WHITE PAPER

The Race to Asia Pacific

A Connected Car Strategic Framework for Acceleration

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Executive Summary

Automotive manufacturers (OEMs) are grappling with a tsunami of change that is engulfing the industry. From ensuring increasing levels of safety with advanced driver assistance systems (ADAS) that will lead to autonomous vehicles, to reconfiguring global supply chains to mitigate issues impacting the sustainability of their business. This, at the same time fundamentally, transforms the product itself from a hardware-based internal combustion engine (ICE) to a software-defined battery-electric vehicle (BEV). While the complexities keep mounting, the future viability of all these transitions is anchored on the increasing use of connectivity and cloud capabilities, that are constantly evolving. This paper highlights the challenges and considerations of a global connectivity strategy and explains why there is a need to consider a broader strategic management function of connectivity by the OEMs. It also identifies an alternative Asia Pacific (APAC) strategy framework that could simplify taking advantage of this fast-growing regional market and set a pathway to a redefined global strategy.

Current Landscape

Evolution of the Connected Car

The connection of a vehicle to a radio network is not new; the first commercial mobile phone services were initiated 76 years ago in 1946 in the U.S. on the IMTS service in St Louis. Things have progressed over the last seven and half decades from the initial 5,000 customers in 1948 to a global service connecting hundreds of million vehicles and billions of people.

Today's cellular systems have progressed through five generations of technology, moving from analog to digital voice to encompassing telematic service, Internet service, and now enabling cloud services. These network services are delivered to enhance infotainment systems for both drivers and passengers. Additionally, the safety systems of vehicles are increasingly utilizing wireless connectivity for HD mapping to enable enhanced cruise capability.

Connected vehicles (CVs) today are complex systems that increasingly interact with other complex systems and services, including intelligent transport systems and mobility services as well as smart city infrastructures. These interactions are not static or uniform and so it's essential that the vehicles remain up-to-date and can be updated during their operational life. Connectivity is rapidly becoming a mission-critical aspect of both the vehicle and the automotive manufacturers' business model.

The Revolution Enabled by eSIM

The global cellular systems rely on a SIM card (also known as a Universal Integrated Circuit Card or UICC) to access 2G, 3G, 4G LTE, and 5G networks. In the same way, as the network architecture is evolving, the SIM has changed significantly. The embedded SIM or eSIM is a physical SIM that is soldered into a Telematic Control Unit (TCU) and enables storage and remote management of multiple network operator profiles. This significantly simplifies and reduces the implementation and programming costs when delivering cars to 170 countries.

An eSIM can support at least 10 different CSP profiles and this provides flexibility to remotely switch to any CSP in any country with which they have a provider contract. The OEM contracts with a prime CSP to deliver connectivity services and remote subscription management of the eSIM for the duration of the contract. At the end of the contract period, if the OEM decides to change to another CSP for connectivity services, then the new CSP can download their profile and manage connectivity. This potentially simplifies the CSP relationships and reduces lock-in effects for the OEM.

Connectivity Service Development

Two distinct types of services have developed in the connected-car space. In-car services are one that focuses on Infotainment (music, weather, social) and Navigation (location/traffic, landmarks, etc.). This is now being supplemented with in-car Wi-Fi connectivity to access streaming services. The second set of services is outside of the car and includes traditional telematics/M2M applications as well as incremental services such as insurance, preemptive repairs, and remote services, including stolen-vehicle tracking and parking information. These incremental services can be supplied by both the OEMs and aftermarket providers.

The connected vehicle has facilitated a range of new mobility experiences for drivers and passengers. Cars can be owned, rented, or shared, with drivers increasingly expecting to have a tailored and personalized experience as soon as they enter the vehicle. This expectation requires automotive companies to partner with telecom, payment, and security providers to deliver biometric-powered digital profiles (enrollment and verification of documents and biometrics) for secure access to personalized in-car services. This has been an enabler of multiple mobility-as-a-service platforms where digital profiles are essential to enable simple-to-use subscription services.

Current OEM Connectivity Strategies

Initially, CSP relationships were established in the home country of the OEM or in the most significant markets but, over time, this approach has morphed to OEMs generally working with a single large CSP with global capability. The relationships have not always been harmonious, but the connectivity contracts and the commitments are difficult for OEMs to walk away from.

The value chain for connected services is rapidly evolving and linked with sophisticated developments of software-defined vehicles and new technology developments, as well as the shift to electric vehicles. This has resulted in OEMs reconsidering many aspects of their "build versus buy" decision-making regarding connectivity. A consistent approach has yet to emerge, but the critical focus areas are over-the-air (OTA) capability, new revenue streams, and cyber security, as well as the global ability to deliver a consistent set of safety and infotainment services, with assurance.

To address these challenges, some automakers have acquired capability and are bringing connectivity in-house, while others are partnering with tech and cloud providers together with CSPs to deliver cloud-connected solutions. This is the key; it's not just about connectivity, it's about the connected-cloud-to-car continuum and ecosystem to deliver the services now as well as in the future.

Vehicle OEMs need to think globally about their connected-vehicle programs and how to manage connected-cloud-continuum experiences across continents. At the same time, they must also be aware of the constantly changing local and regional regulations to ensure that compliance is met, no matter where the vehicle operates.

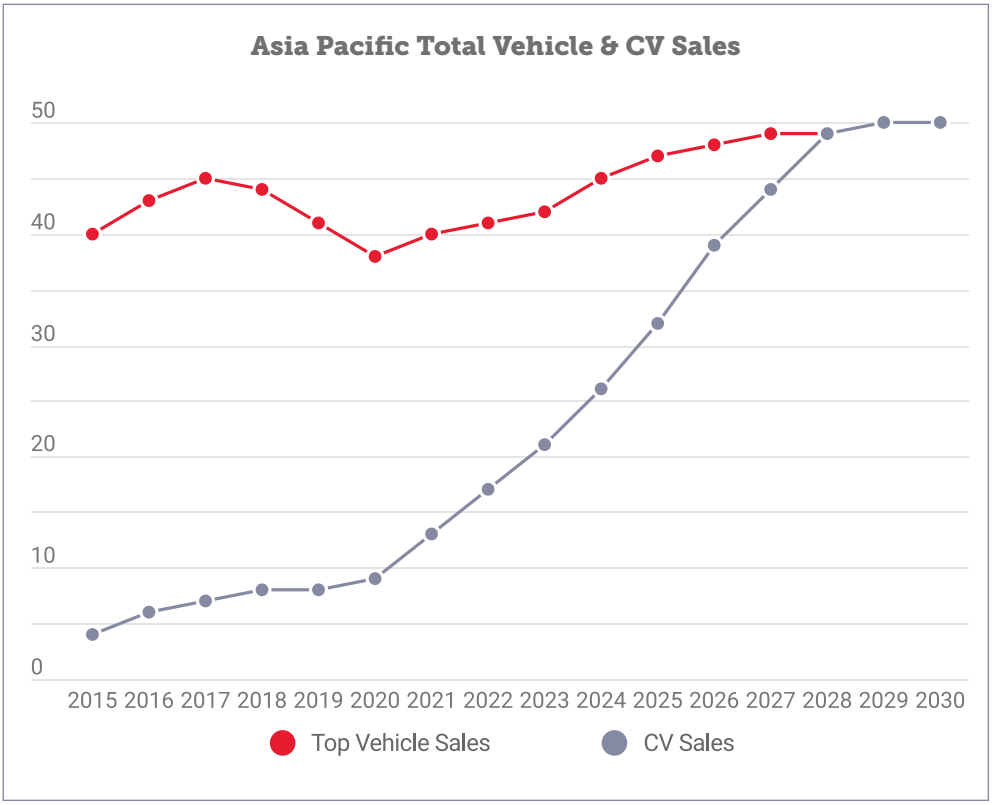
The Growth Opportunity in APAC

The APAC region is a large and diverse area, with various definitions of which countries are included. Our sister research company, Omdia, defines the area as Asia Oceania and includes 58 countries in the grouping. The area is home to 60% of the world's population, including two of the largest population areas India and China.

According to the GSMA , mobile broadband networks cover 96% of the population of APAC, with 1.2 billion people accessing mobile Internet services. There are at least 540 network operators or CSPs in the region. 5G momentum is accelerating across the region with commercial 5G services available in 14 countries, and several others, including India and Vietnam, are expected to start up soon. Consumer 5G roaming is gradually becoming available across the region and enterprise 5G roaming will follow. By 2025, there are expected to be 400 million 5G connections across the region – just over 14%of the population.

It is still early days in the APAC CV market, which is compounded by the number of CSP players in the region together with the highly diverse, disparate, and varying stages of communications-infrastructure development. This means that rolling out consistent CV services could be challenging, especially with fragmented bilateral and multilateral roaming regulations at a country and regional level.

Nonetheless, Wards Intelligence sees the growth of CVs accelerating over the next eight years, with all new cars sold in the APAC region being connected by 2030.



Source: Wards Intelligence

Deployment Challenges

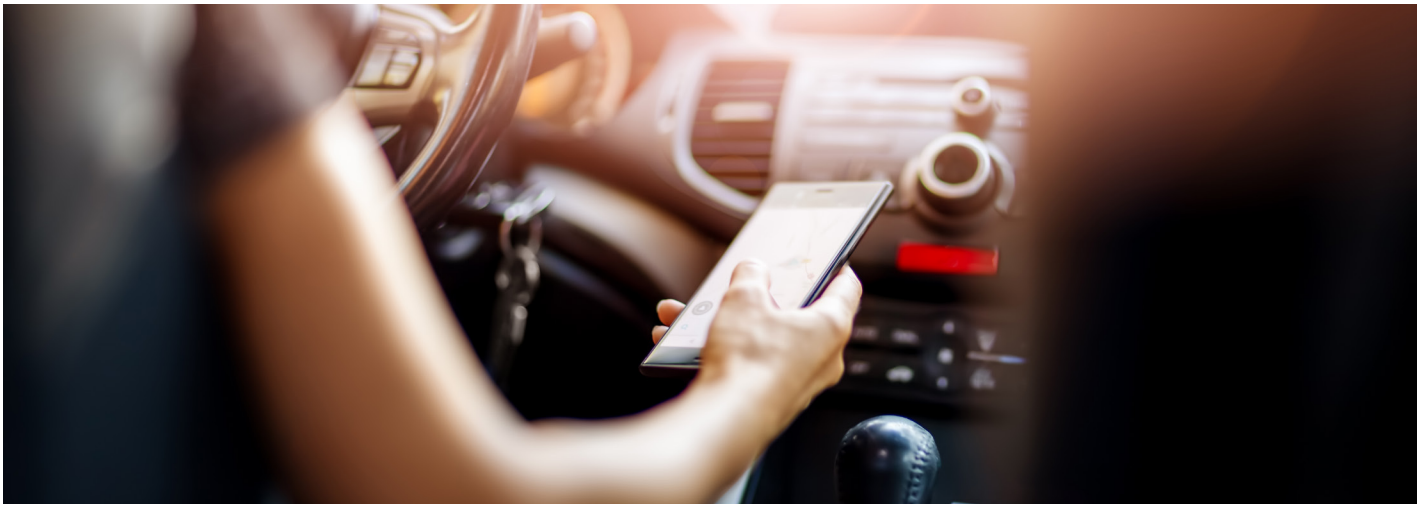
With the ever-increasing number of connected vehicles that are being shipped each year, the global operational fleet of connected vehicles continues to grow. The average life of a vehicle is around 11 years but, with the shift to BEVs, this lifecycle is anticipated to extend. This means that increasing amounts of in-vehicle software will need to be maintained and updated. The good news is that, with OTA capability, many of them can also be updated with new software and services.

Local Requirements

The global launch of new services in incremental and existing markets could be risky for vehicle OEMs. Service launches are complicated, and the longer they take, the costlier they become. Even if services can be done on a global scale utilizing OTA capabilities, vehicle manufacturers must still abide by local and regional regulatory-compliance requirements. Using trusted local partners with a knowledge of these requirements ensures that each service is compliant, including know-your-customer (KYC) checks that over 150 governments require for access to mobile services.

Data, Privacy, and Sovereignty

Connected vehicles collect and continuously communicate huge amounts of data, particularly regarding a user's location and behavior. In most countries, there was a simple divide between voice traffic and telematics regulations, but emergency call systems have blurred this separation in terms of required licenses. The introduction of advanced infotainment systems and Wi-Fi into vehicles has steadily increased this data volume, which means that the requirements for a license have become a grey area. In some cases, it's not just a telecoms license but also an Internet service provider (ISP) license that is required.



The wealth of data being generated must be protected on the vehicle as well as when transmitted over the network. Data authenticity and integrity issues caused by data tampering, manipulation, and spoofing could be disastrous for connected vehicles. It is critical to ensure compliance with local and regional data and cybersecurity regulations, and that the vehicle system meets all local technical requirements for the integrity and accuracy of data stored and transmitted. In many countries, particularly in China, the U.S., and India, the regulations relating to data privacy and sovereignty will not let user data be deployed outside of the country.

Integration and Interoperability Across Multiple Operators

Vehicle manufacturers that introduce a new service want to ensure it can be utilized by customers, no matter the region. This requires that CSPs have networks and capabilities that support the service, including connectivity compatibility and software lifecycle management competence. One challenge is that these requirements may not have been considered when the initial global, regional or local CSP arrangements were negotiated.

Roaming is traditionally about delivering basic connectivity and communication, which means that some more advanced services and related capacity requirements may not be met outside a vehicle's home network. Most network roaming architectures are designed to route traffic to the home network first, which may prove increasingly problematic as automotive use cases become steadily more latency-critical or produce high data throughput.

If a vehicle is shipped to a country still using a CSP profile established when it was tested in the home network factory and activated for the customer by a dealer, then the vehicle is now roaming on that host country's mobile network. If it continues to operate for 90 days or more, it is deemed to be permanently roaming. In many countries, permanent roaming is restricted - and in some prohibited -which can lead to termination of the connection.

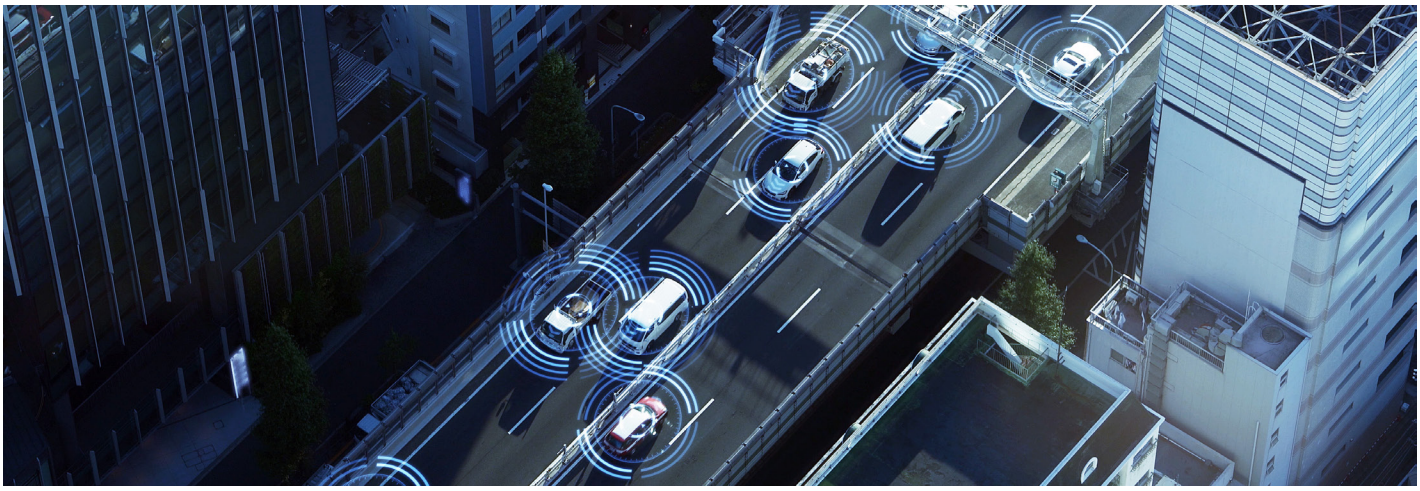
The introduction of eSIM/eUICC means it's possible to avoid the roaming model altogether by using local subscriptions and eSIM technology for provisioning in each local network. This approach ensures access to all the functionality and capacity provided by the local network, including direct access to local data centers. In an ideal scenario, regional orchestration of service, subscription, and cost models between the operators would be optimum to achieve consistency of experience.

An eSIM management platform provides the ability to provision eSIMs for different countries remotely using over-the-air updates. OEMs can use an in-house connectivity and subscription management platform, or they can buy services from one global CSP, regional CSP, or even a Virtual CSP / Telematics service provider (TSP). The main challenge is determining the trade-off between the options in terms of complexity and management costs. Unfortunately, it is also essential that the CSPs' different systems are interoperable in order to provide simple and flexible management and orchestration for OEMs.

Working Within the Constraints of Existing MNO agreements

One of the challenges for OEMs is who in the organization is dealing with connectivity. Traditionally, this has been split between purchasing and a technical lead on a specific program. As the pace of technology advances and the criticality of connectivity becomes a fundamental enabler of lifetime vehicle revenue, the decisions become increasingly more strategic.

Local and long-term agreements that are optimized on initial costs may not be the best solution over the long term from a revenue perspective. Connectivity costs vary across countries and as data volumes increase, the costs associated with transmission become increasingly important. This will require vehicle manufacturers to determine what the value of the different types of data are for internal use and then who values the data externally and whether can it be monetized in a compliant, standardized, and consistent way.



In the future, OEMs need to consider a strategic perspective of global connectivity. They will be required to look at the global operations of not just new vehicles but also the existing operational fleet and consider the impact of connectivity decisions on lifetime revenues as well as the traditional focus on cost.

The table below identifies some of the factors OEMs consider in selecting connectivity partners and services, and why a strategic versus solely technical or purchasing perspective is critical.

A Strategic Connectivity Perspective

Connectivity Considerations	Purchasing	Product / Technology	Strategic
Coverage and capacity service agreements	✓		✓
Data security and management		✓	✓
Connectivity and subscription management	✓		✓
Regional / Local data cost and volumes (Group /Brand)	✓		
Consumer service/ price plans (Group /Brand)	✓	✓	✓
Vehicle Fleet lifetime revenue (Group /Brand)			✓
Vehicle Fleet Global data cost and volumes (Group /Brand)			✓
Split billing	✓		✓
Regulatory compliance		✓	✓
Innovation and service introduction		✓	✓
Connectivity technology		✓	✓
Cloud & edge technology		✓	
Customer experience index			✓
Service / Apps ecosystem		✓	✓
Emerging adjacencies			✓

Source: Wards Intelligence

Keeping Pace with Technology

Transitioning to 5G

As highlighted, the pace of technology change is accelerating, and being able to stay attuned and aligned with it is challenging. One of the biggest challenges will be gauging the right time to transition CVs from 4G LTE to 5G by country or region. The time-to-market for 5G networks and services is moving much faster than in earlier generations, and this needs to be considered and potentially addressed preemptively.

5G technology can deliver dramatically improved network connectivity with faster broadband that is low latency and secure, as well as more cost-efficient. The connectivity capabilities can be tailored to different services using mechanisms that enable both separate quality of service (QoS) and billing. For a connected vehicle, it means a CSP can support ultra-high-definition broadcast services separate from vehicle-to-everything (V2X) services on the same network.

As the connectivity needs of the automotive ecosystem grow more diverse and complex, OEMs need to take a holistic network approach rather than a single market silo approach.

The Impact of V2X

C-V2X technology will ensure that cars with ADAS capability are not limited to only using onboard sensors to make critical safety decisions. C-V2X provides over-the-horizon and around-the-corner intelligence from other vehicles, infrastructure, and the cloud network. This technology can make cars safer today and will enable the evolution of the autonomous vehicles of tomorrow; it turns the car into an autonomous digital platform capable of interacting with infrastructure, people, vehicles, and the network, unlocking the opportunity for a plethora of digital services.

It's thought that network slicing will be an enabler of these services. Network slicing allows CSPs to operate multiple logical networks, or "slices," using their common 5G infrastructure to serve many customers while simultaneously isolating the network slices to ensure specific service level agreements (SLAs). This has yet to be commercially proven and will be dependent on spectrum availability and usage in each country.

With each OEM being supported by different CSPs in different regions and markets, there is a need for C-V2X service realization across CSPs. This requires V2N services to function seamlessly across multiple CSPs, especially for use cases requiring data pooling and information sharing from all possible vehicles.

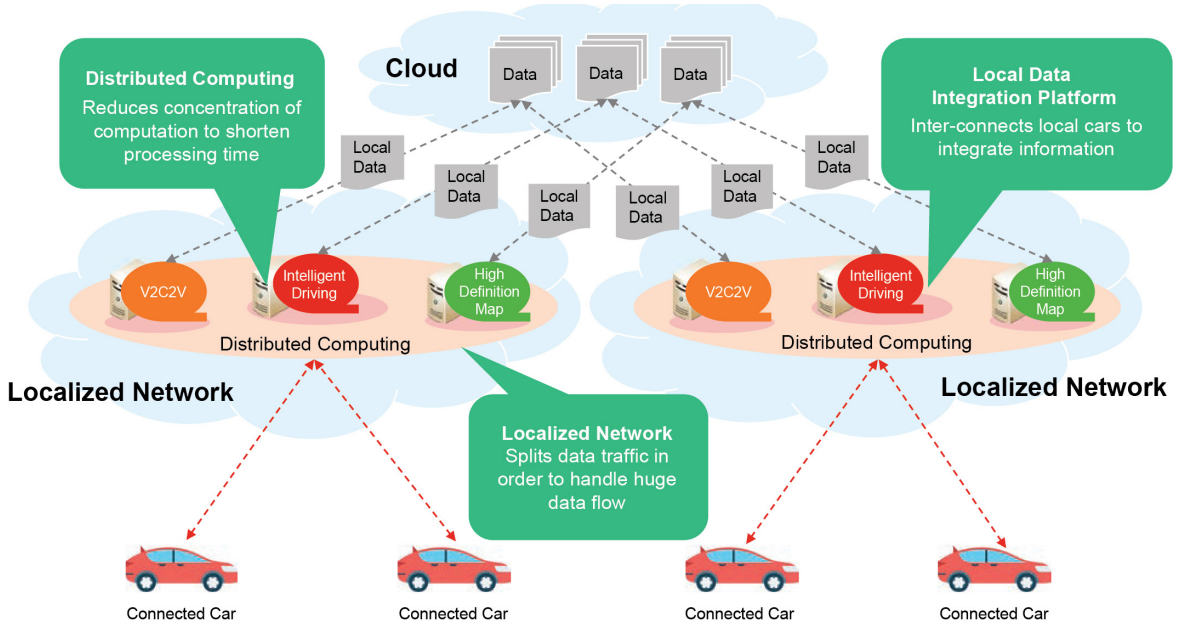
Workloads on Cloud and Edge Architectures

Today's cellular networks can support the data volume generated by the relatively small daily duty cycle of a vehicle. Currently, most telemetry data from connected vehicles is transported back to centralized data centers for processing. However, as the number of connected software-defined vehicles increases and the data volumes they create increase, CSPs and vehicle OEMs will have to consider ways to cost-effectively handle significant data volumes on a global scale. OEMs would benefit when the computation of the data can be performed closer to the location of the vehicles as it reduces the volume of data that needs to be transported and paid for.

The Automotive Edge Computing Consortium (AECC) has created an architecture for CSPs and automotive OEMs to collaborate and optimize the workload and data tiering topology, to deliver a seamless data lifecycle.

CSPs are owners of the network access points and, by using host edge servers running cloud-based applications, CSPs can partner with cloud hyperscalers (that OEMS already work with) to deliver tailored services. By gaining a better understanding of the connectivity, computing, data storage, distribution, and security needs of the automotive industry, they can devise creative ways to work together.

Distributed Edge Computing on Localized Networks



(Source: AECC)

It's recognized that Infotainment, such as video, benefits from delivery points that are closer to the vehicle. Several other emerging automotive services that require vehicles to be connected to the cloud and network edge to facilitate the transfer of a large amount of data are HD-Mapping and Vehicle to Cloud (V2C) Cruise Assist, which encompasses vehicle-to-vehicle (V2V) connectivity capabilities to enable enhanced collaborative vehicle operations.

Open SIM Management and Better Interoperability

Many CSPs treat connected cars as just another IoT device and leverage the same device management and application platforms. Unfortunately, with advanced infotainment and content services, it's about ensuring that a seamless consumer experience is delivered, not just a data-management service. When different platforms are being used in a region it can be beneficial to have a lead operator, or alliance with a platform, that interoperates with the other CSP platforms.

There are more than 15 GSMA-accredited eSIM management platform suppliers. Many of these have been supplying traditional SIM cards and have established strong relationships with global CSPs, meaning that eSIM platforms are being operated as closed systems or walled gardens. The result is that multi-partner or multi-system approaches to eSIM management are difficult to implement and require considerable investment.

However, cloud-based open eSIM platforms could change the game because they are vendor agnostic. They will allow progressive CSPs and automakers to consider a multi-vendor procurement strategy for eSIM and management platforms. This should allow them to capitalize

on improved competitiveness and ensure business continuity and geo-redundancy. Moving forward, faster time-to-market and flexible services will drive lower-cost and lower footprint deployment that will reinforce simple open management of eSIM technology.

Emerging Opportunities

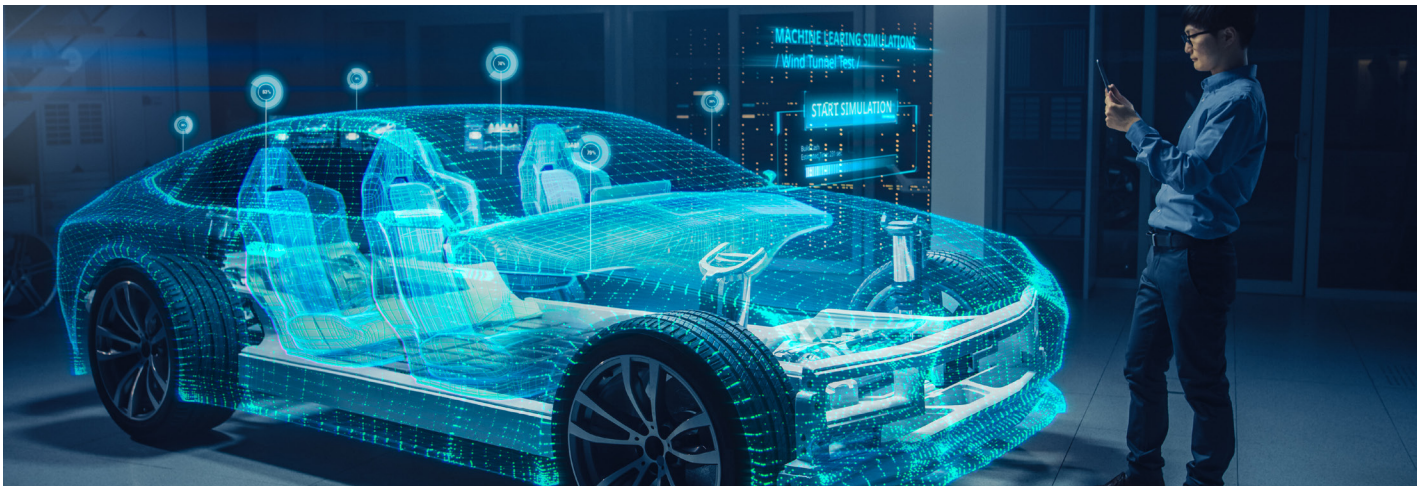
Smarter Mobility and Cities

4G-powered smartphones facilitated the emergence of shared mobility models that changed how people live and travel in cities and forced them to rethink car ownership. Although connectivity facilitated the shift, it was the combination of cloud-based platforms and the utilization of data that powered the growth of mobility services. Mobility intelligence that combines data from different sources to help with scheduling, tracking, and sharing the progression of shared mobility fleets will make even further steps forward as more connected-vehicle data becomes accessible and usable.

Software-defined vehicles with cellular connectivity and C-V2X will increase the flow of data, leading to better information. Mobility intelligence takes this data and blends it with other IoT, smart city, and intelligent transport system data to increase safety and deliver smoother journeys. A significant benefit of smoother journeys is less congestion and reduced idling, leading to a reduction in pollution and contributing to the sustainability efforts of cities and transport systems.

Localized Co-Creation

According to a McKinsey study, 37% of consumers would switch car brands if it meant improved connectivity . So, having optimized and resilient connectivity that car owners trust will be key to loyalty. Going forward, consumers' expectations will be shaped by their digital life experience, and they will demand a good experience, particularly if they invest



in expensive OTA feature upgrades. Owners will anticipate OEM branded connected vehicle services to be delivered seamlessly and without fuss, which is why the quality of connectivity will become business critical.

A regional and local partner can ensure not only optimized and resilient connectivity but can help co-create advanced localized services with regional ecosystem partners. Jointly, the partners can not only leverage the unique and valuable insights into driver interactions with vehicle systems, but also the localized connected environment, such as regional smart cities. This allows the development of regional-specific offerings based on services that local customers already access on their mobile phones and by curating digital entertainment packages based on a driver's personal profile.

Broader Business Models

Broader opportunities can be derived from data by OEMs making their organization more efficient, more agile, and more managed end-to-end. Regional CSPs and partners that have extensive IoT experience and engagements can assist in delivering these broader opportunities. This includes enhanced transparency, monitoring and improvement of sustainability and efficiencies along the supply chain, as well as taking advantage of smart factory use cases with 5G private networks to accelerate digital transformation. As a result, each vehicle will be connected in the factory and it will remain connected during distribution and when it leaves the dealership and goes to its first and subsequent owners. This enables the vehicles to deliver real-time data and information to improve manufacturing and design features, as well as enabling OEMs to respond faster to customer needs.

A Different Approach

As highlighted, the opportunity in APAC for CVs will accelerate and the growth of connected services will expand. This requires a strategic and holistic view of the connected cloud continuum as it develops to ensure the ability to deliver capability for connected vehicles: Specifically, how they will operate within intelligent transport systems and smart cities and how connected BEVs can interact with smart grids. Additionally, the automotive supply chain and manufacturing ecosystem will need to leverage the connected cloud continuum to deliver OTA updates and upgrades, as well as be best positioned for the introduction of digital twins that track and shadow the vehicle throughout its life. All these opportunities provide a chance to accelerate sustainability compliance and align with broader OEM corporate ESG goals.

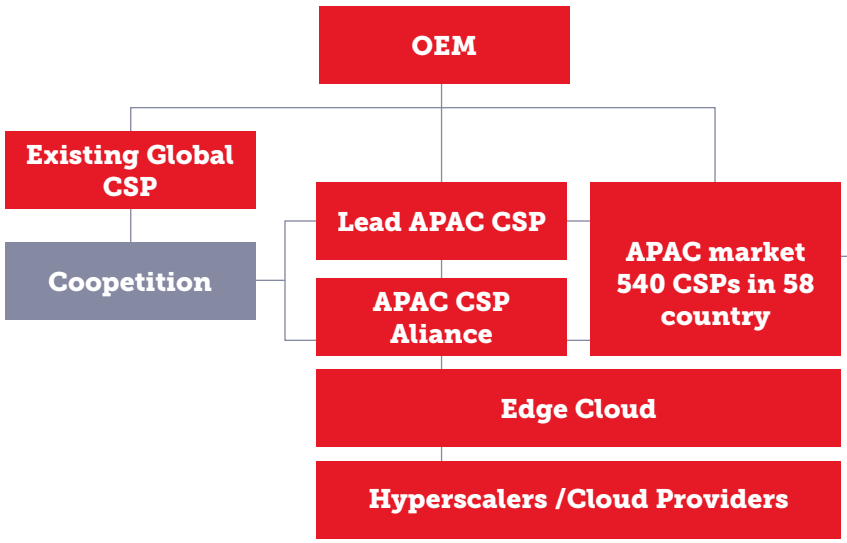
There is a requirement for a long-term perspective rather than a short-term cost focus. OEMs need to consider all the service criteria and challenges identified in this paper, as well as an estimation of lifetime fleet data traffic and service revenue and costs.

To determine the best approach to addressing the APAC market, the following chart summarizes the challenges identified in this paper and the routes to market via direct-to-local CSPs, regional lead CSPs, and alliance partners. It also captures the reality of having to think through the complexities of cloud edge compute arrangements and hyperscale partnerships to handle data sovereignty and data triage challenges of the current and future CVs.

Framing the APAC Strategic Choice

Current Situation

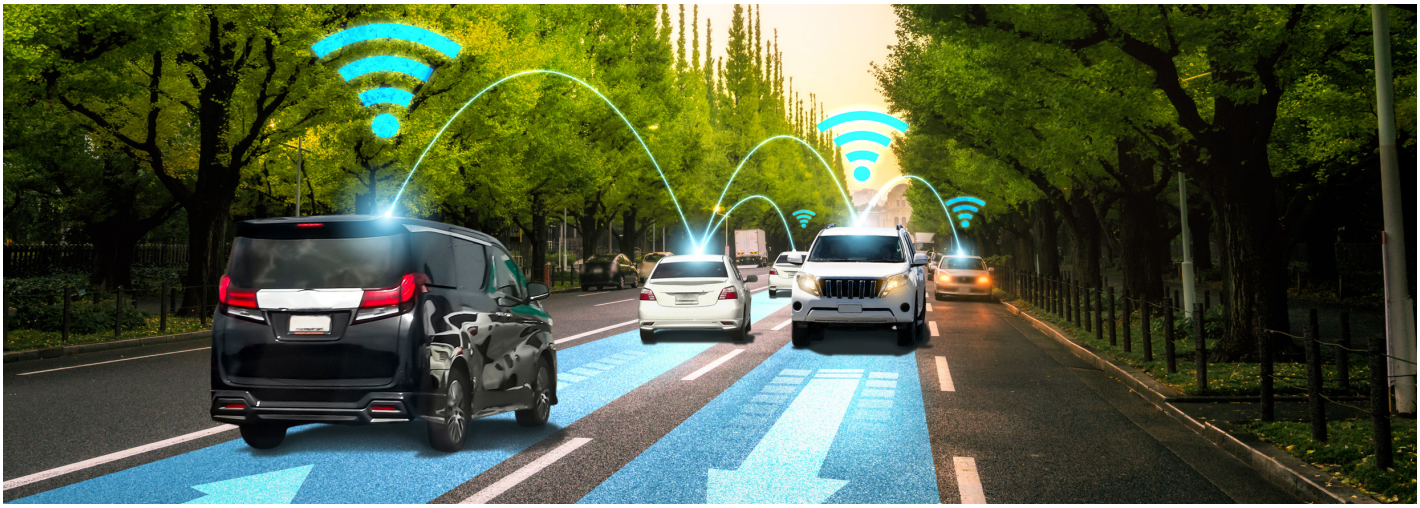
- CV concept & services evolving
- eSIM Flexibility & Mgmt
- Services & Mobility development
- Long term considerations
  - OTA
  - Cybersecurity
  - Consistent service delivery
- Asia CV market growth
- Service Deployment
  - Risk reduction
  - Compliance
  - Partnering
  - Network compatibility
  - Roaming & eSIM mgmt.
  - Open versus walled garden eSIM mgmt.
- Pace of change
  - 4G/5G transitions
  - Positioned for C-V2X
  - Data storage mgmt.
  - Edge cloud support



Key CV service Elements

- Billing & Tax
- Know-your-Customer (KYC)
- IoT Regulations
- Device certification
- Licensing
- Connectivity regulation
- Data security & residency
- CSP regulations

Source: Wards Intelligence



Based on these options, it is essential that OEMs consider the recommendation to adopt a strategic rather than purely technical or purchasing perspective. To assist with this, the following decision framework captures the key areas addressed in this paper that need to be considered from all three viewpoints and should lead to the optimum strategic direction for an OEM APAC strategy.

Across all these perspectives, the ones emphasized at the bottom of the chart (highlighted in gray) are the interlocked characteristics that are critical to ensuring a consistent brand experience for OEM customers. This is and will continue to be the primary aim of connected vehicle services; the ability to globally deliver on the OEM's brand promise and enhanced relationship with their customers across the connected cloud continuum.

APAC Decision Criteria

Purchasing Criteria	Technical Criteria	Strategic Criteria
Voice /SMS and data costs	4G/5G transition plans and C-V2X introduction plans	Strategic risk assessment
e-CALL capabilities	Market readiness	Tech and strategic alignments to alliances (bridge alliance) and standards bodies (GSMA, AECC, 5GAA)
CV service level elements checklist	Connectivity, eCALL and Internet regulation	Sustainability compliance and enhancement opportunities aligned to ESG goals
	Services – infotainment & content	Adjacency & broader business model opportunities (Smart grid & Smart city)
	Open eSIM management	Supply chain & manufacturing connected cloud continuum (Industry 4.0/ private networks/ digital twin)
	Fit for purpose automotive platform	Ability to cooperate on data sovereignty and triage and work with partners on cloud edge compute requirements
	CSP Technical competence and ability to shape technical direction	Estimated lifetime fleet data traffic and service cost and revenue
Network and service compliance	Assurance on consistent service delivery	Brand alignment & assurance

Source: Wards Intelligence

Singtel

Singtel is the largest multi-domestic CSP in the APAC region and is a founding member of the Bridge Alliance, the APAC region's largest M2M alliance joint venture, established in 2004. Singtel and Bridge Alliance members' intent is to be the partner of choice for multi-domestic mobile connectivity requirements. Through its members, Bridge Alliance provides a gateway to Asia for enterprises and, via its Bridge Alliance Ecosystem, a network of trusted partners that are motivated by co-creation.

Singtel was chosen by a European-based global OEM to accelerate its regional connected-car program across thirteen APAC countries with a managed regional IoT connectivity solution. Singtel acts as the lead CSP and single point of contact using a unified managed solution with a centralized and open integration platform to serve the target markets and beyond.

Another example is when an Asian-based global OEM rolled out its connected-car program across five APAC countries with a managed regional IoT connectivity solution. Again, Singtel acted as the lead operator and as a single point of contact with a unified managed solution using a centralized and open integration platform.

In both these examples, Singtel provided essential local operator domain knowledge and compliance with in-country regulatory fulfillment.

1. https://data.gsmaintelligence.com/research/research/research-2022/the-mobile-economy-asia-pacific-2022
2. https://aecc.org/wp-content/uploads/2021/05/MWL_-_AECC_whitepaper_-_Design_v2.0.pdf
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