

Development effectiveness and efficiency: new priorities in software development

Potsdam, November 2, 2023

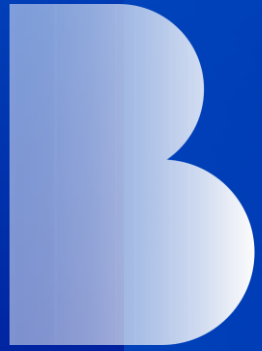
Roland
Berger

Contents

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A. SW budget situation will become challenging

Software became a key differentiator for automotive OEMs and Tier-1

WirtschaftsWoche

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RETTENDE SUPERREICHE Wie Family Offices das Überleben von Biotech und Co. sicherten
FEUER FREI Nach dem Bezos-Abgang nehmen die Regulierer Amazon ins Visier
ÜBERHITZTE BÖRSE Fast alle Indikatoren signalisieren einen drohenden Crash



IT'S THE SOFTWARE, STUPID!

VW und Co. versuchen hektisch, eigene Betriebssysteme zu entwickeln. Denn die Silicon-Valley-Giganten sind schon deutlich weiter - und drohen bald auch die deutsche Autoindustrie zu beherrschen

Bestenfalls 68,90 | Bestenfalls 68,90 | Platz PL 1, 30,00
 Standard 69,90 | Infrarotdrucke Map. CEN 220



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Wir sind - drin?

Die deutschen Autobauer VW, BMW und Daimler müssen sich als Softwareschmieden neu erfinden, wollen sie das Steuer nicht den Elkoszenen aus dem Silicon Valley überlassen. Daimler spaltet dafür den Konzern auf. VW baut einen Softwareriese - das Rennen um das Auto der Zukunft ist eröffnet.

VON MATTHIAS SCHNEIDER, STEFAN HILKE, ANASTAS KONSTANTINIDIS, MARTIN DEHRT



30 TITEL

mischen und was nicht. Ein Auto aus dem Softwarekasten, laufend hochgerüstet - das ist der neue Standard, den Tesla setzt. Und die Deutschen? Die haben (noch) weit hinterher. Selbst beim wichtigsten Hoffnungsträger ID.3 von Volkswagen, will Tesla 2020 auf dem Markt, während andere in 2020 Autos wegen fehlender Software in die Werkbank rufen. „Über die air“ - das ist das neue VW - ist im Laufe des Jahres im Oktober der Volkswagen - Chief bereits 2019 von „Jahres auf Jahre“ schrittweise.

Das schickende Team Altkonsum mit Marktformen aus der Softwarewelt wie Amazon, Microsoft und der Intel-Strategie AT - und hat eine neue Einheit auf Car Software CxO. Eine Zeit, die über alle Marken erheblichen Betriebssystemen mit der Abkündigung von VW.

Das ist die neue Einheit, die VW seit Ende des Jahres 2019 hat. VW hat mehr als 1000 Mitarbeiter in VW, Porsche und Audi, die das was in anderen Divisionen rekrutiert oder eingekauft. Momentan sind 100 Mitarbeiter im Einsatz. Und in einigen Jahren soll die Firma, deren Zentrum in Regensburg angesiedelt ist und in den nächsten Monaten mit einem angeschlossenen Team akquiriert werden soll, mehr als 10.000 Mitarbeiter beschäftigen. Damit noch 100.000 weitere, die Software-Entwickler. Deutschland einwachen.

Die Ziele sind ambitionierter. CxO soll VW helfen, den Anteil selbst programmierter Software von derzeit 10 auf 40 Prozent zu erhöhen. Außerdem soll das Betriebssystem - so wie die Google-Software Android für Smartphones - als Betriebssystem für Autos selbst zu Verfügung stehen.

Wenig neu programmierte Softwareentwicklung auf einem neuen Elektromotor von Audi zum Einsatz kommen. Die Linienarbeit mit dem vorläufigen Namen Leudat soll - in die Vorgabe von Daimler - bei Software und IT im Jahr vorübergehen.

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„Wir müssen einen Sprung machen. Neue Player sind sofort diesen Weg gegangen“

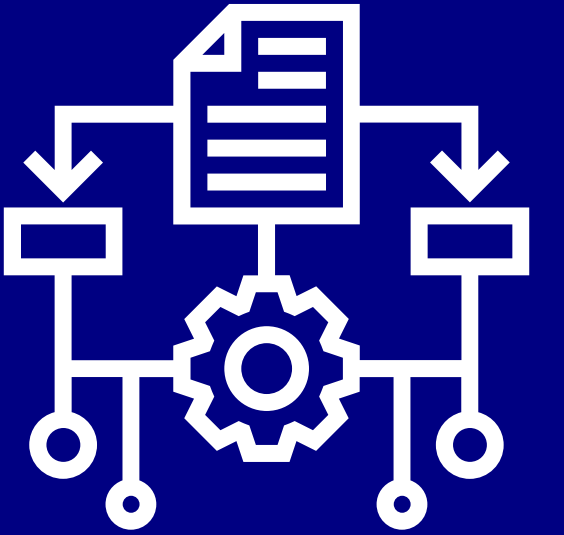
Stefan Hilke, VW-CEO

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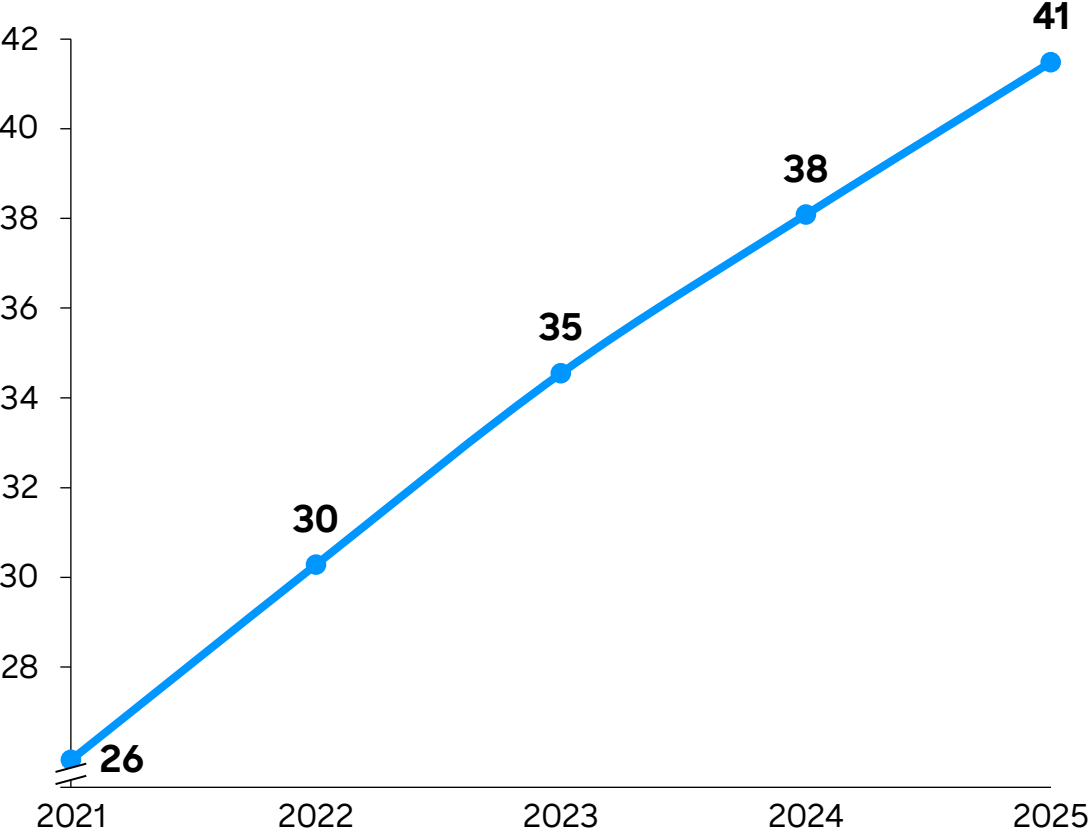
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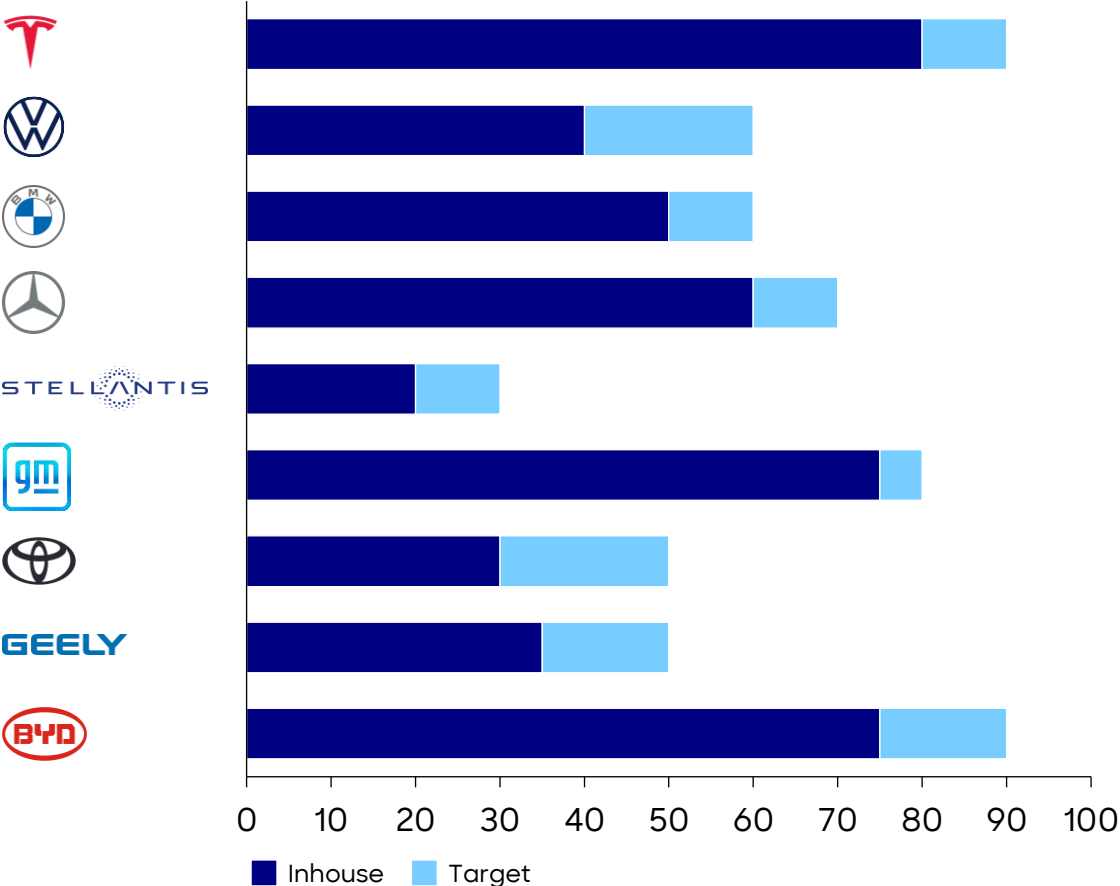


Software development budgets grew and ambitions for inhouse SW development rose

OEM's SW development budget²⁾ [USD bn]
(incl. external development and licenses)



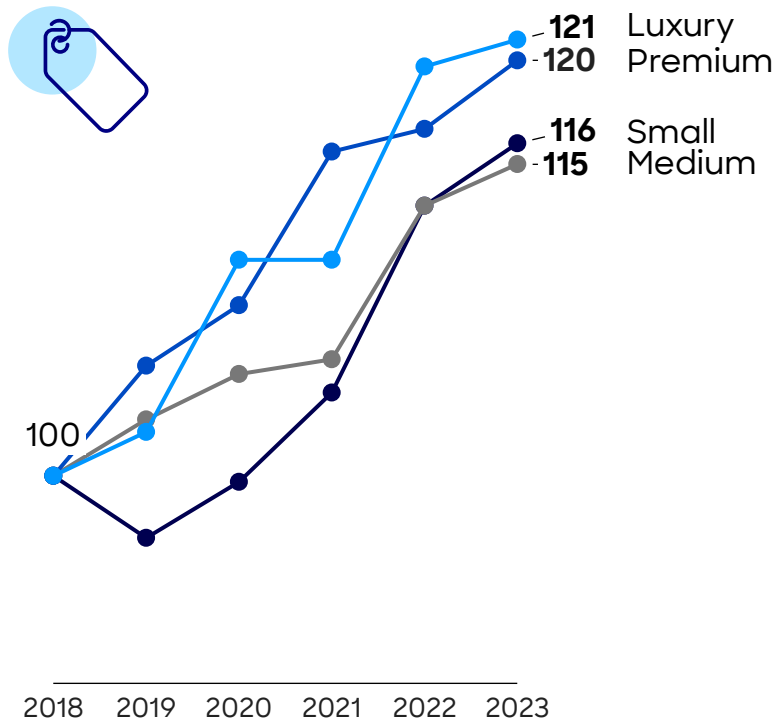
OEM's inhouse SW development share¹⁾ [%]



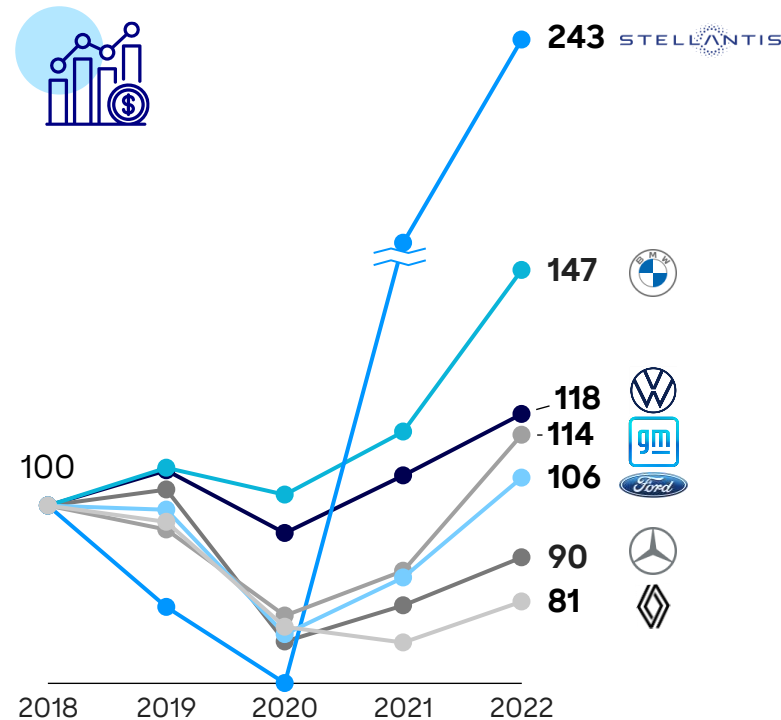
1) Budget plan as of Q3 2022

... this had been possible as prices, revenues and profits grew

Price development 1)

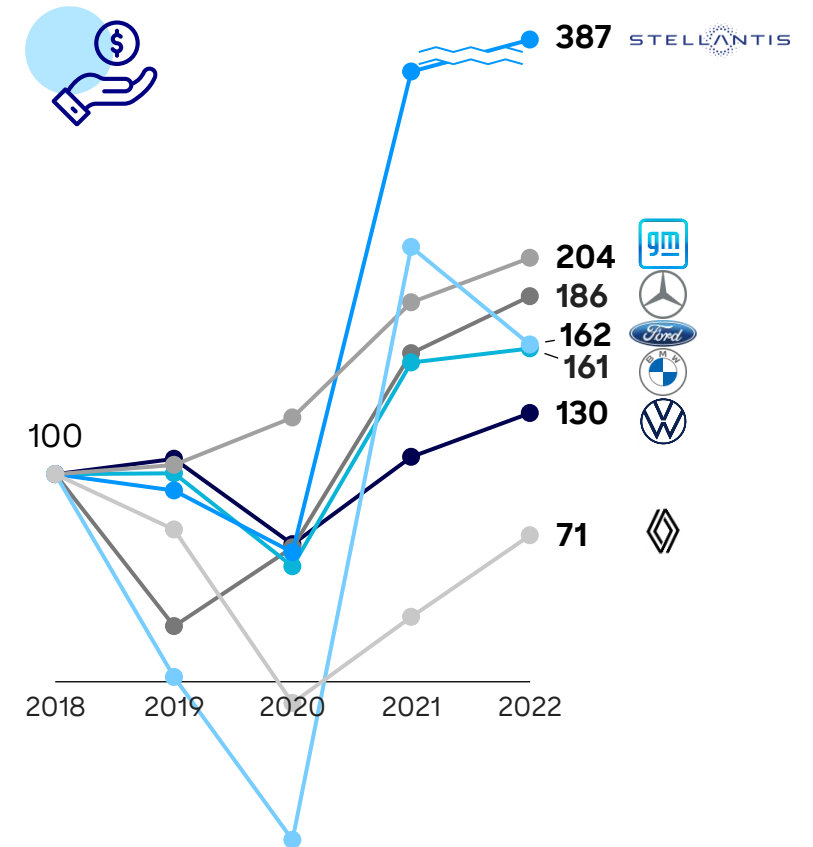


Revenue development



Stellantis: before 2021 PSA revenue only
Mercedes: before 2021 incl. Daimler Trucks

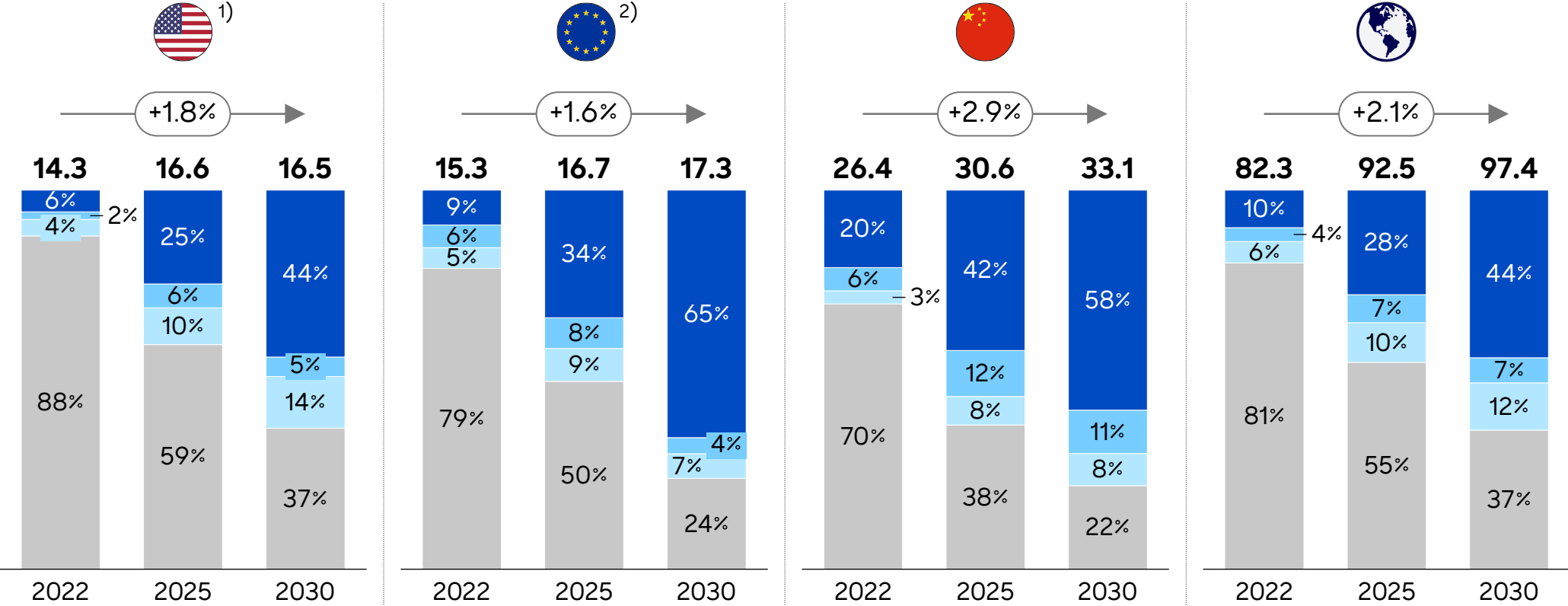
Profit development



1) Europe, North America; Based on selected vehicle sales prices of Audi, BMW, Mercedes-Benz, Renault, Skoda, VW and Volvo

BEV share will grow in all regions

PC production forecast by region & powertrain, 2022-2030, [m units, % of production]



BEV/PHEV 2030
[m units]

- USA (1) **8.1**
- EU (2) **12.0**
- China **23.0**

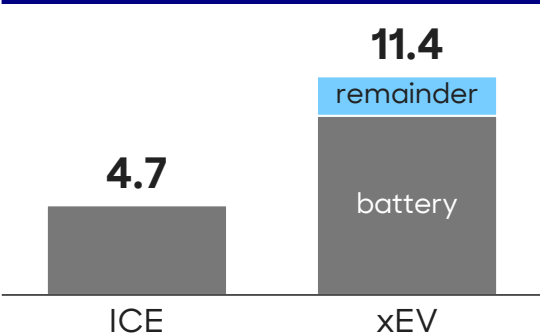
■ BEV ■ PHEV ■ FHEV ■ ICE/MH

1) Incl. Mexico and Canada 2) EU27+UK, Norway, Switzerland FCEV are part of PHEV or FHEV

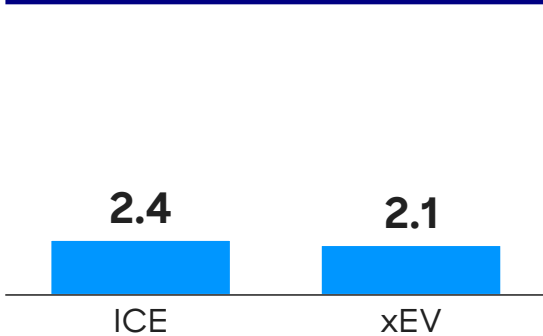
BEVs' higher material cost will become a major challenge - Little cost decline likely

Product cost ICE vs. xEV¹⁾ for C-segment SUV [k EUR]

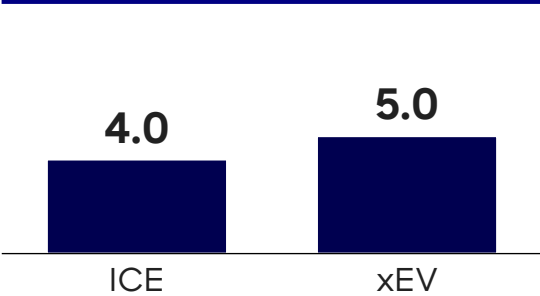
Powertrain²⁾



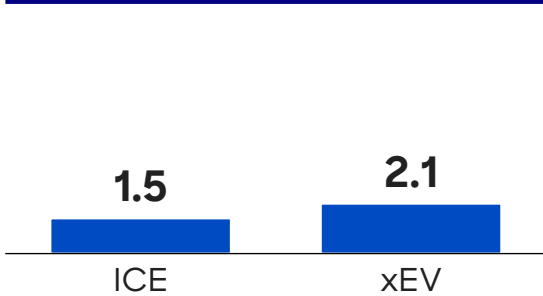
Chassis



Exterior/Interior

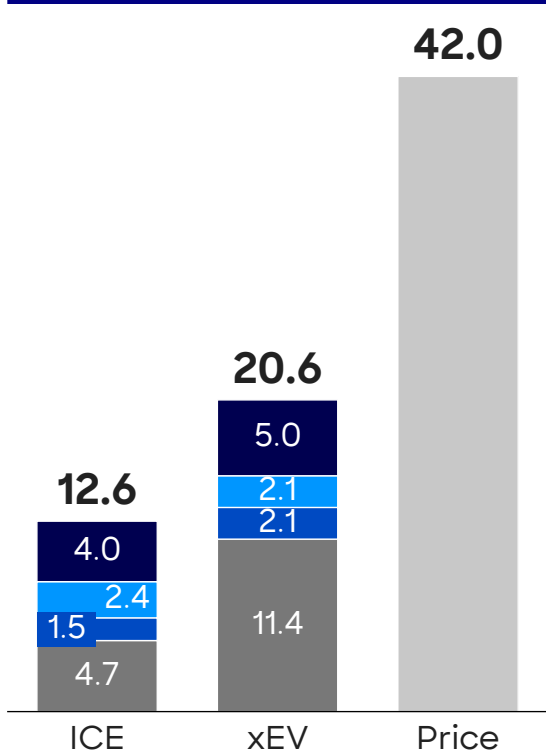


Electronics



■ Powertrain ■ Electronics ■ Chassis ■ Exterior ■ Retail EU w/o VAT

Cost comparison



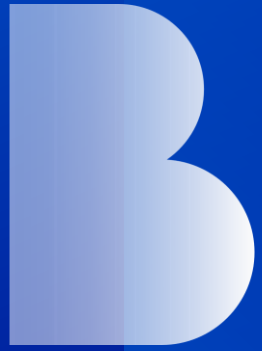
Challenges

Limited additional willingness to pay for BEVs - **Follower and laggards expect price parity**

Minor cell cost reduction

Declining ICE volumes will cause a **long-term cost challenge**

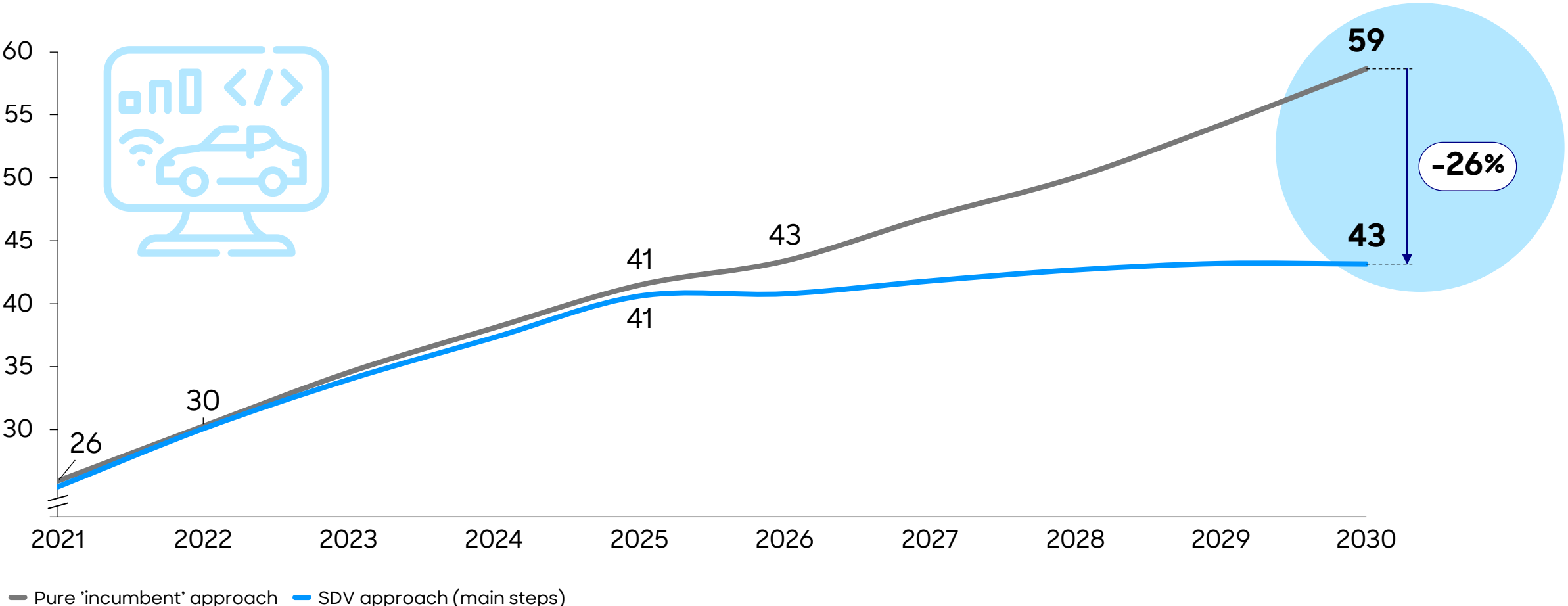
1) no development cost allocations and production costs; 2) BEV: 80 kWh battery, 150 kW peak; ICE: 170 kW, EURO 6d, AWD, DCT



B. A more effective and efficient SW development approach

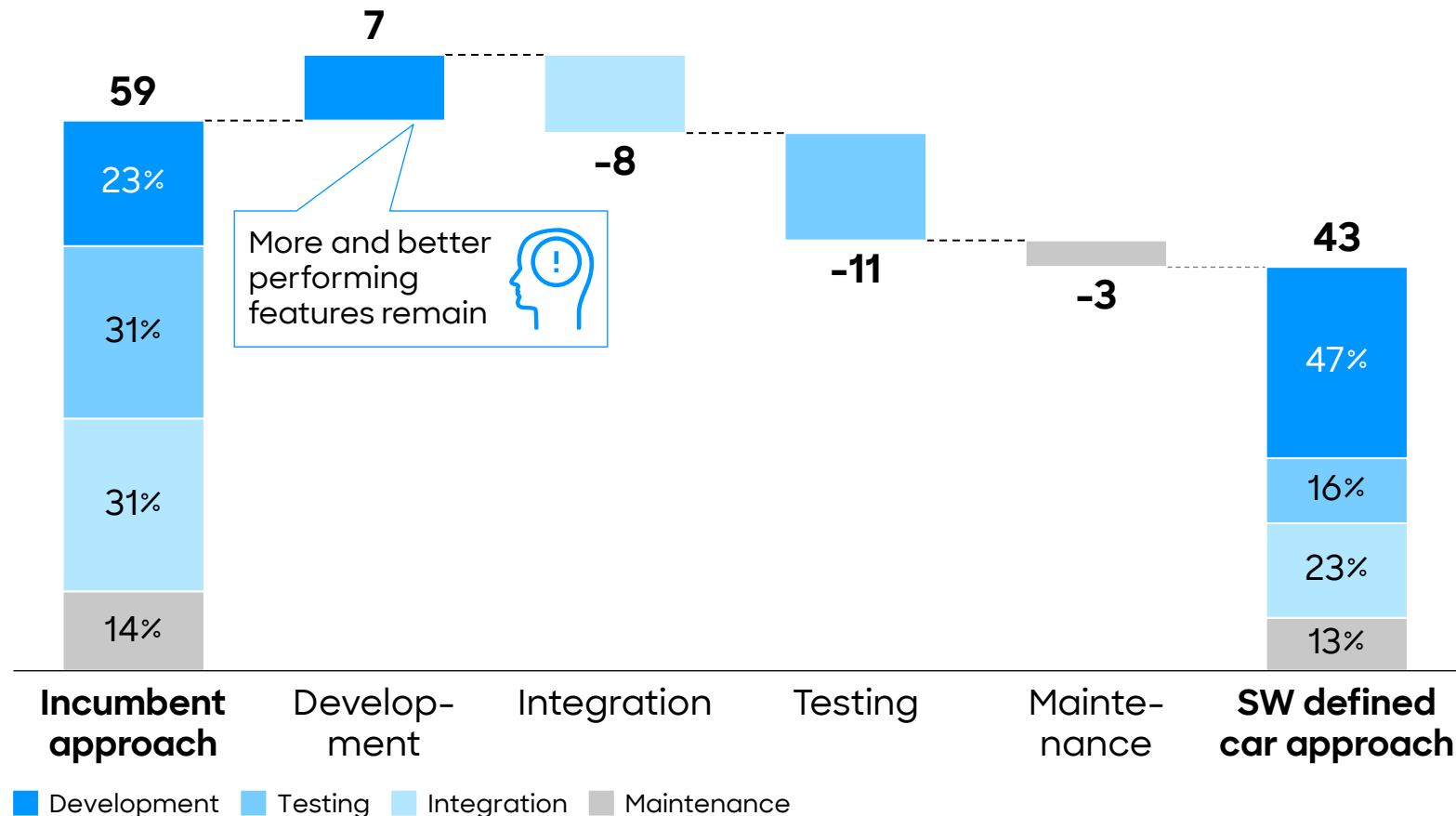
A new approach for software development is required, more effective and efficient approach for SW development is required

OEMs' in-vehicle SW budget 2021-2030 [USD bn]



The increased upfront effort to develop SW based on a 'SW defined car' approach is over-compens. by significant savings from testing, integration & maintenance

OEMs' in-vehicle SW spending 2030 - 'Incumbent' vs. SDV approach [USD bn]



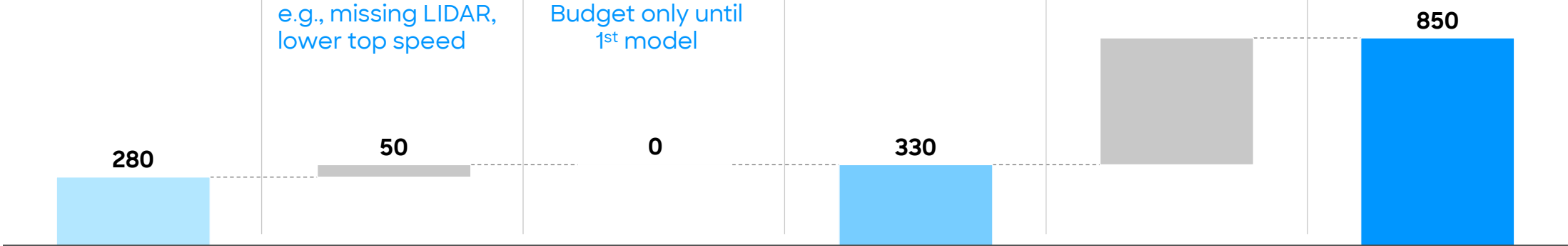
Enabler - OEM view

- A** Reduce **variant complexity**
- Implement a **SW first Governance**
- B** Shift to new **SW architecture**
- C** Rethink captive share and leverage **partnerships**
- D1** Dissolve **typical SW R&D inefficiencies**
- D2** Improve **DevOPS**

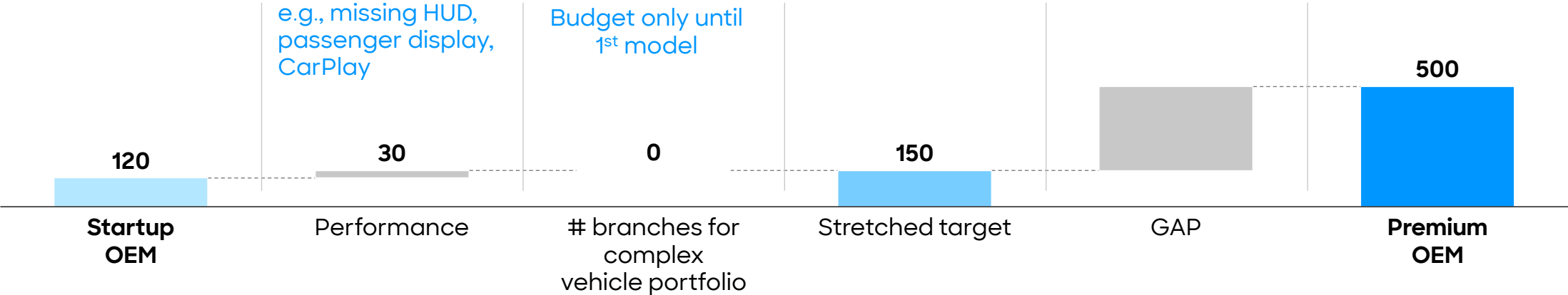
Major projects at SW pioneer OEMs are 2 to 3,5 times more effective and efficient compared to traditional OEMs

Development budget for SW stack [EUR m]

ADAS



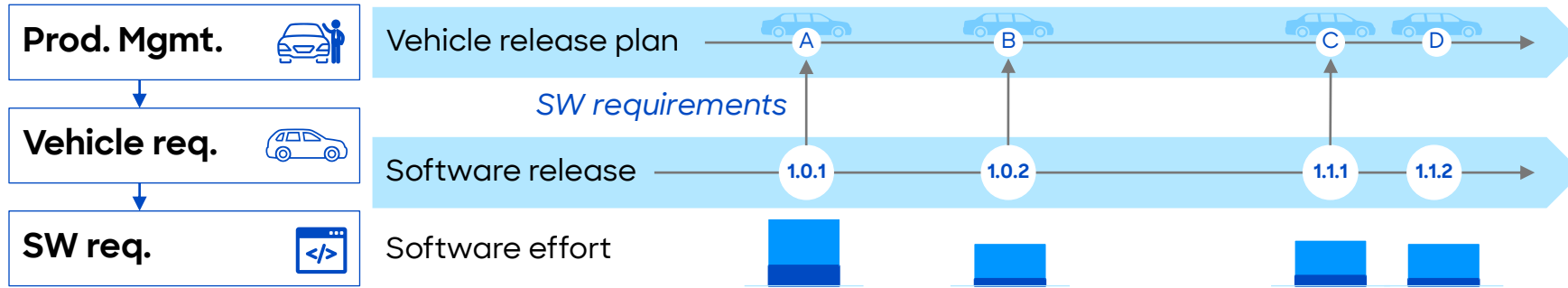
IVI



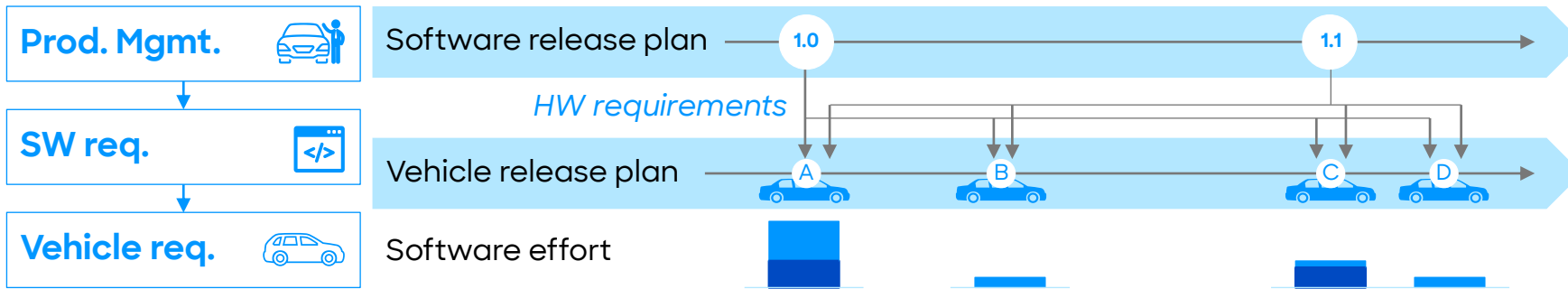
When SW defines the HW in a SW first approach, software adaptation effort per vehicle is drastically reduced

Concept illustration "Vehicle first" vs. "Software first" approach

Incumbent approach ("Vehicle first")



Software-defined approach ("SW first")



A: New vehicle model on new platform with new EE; B: New vehicle model on new platform with same EE
 C: New vehicle model on new platform with new EE; D: New vehicle model on new platform with same EE

■ Left V ■ Right V

Incumbent:

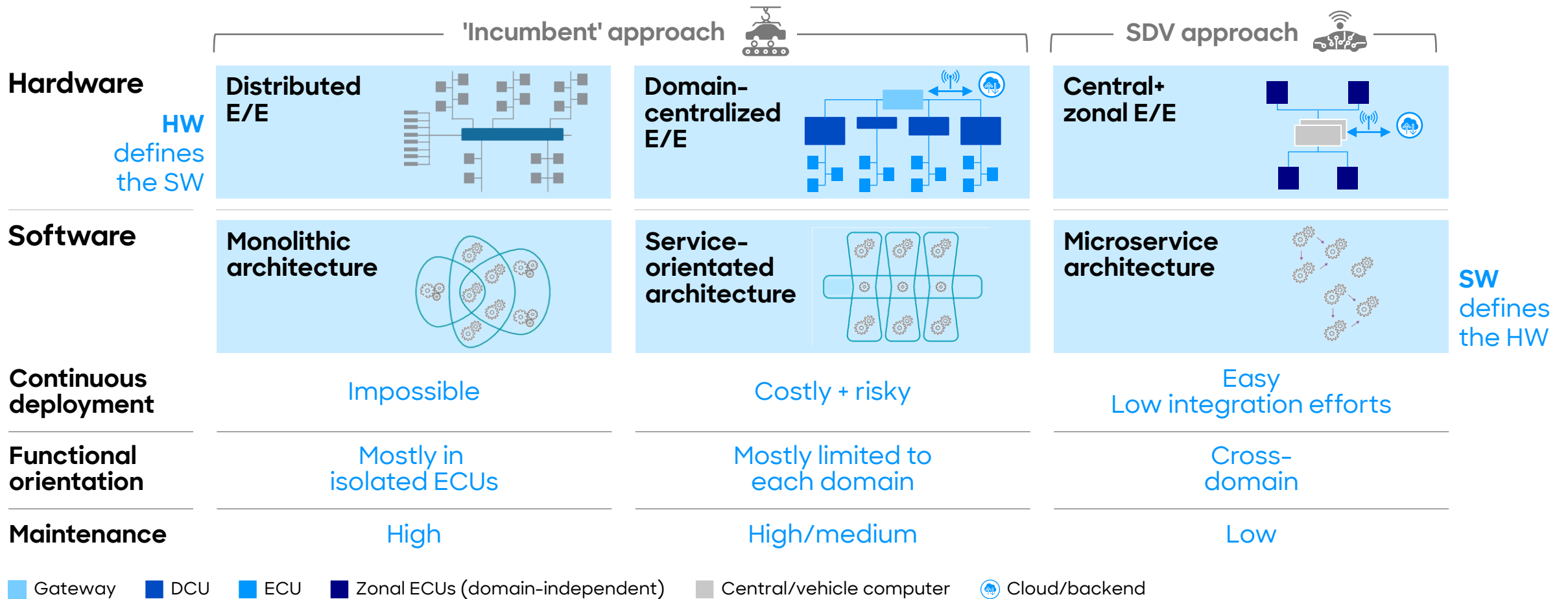
- HW defines the SW
- No/limited HW abstraction
- Each vehicle with individual SW variant
- High integration and testing costs of up to 70% even for same/similar functions

SW first:

- Innovation from SW releases
- "Identical" SW across models - largely reduced adaptation efforts
- HW with headroom

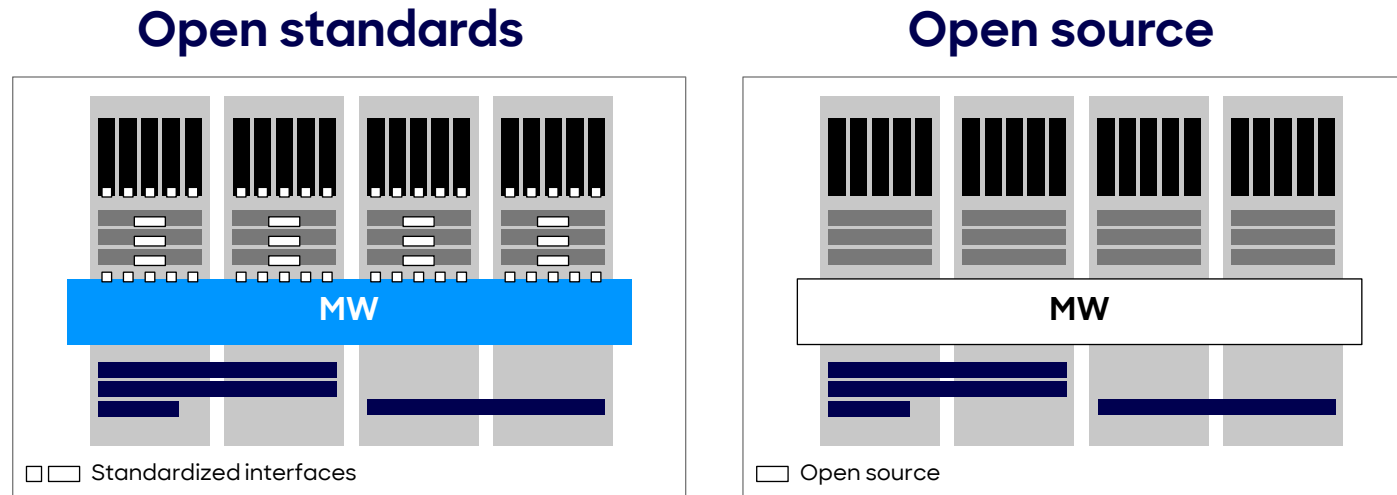
Advanced EE architectures go hand in hand with modern SW approaches and are therefore a prerequisite for efficiency gains

Definition of 'incumbent' vs. SDV approach



Open standards and open source are 2 intensively discussed options to realize a cross OEM middleware

Realization options for Cross OEM MW



Description

- OEMs agree on **standards for all key interfaces**

Benefits

- Middleware provides **can easily be exchanged**

Status

- **AUTOSAR and ECLIPSE** are key initiative

Open source

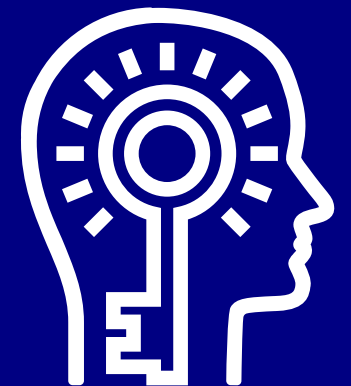
- **Solutions / technology is open source** while a partner is maintaining and improving MW and toolchain based on contract
- Red Hat's business model is the blueprint

- **Low exchange cost** for Middleware provider

- **First suppliers** are in discussions with OEMS

■ Apps (customer feature) ■ Service ■ Cross OEM middleware (OS, HW abstraction) ■ HW (ECU) ■ Domain

Open standards can be agreed on domain levels, however **open-sourced MW with stronger impact** if fully implemented and accepted by OEMs.



SW R&D inefficiencies to be addressed, dedicated SW R&D steering model & KPIs required, as well as state-of-the-art dev & V&V methods & cost transparency

Key success factors SW R&D inefficiencies and player assessment

Success factor

Description

Assessment

Dedicated steering model and KPIs within R&D



- Shift of **financial steering KPIs** towards "recurring revenues" & SW business models
- **Technical early-warning KPIs** required to drive efficient steering models
- Balancing **SW R&D development steering in a still HW-mindset** industry



Transparency on SW development cost drivers



- **Lack of understanding** of how tailoring and architecture inefficiencies drive SW development costs
- Often **inefficient SW procurement**, due to unfamiliarity with SW costing
- Partly lack of ability to deal with **SW specifics (licensing costs, Ota updates etc.)** in HW-heavy industry



State-of-the-art development & testing methods (e.g., reuse, virtual testing)



- More dedicated SW validation & verification activities, such as **virtual testing** and increase use of **SiL (& HiL) testing**
- Leverage of **system engineering development** approach and **quality gate checks**
- **Drive re-use and standardization** of development (higher targets than in HW R&D)

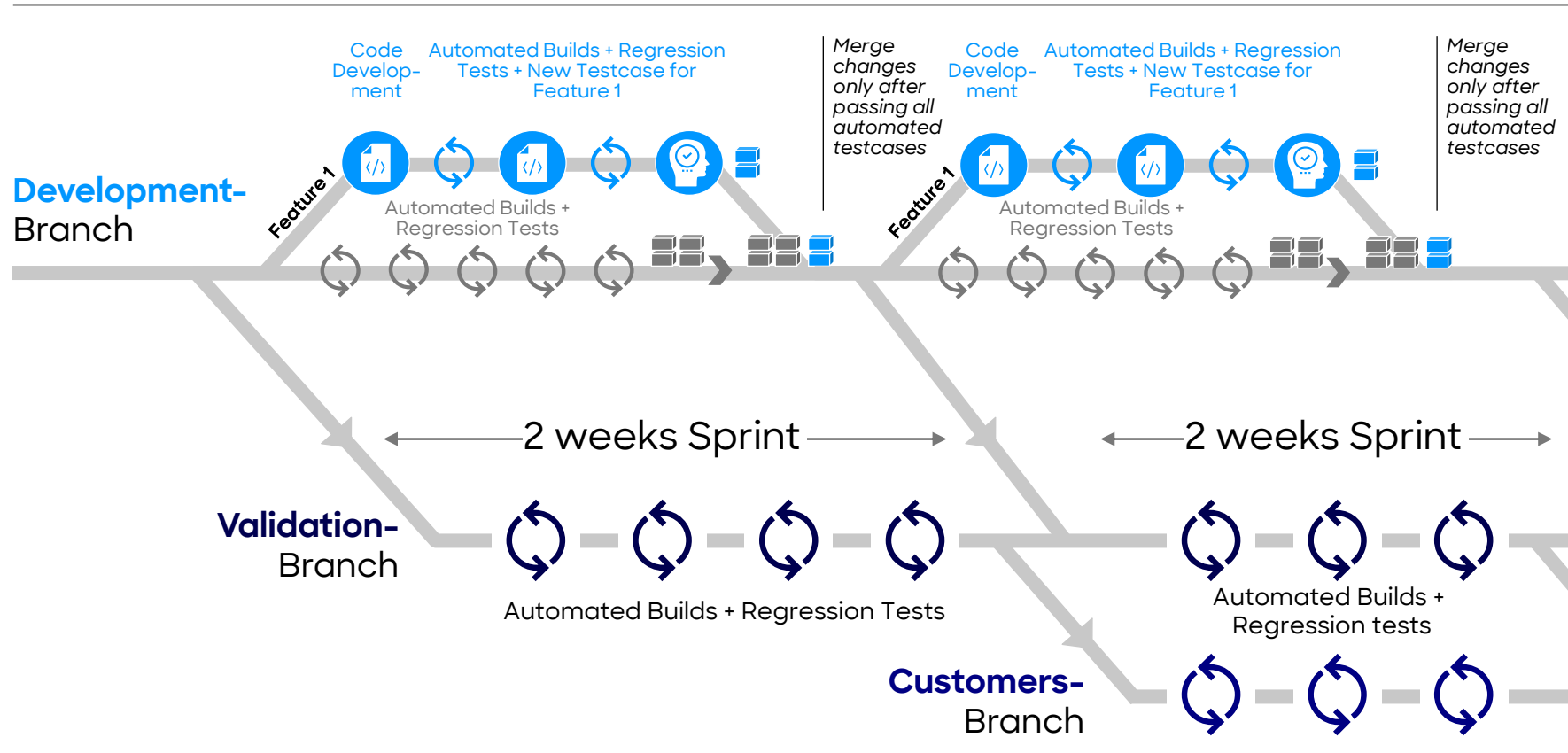


SW OEMs = OEMs build on SW competencies
Trad OEMs = Established OEMs

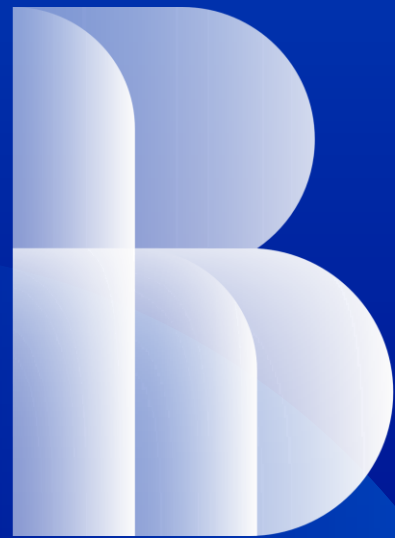
SW Tier-1 = Tier-1 with strong heritage in large SW projects
Follower Tier-1 = Supplier with limited SW experience

Separate development, validation, and customer Branch provide a stable basis for releasing and integrating features, fixing bugs and stabilizing SW functions

CI/CD (Continuous Integration/ Continuous Delivery)



- **Development-Branch:** All new functions are developed and defined here
- **Validation-Branch:** No new functions are merged here, but only used for validation- / error correction
- **Customer-Branch:** Stable code base for customers and only open for critical bugs (hotfixes)
- After each sprint, the validation-Branch becomes a new customer Branch, and the development-Branch becomes a new validation-Branch
- Regression tests are regularly performed in all code Branches



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