



2023 Mobility Intelligence Dialogue - India

E/E Architecture for Software Defined Vehicle

AutoTechInsight

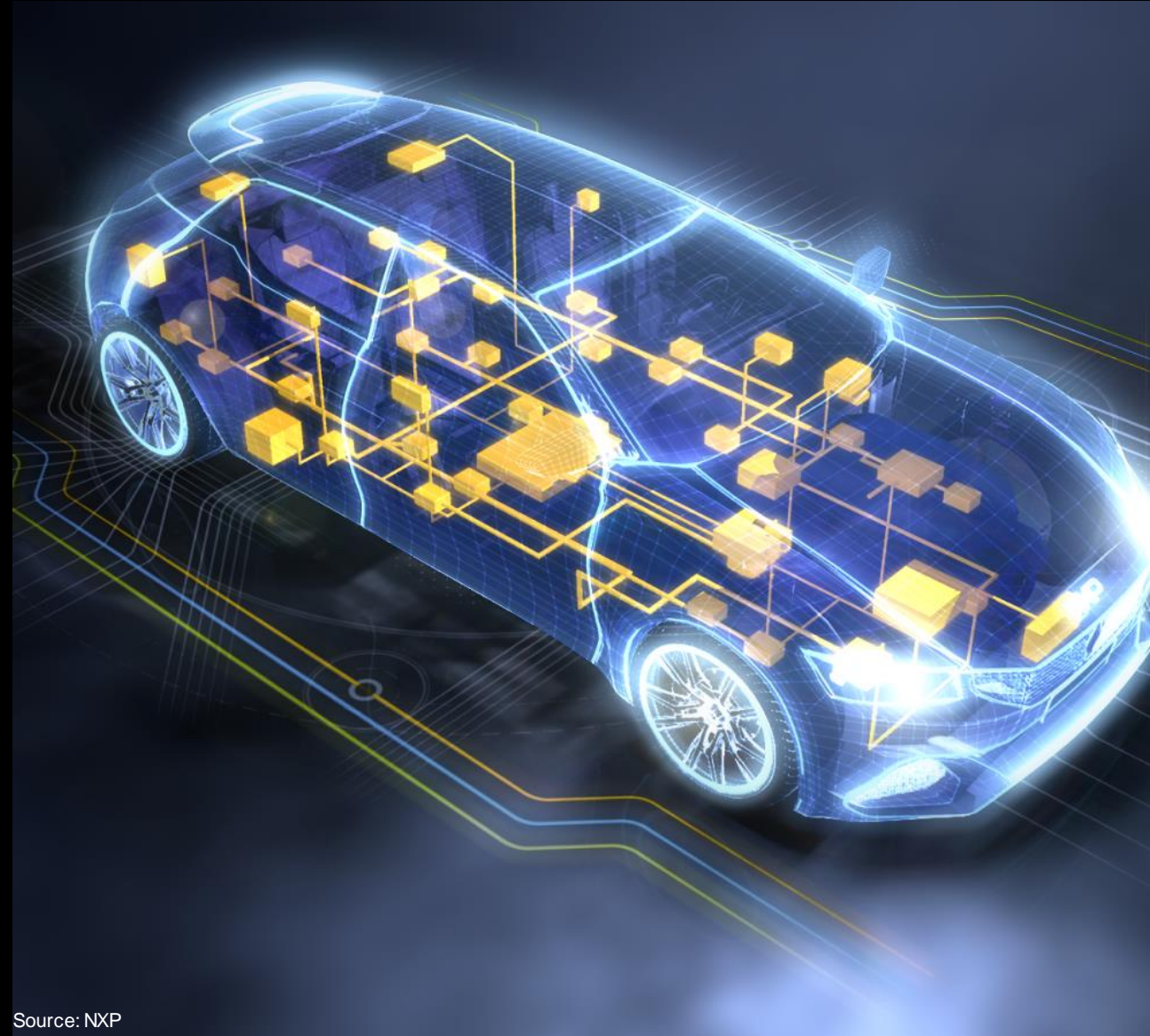
S&P Global
Mobility

Pawan Kumar Sahu
Principal Research Analyst
EE and Semiconductor
S&P Global Mobility
13 October 2023

Outline

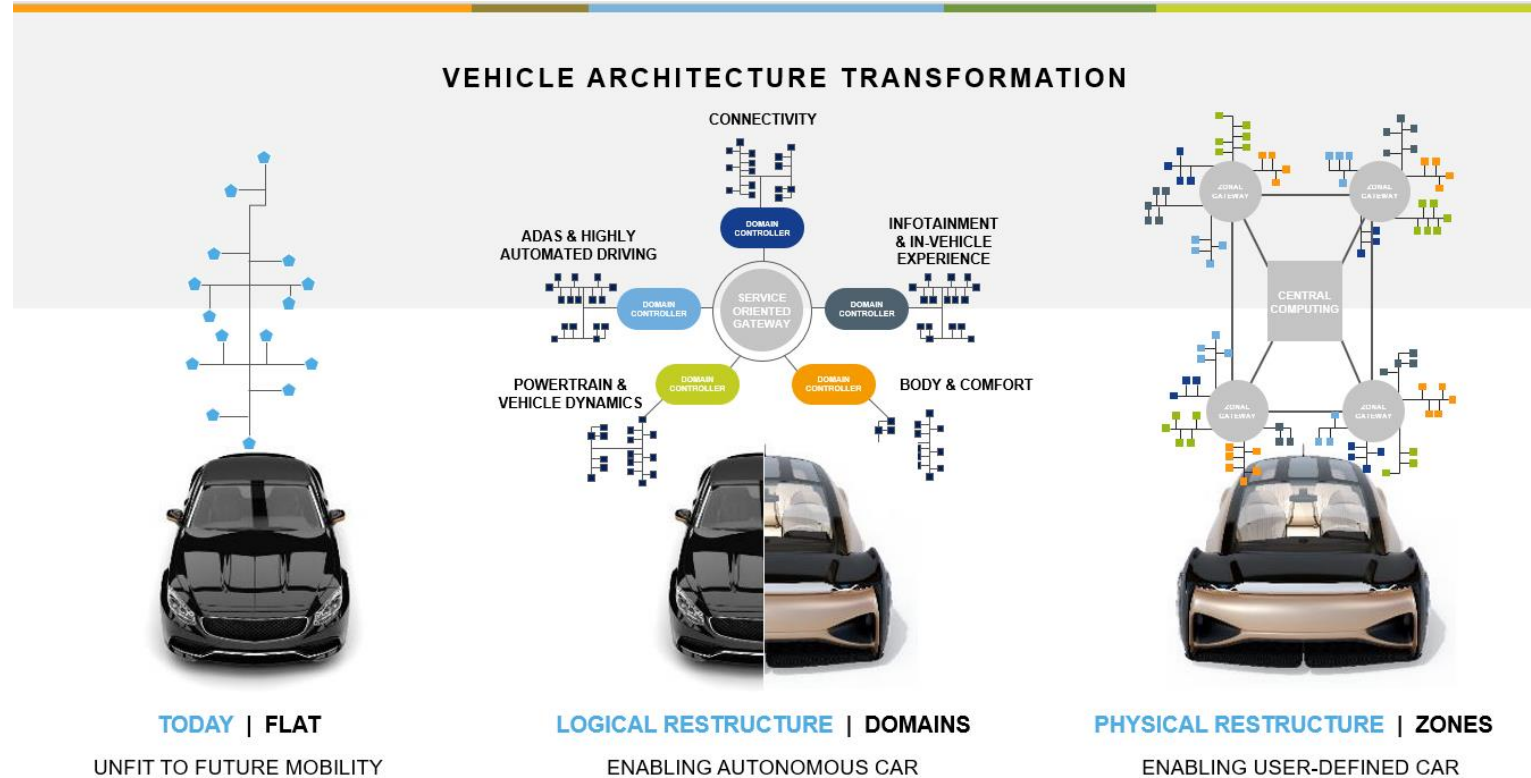
- Introduction to Electric/Electronics (E/E) architectures
- E/E Architecture migration has started
- Migration is easier said than done
- Summary

Introduction to Electric/Electronic (E/E) Architectures



Source: NXP

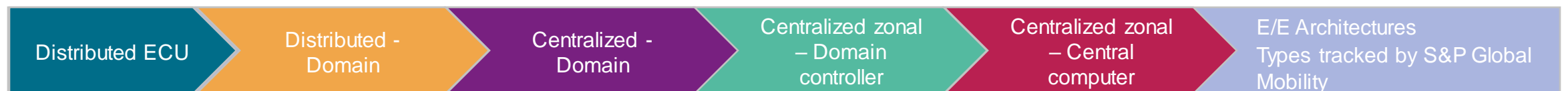
Introduction to Electric/Electronic (E/E) Architecture migration



Virtualization of functions, i.e., hardware abstraction

- The trend is towards connected cars that can update more frequently vehicles controlled by software
- We explore the hardware supporting these goals
- In ECUs and domain controllers, functions are embedded (hard-coded) in the hardware
- In zonal controllers and central computers, functions are implemented as software in domain-agnostic hardware

Source: NXP



Why a migration towards zonal E/E architectures?

Enabling the Software-Defined-Vehicle

- Easier for OTA (Other-The-Air) update
- Enabling paid services and new business models for OEMs

Less ECUs, less wiring, less weight

- Reduced complexity of electronics while adding more autonomy, cockpit features.
- Reduced number of ECUs and associated wiring
- Lower weight = increased BEV range
- Potential for automated wiring harness assembly

Source: Tesla

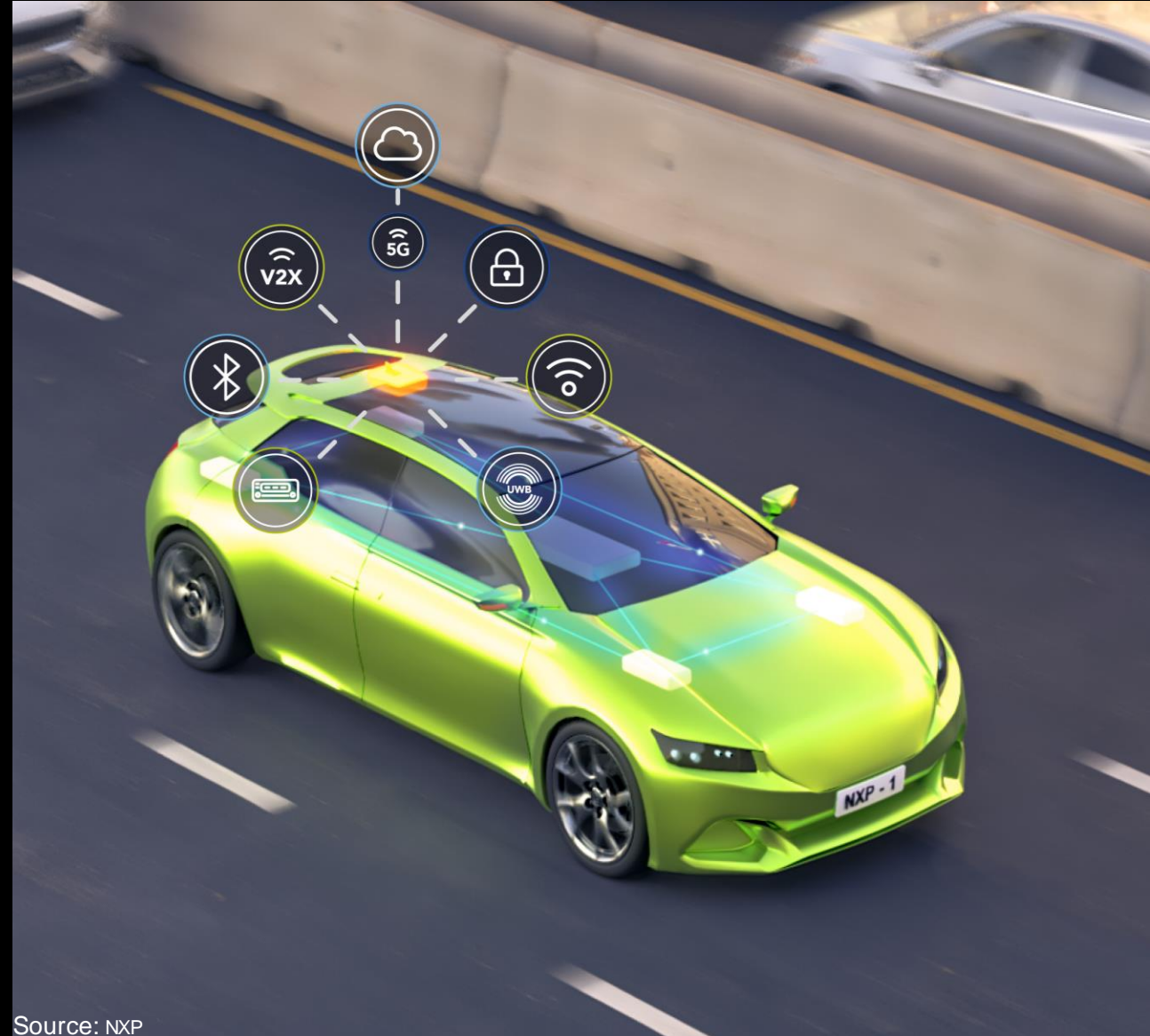
Tesla leads the way

- 2017 Tesla Model 3 was the first vehicle with zone controllers and central computer



- Paid OTA activation of functions like L3/L4 Autonomy
- 50% less wiring compared to previous Model S
- Big reduction of number of ECUs – more than 50%
- Faster car assembly time through higher automation

E/E Architecture migration has started

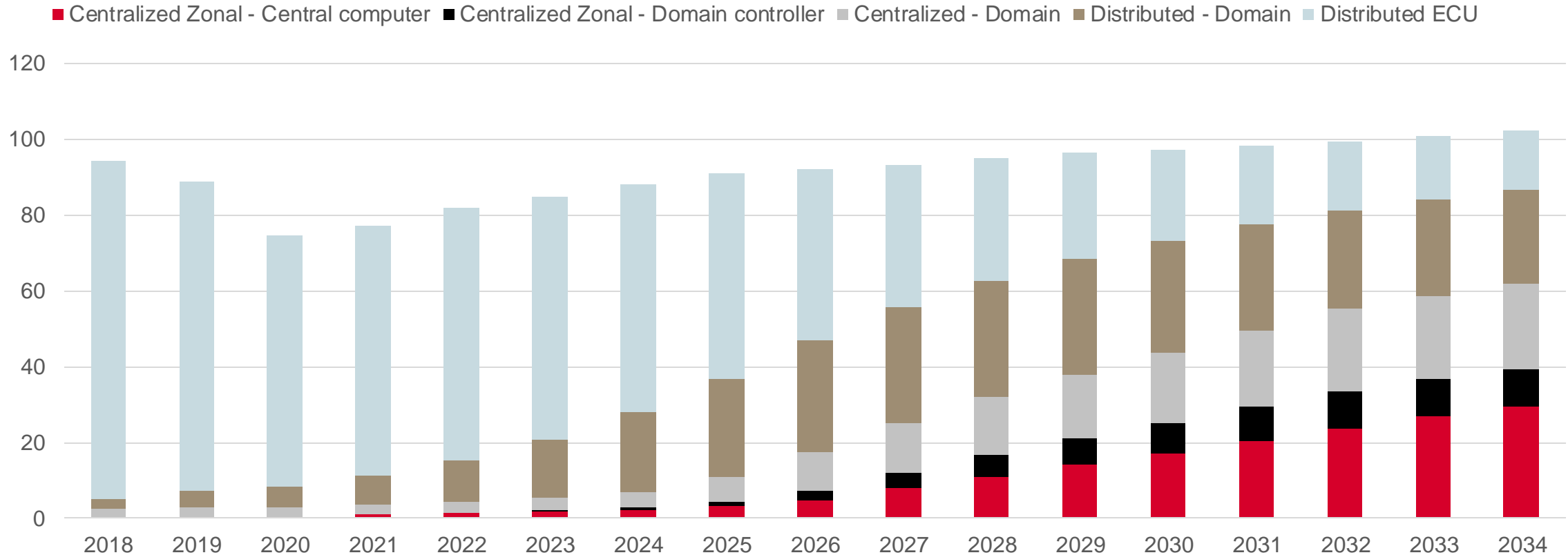


Source: NXP

Migration to Zonal E/E Architectures has started

Zonal* architecture in 39% of vehicle produced in 2034, up from 2% in 2022

Light vehicle production forecast by E/E Architecture, 2018–34 (millions)



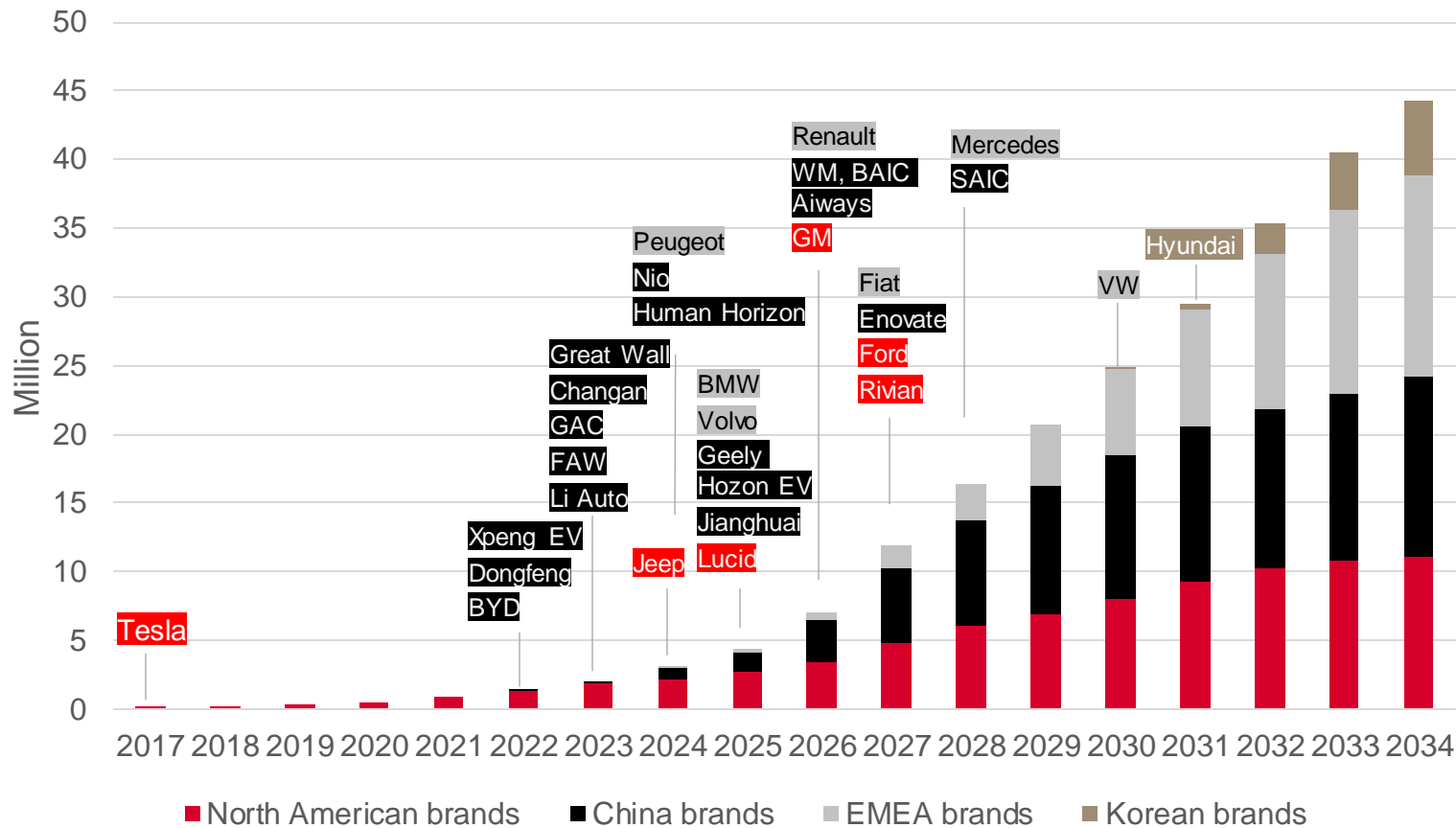
*Zone defined as simple I/O unit, up to local zone and energy management.

Data compiled August 2023.

Source: S&P Global Mobility EE Architecture Platforms Forecast.

Migration pace towards zonal architectures varies by OEM and region

Adoption of zonal E/E platforms by region of brand



- North America
 - Tesla has 5-year lead
 - Jeep is advanced at Stellantis
 - Ford and GM in 2026 – 2027
- Mainland China is rapid adopter
 - Aggressive roadmaps, follow Tesla
 - Less legacy architecture
 - Tailor to niche sub-brand BEV
- Europe trails mainland China
 - Zonal adopters include BMW, Volvo and Renault, Mercedes and VW later
- Korea trails Europe
 - Initially focused on Domain Controller architectures. Now considers zones for next gen after 2030
- Zonal architecture is not a focus for Japanese OEMs
- Indian OEMs may start adopting zonal E/E around 2030.

Data compiled August 2023.

Note: Only the first brand shown by an OEM, if multiple brands from the same OEM introduced the same year, only name of the largest brand shown. Mainland China's sub-brands not shown, only parent. New brands in mainland China shown until 2028 only for clarity.

Source: S&P Mobility Global, EE Architecture Platforms Forecast.

Software-Defined-Vehicle on Indian roads

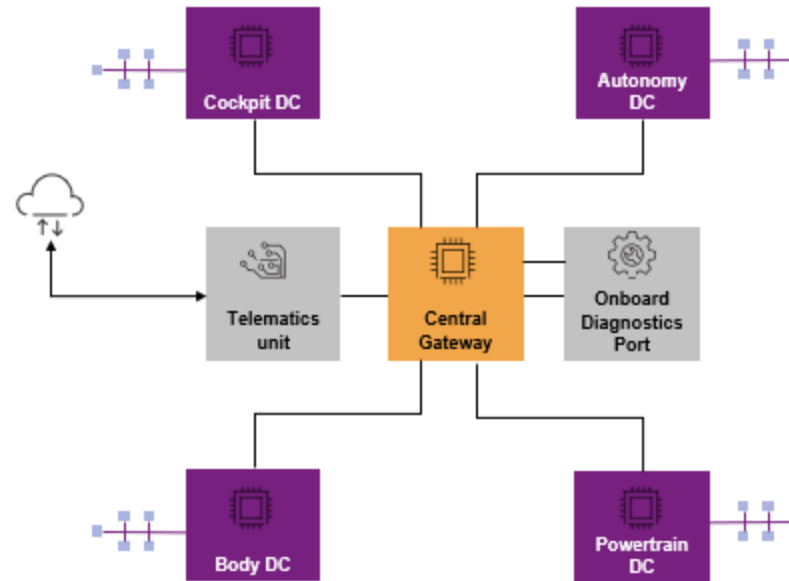
Indian OEMs are moving from Distributed ECUs architecture to domain-based architecture

- Mahindra has collaborated with Volkswagen for MEB platform and will use MEB components in its new INGLO architecture. The INGLO platform will feature 3 integrated high-performance computer(HPC).
- Maruti Suzuki and Toyota collaborated to share technology expertise.
- Tata Motor launched Gen-3 EV Architecture which is expected to have minimum range of 500 km.

Advancement in E/E architecture is driven by need of :

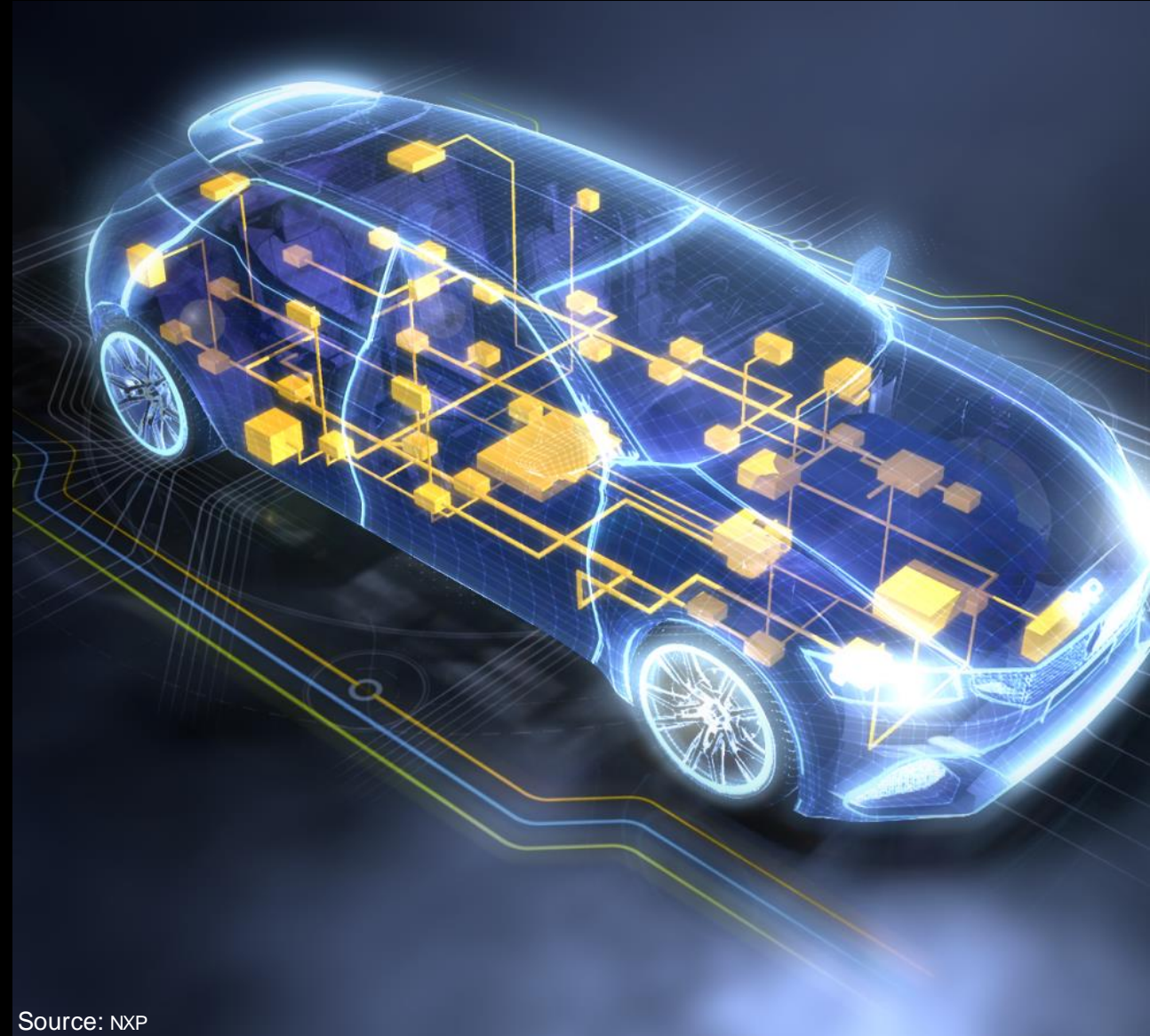
- Electrification
- Connectivity
- Safety

Distributed Domain E/E Architecture



*DC : Domain Controller
Source: S&P Mobility Global

Migrating E/E Architecture is easier said than done



Source: NXP

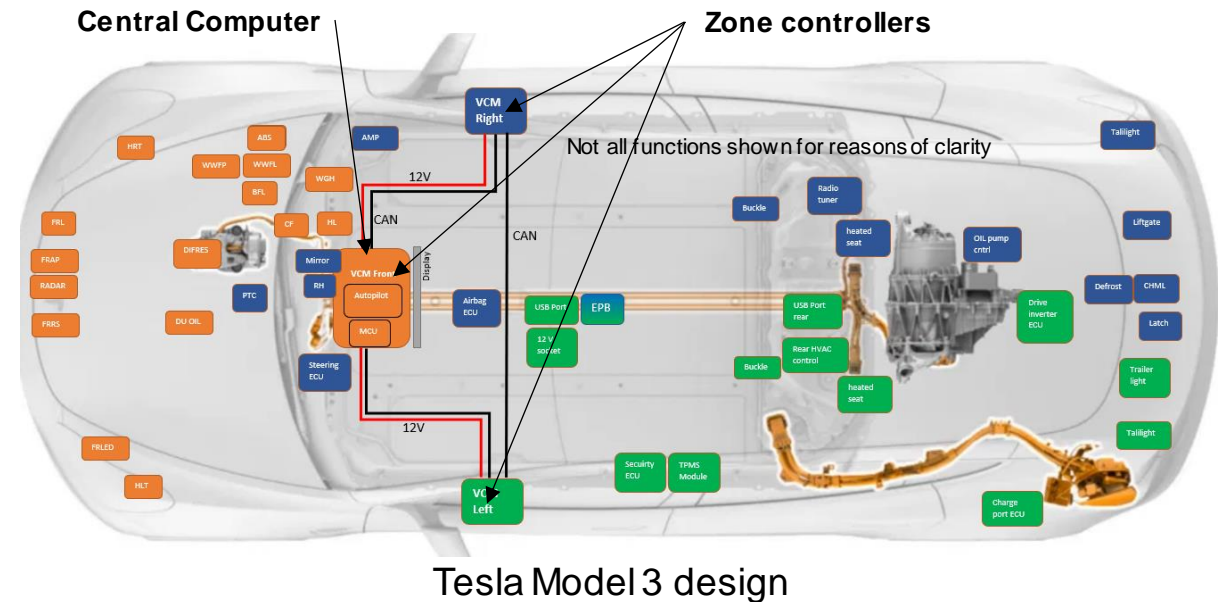
Tesla remains far ahead of everyone including Chinese EV brands

Zonal E/E architectures: Tesla vs the world

	Zonal Architecture	Wiring harness reduction with Zonal Architecture (est.)
Tesla	2017	50%
BYD	2022	n.a.
GAC (with Huawei)	2024	20%
BMW	2025	20%
Volvo	2025	20%
Renault	2026	20%-30%

- Revolutionizing manufacturing
 - Automation of wiring harness
 - Faster car assembly time

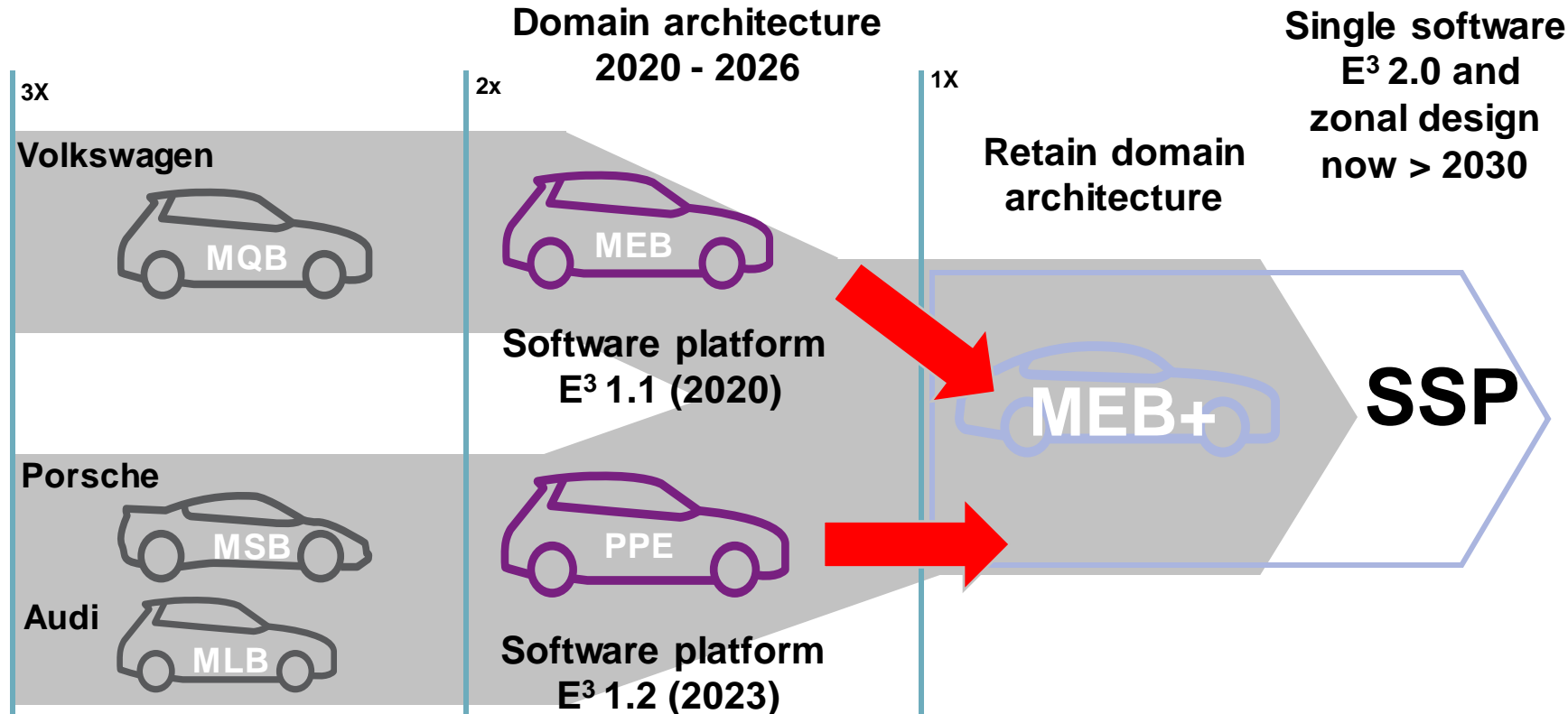
- Tesla model 3 design (2017) remains 5 to 10 years ahead of rest of industry
- Further than competition in virtualization of functions in zonal and central computer -> achieves greater simplification of wiring harness



Source: S&P Mobility Global

Volkswagen's revised vision 2026 BEV portfolio

Changes to SSP plan – MEB+



- Software challenge
- Wide portfolio
 - Trying to accommodate too many requirements with single E³ 2.0 software platform for all segments from small economy to premium BEV
- Weight of legacy hardware
 - Traditional OEMs like to reuse legacy hardware for next platform
 - Hard to break from legacy hardware to fully “virtualise” functions
- Weight of internal structure
 - Unions in the way of building new dedicated EV factory
 - Outlook for automating wiring harness assembly thanks of new EE Architecture reduced

Source: S&P Mobility Global (based on Volkswagen presentation)

Summary

- Migration to new E/E Architecture has started to support the Software Defined Car but also:
 - Simplified wiring for reduced weight / extend BEV range
 - Ease / speed of manufacturing
- North American and Chinese OEMs are far ahead in adopting zonal architecture.
- Indian OEMs are moving E/E architecture from Distributed ECU architecture to Domain based architecture.
- Migration is tougher for OEMs with wide portfolio.
 - OEMs migrating at different rates depending on portfolio, legacy and philosophy

Appendix E/E Architecture Platforms forecast launched on February 1st 2023

Quick Facts: Electric/Electronic Architecture Platforms

E/E Architecture Platforms | Launch Date: February 1, 2023

- New model-level forecast describing OEM migration strategy from distributed to centralized architectures.
- The forecast captures key hardware comprising of domain controllers, zonal controllers and central computers
- Production Forecast Subscription
 - Extended forecast 2034
 - Non-extended on demand only
- 12 months access
- Quarterly updates
- Production Forecast
- Provides clarity for OEM EE migration strategies
 - Which OEMs pioneer, which are lagging?
 - What steps will an OEM take on way from distributed to fully centralized architecture?
 - Which OEMs are scaling architecture to all platforms, and which align centralized architectures to their BEV platforms roadmap?
- The forecast provides actionable insights for suppliers to understand the impact of new E/E Architecture Platforms on their business

Customer Care

Email AskMobility@spglobal.com

Telephone

Americas +1 800 447 2273

Europe, MEA +44(0) 134 432 8300

Asia Pacific +604 291 3600

Japan +81 3 6262 1887

Corporate Site

Japanese: SPGlobal.com/Japan_Automotive

Chinese: SPGlobal.com/China_Automotive

Korean: SPGlobal.com/Korea_Automotive

English: SPGlobal.com/Mobility

Calendar

SPGlobal.com/AutoCalendar

Community

SPGlobal.com/News-Assets

Conversation

SPGlobal.com/ConversationalSurvey

Automotive LinkedIn Group



Automotive WeChat



Copyright © 2023 S&P Global Inc. All rights reserved.

These materials, including any software, data, processing technology, index data, ratings, credit-related analysis, research, model, software or other application or output described herein, or any part thereof (collectively the “Property”) constitute the proprietary and confidential information of S&P Global Inc its affiliates (each and together “S&P Global”) and/or its third party provider licensors. S&P Global on behalf of itself and its third-party licensors reserves all rights in and to the Property. These materials have been prepared solely for information purposes based upon information generally available to the public and from sources believed to be reliable.

Any copying, reproduction, reverse-engineering, modification, distribution, transmission or disclosure of the Property, in any form or by any means, is strictly prohibited without the prior written consent of S&P Global. The Property shall not be used for any unauthorized or unlawful purposes. S&P Global’s opinions, statements, estimates, projections, quotes and credit-related and other analyses are statements of opinion as of the date they are expressed and not statements of fact or recommendations to purchase, hold, or sell any securities or to make any investment decisions, and do not address the suitability of any security, and there is no obligation on S&P Global to update the foregoing or any other element of the Property. S&P Global may provide index data. Direct investment in an index is not possible. Exposure to an asset class represented by an index is available through investable instruments based on that index. The Property and its composition and content are subject to change without notice.

THE PROPERTY IS PROVIDED ON AN “AS IS” BASIS. NEITHER S&P GLOBAL NOR ANY THIRD PARTY PROVIDERS (TOGETHER, “S&P GLOBAL PARTIES”) MAKE ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, FREEDOM FROM BUGS, SOFTWARE ERRORS OR DEFECTS, THAT THE PROPERTY’S FUNCTIONING WILL BE UNINTERRUPTED OR THAT THE PROPERTY WILL OPERATE IN ANY SOFTWARE OR HARDWARE CONFIGURATION, NOR ANY WARRANTIES, EXPRESS OR IMPLIED, AS TO ITS ACCURACY, AVAILABILITY, COMPLETENESS OR TIMELINESS, OR TO THE RESULTS TO BE OBTAINED FROM THE USE OF THE PROPERTY. S&P GLOBAL PARTIES SHALL NOT IN ANY WAY BE LIABLE TO ANY RECIPIENT FOR ANY INACCURACIES, ERRORS OR OMISSIONS REGARDLESS OF THE CAUSE. Without limiting the foregoing, S&P Global Parties shall have no liability whatsoever to any recipient, whether in contract, in tort (including negligence), under warranty, under statute or otherwise, in respect of any loss or damage suffered by any recipient as a result of or in connection with the Property, or any course of action determined, by it or any third party, whether or not based on or relating to the Property. In no event shall S&P Global be liable to any party for any direct, indirect, incidental, exemplary, compensatory, punitive, special or consequential damages, costs, expenses, legal fees or losses (including without limitation lost income or lost profits and opportunity costs or losses caused by negligence) in connection with any use of the Property even if advised of the possibility of such damages. The Property should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions.

The S&P Global logo is a registered trademark of S&P Global, and the trademarks of S&P Global used within this document or materials are protected by international laws. Any other names may be trademarks of their respective owners.

The inclusion of a link to an external website by S&P Global should not be understood to be an endorsement of that website or the website’s owners (or their products/services). S&P Global is not responsible for either the content or output of external websites. S&P Global keeps certain activities of its divisions separate from each other in order to preserve the independence and objectivity of their respective activities. As a result, certain divisions of S&P Global may have information that is not available to other S&P Global divisions. S&P Global has established policies and procedures to maintain the confidentiality of certain nonpublic information received in connection with each analytical process. S&P Global may receive compensation for its ratings and certain analyses, normally from issuers or underwriters of securities or from obligors. S&P Global reserves the right to disseminate its opinions and analyses. S&P Global Ratings’ public ratings and analyses are made available on its sites, www.spglobal.com/ratings (free of charge) and www.capitaliq.com (subscription), and may be distributed through other means, including via S&P Global publications and third party redistributors.