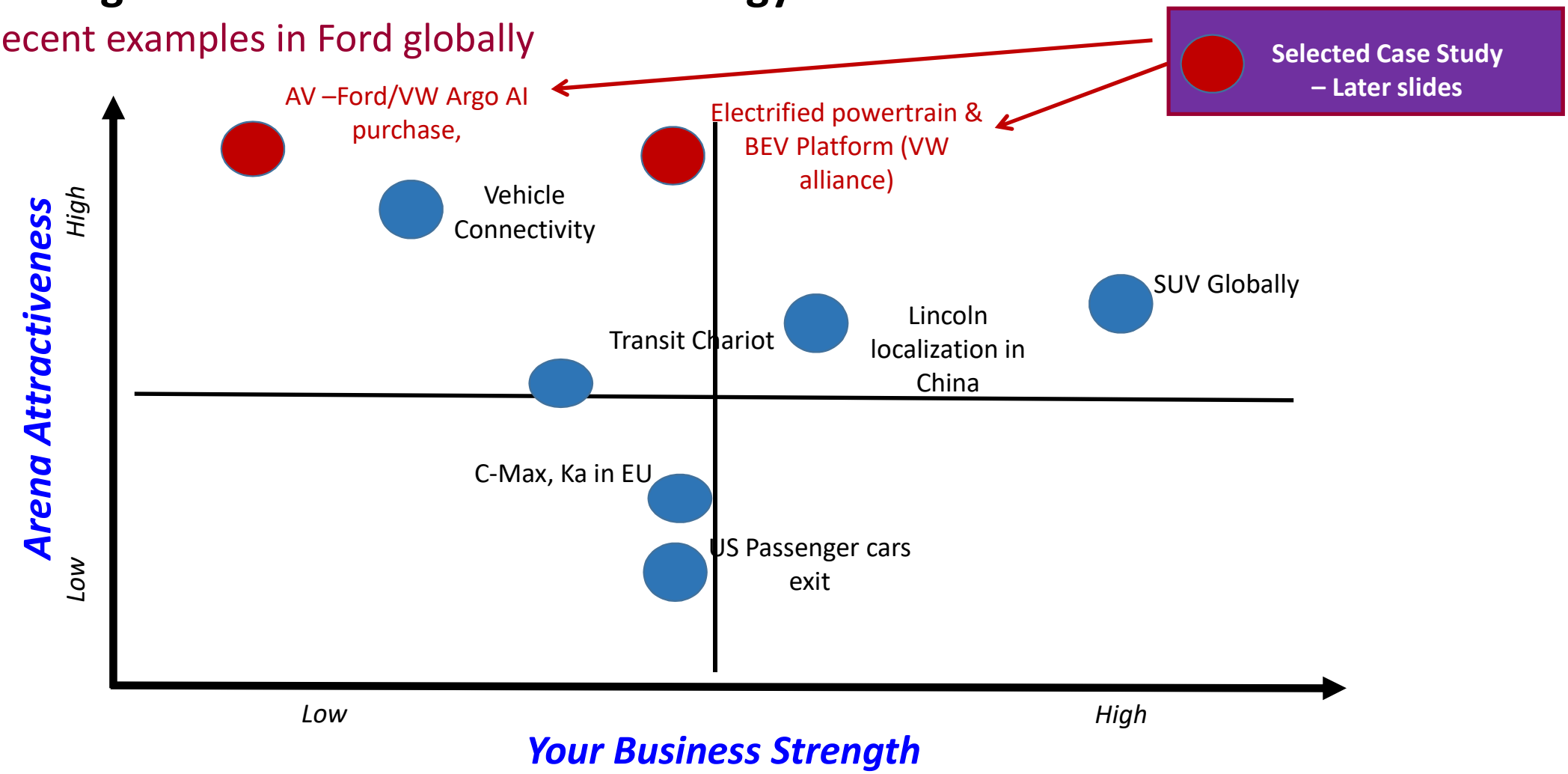
Creating your own strategy map – **re-adapted**



Source : Adapted from *"Winning at New Products"* Revised and Updated Edition, RG Cooper, 2017

Strategic Arenas – Ford Product strategy & Innovation

Recent examples in Ford globally



*Source : Adapted from *"Winning at New Products"* Revised and Updated Edition, RG Cooper, 2017

Strategic Arena

An Strategic Framework - Where to play and how to win?

- **Which Markets:**
  - North America
  - South America
  - Europe
  - China
  - RoW/Emerging Market

- **Which Segments:**
  - SUV
  - Passenger Cars
  - Commercial vehicles
  - Performance
  - Others

- **Which Technology**:
  - ICE
  - PHEV, HEV
  - BEV
  - ADAS
  - HMI
  - Mobility
  - Clouds TMC
  - Self Driving Systems
  - Others

- **Which Alliance & Partnership?**
  - JV for Mfg
  - Collaborative PD
  - Strategic Alliances
  - Shared platform
  - Shared Technology
  - Complete M&A
  - Buying into start ups
  - Others

Strategic Arenas Model – Key Considerations for Market & Product Exit and Entry

Strategic Importance

- Strategic role in the company portfolio
- Does this fit overall long term strategy
- Consistent with Company vision and strategic goal

Long term profitability

- Market and segment attractiveness
- Revenue growth potential, profit pool
- Operating cost and profits
- ROCI and ROS

Market & Business Impacts

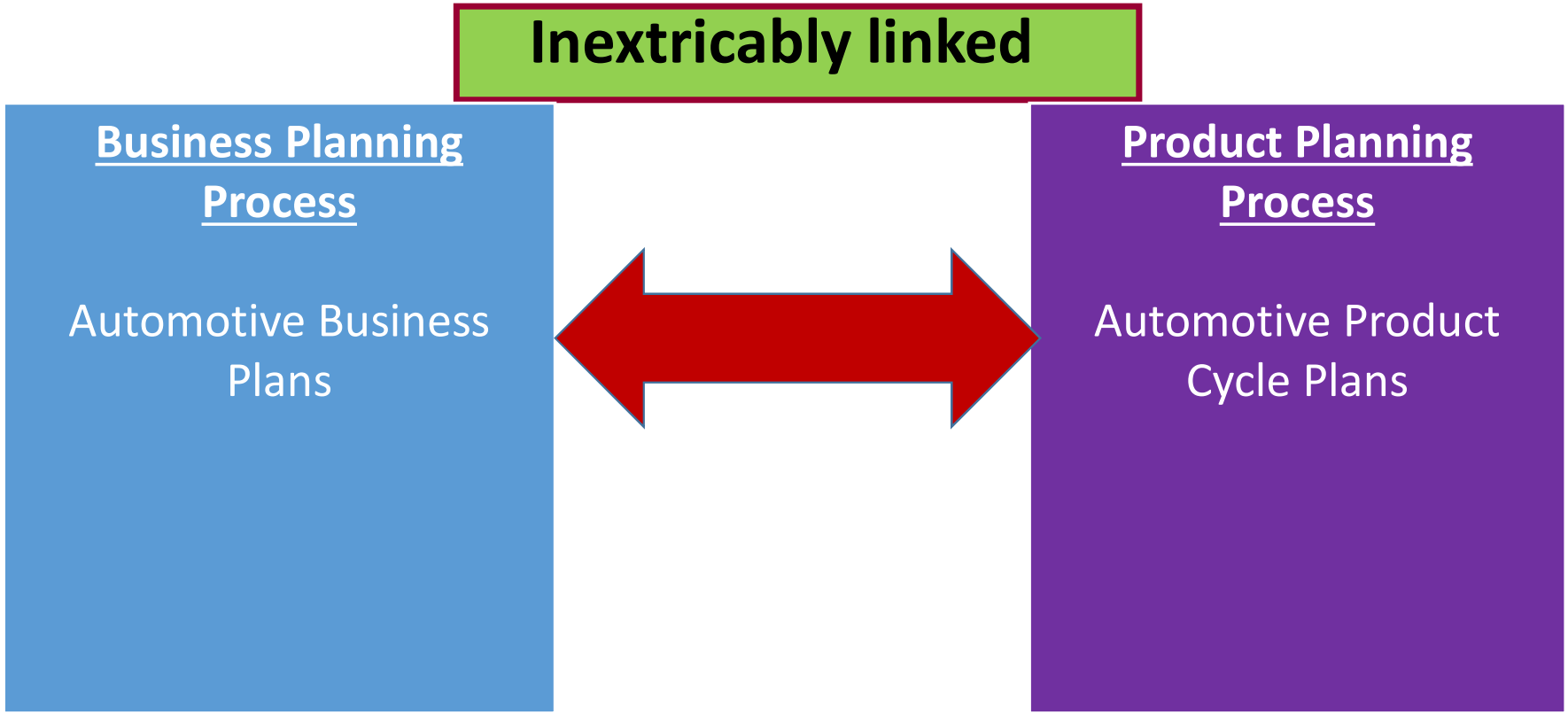
- Global footprint (Mfg, PD, MSS etc)_
- Dealership and customers
- Supplier liability and exit penalty
- Brand impact

Capital and Competence

- Restructuring effort and organizational impact
- Resourcing, Internal capabilities and competence
- Capital allocation & ranking criteria

Automotive Product Life Cycle Plan – heart of company strategy & planning

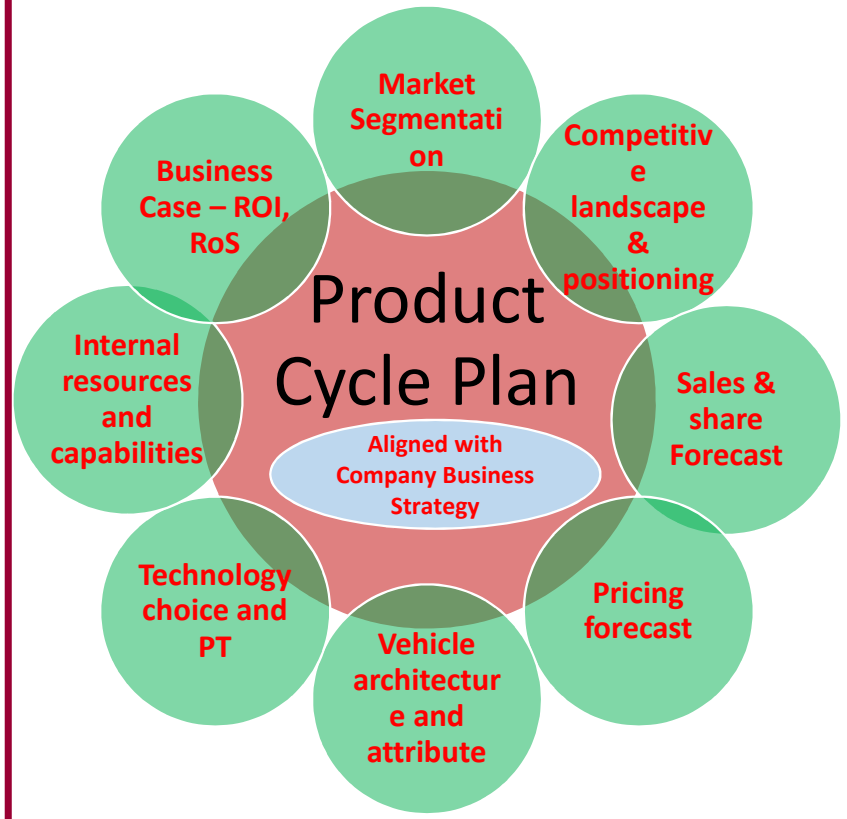
… provides robust product pipelines to support company business plans - Critical to company's future success



Automotive Product Cycle Plan Process – At a glance

…….covering products, technologies, markets, strategies, competitions etc.

- **Automotive Product cycle plan process involves analysis and considerations of many external, internal, vehicle & Technology factors**
- **It is a critical cross functional effort to support company's business growth plans, market & profit strategies**



Key considerations of product cycle plan process

Covering wide range of company business activities and areas, requiring senior management alignment on directions and decisions…..

- **Market & Industry Analysis :**
  - "Futuring" process for market current states and future states
  - Market structure, segments, size/volume
  - Competitive landscapes, positioning
  - Expected sales, share and pricing – analysis and justifications
  - PESTLE
  - Consumer preference and trends

- **Product & Technology Options:**
  - Architecture/platform, size
  - Product features, attributes, performance targets
  - New Technology choice including drive train, connectivity, etc
  - Product Contribution costs

- **Business Case:**
  - Aligned with Business strategy and vision
  - Profitability RoS
  - Investment Return – ROCI
  - Capital allocation
  - Resource availability – e.g Engineering HC
  - Plant Capacity Planning
  - Risk assessments

Ford Aspirations - Best-in-lass Product Quality in C.A.S.E. contexts

'FOUR PILLARS' OF GLOBAL PRODUCT STRATEGY

- Product Quality Strategy is an integral part of overall company business strategy, inextricably linked to sales, market share and company bottom line
- Vehicle product excellence requires robust and compelling design, flawless execution and capable & repeatable manufacturing processes.
- User experience (UX) – covers all aspects of product. Supreme UX is the outcome of deep understanding of customer insights and preferences.
- Maintaining a consistent and long lasting product quality with more and more complex technologies and their integrations (C.A.S.E.), legislative requirements and consumer demands is challenging for all OEMs

Ford Global Product Development Process (GPDS) Ensures "Design in Quality"

Ford's quality offensive plan….

Design in Quality

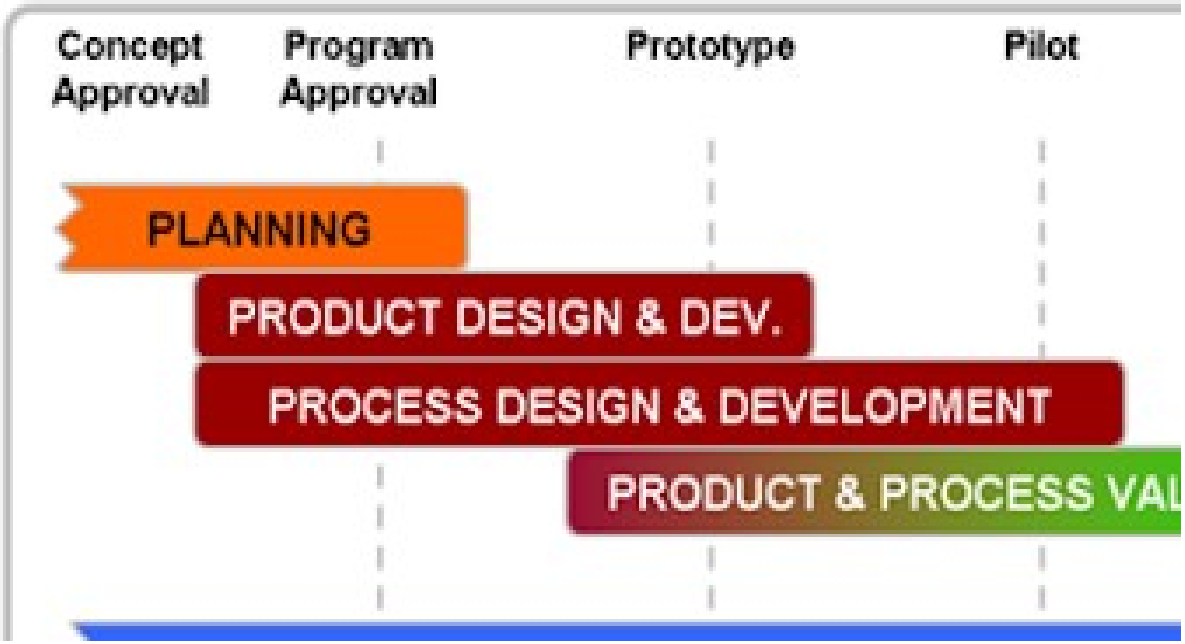
- Standard global process
- Global Product DNA: looks, sounds, feels like a Ford
- Don't compromise customer wants for lower cost
- Verify designs further upstream through virtual tools

Build in Quality

- Read every claim, every day; address in 24 hours
- Virtual manufacturing to reduce worker injury/strain
- Each assembly function (body, paint, etc.) has a dedicated team of problem-solvers

People Quality

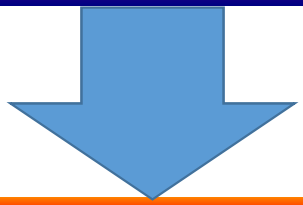
- Developing a critical mass of problem solvers
- Ford has trained over 90,000 Green Belts, over 9,000 Black Belts and over 500 Master Black Belts worldwide
- Ford has over 900 technical specialists



- Product Design quality is achieved by a robust planning, product and process design and verifications before the product launch. Structured Product Development process and Advanced Product Quality Planning (APQP) are to ensure product quality is "designed –in" before the build and leaving for customers
- Ford GPDS involves extensive use of high fidelity CAE modelling, digital pre-build to assess design robustness & reliability, performance and functionality of components and systems. Extensive key-life testing and rigorous engineering sign off are to ensure product design quality

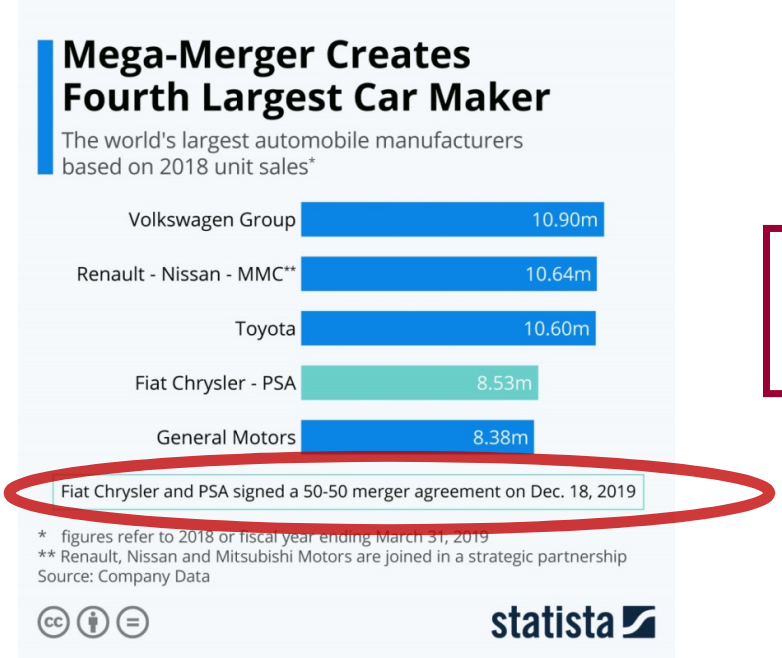
Auto OEM Alliance and Partnership Example

Ford & VW Strategic Alliances – 2019



Joint investment in Argo Self-Driving, CV Partnership & BEV Platform Sharing

Some Automotive OEMs prefer a full merger, some prefers strategic alliances



VS

- Western OEMs resort to mega merger to create global scale and synergy. Merging two cultures can be difficult and take times
- Ford and VW alliances is more pragmatic to address specific issues for technology co-development and platform sharing for CV segment, and Ford using licensed VW BEV platform

Ford – VW Strategic partnership - Not a Merger

One of the biggest strategic alliances Ford has set out in recent years

- The Ford/VW partnership will address **three strategic arena** issues – Self Driving technology, Electrified vehicles & Commercial Vehicle platform sharing
- Both firms need scaled products and technology to defend their dominant global market share leading positions
- One shot kills three birds……. Win-Win for both after a lot of "horse trading" behind the screen
- A very balanced package deal reached…..

VW's Sustainability reputation has been tarnished by the Diesel gate scandal – Any negative impacts for the Alliances?

- Publics statements on sustainability and company's actions in real world can be different things
- VW scandal has prompted automotive OEMs to have more rigorous internal audit and assessment procedures to prevent similar events from happening again
- Auto OEMs are learning the lesson from the VW scandal
- The benefits of this strategic alliances outweighs the potential reputation risks. Can be carefully managed via effective communications

Two big OEMs investing in Argo AI – a Strategic fit

Strategic advantages in hugely competitive and uncertain technology development

- Volkswagen to join Ford in investing in Argo AI, the AV platform company, at a valuation > $7 billion.
- Tie-up allows both to independently integrate Argo AI's SDS into their own vehicles, delivering global scale - common Shared AV technology platform
- Ford and VW both have equal stake in Argo AI - jointly own majority of Argo AI
- VW Self-driving division in Europe is rolled in the expanded Argo's company

Argo AI is a leading technology firm in self-driving technology

Ford/VW and Argo business & operation framework: a unique 3-way partnership model

- Argo maintain its independent structure and compensation allowing it to be run like a technology firm without Ford/VW culture influence
- Argo is to provide a common SDS technology platform to serve both OEM with their unique product strategy and GO-to market plans
- A new type of three way alliance model to share the investment costs, risks, and gain competitive advantages

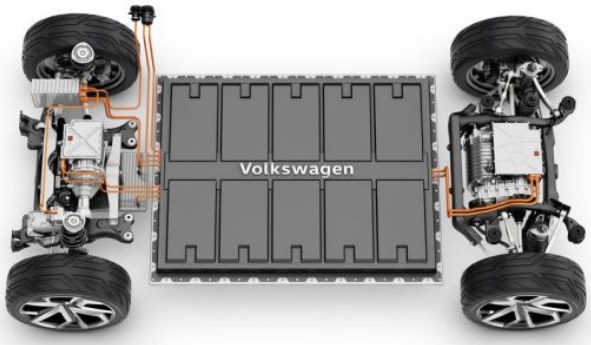
Comprehensive partnership with two big OEM - Strategic fit

Argo AI's focus remains on delivering a SAE Level 4-capable SDS

- Argo AI will provide the autonomous technology platform for Ford an VW to deliver fully integrated self-driving vehicles
- Ford and VW need to manufacture them at scale for ride sharing and goods delivery services in dense urban areas – 2021 introduction of Ford purpose build vehicles

Comprehensive partnership with two big OEM - Strategic fit

- Ford to use VW MEB BEV platform to accelerate its Eu BEV introductions



- VW's MEB architecture started in 2016, **platform costing $7 billion**.
- VW is to build 15 million cars for the group 2020-2030
- Ford expects to deliver 600,000 European vehicles using the MEB architecture 2021-2026
- VW will supply & license MEB components to Ford as a part of the collaboration

Comprehensive CV Platform sharing for global scale and market access

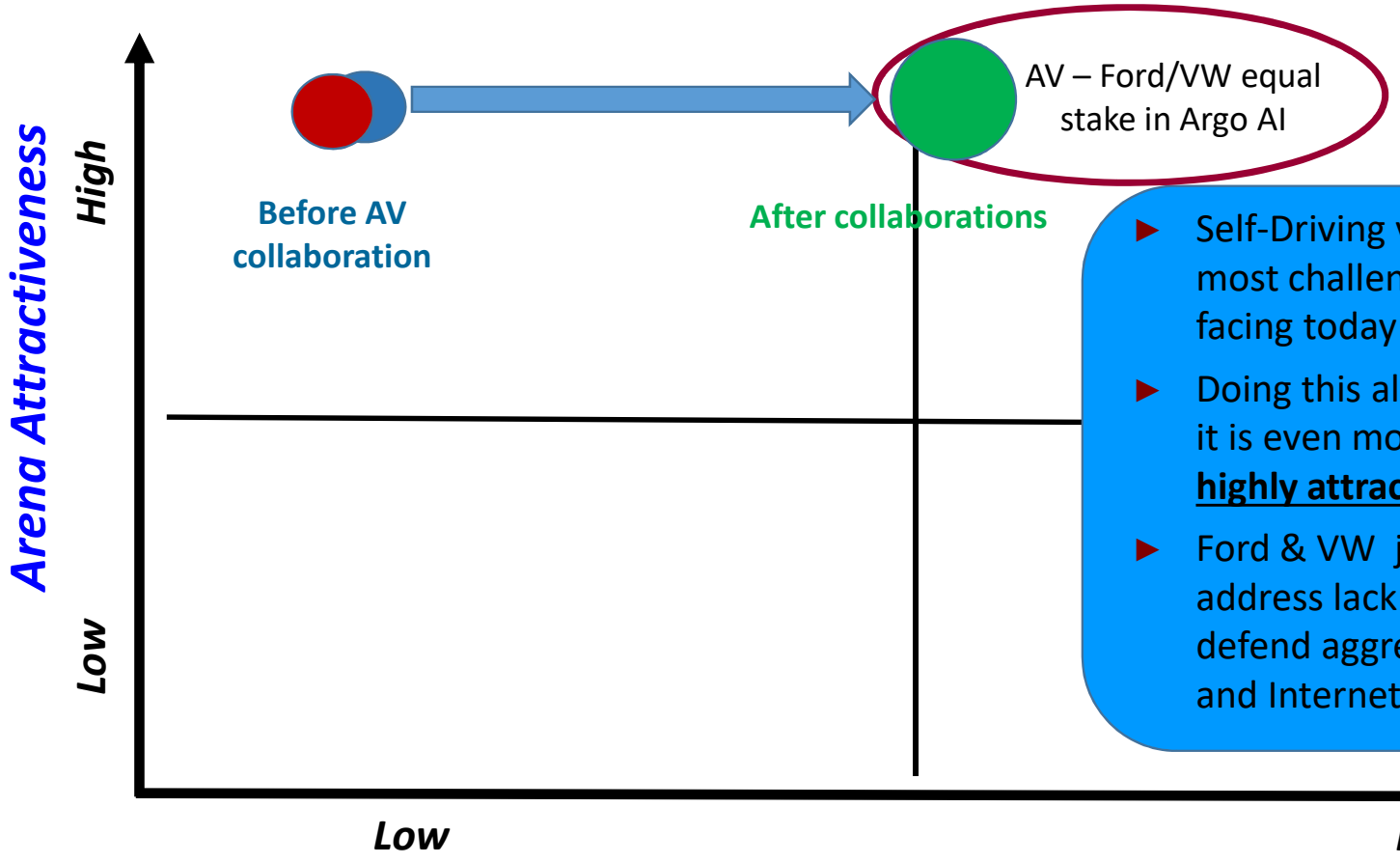
Cost saving on Product development &manufacturing – leveraging each other's strength

	Ford	Volkswagen
Pickup	Ranger	Amarok
Small van	Transit Connect	Caddy
Medium van	Transit Custom	Transporter
Large van	Transit	Crafter

- 2 Ton Category Commercial Vehicle – Under discussions
- Need to synchronize 2 ton cycle plan for both Ford and VW
- Ford 2 ton covers US/Europe,
- Ford 1 ton covers Europe

Strategic Arenas – Ford Product strategy & Innovation

Argo's independence to innovate – without Ford/VW organisational & culture influence

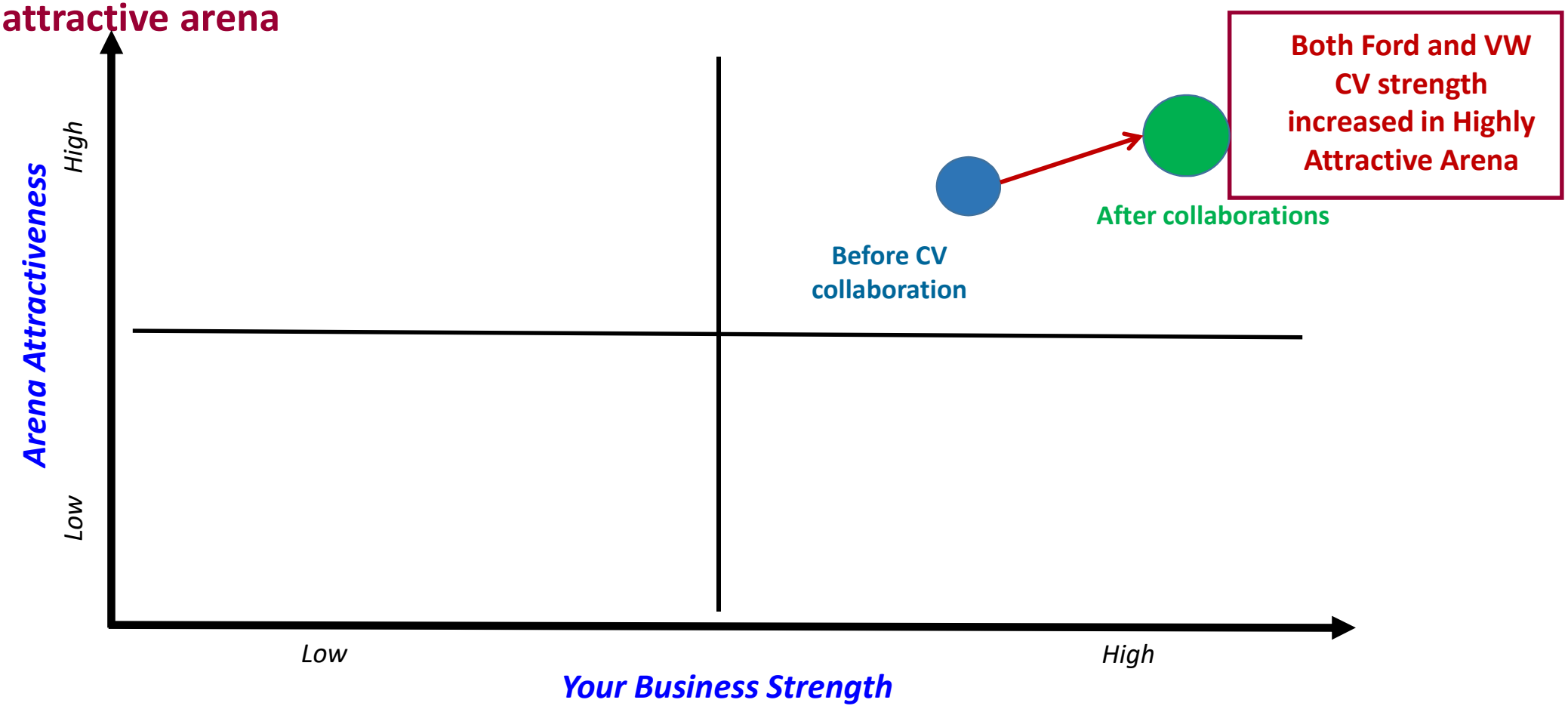


- Self-Driving vehicle is by far the biggest and most challenging technology that OEM is facing today
- Doing this alone is costly and risky, Not doing it is even more costly and riskier long term – **highly attractive arena**
- Ford & VW jointly investing in Argo is to address lack of skill/capabilities, also to defend aggressive advance from Technology and Internet firms.

*Source : Adapted from *"Winning at New Products"* Revised and Updated Edition, RG Cooper, 2017

Strategic Arenas – Ford and VW Collaboration on CV

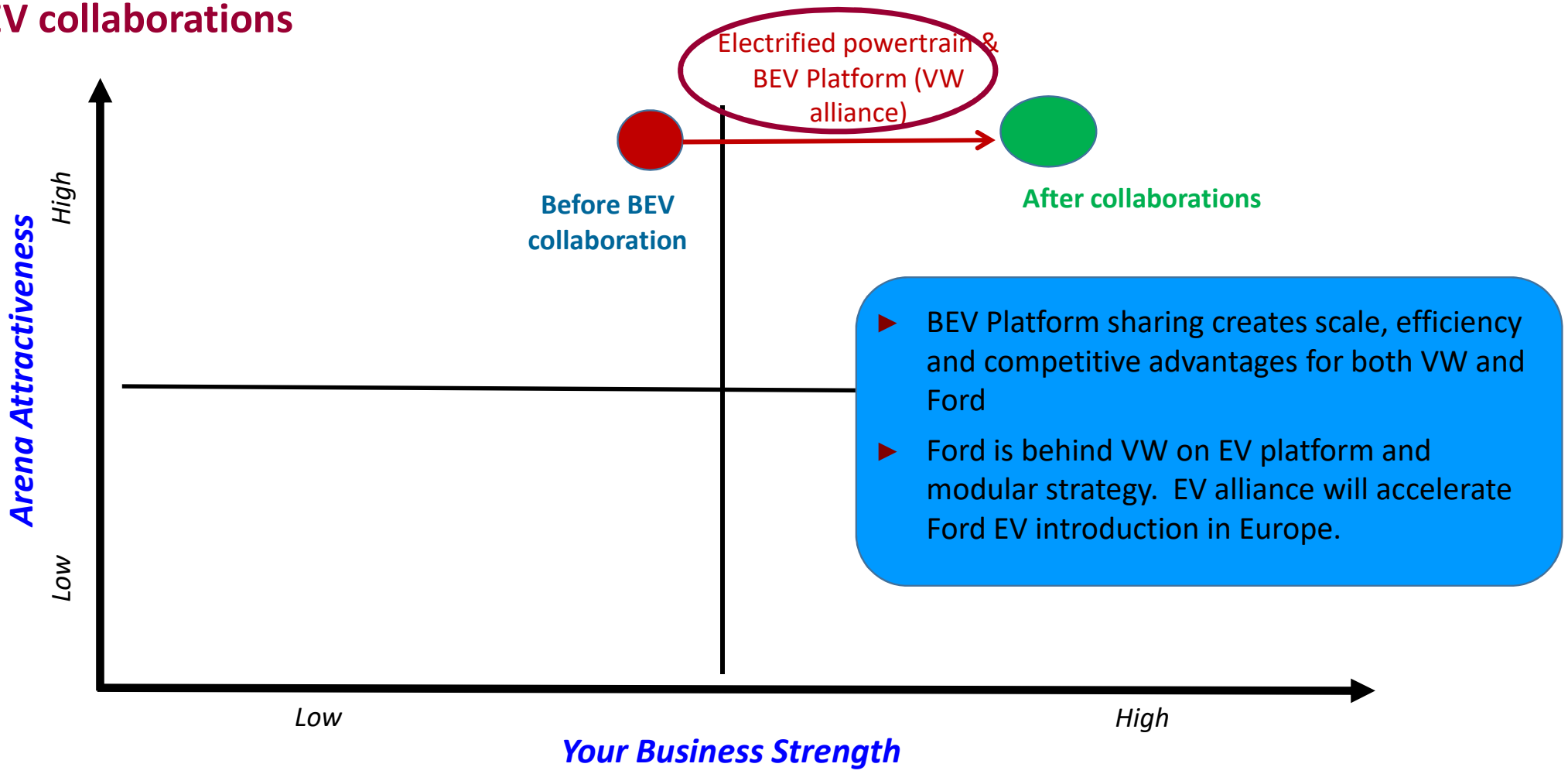
Ford, VW CV Collaboration make the strong business even stronger in the highly attractive arena



*Source : Adapted from *"Winning at New Products"* Revised and Updated Edition, RG Cooper, 2017

Strategic Arenas – Ford Product strategy & Innovation

BEV collaborations



- BEV Platform sharing creates scale, efficiency and competitive advantages for both VW and Ford
- Ford is behind VW on EV platform and modular strategy. EV alliance will accelerate Ford EV introduction in Europe.

*Source : Adapted from *"Winning at New Products"* Revised and Updated Edition, RG Cooper, 2017

Key take-away

- Auto product innovation Megatrends will drive a complete transformation of automotive industry and change in the landscape of social and economic activities
- Four megatrends predicting future vehicles will be CASE: connected, electrified, autonomous and shared
- These 4 megatrends will reinforce each other, creating a self perpetuating trend for business growth and broadened scope for social and economic possibilities.
- **CAV – Connected Autonomous Vehicle technology is the single biggest product innovation challenge in auto industry today**
- PwC reports that electrification is a key megatrend – more than 55% of vehicles by 2030 will be electric.

- Auto OEMs are facing: reduced investment return due to material & labor economics, competitions, stringent legislations, reduced retail sales/increased fleet sales and major investment spending for R&D and new digital factories
- Strong technology leadership and product innovations in AV, together with added strength and competence in digital and connectivity space will ensure that OEMs have competitive advantages over Technology companies, internet Mobility companies and other new entrants in future years.
- OEM's key considerations with **overarching principles**:
  - Specialized portfolio with **narrow focus on profit pillar products** - They need profit stream to fund costly R&D for CAV and mobility initiatives
  - Focused value proposition – Carefully decide which part of value chain to play to avoid effort and capital dilutions
  - Rigorous financial management – ROCI and ROS for investment criteria, manage risks
  - Collaborate with others in CASE-oriented innovations and capital investment (Like Ford and VW)

Questions and Answers