beyond leading technology KIAT

재외한인공학자 네트워크 세미나

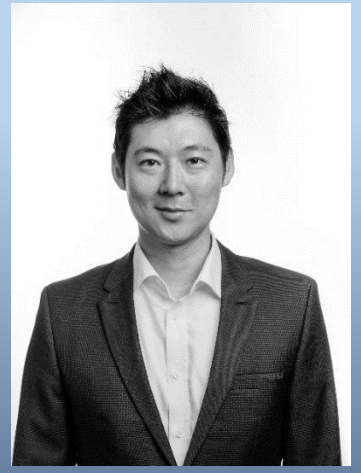
모빌리티 신기술 트렌드과 패러다임 전환
New Technological Trends in Mobility & Paradigm Shift

12th July 2023

민호건 Hogun Min, Innovation Team Leader at TMIG, NTU Singapore

Disclaimer

About Speaker



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Innovation Team Leader, Senior Research Engineer II, Translational Materials Innovation Group (TMIG), MSE, NTU

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ex) Innovation Team Leader, Ecolabs Centre of Innovation for Energy, Project Manager/Project Cost Manager, Samsung Heavy Industries

Hogun Min is an Innovation Team Manager at EcoLabs Centre of Innovation for Energy, creating and managing the investors and corporates pipeline as well as engaging in partnership with Institutes of Higher Learning (IHLs) and Research Institutes. He plans and executes the translator/accelerator and co-innovation program and scouts emerging start-ups through rigid screening and due-diligence processes. He supports overall start-ups ecosystem by technological capability building in SMEs and start-ups and coordinating investment opportunities with Global Corporate and Venture Capital. Also, he has developed and managed global energy projects for more than 10 years in Samsung Heavy Industries. He has successfully developed FLNG projects with cost technology improvements and completed delivery of the wind energy projects.

- Shell Prelude/Browse FLNG: Project Construction Cost Planning/Management
- Wind Farm Projects at Ontario Canada and Austin Texas US
- Offshore Prototype Wind Turbine (7MW) Project at Fife, Scotland
- 96k Drillship Petrobras Project: Project Engineer

MBA, National University of Singapore
MBA, Peking University Guanghua Business School
Aerospace System Engineering (BSc), Korea Aerospace University

Mobility Paradigm Shift

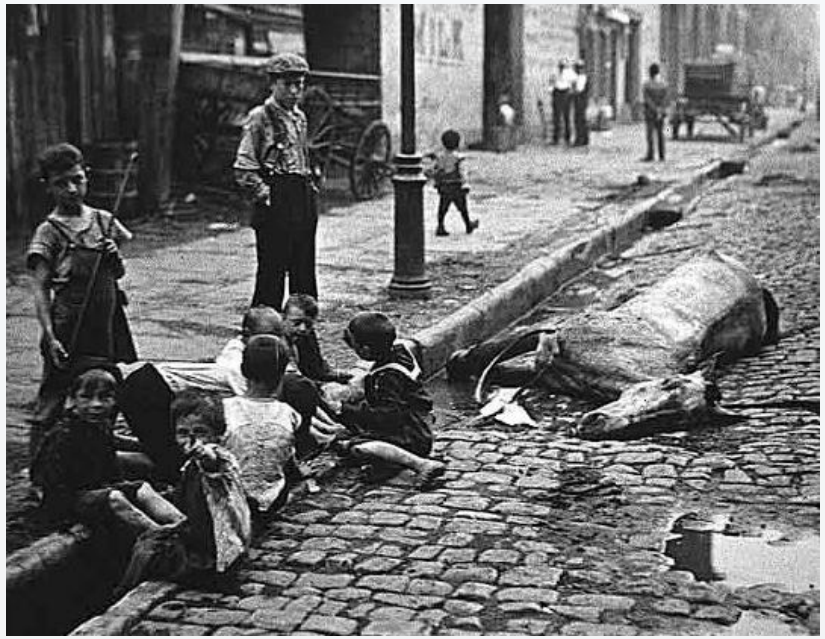
Easter morning 1900: 5th Ave, New York City. Spot the automobile.

Source: US National Archives.

Easter morning 1913: 5th Ave, New York City. Spot the horse.

Source: George Grantham Bain Collection.

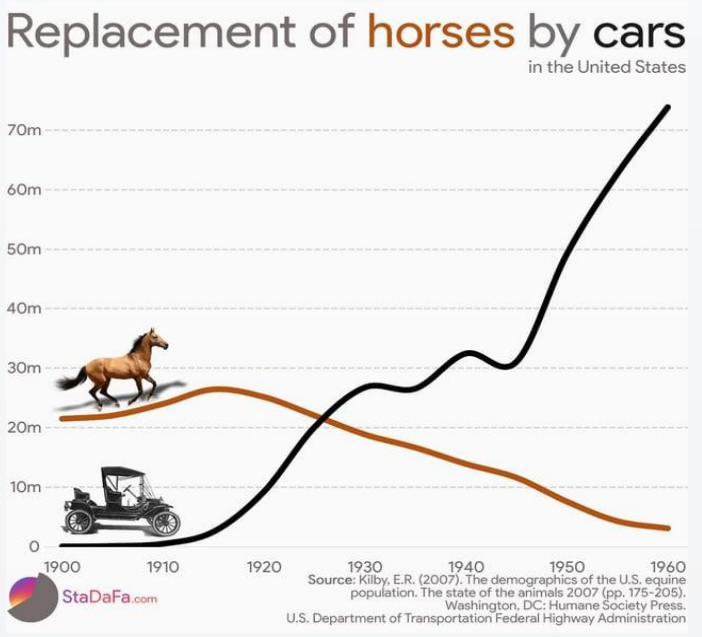
Mobility Paradigm Shift



In New York in 1900, about 200 people were killed by horse-drawn vehicles – much more fatality density

MORTON STREET, CORNER OF BEDFORD, LOOKING TOWARD BLEECKER STREET, MARCH 17, 1893.

The average horse produced 20 kg of dung and 3.8 litre of urine per day.

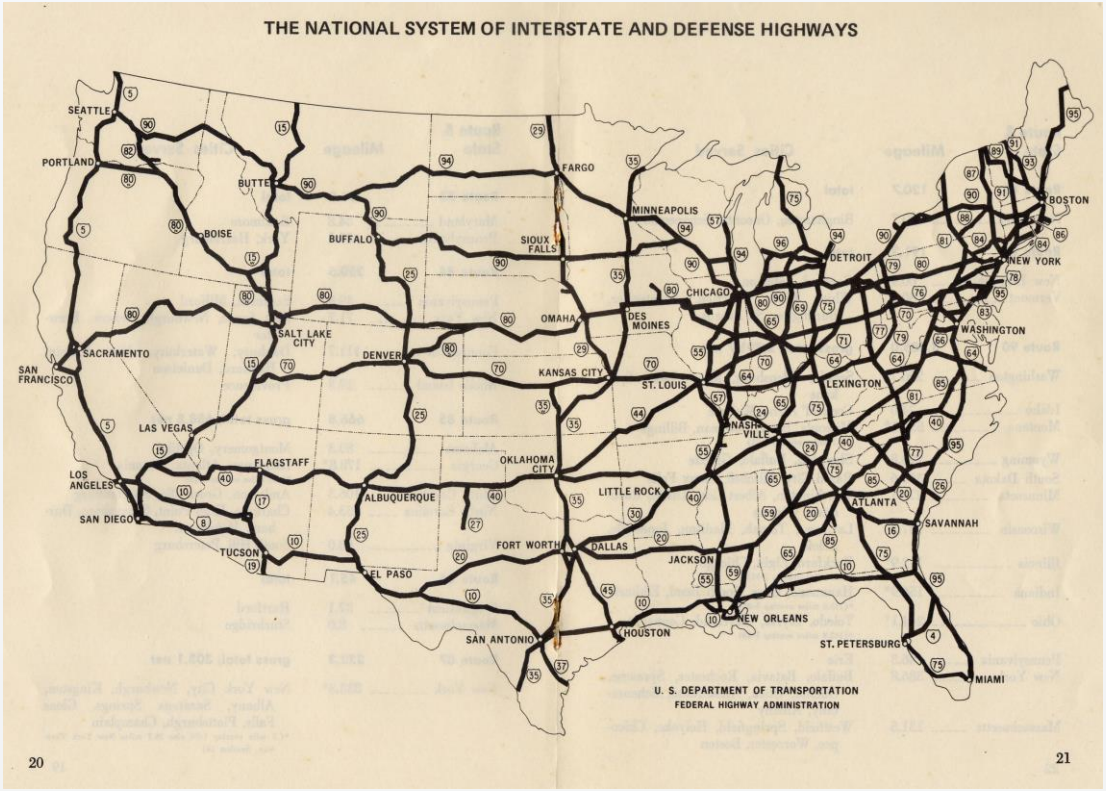


A Model T cost $850 in 1908 and $260 in 1916 much less than owning a horse

Mobility Paradigm Shift

Photo: Library of Congress, USA

In 1904, the first inventory of all rural roads in the nation showed that only about 7 % of 2.1 million miles of rural roads had any kind of surfacing, according to the FHWA (Federal Highway Administration)



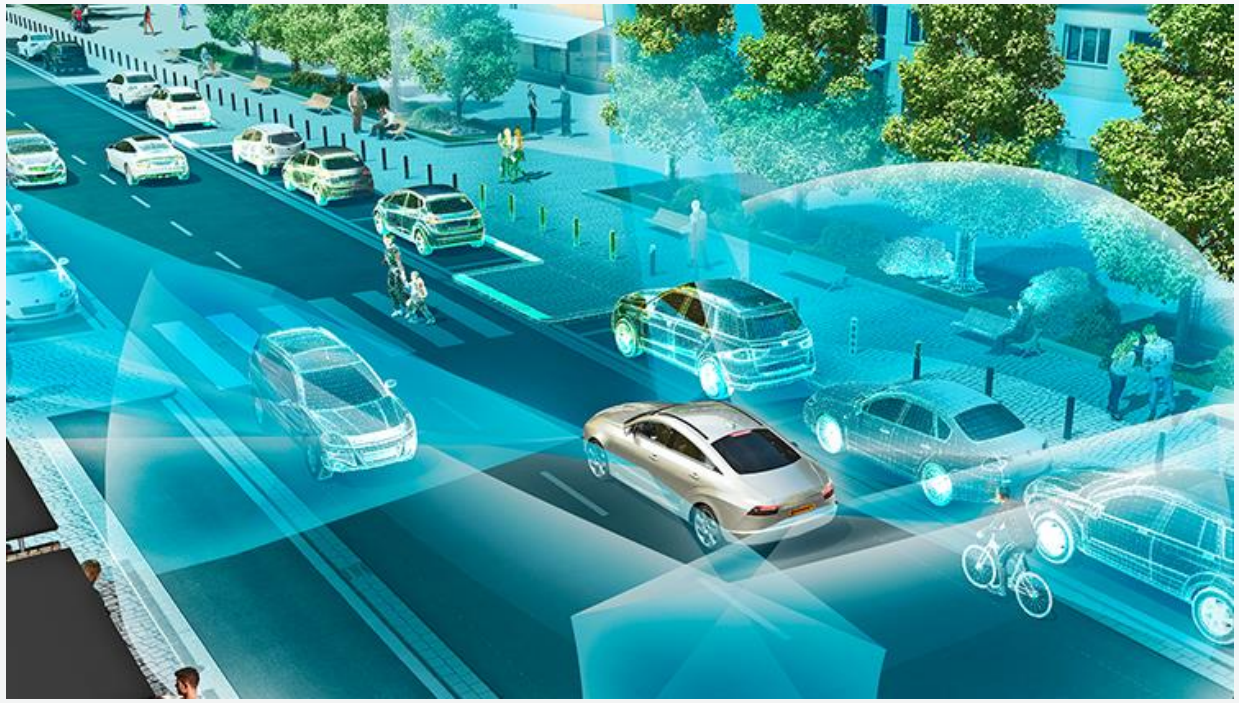
In 1922, it began to prioritized the paving of 78,000 miles of roads using military defense as the basis for funding. It took decades to complete.

Mobility Paradigm Shift

Photo: Bob Sorokanich / Jalopnik

In 21st Century, Electronic Vehicles running on 5th Ave New York

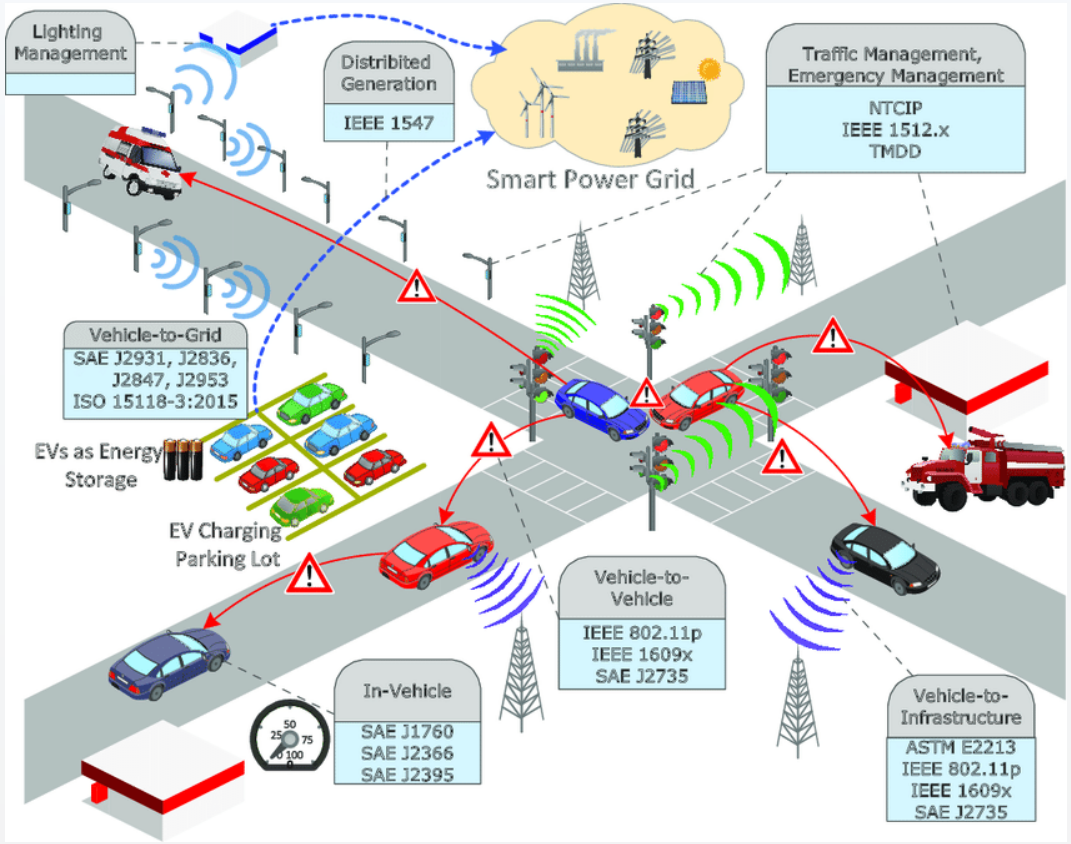
(GMC Hummer EV)



Source: Continental

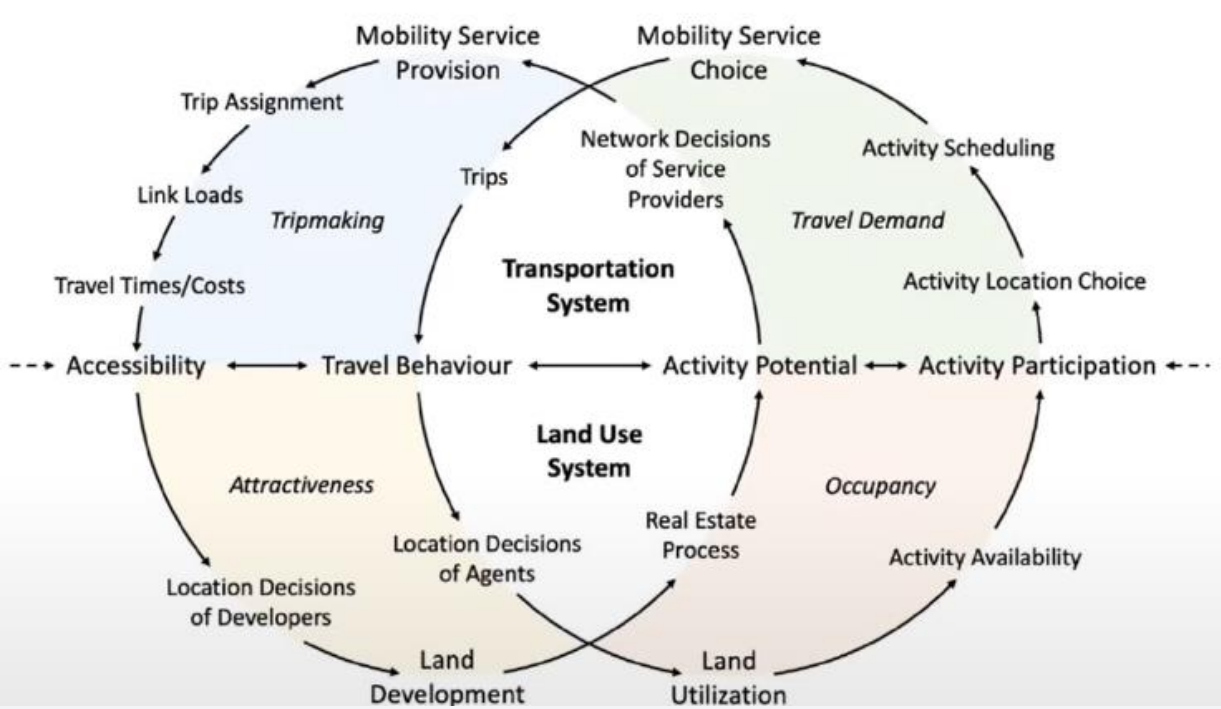
As 21st Century progresses, now there is an effort to remove another animal on the road: human

Mobility Paradigm Shift



Source: Turner & Uludag 2015

Intelligent Transportation Systems and the smart grid in a smart city



Source: Higgins et al. 2021

Transport and Land Use Dynamics

System Related Factors

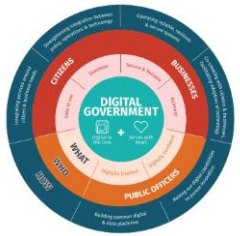
e.g. Autonomous vehicles will require a different type of road surface to resist precise, repetitive wear

Mobility and Smart City

Digital Economy

- Digital Industries
- Integrated Ecosystems
- Industrializing Digital

Digital Government



Digital Society

- Digital Access
- Digital Literacy
- Digital Participation

Source: Smartnation.gov.sg

Strategic National Projects

National Digital Identity (NDI)	▪ Digital Identity for cross-border transaction ▪ Widespread adoption of NDI (2022) ▪ 3 million SingPass Mobile users
E-Payments	▪ E-payment option for all payments to and from Govt. (2023) ▪ No more cheques (2025 and beyond)
Moments of Life (MOL)	▪ More personalized services to benefit more Singaporeans
GoBusiness	▪ Further streamlining and improving Govt. services for businesses
Core Operations, Development Environment, and eXchange (CODEX)	▪ Majority of eligible Govt. systems on commercial cloud (2023)
Smart Nation Sensor Platform (SNSP)	▪ City-level sensor data available for industry and public ▪ Computer vision drowning detection system at 27 swim centers ▪ Smart Utility Meters roll-out (2024)
Smart and Sustainable Punggol	▪ Smart Grid solutions to reduce carbon emissions (2023) ▪ Open digital platform to integrate smart tech and data-share ▪ Smart facilities management for predictive maintenance
Smart Urban Mobility	▪ Pilot deployment of Autonomous buses and shuttles ▪ Progressive deployment of next-generation smart traffic light control system

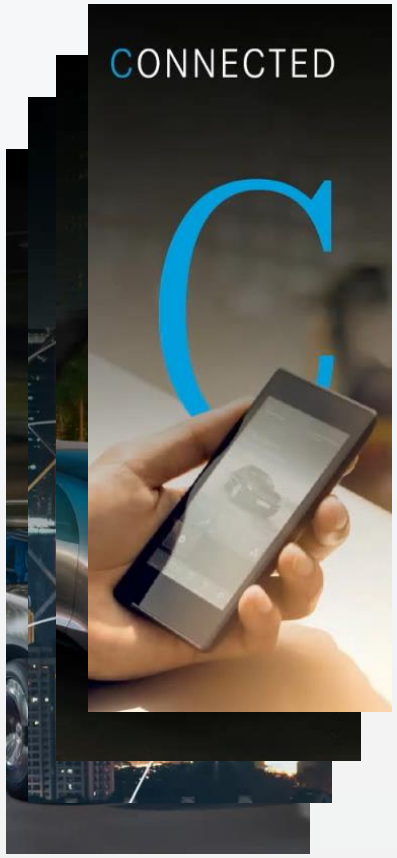
Past-Present-Future

	Digitization	Digitalization	Digital Transformation
 Mobility	**High Performance & Fuel Efficiency** – High powered engine  	**EV (Electric Vehicle)** – Hybrid & EV – Battery & Charging  	**EV, HV & AV and Connectivity** – EV, Hydrogen & Air Mobility – Autonomous Driving  
 Energy	**Stable Power Generation & Transmission** – Reliable Conventional Power – Infrastructure Expansion  	**Optimization & Renewables Expansion** – Digitalization in the power generation 	**Distributed Energy with Harmonic Interaction** – Net zero carbon emission 
 AI, IoT & Big Data	**Digitization** – Transition from analog to digital 	**Digital Integration** – Digitalization & 5G  	**Connectivity, Convergence and Openness** – AI, Intelligent data management through digital platform 

Mobility Technology Trend

Source: Daimler at FOSS Asia event in Singapore, 2018

Connectivity Mobility Technologies



Technology Categories	I. Vehicle-to Vehicle (V2V) Communication	II. Vehicle-to-Infrastructure (V2I) Communication	III. Vehicle-to Cloud (V2C) Communication	IV. In-Car Connectivity & Infortainment	V. Cybersecurity for Connected Car	VI. Connected Vehicle Data Analytics	VII. Augmented Reality (AR) for Navigation	VIII. Remote Vehicle Control and Assistance
	Cellular Vehicle-to-Everything (C-V2X) technology	Intelligent Traffic Management Systems	Cloud-based vehicle management platforms	5G connectivity for high-speed data transfer	Secure communication protocols	Big data analytics for traffic patterns	AR-based heads-up displays	Remote vehicle locking/unlocking
	Dedicated Short-Range Communications (DSRC)	Smart traffic signals	Over-the-Air (OTA) software updates	Advanced infotainment systems	Intrusion detection systems	Predictive maintenance and vehicle health monitoring	3D navigation overlays	Remote engine start/stop
	V2V data sharing platforms	Dynamic traffic routing	Fleet management systems	Voice-controlled assistants	Security gateways and firewalls	Personalized driving behavior analysis	Real-time object recognition	Stolen vehicle tracking and recovery
	Cooperative collision warning systems	Roadside infrastructure sensors	Remote vehicle diagnostics	Augmented reality (AR) displays	Over-the-air security updates	Real-time traffic congestion prediction	Lane guidance and navigation prompts	Emergency assistance and roadside support
	Intersection priority management	Traffic data analytics platforms	Data analytics for predictive maintenance	Gesture-based controls	Secure software development practices	Intelligent route planning	Augmented parking assistance	Remote climate control
	Traffic flow optimization systems	Vehicle-to-Grid (V2G) integration	Real-time traffic information services	Personalized content and services	Biometric authentication for vehicle access	Usage-based insurance analytics	Enhanced road sign information	Fleet monitoring and management tools

Technology Types

Hardware Technology	Hybrid Technology	Software Technology

Autonomous Mobility Technologies

Technology Categories	I. Level 2 Advanced Driver Assistance Systems (ADAS)	II. Level 3 Conditional Automation	III. Level 4 High Automation	IV. Level 5 Full Automation	V. Sensor Technologies for AVs	VI. Artificial Intelligence (AI) for AVs	VII. Connectivity for AVs	VIII. Human-Machine Interface (HMI) for AVs
	Adaptive cruise control	Traffic Jam Pilot	Urban driving automation	Fully autonomous vehicles for all road conditions	LiDAR sensors for 3D mapping and object detection	Deep learning algorithms for perception and decision-making	V2V communication for cooperative driving	Intuitive and informative display systems
	Lane-keeping assist	Highway Pilot	Robo-taxis and autonomous ride-hailing	Self-driving trucks for long-haul transportation	Radar systems for long-range perception	Sensor fusion and data integration	V2I communication for traffic management	Driver monitoring and attention systems
	Traffic jam assist	Intersection assistance	Shuttle services	Autonomous public transportation fleets	Cameras for visual recognition and object detection	Reinforcement learning for behavior adaptation	Vehicle cloud integration for data sharing	Voice and gesture-based interaction
	Autonomous emergency braking	Autonomous valet parking	Last-mile delivery robot	Unmanned aerial vehicles (drones) for package delivery	Ultrasonic sensors for short-range detection	Predictive analytics for proactive driving	Real-time map and traffic updates	Clear and proactive communication of autonomous mode status
	Blind-spot detection	Remote summoning	Autonomous shuttles for public transportation	On-demand autonomous vehicle services	Inertial measurement units for precise vehicle localization	Simulation and virtual testing environments	Fleet coordination and platooning	Redundant safety features and user trust indicators
	Rearview cameras	Traffic signal recognition and response	Geofenced autonomous zones	Mobile offices and living spaces	Environmental sensors for weather and road condition monitoring	Real-time path planning and trajectory optimization	Cooperative intersection management	User experience customization options

Technology Types

Hardware Technology	Hybrid Technology	Software Technology

Shared Service Mobility Technologies

Technology Categories	I. Car Sharing Platforms	II. Ride-Hailing and Ride-Sharing Services	III. Mobility Subscription Services	IV. Micro-Mobility Solutions	V. Autonomous Shuttles and Public Transportation	VI. Mobility Analytics and Demand Prediction	VII. Autonomous Delivery and Logistics	VIII. Mobility Integration and Seamless Travel
	Peer-to-peer car sharing	On-demand ride-hailing platforms	All-inclusive vehicle subscription plans	Electric scooters and bikes	Self-driving shuttles for first/last-mile connectivity	Data-driven demand forecasting models	Autonomous drones for last-mile delivery	Multi-modal journey planning applications
	Car rental platforms	Dynamic pricing algorithms	Flexible vehicle swapping options	Electric skateboards and hoverboards	Autonomous buses and trams	Real-time mobility analytics platforms	Unmanned ground vehicles (UGVs) for package transportation	Interoperability and ticketing integration across transportation
	Carpooling and ride-sharing services	Shared rides and pooling options	Maintenance and insurance coverage	Shared electric micro-mobility fleets	Demand-responsive transit services	Optimal fleet management and deployment strategies	Automated warehouse and fulfillment centers	Real-time information sharing across different service providers
	Station-based car sharing	Integration with public transportation	Access to different vehicle types	Dockless rental systems	Real-time transportation planning and optimization	Route optimization and congestion management	Robotics and automation in supply chain management	Seamless transfers and connections between modes
	One-way car sharing	Micro-transit services	Concierge services	Integration with public transportation	Integration with multi-modal transportation networks	Pricing and incentive strategies based on demand patterns	Dynamic routing and delivery optimization algorithms	Integration with smart city infrastructure and services
	Subscription-based car sharing	Mobility-as-a-Service (MaaS) platforms	Subscription plans for other mobility modes	Micro-mobility infrastructure development	Accessibility enhancements for inclusive mobility	Integration of data from various transportation providers	Real-time tracking and monitoring of delivery processes	Personalized travel recommendations and incentives

Technology Types

Hardware Technology	Hybrid Technology	Software Technology

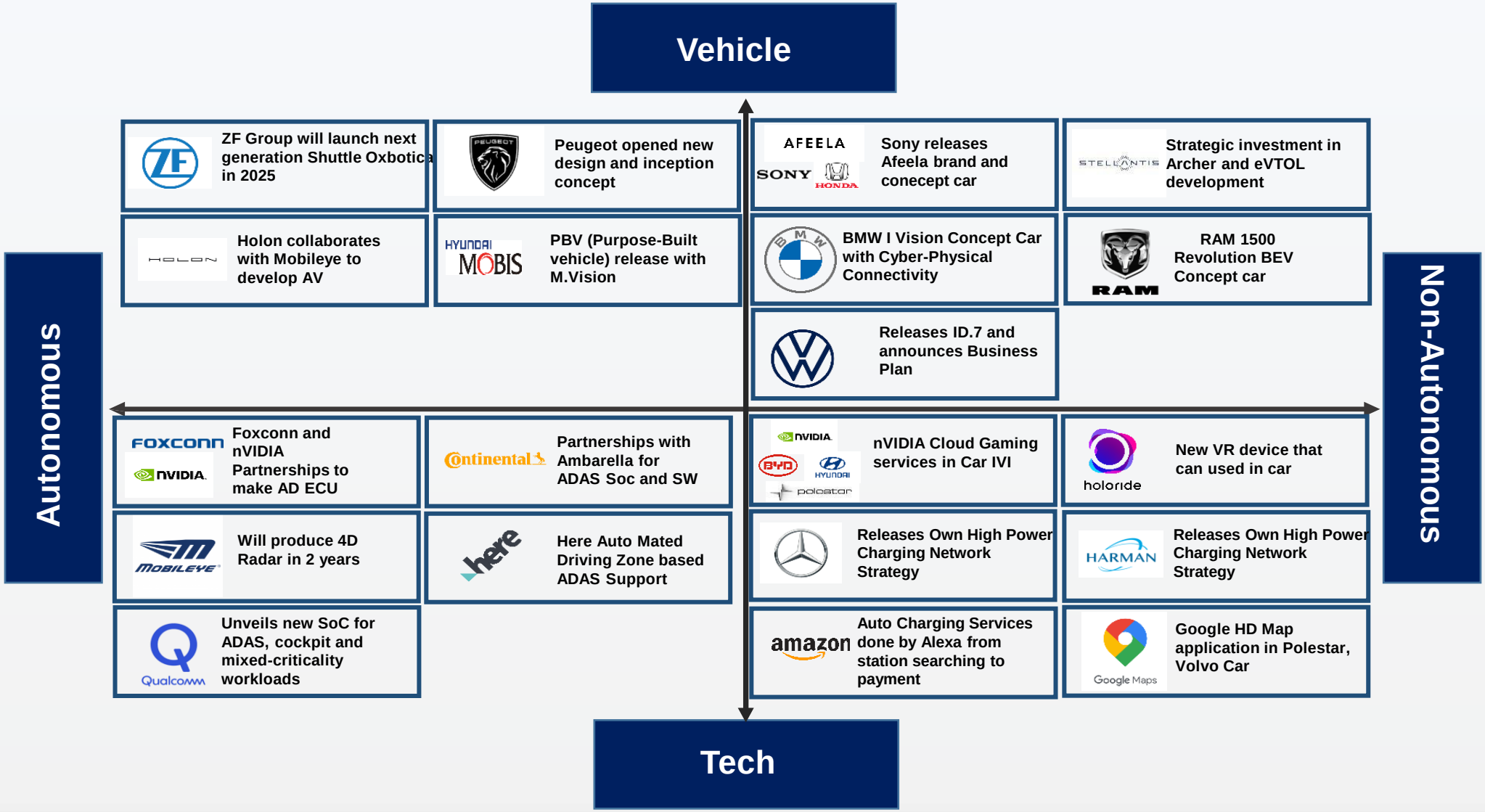
Electric Mobility Technologies

Technology Categories	I. Electric Vehicle (EV) Charging Infrastructure	II. Battery Technologies	III. Electric Vehicle Range & Performance	IV. Charging Infrastructure Expansion	V. Electric Commercial Vehicles	VI. EV Integration with Renewable Energy	VII. Electric Vehicle Design & Manufacturing	VIII. Energy Storage Solutions
	Fast-charging stations	Solid-state batteries	High-capacity battery packs	Public charging network expansion	Electric trucks and vans	Vehicle-to-Home (V2H) integration	Lightweight materials for improved efficiency	Home energy storage systems
	Ultra-fast charging networks	Lithium-ion battery advancements	Battery thermal management systems	Residential and workplace charging solutions	Electric buses and coaches	Vehicle-to-Grid (V2G) integration	Advanced manufacturing processes for EV components	Grid-scale energy storage solutions
	Wireless charging technologies	Graphene-based batteries	Lightweight materials for improved efficiency	Destination charging (hotels, malls, etc.)	Electric delivery vehicles	Smart charging with renewable energy sources	Integration of EV-specific components	Vehicle-to-Home (V2H) integration
	Vehicle-to-Grid (V2G) integration	Sodium-ion batteries	Efficient power electronics and motor systems	Integration with parking infrastructure	Charging infrastructure for commercial fleets	Integration of EV charging with solar and wind power	Battery pack design and optimization	Battery energy storage for renewable integration
	Bidirectional charging capabilities	Advanced battery management systems	Energy recovery systems (regenerative braking)	Charging stations with renewable energy sources	Fleet management and optimization systems	Energy management systems for optimized charging and consumption	Vehicle-to-manufacturing (V2M) connectivity	Microgrid solutions with energy storage
	Smart charging management systems	Battery recycling and second-life applications	Aerodynamic design enhancements	Charging infrastructure standardization	Sustainable logistics solutions	Grid stabilization through EV integration	Circular economy practices in EV manufacturing	Demand response and peak shaving applications

Technology Types

Hardware Technology	Hybrid Technology	Software Technology

Macro Mobility Trend from CES 2023

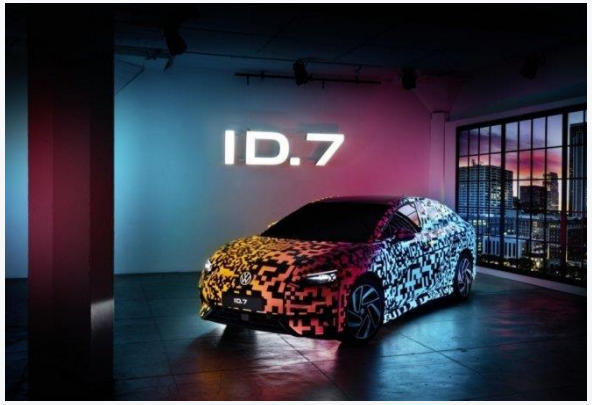


Source: Automotivenews

Mobility Trends Global OEM Enterprises

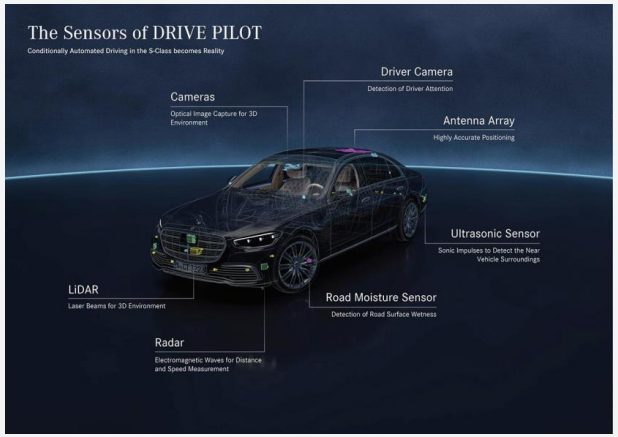
BMW

- Auto exterior full color change by millions of special micro-capsule wrapping.
- Advanced HUD covers the whole area of windshield



Volkswagen

- ID. 7 – travels 700 km by single charge using VW MEB platform
- New concept display, AR HUD, 15 in screen IVI, enhancing user interface



Mercedes Benz

- 1,200km range EV EQXX and charging infra vision in America
- L3 Autonomous Driving in partnership with nVIDIA (end to end)

Stellantis

- Electrification for all companies. Dodge RAM 1500 EV, Jeep, Chrysler, Peugeot
- UAM eVTOL development with Archer, $150mil investment by 2024

Source: BMW, Volkswagen, Benz, Stellantis

Mobility Trends Global Parts Enterprises

Hyundai and Hyundai Mobis

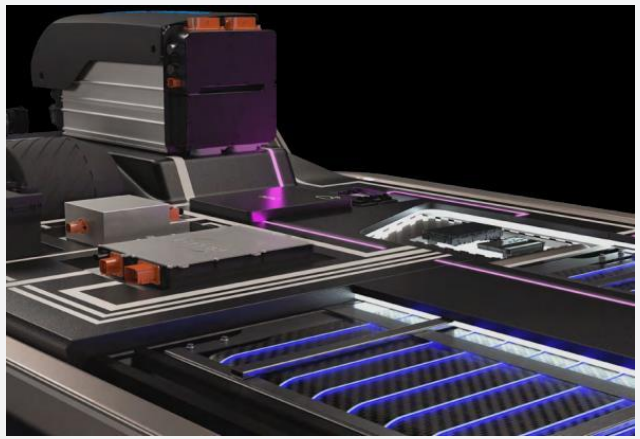
- PBV and L3 AD ECU development in collaboration with Qualcomm
- Variable 34-inch display IVI and 90 degrees rotatable E-corner module

HL Mando

- Flexible Move: broad and flexible movement by E-corner module
- Clever Move: L2~L4 AD solutions such as 4D imaging rader to OTAable camera

Bosch

- Digitalization & Quantum Computing for auto AI
- Micro sensor MEMS for key AD solution parts



Forvia

- Merging Hella, they are developing various auto parts
- SSL HD, high voltage battery, TMS, eFuse tech (E/E architecture Zone module)

Source: 현대모비스, 만도, Bosch, Forvia

Mobility Trends Global Enterprises Unexpected EV Leader

John Deere

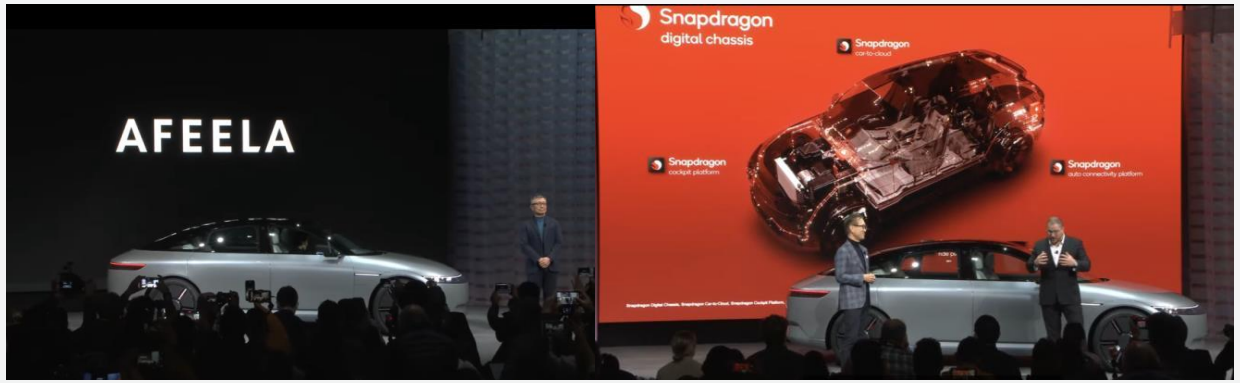
- First real-scale Autonomous Driving applications in mobility
- E-T-L Processing and sensing technology by AI, Cloud and Big Data

Caterpillar

- 100 ton unmanned autonomous driving truck Cat 777
- 24 hours of operation without rests under the controlled environment

VinFast

- Vietnam EV Mobility enters into USA (VF8 in sale already, VF6 & 7 launch soon)
- Battery subscription model $100/month and reduce car price (47k~55k)

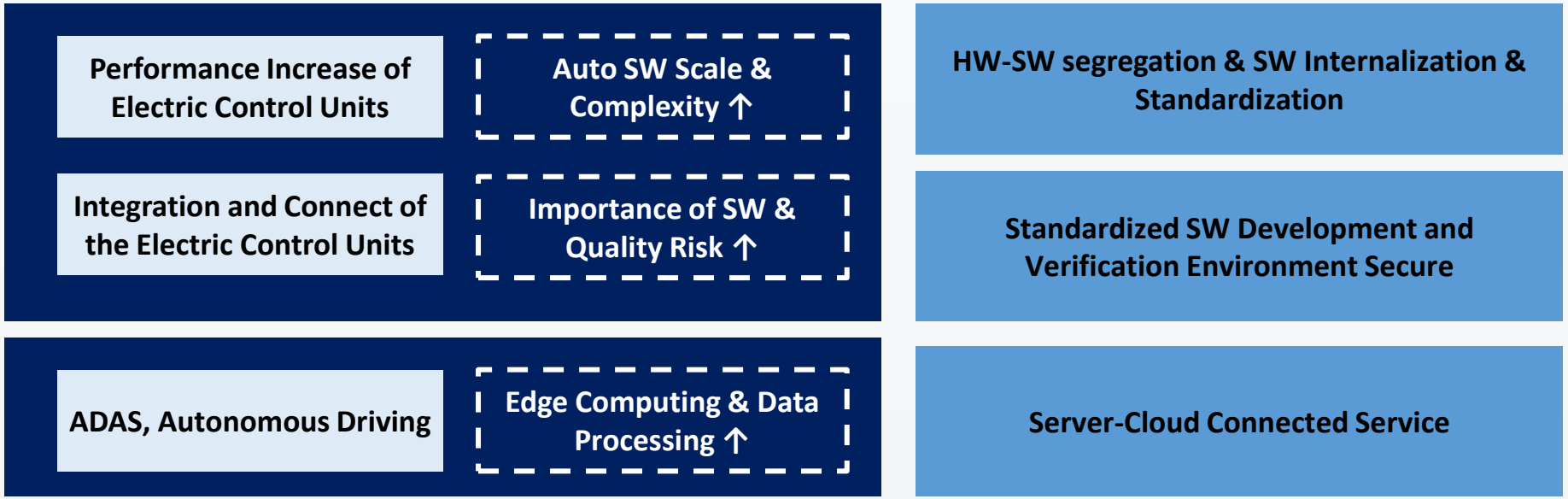


Sony

- Unveils concept EV Afeela and share the Autonomous road map
- Focuses on Augmentation for in vehicle entertainment (IVI) services

Source: John Deere, Caterpillar, VinFast, Sony

SDV – The Way to True AD Current Mega Trend in Mobility



Increased adoption of smart options : Traditionally, the value of cars has been determined by the performance of hardware such as engines, but now the value of software has begun to have a significant impact on sales prices. A break in profitability between Tier 1, which supplies hardware, and finished cars begins

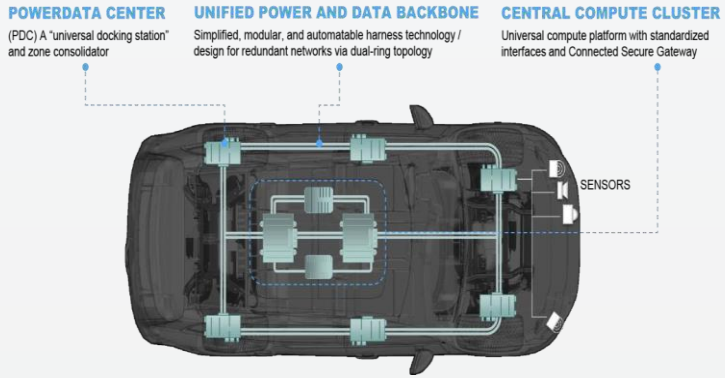
Vehicles becoming Smarter : Smartening of automobiles is becoming a new paradigm for the industry. The more customer data you secure, the more complete you can introduce autonomous driving technology and connected car services.

Source: Hyundai Autoever

SDV – The Way to True AD Current Mega Trend in Mobility

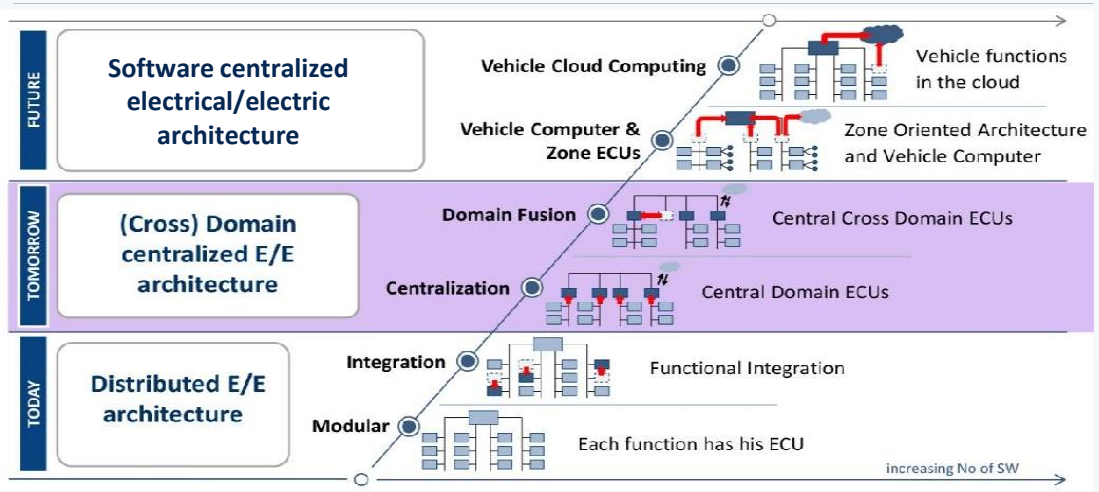
Hyundai Motors

- Announced in Oct 2022 that it plans to convert all models into 'software-defined automobiles (SDV)' by 2025.
- Domain Centralized Architecture - Reduce ECU and design complexity



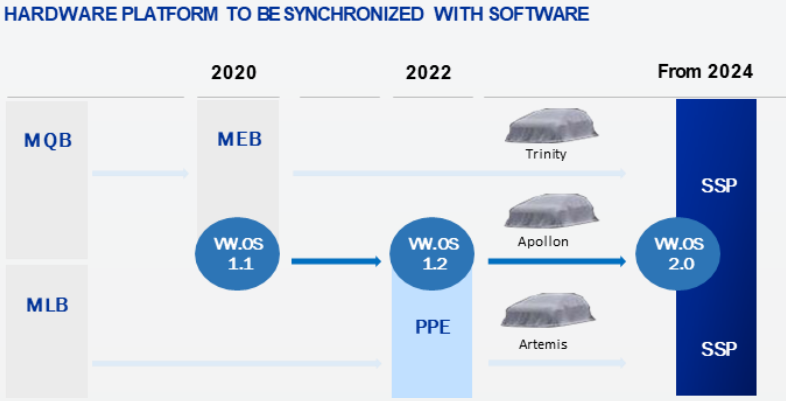
Aptive

- Centralize computing, data processing, and power allocation with Zone control



Bosch

- Changes from distributed architecture to main and software-oriented design

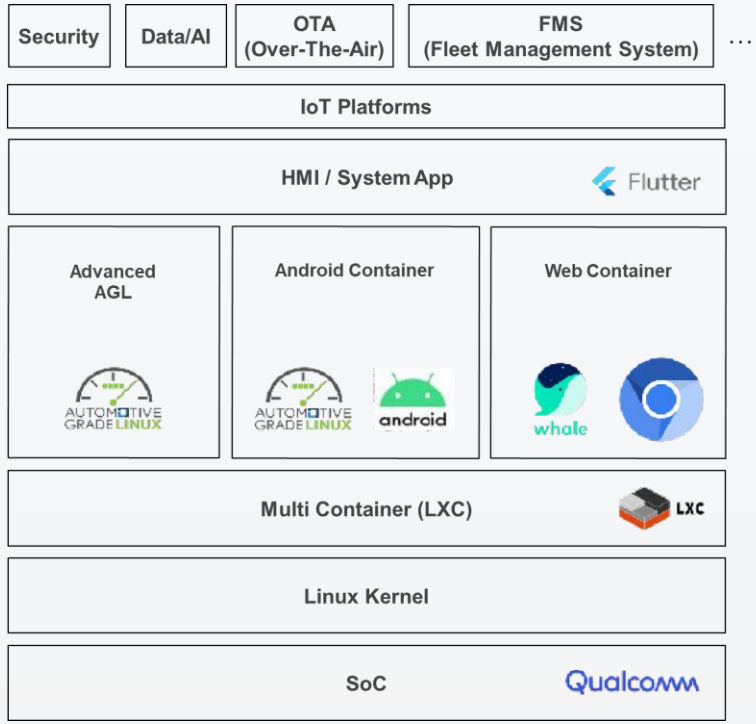


Volkswagen

- Introducing own OS and internalizing 70% of software

Source: 현대차, Bosch, Aptive, Volkswagen

IVI – The Only Gateway to Human Current Critical Trend in Mobility



Increased Importance of the In-Vehicle Infortainment System: The infotainment system provides the numerous convenient functions which has high technology & economic value creation potentials as it is the only gateway that connects humans to vehicles.

Infortainment System embraces Automotive Operation and Applications: A technology sector that can extend the limits of automotive utilization much further with versatility to install a variety of applications (both new, and existing in Android/iOS/Linux app) and scalability to continue to stack high performance vehicle management systems.

Source: DRIMAES

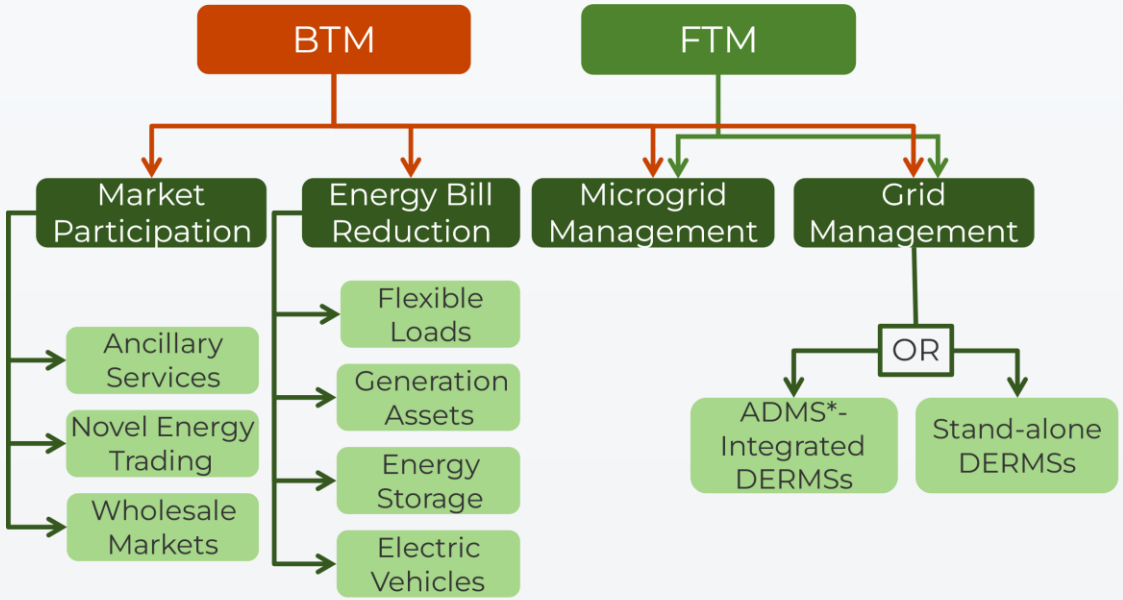
IVI – The Only Gateway to Human Current Critical Trend in Mobility

Enhancing Driver Experience: In-Vehicle Infotainment (IVI) systems provide drivers with convenient access to various multimedia features and information, improving their overall driving experience.

Integration and Connectivity: IVI systems enable seamless integration and connectivity with smartphones, allowing drivers to access navigation, music, and other apps while keeping their focus on the road.

Source: DRIMAES

EV Charging Current Critical Trend in Mobility



DERMSs are crucial for unlocking the value of behind-the-meter (BTM) distributed energy resources (DERs)

- A distributed energy resource management system (DERMS) is a platform that controls and optimizes the dispatch of grid-connected DER assets for distribution networks, markets, and asset owners.
- DERMS companies are typically differentiated by what variable is being optimized (the dark green boxes to the right), where it is being optimized (BTM or FTM), and what assets it can manage.

Taxonomy of DERMS

- Distributed energy resource (DER) owners and utilities are increasingly able to thoughtfully control the output or consumption of DERs for various applications, such as market participation. Developers have started to offer a software platform to manage these DER assets, called a distributed energy resource management system (DERMS)
- There are many DERMS startups, and the most promising ones will likely be acquired; thus far, oil and gas players, such as Shell and BP, have been active, as have hardware firms such as Schneider Electric.

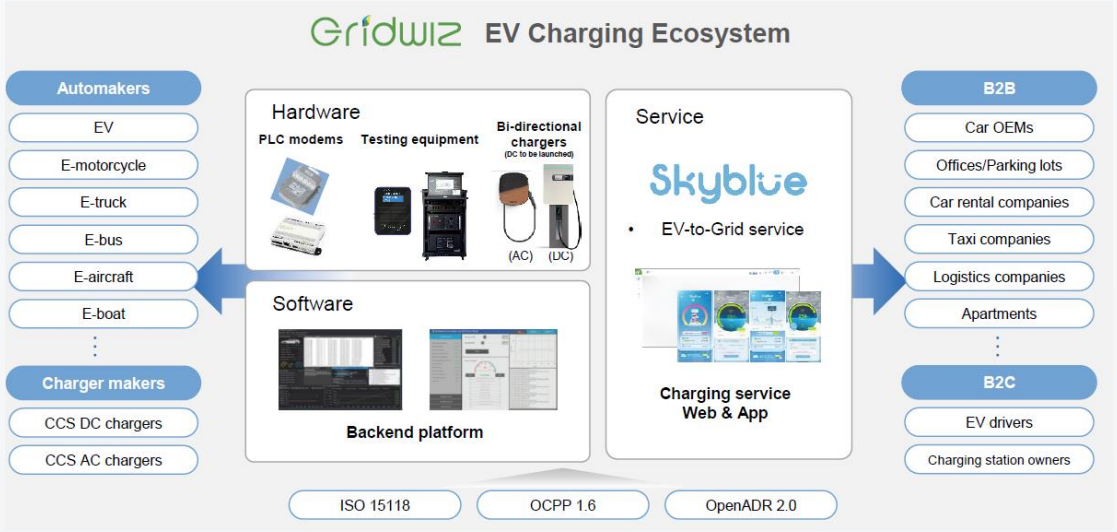
Source: Autogrid, Lux Research

EV Charging Technology Current Critical Trend in Mobility

- **Wireless Charging**
  - Wireless charging technology uses electromagnetic fields to transfer energy from a charging pad or station to the electric vehicle without the need for physical cables.
- **Bidirectional Charging**
  - Bidirectional Charging: Bidirectional charging technology allows electric vehicles to not only receive energy from a power source but also return excess energy back to the grid, enabling vehicle-to-grid (V2G) capabilities.
- **Battery Swapping**
  - Battery Swapping: Battery swapping technology involves quickly replacing the depleted battery of an electric vehicle with a fully charged one at dedicated stations, allowing for rapid turnaround times and extended driving range.
- **Fast Charging**
- Fast Charging: Fast charging technology utilizes high-power charging infrastructure to deliver a significant amount of electricity to an electric vehicle's battery in a short period, reducing charging time compared to standard charging methods.
- **EV Charging Management Software**
  - EV Charging Management Software: EV charging management software provides the necessary tools and algorithms to monitor, control, and optimize electric vehicle charging infrastructure, enabling efficient scheduling, billing, and load management for charging stations or networks.

Source: Lux Research

EV Charging Technology Current Critical Trend in Mobility



Xnergy Gen 2 Wireless Charing

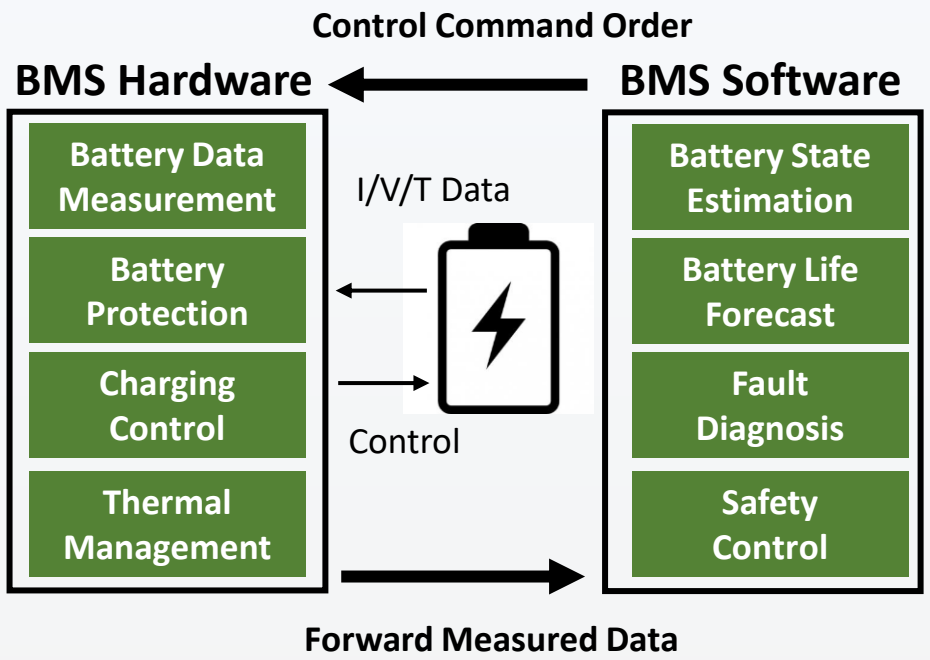
- Singapore based startup that pioneers leading contactless power transfer technology
- Wireless charging solution that improves the AGV up-time with 24-hours opportunity charging
- Infineon's unique CoolSiC MOSFET

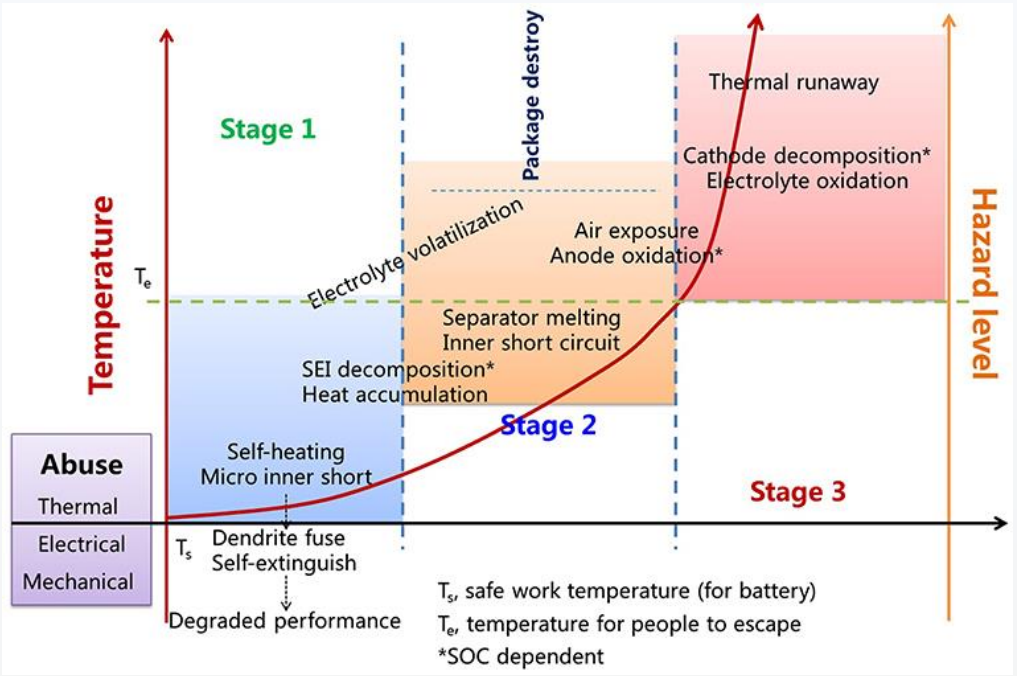
GRIDWIZ Aggregates EV batteries and remotely controls EV charging speed to participate in the DR market

- Smart Charging - Controlling charging time & rate for economic benefits
- DR Market Participation - Stop charging or lower charging speed when energy demand is high (Regular DR), Absorb excessive renewable energy by charging EV batteries (Plus DR)
- Bi-directional Charging - Discharging energy stored in EV batteries to home or the grid
- Fleet Management - Vehicle management though anlysis of mileage and battery stats

Source: Xnergy, Gridwiz

Battery Management System Current Critical Trend in Mobility





Source: Xaingkun Wu et al. 2019

Major Function of the BMS

- **Hardware Key Features**
  - Data measurement, battery protection, charge control, battery thermal management, etc
  - Select the appropriate BMS topology according to the purpose of battery utilization

- **Software Key Features**
  - Battery condition estimation, life prediction, fault diagnosis
  - Estimate and monitor health indicators
  - Functional advancement

Battery thermal runaway process and hazards

- Indicators to determine the safety of the battery based on internal factors (SOC, voltage, temperature, etc.) and external factors (impact, vibration, etc.)
- If each condition factor is 1, it is considered safe, and if the factors have a value less than or equal to the degree of safety, it is considered dangerous
- Safety-warning-hazardous stages, and safety measures required for each stage

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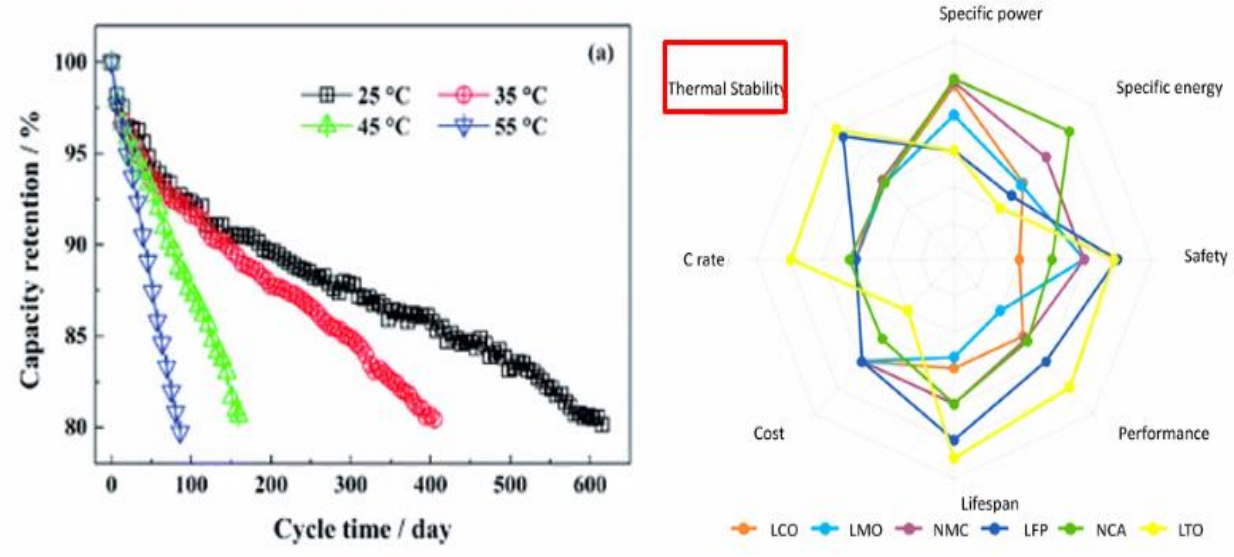
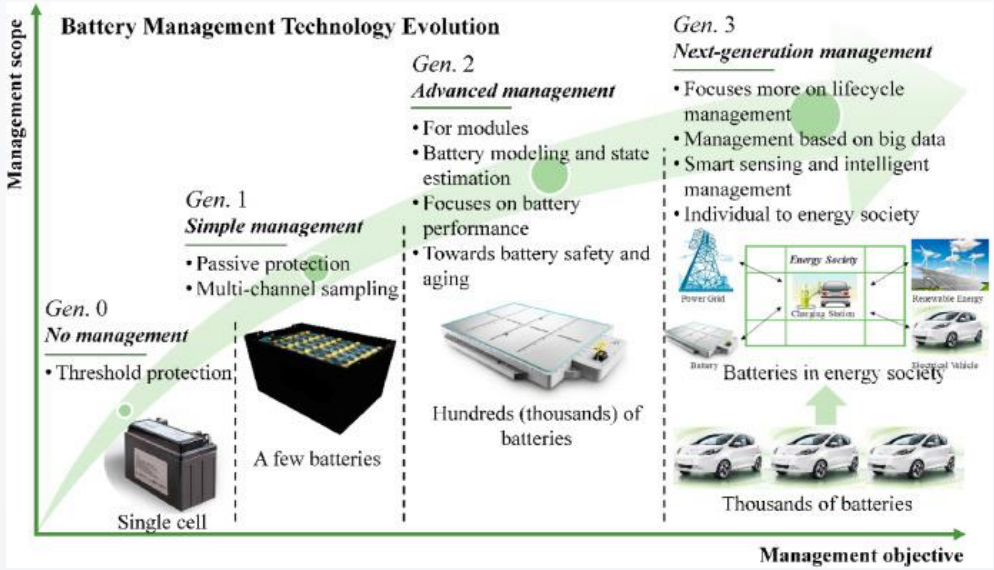


Source: Nourhan Mohamed et al. 2020 and Ruifeng Zhang et al. 2018



Source: Haifeng Dai et al. 2018

Changes in battery capacity by cycle according to ambient temperature & Temperature stability by battery type

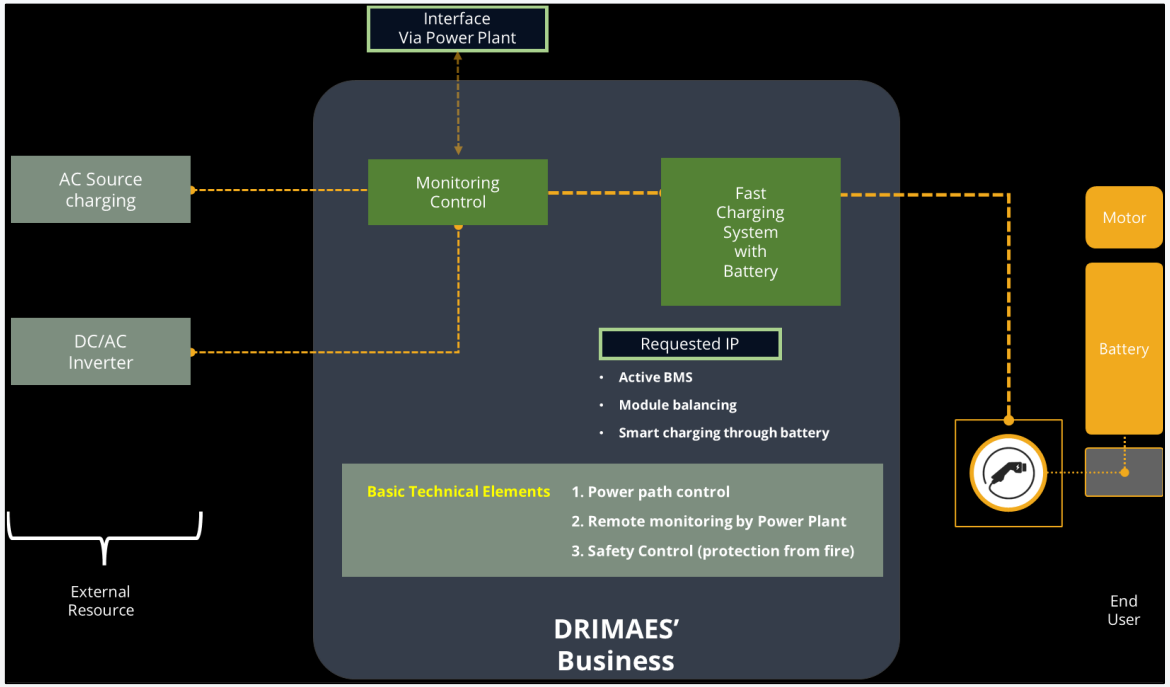
- Different battery types have different characteristics depending on environmental temperature
- Allowable temperature range difference present when charging/discharging
- Thermal stability depending on the temperature of each positive electrode material of the battery
- Capacity reduction according to operating temperature, power characteristics difference exists

Changes in battery management technology

Gen. 0) No Management: management with upper and lower range settings
Gen. 1) Simple Management: Multi-channel sampling for efficient management of multiple cells
Gen. 2) Advanced Management: Stability management through battery modelling and condition estimation (Module/pack)
Gen 3.) Next-generation Management: Focus on battery life management with big data (System)

Battery Reuse Tech for Sustainability

Concept Design by DRIMAES

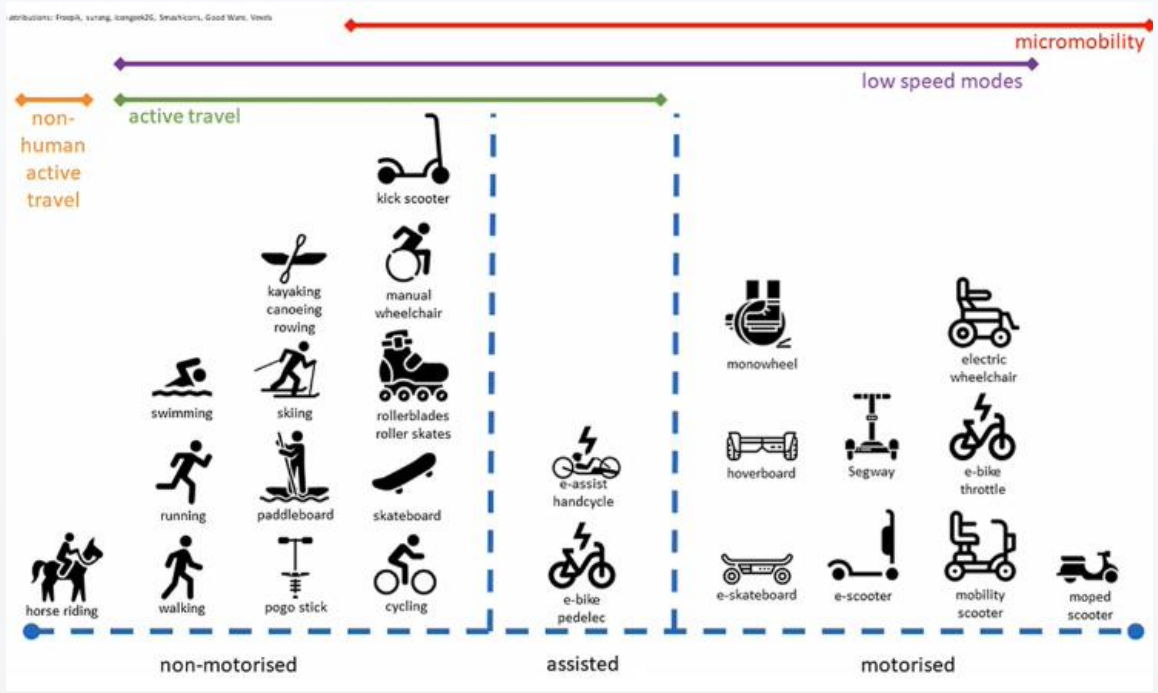


Skyrocketing EV and Battery Manufacture draws concerns on Sustainability: Battery developers, OEMs, and even governments are becoming increasingly concerned about circularity in the battery industry as electric vehicle (EV) sales continue to grow. Although battery can be reused as energy storage system (ESS), most cells and packs are immediately diverted to recycling with little consideration of reuse.

Stackable ESS module reusing used EV batteries to fast charging station: Technology that can integrated different remaining life of used batteries such as active balancing BMS, is capable of make flexible charger with the capacity of 70KWh ~ 250KWh Charger. Stackable ESS can be utilized in many ways

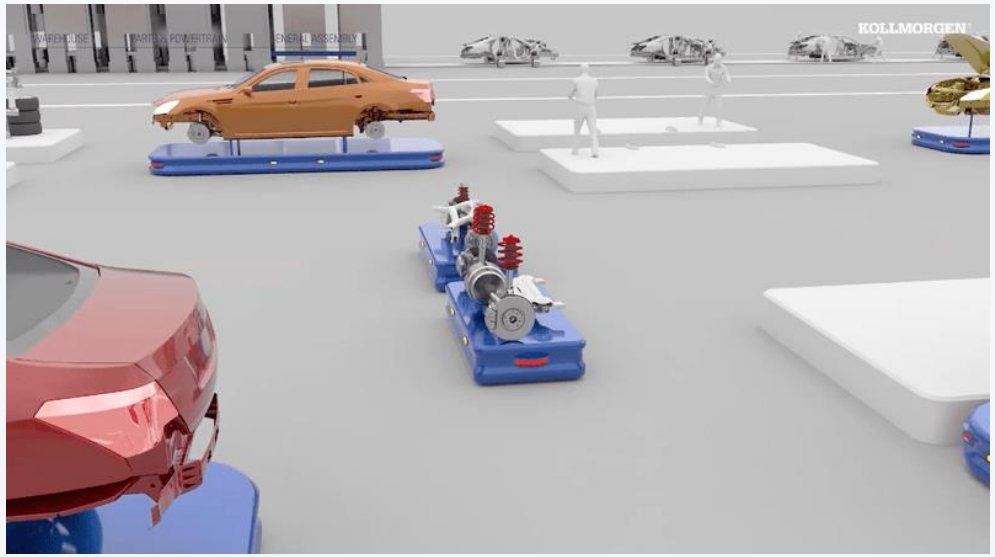
Source: DRIMAES

Micro Mobility is Everywhere

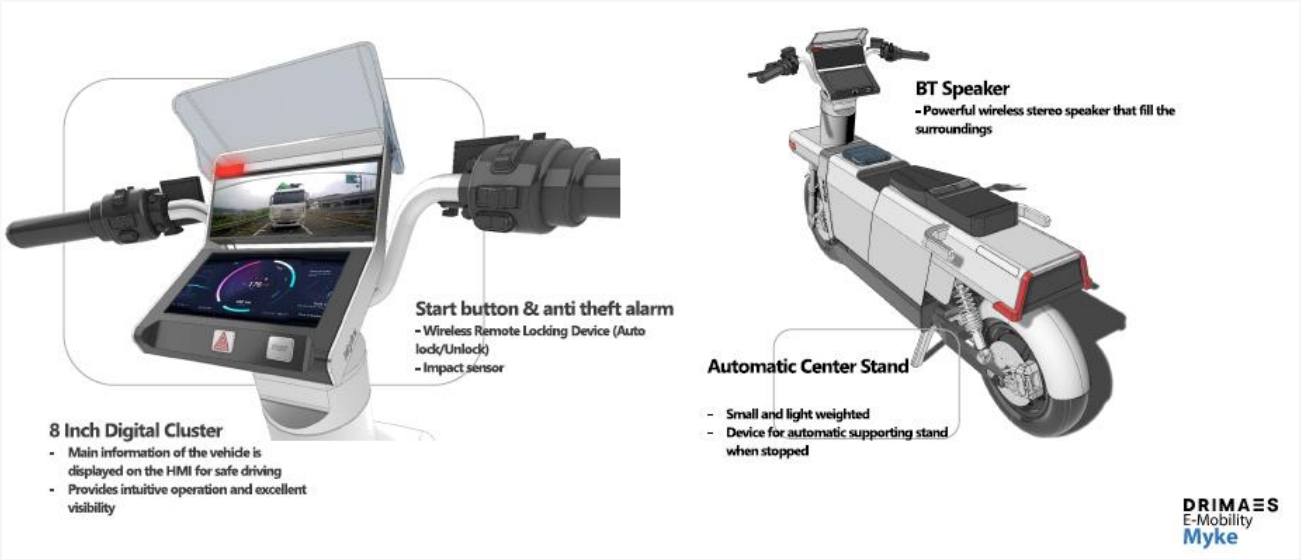


Source: Cook et al. 2022, Grab, Beam, Tryke

Micro Mobility is Everywhere



Source: Kollmorgen



Source: DRIMAES

AGV, AMR offers efficient and flexible solutions for tasks such as material handling, logistics, and urban transportation, enhancing productivity and sustainability in various industries.

- Integration of artificial intelligence (AI) and machine learning algorithms for autonomous navigation and decision-making capabilities.
- Development of advanced sensor technologies for enhanced perception and safety in complex environments.

Premium micro mobility sets higher standards for performance and features and attracts investment

- There are about 150 million motorcycles run the road in South East Asia.
- Electrification of the motor cycle can bring the huge impact in terms of economy, industry and life-style of the people living in.
- Particularly the Telematics, connected app, car to cloud and fleet management of these micro mobility can open the next generation industry landscape in South East Asia.

Mobility Policies in Singapore

Mobility

In 3 years from now, you'll no longer be able to register new diesel cars

As an effort to further pave the way for greener vehicles (other than strictly regulating the number of cars on our roads), new registrations of diesel cars and taxis will cease from 2025 onwards.

Singapore will only allow registrations of electric vehicles from 2030

This means that regular petrol cars will eventually be phased out. The closest to a regular petrol car you'll be able to buy is a hybrid car.

Infrastructure

Singapore aim to deploy 60,000 electric vehicle EV charging points across Singapore by 2030, comprising 40,000 in public car parks and 20,000 in private premises.

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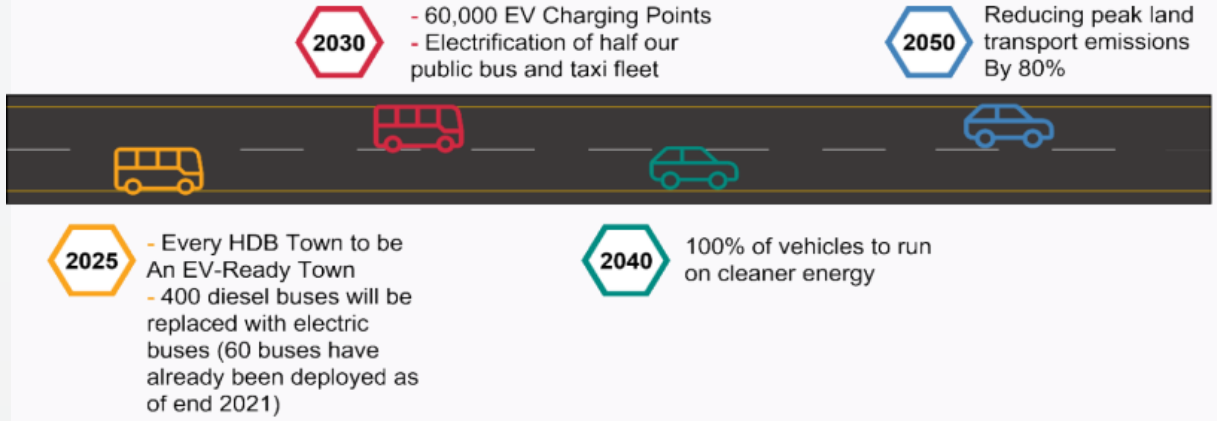
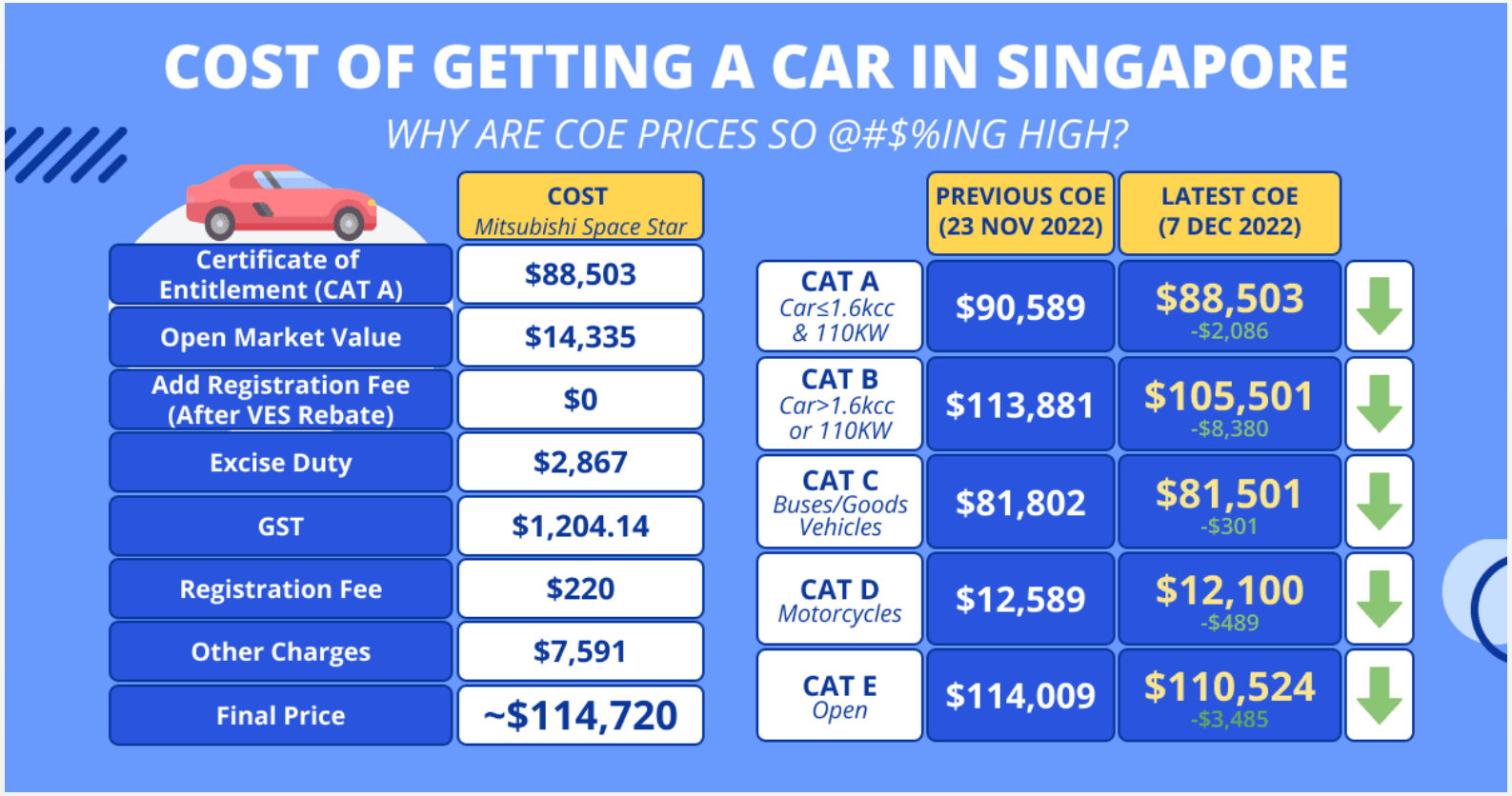


Source: Land Transportation Authority

Mobility Policies in Singapore

Singapore Car Tax: A very unusual car tax system that is unprecedented in the world

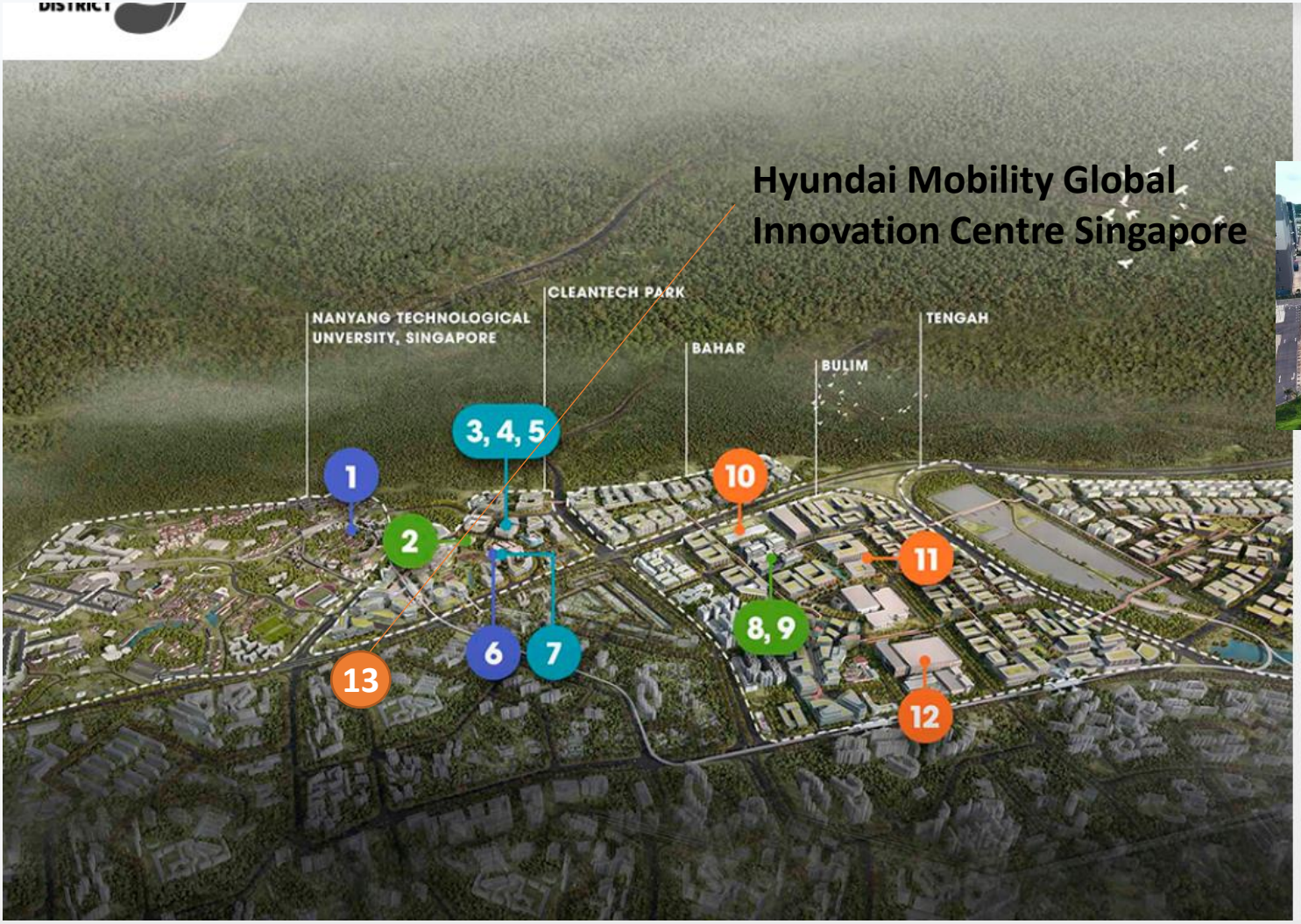
Price Structure	OMV (Import Price)	Consumption Tax (20%)	Registration Tax	Road Tax	Toll Collection	COE (Vehicle Ownership)	ARF (Additional Reg. Fee)	VES (Emission Rating)	EEAI EV Subsidy (max 20k)



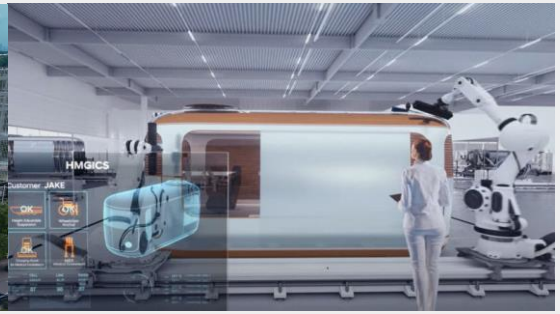
Source: Land Transportation Authority, Ming Feng Blog

Singapore's Future Mobility Industry?

Singapore to have a EV manufacturing facility first time ever at Jurong Innovation Disctrict



Get to know the best and brightest in advanced manufacturing.



Research & development

3. A*STAR Advanced Remanufacturing and Technology Centre
4. A*STAR Singapore Institute of Manufacturing Technology
5. Digital Capability Center Singapore
7. A*STAR National Metrology Centre

Technology providers

2. Sodick Singapore Techno Centre
8. Siemens Advance Manufacturing Transformation Center
9. ISDN Software Business

Factories of the future

10. Shimano
11. Angel Playing Cards
12. YCH Group

Source: JTC, 현대차

모빌리티 신기술 트렌드과 패러다임 전환
New Technological Trends in Mobility & Paradigm Shift

12th July 2023

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