The Future of Trucks

How Technology Will Change Value Chain Structures

Summary of study results

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In order to elaborate clear results the study focuses on selected issues:

Scope and Focus	Approach
■ Technology, truck architecture, module boundaries, value chain structures ■ Focus on chassis and E/E, less focus on engine/powertrain ■ Perspective 2015 ff. ■ Heavy trucks > 16 t ■ Long haul operation (i.e. tractor and semi-trailer combination) ■ Western European market	■ Delphi study methodology ■ More than 30 personal interviews with all European OEMs and selected tier-1 system suppliers ■ …complemented by fleet manager survey and desk research ■ Interview partners from all relevant functions at OEMs

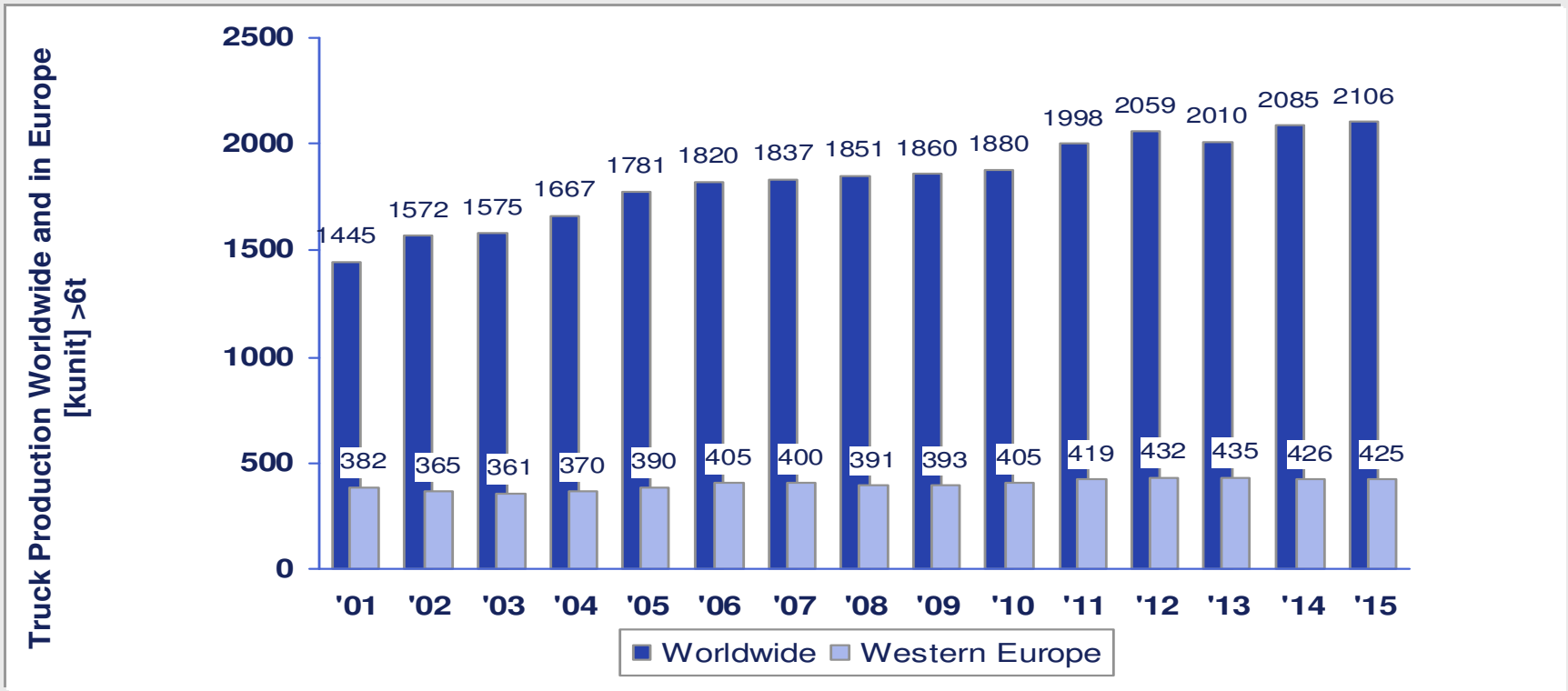
In an almost stagnating market with no structural changes but intensified competition OEMs and suppliers need to focus on reliability and life cycle cost

Key Findings

- Long-term growth in Western Europe remains low with average growth rates in truck production of less than 1% p.a.
- No fundamental structural changes will occur. The trends towards larger fleets and higher importance of leasing are decelerating
- No safety legislations demanding specific equipment or features are expected, only emission standards will continue to have a significant impact on truck technology
- Reliability and life cycle costs are the most important buying factors
- As technology, performance and quality of trucks continue to converge, market leaders need to act to maintain image and price premiums
- Smaller players need to increase scale in order to stay competitive and remain independent – a global approach is necessary

Whereas the global market for heavy commercial vehicles is growing moderately, European production is almost stagnating

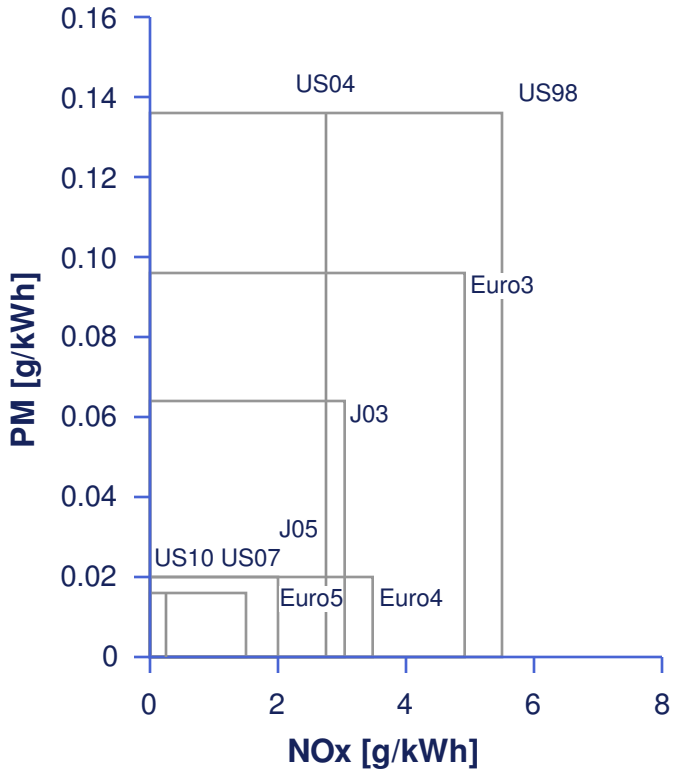
Global volume development



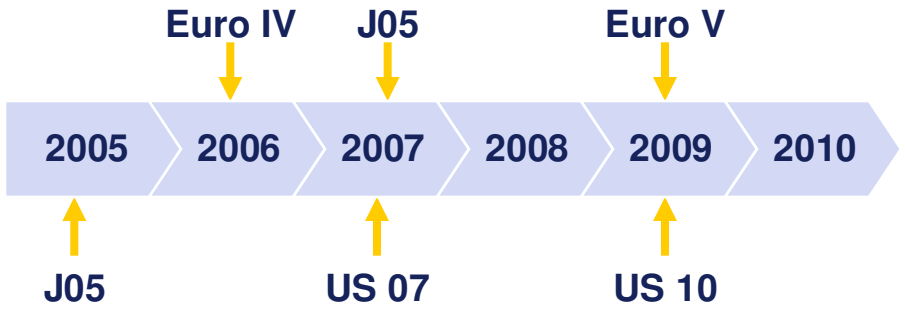
Source: Global Insight , 06/2004

Emission level legislation will remain to have the strongest impact on future trucks – legislation demanding specific safety functions is not expected

Emission Levels



Timeframe Emission Standards

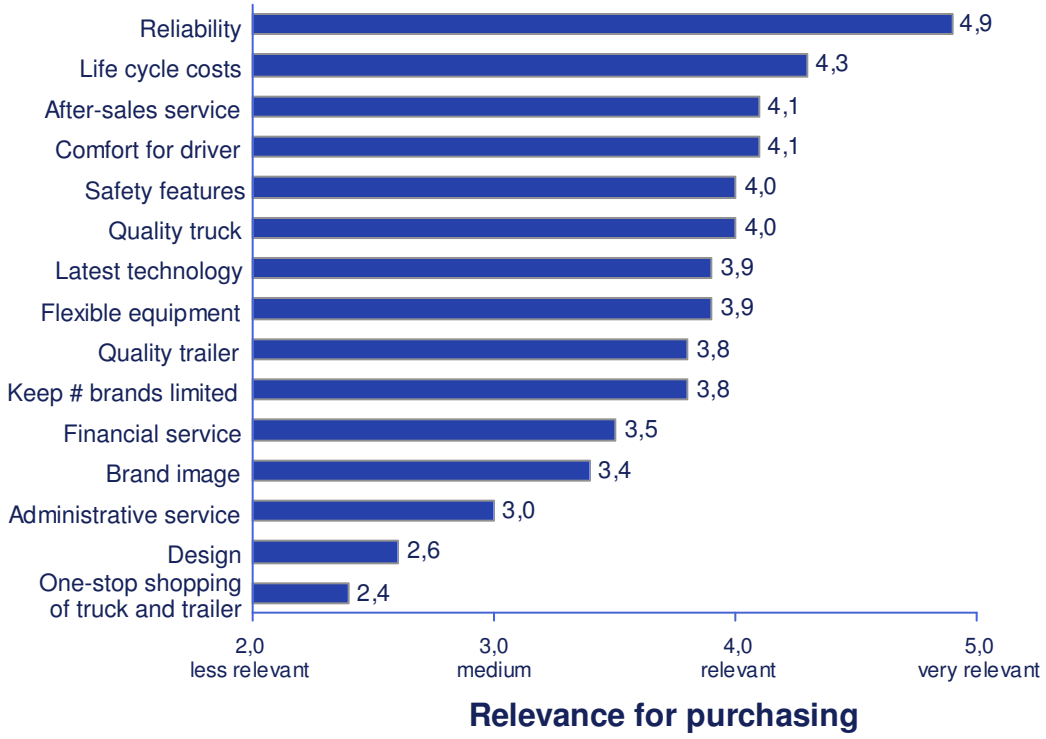


Other legislative requirements

- Regionally specific noise legislation in 2008 (65 db)
- Recycling legislation for light trucks likely to be expanded to medium and heavy trucks
- Truck and trailer length and weights
- On-board diagnosis in combination with emission legislation

Reliability and life cycle costs are the main buying criteria of commercial vehicle fleet managers

Buying Criteria for LSP*



Comments

- Reliability and reduction of other life-cycle costs are major buying criteria. All new technologies must prove to be reliable before introduction to the market
- Brands are always seen as a complete package. Good after-sales service is essential
- Skilled drivers have to be kept. Comfort is an important buying criteria, not only for smaller companies
- Safety issues are regarded as important. But benefits must be obvious – insurance rates are not affected by safety features at present
- For the majority of companies financial services are no differentiating criteria

Source: ADL Fleet Manager Survey 2004

* LSP = Logistics Service Provider

Truck buyers increasingly look at life cycle costs vs. initial investment costs – labor and fuel are the biggest cost blocks

Example: Long-haul 40-ton truck and trailer

Cost Type	Labor	Fuel Costs	Depre-ciation	Mainte-nance	Insurance	Capital Costs	Tires	Tax	Total
Share	36%	27%	12%	9%	7%	4%	4%	1%	100%
Cost p.a. (KEUR)	50	38	16	13	10	5	5	2	139
Most Important Driving Factors	■ Experience of driver ■ Labor rate ■ …	■ Fuel price ■ Driving profile/driver qualification ■ Engine efficiency ■ Route management ■ …	■ Truck price ■ Depreciation factor ■ Resale value ■ …	■ Durability/life time of parts ■ Ease of ex-changeability of parts ■ Minimized downtime ■ Staff qualification ■ Labor rate ■ …	■ Operation without accident ■ Safety features in the truck ■ …	■ Truck price ■ General interest rate ■ Access to capital market ■ …	■ Road conditions ■ Driving profile/driver qualification ■ Tire pressure ■ Tire material ■ ..	■ Emissions ■ …	

Sources: European Co-operation in the Field of Scientific and Technical Research - COST 334, DEKRA CARCOST Database, ADL Fleet Manager Survey

Fixed Costs | Variable Costs

OEMs need to focus on increasing truck reliability and reducing life cycle costs – new technologies must be proven and offer real benefits

Implication for truck and trailer OEMs

- Criteria of operational costs (reliability and life cycle costs) are major decision factors for fleets – OEM must reduce costs rather than offering new product features
- Latest technology is expected by all customers but only if technology is proven – technology must have clear added value and improve reliability
- Purchase of trucks or trailers is always seen as package with after-sales service – the OEMs must develop after-sales service offerings as they develop products
- OEMs must consider comfort for driver as highly ranked purchasing criterion because skilled drivers must be kept
- Safety is amongst top decision criteria - fleets expect that safety features will be considered in insurance or tax bills; if incentives are not provided, truck users will only buy mandatory equipment and importance of criteria will subsequently drop

Electric/Electronics are considered as major improvement areas, especially as many essential future product features are based on them

Improvement potential

- Reliability
  - Electric/Electronics
  - Engine
  - Gearbox
  - Wiring
- Emission reduction
- After-sales service
  - Training programs
  - Software updates
  - 24/7 availability of service

Essential future product features

- Safety features
  - ESP (Electronic Stability Program)
  - RSP (Roll Stability Program)
  - ACC (Adaptive Cruise Control)
  - Lane departure warning
- Essential technologies
  - ESP
  - RSP
  - ACC
  - Telematics/Fleet Management
  - Remote diagnostics

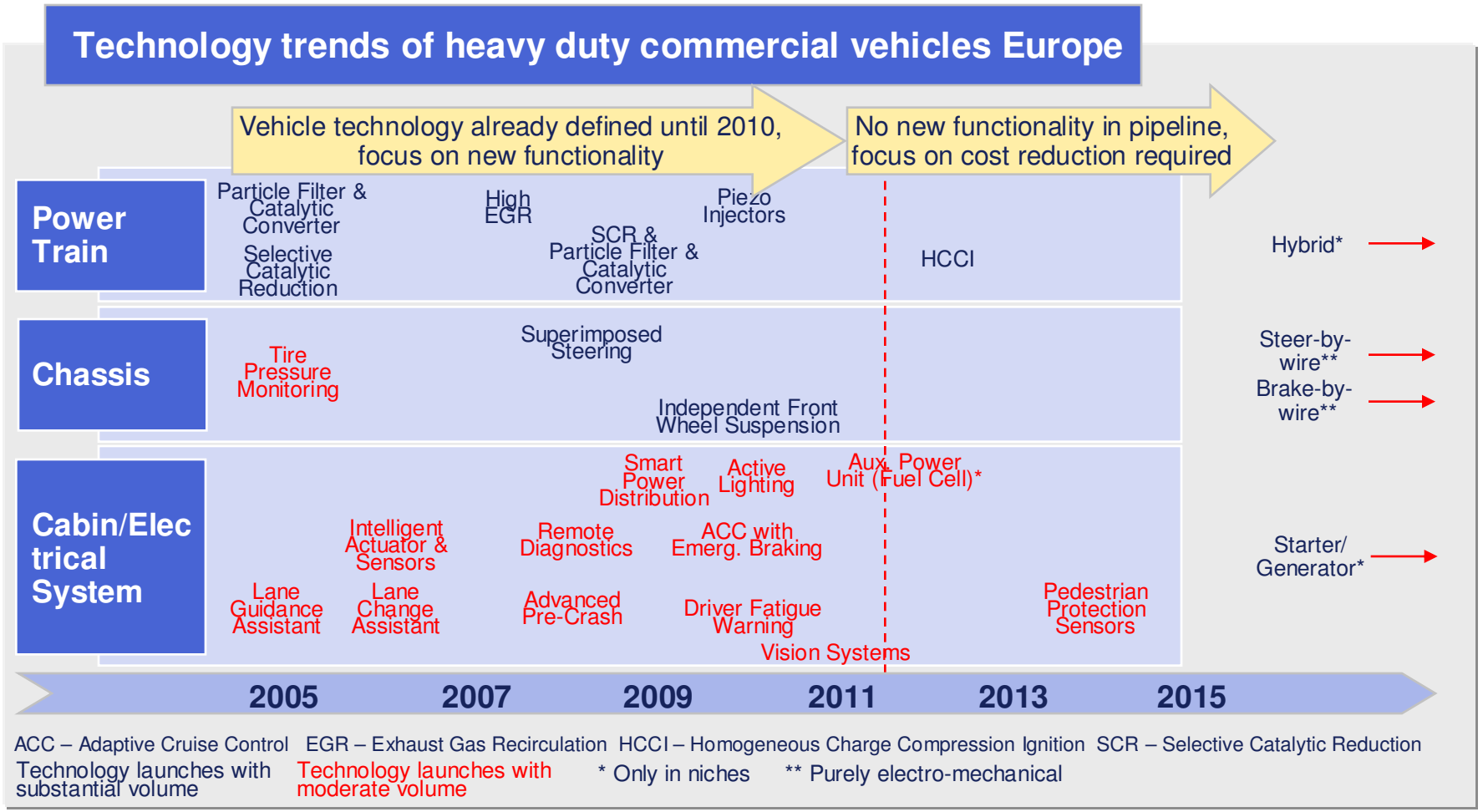
Source: ADL Fleet Manager Survey 2004

Technology needs to increase reliability and reduce life cycle cost rather than just providing new or improved functionality

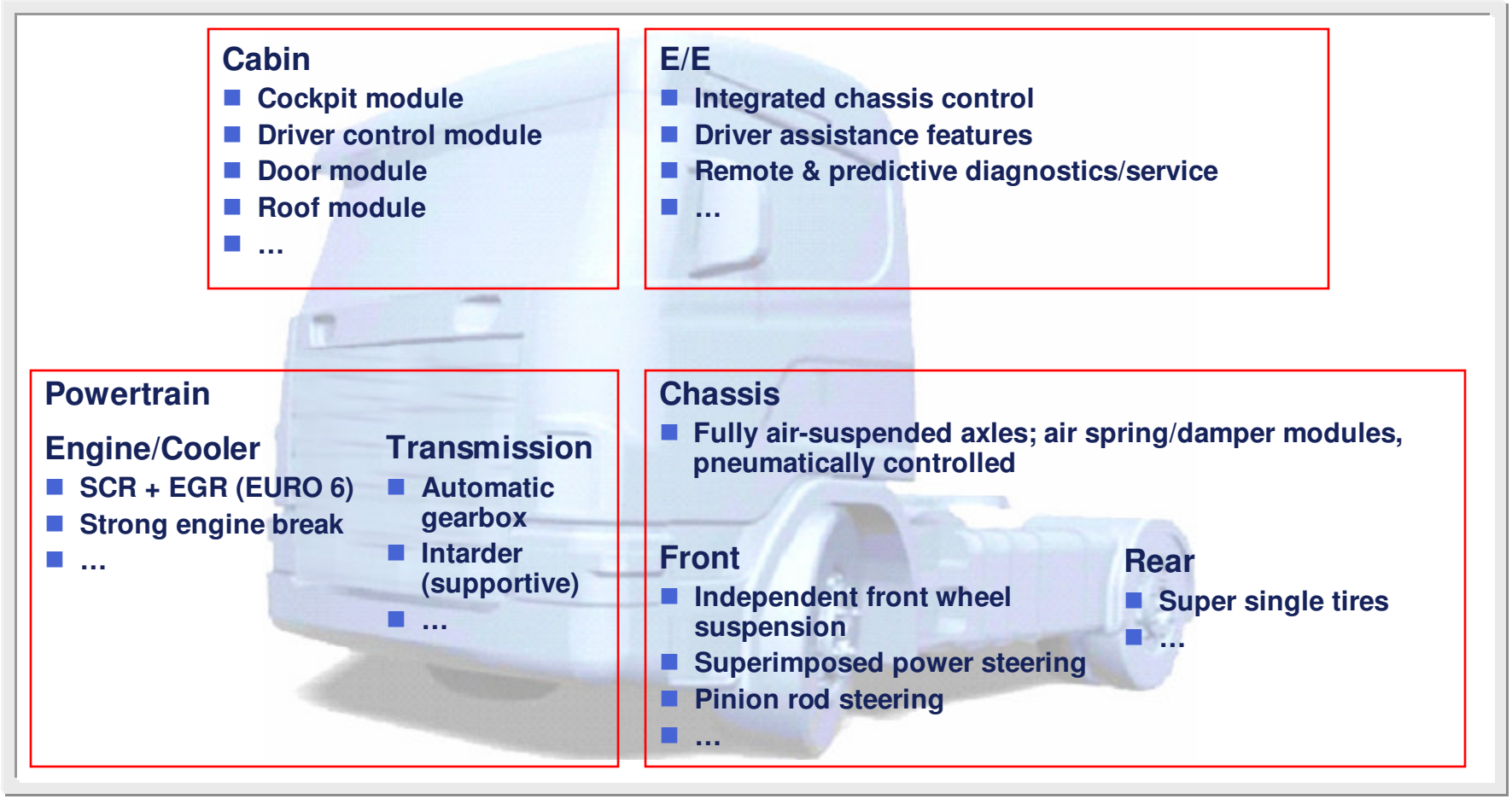
Key Findings

- Independent front wheel suspension (IFWS) and superimposed steering are the new technologies with the biggest impact on future trucks
- Pure x-by-wire technologies will definitely not be introduced before 2015. Furthermore, an introduction is rather questionable as x-by-wire offers no additional functionalities compared to electronically controlled conventional systems
- We will only see small changes in the overall truck architecture – apart from IFWS new modules will primarily be developed in the cabin sector. These cabin modules will be purely cost-driven without any change in technology
- Focus of product development will shift from adding functionality to reducing vehicle costs and increasing reliability – a different approach regarding innovation is necessary
- OEMs are currently moving into the development of application platforms and architecture standards. Nevertheless, we expect that they will refocus on specific applications and overall integration in the long run

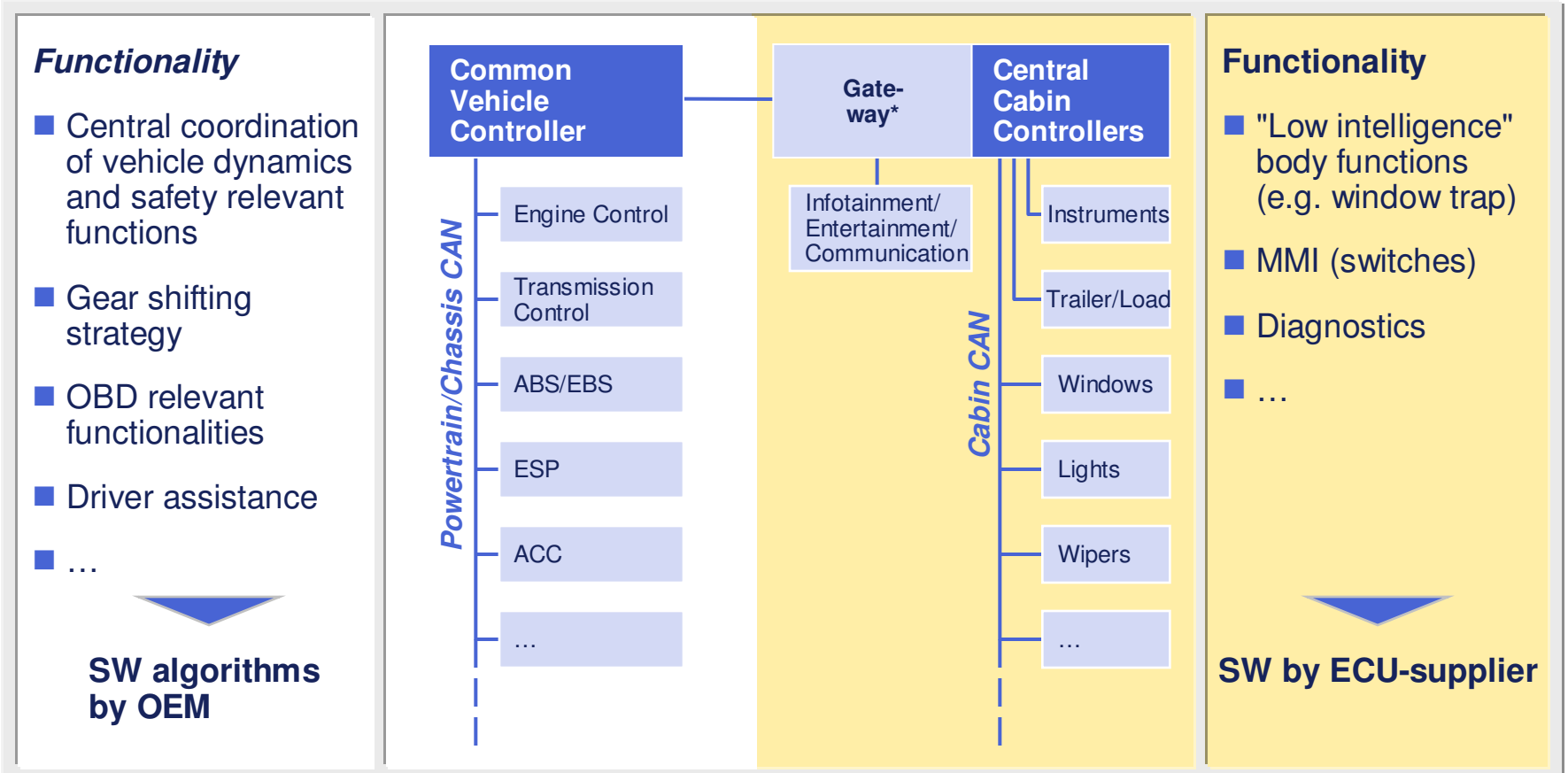
In the past, technology was primarily focused on adding functionality and features – in the future focus must be on generating life cycle cost savings



Trucks will develop evolutionarily with continuous engine improvement and the introduction of independent front wheel suspension and superimposed steering

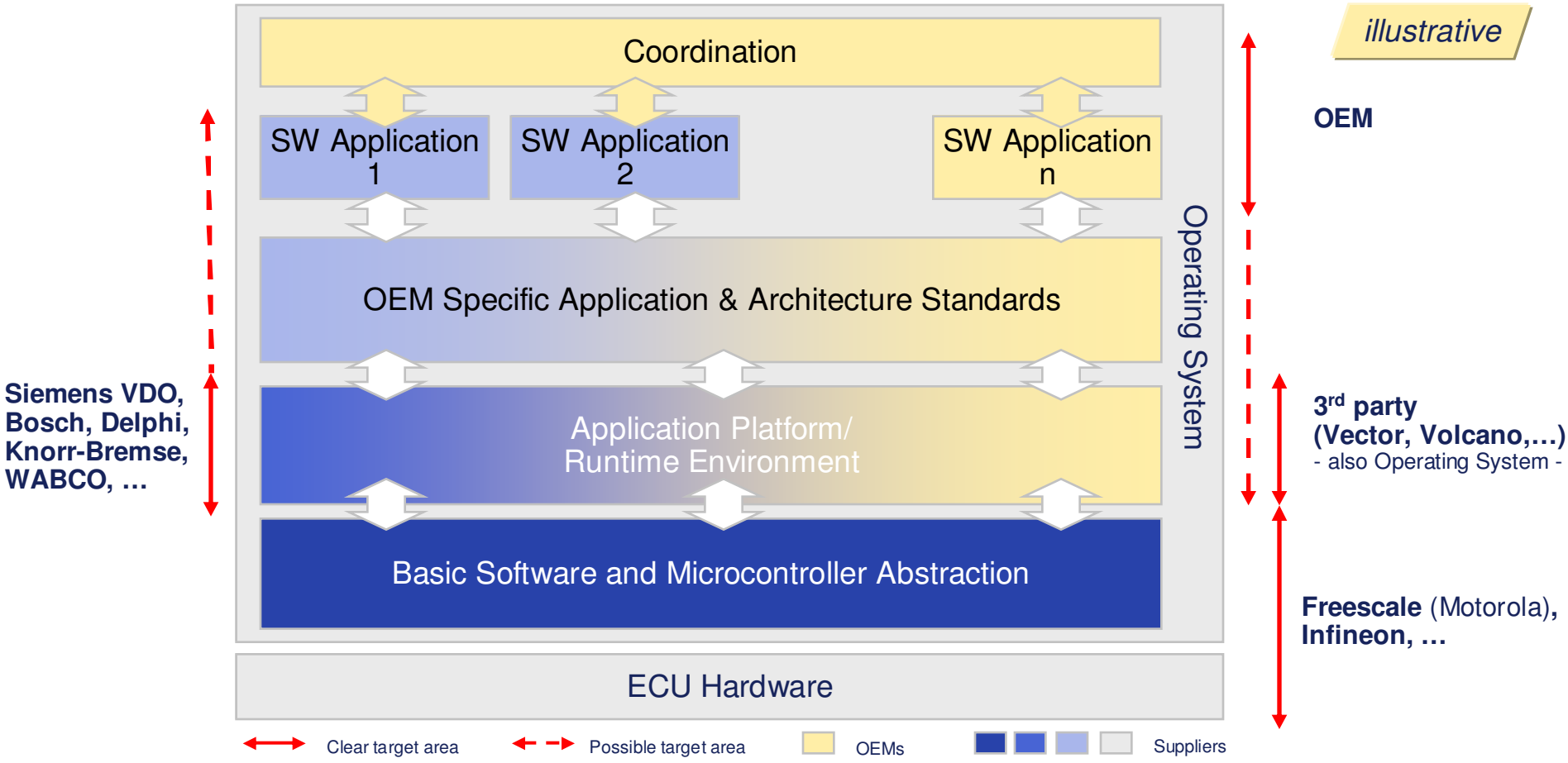


Future electronics architectures move towards higher centralization with two ECUs as “hubs" for vehicle and driver-related functions



* Gateway as separate ECU or integrated in central controller

Currently OEMs are moving into development of platforms and architecture standards - in the long run they will re-focus on specific applications and leave development of platforms and standards to specialists



Outsourcing of modules and systems will increase in the truck segment but will not reach the level seen in the passenger car industry

Key Findings

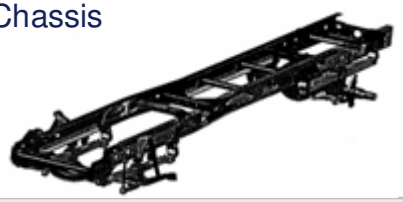
- OEMs will focus competencies on systems and functionalities which determine brand positioning and offer differentiation potential
- Engine, cabin (styling not manufacturing), and chassis are considered as core competencies – steering, axles, and gearboxes are usually not
- Despite outsourcing of development and manufacturing, functional integration of systems (e.g. gear shifting strategy) is considered as core competence and will continue to be performed by OEMs
- Due to various other barriers, primarily insufficient supplier competence and limited synergies or economies of scale, respectively, the number of modules potentially outsourced by OEMs is rather limited
- In many cases only, at best, half of the OEMs are interested in sourcing a complete module or system

OEMs will focus competencies on systems and functionalities which determine brand positioning and offer differentiation potential

high ← **Impact on Brand** → *low*

Core Competence ⟶ **Partnering/Outsourcing**

Mechanics + Manufacturing

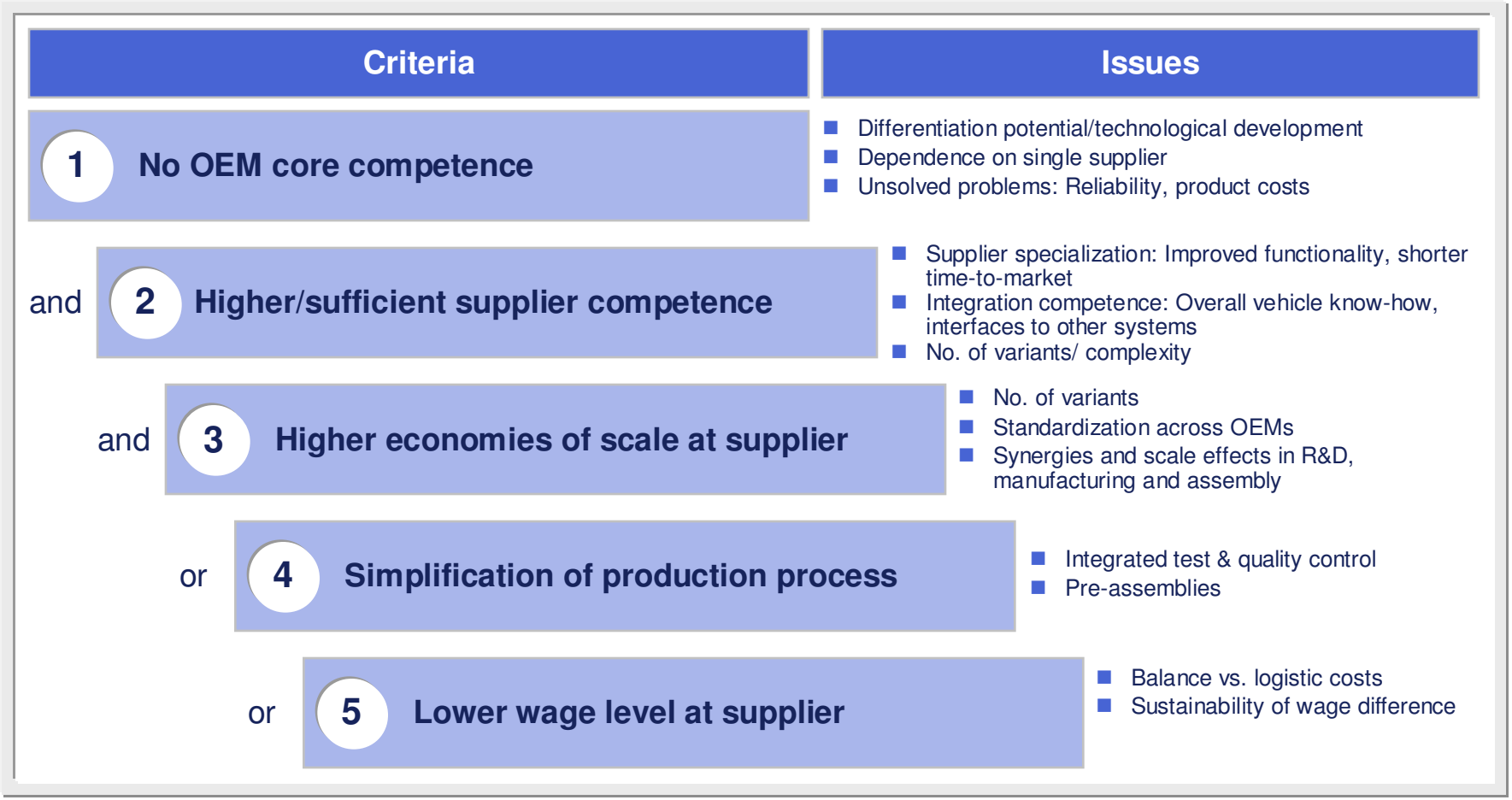
Cabin (Industrial Design) 	Chassis 	Steering 
Engine 	Gearbox 	Axles 

Electronics/SW + Functionality

- System integration (components, driver assistance, etc.)
- Powertrain control and exhaust after-treatment
- Gear shifting strategy
- E/E architecture

- Bus communication
- Basic diagnostics
- Standard body functions (e.g. window lift, trap protection)
- …

OEMs follow a clearly defined path when deciding on outsourcing of complete modules or systems



Highest outsourcing potential in the cabin – limited interest of OEMs to outsource chassis modules and systems

Outsourcing potential per system

- The following cabin modules receive the highest acceptance for outsourcing by OEMs:
  - "Driver Control Module"
  - Cockpit module
  - Door module
  - Front end module
- Other systems with potential for outsourcing in the future are:
  - Complete steering system (below firewall)
  - Chassis suspension system
  - Integrated air supply
  - Intelligent wheel ends
  - Exhaust system
- Axles most probably will not be outsourced – the Volvo/RVI - Arvin Meritor deal will most likely remain an exception
- OEMs consider complete braking and integrated chassis control systems as core competence and will definitely not outsource these systems

While OEMs will shift responsibility and effort to system suppliers they will keep "full" control through an intensified joint development

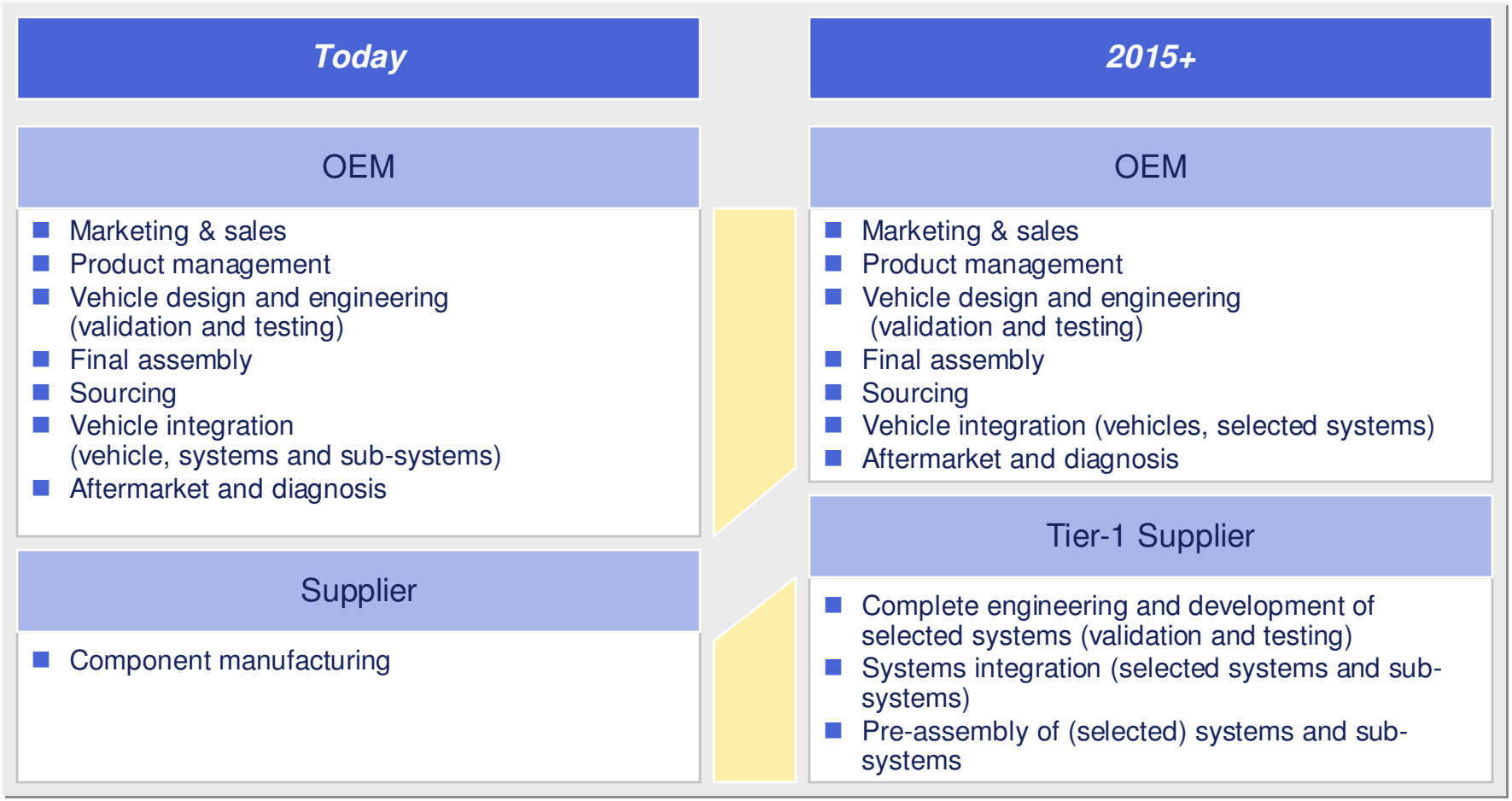
Key Findings

- However, due to heavy investments made and resistance expected from unions, the German OEMs, in particular, seem to be reluctant to decrease their degree of vertical integration. They might be forced to rethink that strategy, if new players with a better cost position (e.g. from Asia) enter the European market
- OEMs prefer a close long-term relationship with one supplier acting as general contractor if competencies of other suppliers are needed as opposed to dealing with project-based cooperations
- Modules and systems will be jointly developed instead of the more traditional approach where suppliers develop independently according to OEMs' specifications
- OEMs need to strengthen competencies in system supplier management ranging from elaboration of precise functional requirement specifications over target costing to quality management
- Suppliers need to upgrade their overall vehicle know-how in order to be a true partner for the OEMs. They need to fully understand all interfaces to other vehicle systems and their systems' impact on driving performance and life cycle costs
- System suppliers will form cooperations if necessary competencies are not available inhouse. Nevertheless, OEMs expect one partner with overall responsibility

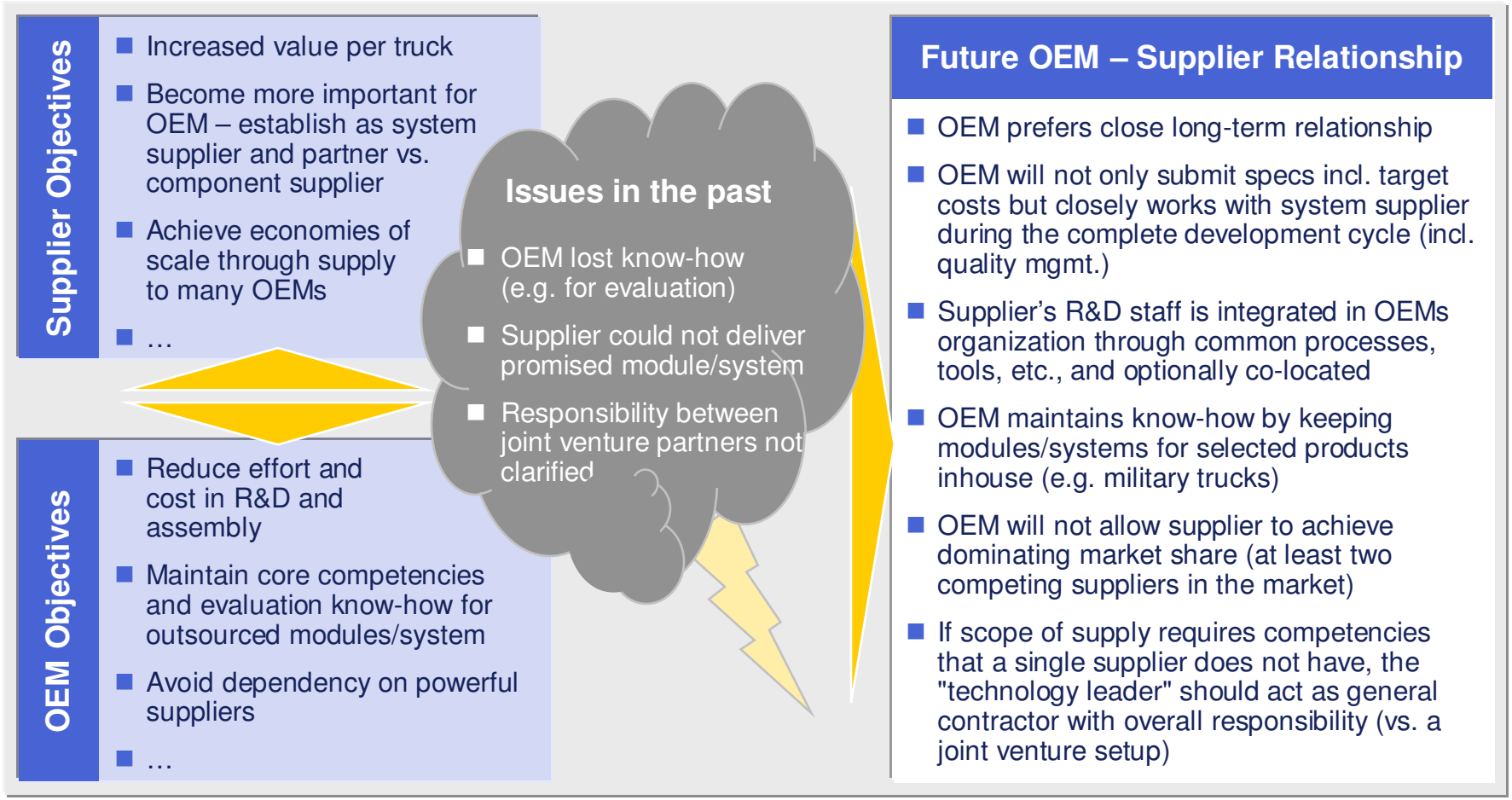
The shift towards systems and modules will change resource and competence structures of OEMs

	Future OEM Competencies	
	… less required in future	**… more important in future**
Design		■ Elaboration of functional requirement specifications (performance, etc.)
Engineering	■ Engineering of (selected) systems and modules	■ Mechatronic know-how ■ SW development/control algorithms (vehicle functions) ■ Early supplier integration
Production	■ Component and sub-system manufacturing ■ Assembly of (selected) systems and modules	■ Early integration of system/module suppliers
Sourcing	■ Supplier search and selection	■ Target costing (design-to-cost) ■ Supplier management (long-term relationship) ■ Quality management
Others		■ IT integration with supplier networks (prerequisite: Transparent OEM processes and open interfaces)

Responsibility for development of outsourced systems and modules will be transferred from OEMs to tier-1 suppliers



OEMs prefer to have a close long-term relationship with one supplier acting as general contractor if competencies of other suppliers are needed



In order to meet competence requirements suppliers will cooperate – as long as responsibilities are clearly defined OEMs accept any cooperation form

Forms of Cooperation

- Joint project/product specific R&D projects
- Virtual networks
- System specific R&D alliance or cooperation
- Joint ventures (joint manufacturing)
- Mergers
- Acquisitions

Examples

System	Partner 1	Partner 2	Description
Steering systems	ZF	Bosch	JV "ZF Lenksysteme", Bosch (50%); ZF (50%)
Drivetrain components (ABS, axle, brake, clutch, driveshafts, transmission, ..)	Eaton	Dana	"Roadranger", The drivetrain components from both companies are marketed as a single system during a 10 year period with annual option to renew the agreement
Exhaust systems	Arvin Meritor	Zeuna Starker GmbH	After a joint venture, Arvin Meritor took over Zeuna Starker completely
Front modules	Hella	Behr	Joint venture to combine cooling and lighting competence critical for front module design