Analysis and Standardization of Truck Architectures

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Abstract:

The road vehicle price has to fluctuate unnoticeably for customers even with new functionalities being introduced. To achieve this goal, truck manufacturers usually design common multifunctional platforms that integrate trucks' main mechanic, electric and electronic functionalities. These platforms can be used as a base for different types of vehicles including heavy and medium-size trucks, buses, and construction machines. Then, the platform is extended with various components on later design stages. In this paper, our goal is to propose a common electronic platform among several companies. This approach will help to significantly reduce total net costs of electronic part, which will benefit manufacturers and will enlarge the market of components and services for third-party vendors. We study different truck architectures by three leading companies, Volvo Trucks, Daimler Chrysler, and Scania in order to propose a generalized cost-efficient and dependable electronic architecture.

1 Introduction

Every owner of the truck would prefer a vehicle that is made especially for his/here needs, designed with considering all the wishes and requests and, at the same time, of course, the vehicle should be reasonably-priced. However, producing of tens thousands unique trucks will lead to unaffordable costs of manufacturing and design, which is unacceptable. Therefore, manufacturers are eager to find a good engineering trade-off among product originality and production costs.

The design based on a platform [1] is a capable method to solve this hitch. According to its principles, designers should standardize and unify the main system parts and main functions of different types of vehicles. The result of this process is a common *platform*, which can be used as a base for several products. To extend the platform up to, for example, a certain bus, a certain type of truck, designers have to stick a set of appropriate components on this base. These components should be large enough to embed a consistent piece of functionality and be self-sufficient and logically independent from others.

The component-based design [2] increases flexibility of the product and allows to combine components supplied from different third-party vendors, which can significantly reduce costs of the final product. However, it introduces some certain requirements and complications into the design process. Compared to ad hoc solution, the component-based demands intelligent separation of system into several modules, defining a clear interface among them, and specifying modules' properties. Issues of separation and composition are notorious for their complexity. Moreover, the complexity has a special meaning for real-time safety-critical systems, which, of course, includes trucks. Timing and dependability properties have to be verified with special methods of formal verification, mathematical models, testing, and simulation. Although the component-based design is not that easy, there are several methods that allow to apply it in order to design even very complex system [2] such as a spacecraft.

In this paper, we do not focus on theoretical aspects of platform concept and component-based design and, therefore, we would like the interested reader to get acquainted with the recent work in these areas [1][2]. Rather then that, this paper is very practical-oriented and includes study and analysis of existing platforms for component-based systems, truck electronic architectures. Many truck manufacturers have successfully used these architectures to design road and construction vehicles over years. However, an increase in international competition demands integration of the architectures into one common platform that will be used by several truck producers. Another economic benefit that we can foresee besides reducing the total cost is an enlargement of the component and service market for third-party vendors. They will not have to develop components for different companies and to support different interfaces. Instead independent vendors can design products with optimizing for one platform and spend most of the effort on improving quality and enhancing of functionality.

To begin with, we study three newest versions of truck architectures independently developed by Volvo Trucks [3], Daimler Chrysler [4], and Scania [5]. First, in the next section, we summarize common properties of these architectures and analyze their advantages and disadvantages with paying a special attention on dependability characteristics. In Section 3 we propose a *PRO*totype of *G*eneralized *T*ruck *AR*chitecture (PROGTAR) that integrates three separate truck architectures into one. In Section 4 we compare the PROGTAR to the corporate truck architectures. Conclusions and possible extensions of our approach, as well as suggestions for practical implementation, can be found in the last section.

2 Three Different Truck Architectures

In this section we review and analyze three different truck architectures developed in Volvo Trucks [3], Daimler Chrysler [4], and Scania [5]. Our main concern is their dependability characteristics and we are mainly interested in differences between architectures. To understand why the architectures intended to achieve the same goal significantly differ from each other, we should think about design of truck architecture as about a very challenging task. Hundreds of people with different background, interests, and expertise were involved. Sometimes very bounding decisions were taken during design process and years of modifications and extensions, trials and errors. As the result, the corporate truck architecture became unique although its functions can be very much similar to alternatives from competitors.

Analysis of the architecture is a complicated process, where the most important properties should be assessed and strong points as well as weaknesses should be indicated. In general, we will examine all the architectures with respect to six properties:

- *Structurability* that shows how close the architecture is following the component-based design principles, how properly functionalities of modules are defined, and how easy to reconfigure the architecture for particular customers' needs.
- *Scalability* that grades the potential for adding new modules.
- *Accessibility* that indicates a possibility to access the system for maintenance, upgrade, and diagnosis.
- *Security and reliability* that indicate levels of protection against malicious actions and hijacking, and ability to tolerate faults. According to the common agreement in automotive industry, any single critical fault should be tolerated, so that the truck (or a passenger car) can reach the first service station without stopping in the middle of the road and causing accidents.
- *Simplicity* that shows a level of complexity that the system has.
- *Cost* property that illustrates an impact of architectural decisions on a net price of the truck.

Every property is graded between "0" and "5". "0"-level means that the architecture does not satisfy the property, while "5" is an indication of excellence in term of the property. "1", "2", "3" and "4" mean "satisfactory", "very satisfactory", "acceptable", and "very good" reflection of the property in the system, respectively. We admit that our evaluation is subjective and future investigation will be needed to confirm or adjust our points.

2.1 Volvo FH Truck Architecture[1]

The first architecture that we have chosen to analyze is the one used in Volvo Trucks for designing heavy vehicles and construction machines. Volvo trucks are intended for goods transportation and logistics, building and construction, and city distribution and waste handling. Volvo FH architecture, illustrated in Figure 1, consists of several modules interconnected through J1939 and J1708/J1587 buses. J1939 bus is based on the control-area network (CAN) protocol and has bandwidth of 250 kbit/sec, where the CAN protocol is an event-driven protocol for real-time systems. J1708/J1587 is an older version that was used before J1939. J1708/J1587 provides a speed of 9600 bit/sec and is mainly intended for diagnostics and some fallback for J1939 [6]. Both buses are duplicated at one twisted pair cable by transmitting high and low frequency signals.

Volvo FH's architectural elements can be split into several groups according to functional properties and placement in the hierarchy. The first group is sharing the J1939-1 bus together with the J1708/J1587 control bus starting from the *ACC (Adaptive Cruise Controller)* module on the left side and ending with the *BBM (Body Builder Model)* on the right side of the Figure 1. All the units belonging to this group are safety-critical and responsible for such functions as engine control, braking, and road collision detection.

The second group of modules is related to security, comfort and logistic system functions, starting from the *Alarm* module and ending with the *Dynafleet* module (telematics system for traffic logistics). The units are interconnected through the J1708/J1587 bus for control and testing and are more or less separated from each other. Attached to this group of elements through special sockets, *VCADs* are the personal computers that can be connected to truck's network for maintenance, reconfiguration, solving technical problems.

The third group of modules provides infotainment functions such as Phone (a telephone), Radio and Audio (audio system module). It also includes an interface from driver to infotainment equipment. This interface is implemented in *SWM (Steering Wheel Module)* that connects control buttons placed on a steering wheel to radio, telephone, and other infotainment functionalities. This group is separated from safety-critical units by the gateway (*Cluster*). The group begins with the *Audio* module for listening radio, DVDs, and music tapes and ends with the *TPM (Tire-Pressure Monitoring)* module for monitoring air pressure in tires.

According to Volvo's application model, every module implements its own functions, e.g. braking, steering, engine control, logistics. However, some applications can be distributed over several units, and even clusters. Modules can let some of its application parts run on other units, for example, the cruise-controller may use *ABS (Antilock Braking System)* modules and the *EMS (Engine Management System)* [7] to perform some of its functions.

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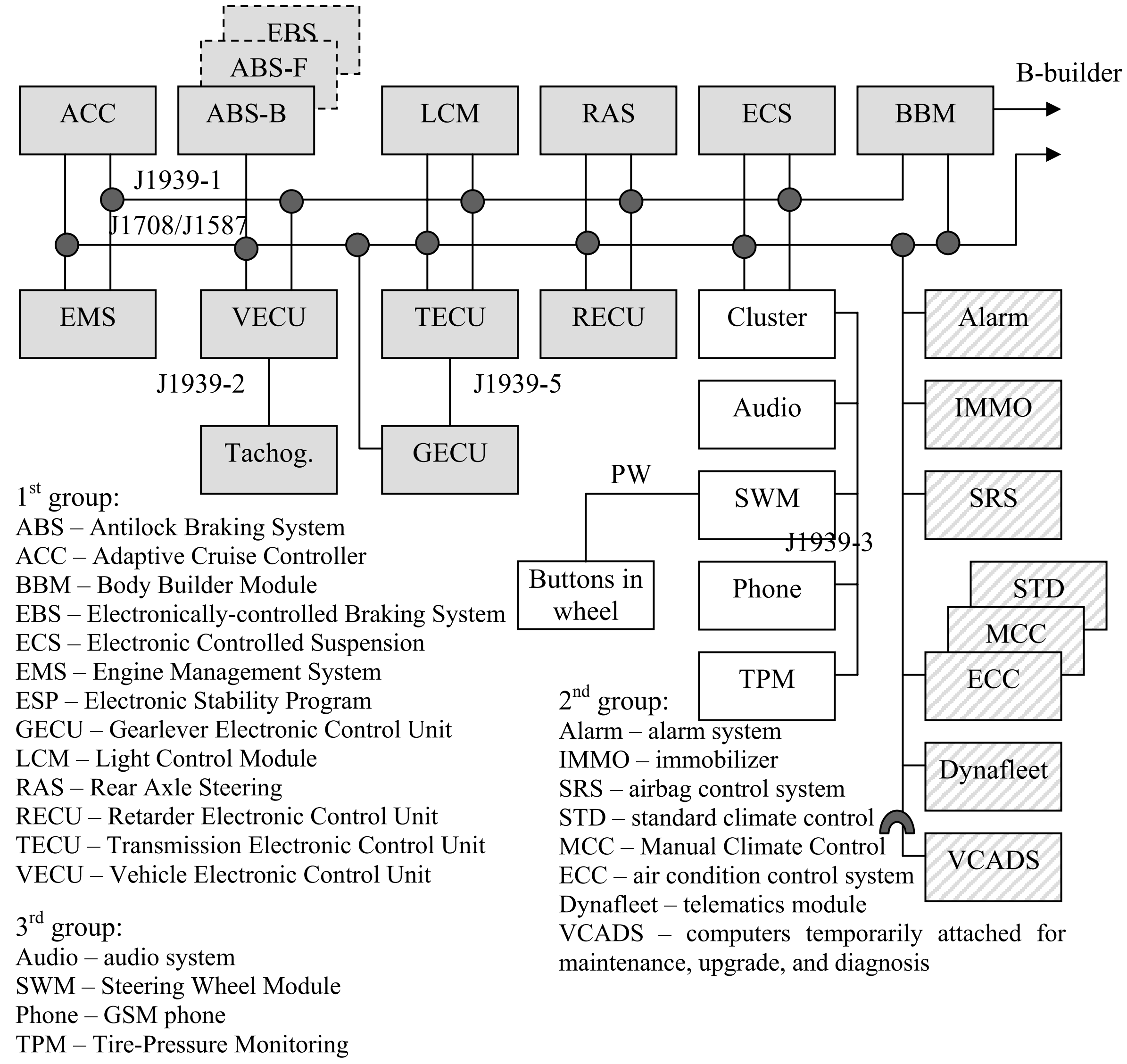
[1] The material is taken from ”Presentation av Påbyggar funktioner på Volvo” at Mälardalen Högskola, Volvo 3P, 2004-05-26, ref. 3



1st group:
ABS – Antilock Braking System
ACC – Adaptive Cruise Controller
BBM – Body Builder Module
EBS – Electronically-controlled Braking System
ECS – Electronic Controlled Suspension
EMS – Engine Management System
ESP – Electronic Stability Program
GECU – Gearlever Electronic Control Unit
LCM – Light Control Module
RAS – Rear Axle Steering
RECU – Retarder Electronic Control Unit
TECU – Transmission Electronic Control Unit
VECU – Vehicle Electronic Control Unit

3rd group:
Audio – audio system
SWM – Steering Wheel Module
Phone – GSM phone
TPM – Tire-Pressure Monitoring

2nd group:
Alarm – alarm system
IMMO – immobilizer
SRS – airbag control system
STD – standard climate control
MCC – Manual Climate Control
ECC – air condition control system
Dynafleet – telematics module
VCADS – computers temporarily attached for maintenance, upgrade, and diagnosis

Figure 1. Volvo FH Architecture [3]

2.1.1 Analysis and Conclusions

Our analysis of Volvo's architecture is based on a visual study as well as on the material taken from [3] and [6].

This architecture is a good example of component-based design of embedded systems. Volvo FH architecture has a clear structure since all functions are properly defined. Every module performs its inherited functionality although distribution of applications is also possible. According to Volvo's documentation, buyers of the truck can install additional components or can even choose the most appropriate combination of the core modules. For example, *EBS (Electronically-controlled Braking System)* can be installed instead of the traditional hydraulic braking system (dash-line boxes), which makes the architecture flexible.

VCADs modules, structurally belonging to the second group of components, allow direct access to the network either at a service station or on the road to provide maintenance, upgrade software, correct possible design uncertainties. Therefore, Volvo FH architecture is easily maintainable. However, VCADs are connected to a slow bus, the J1708/J1587, which could make upgrade of software noticeably slow.

The architecture is not complex, however, there are some complications related to introducing the J1708/J1587 bus in addition to J1939-based buses. The cost seems to be also not that high even though there could be some problems related to distribution and decentralization of control functionalities.

However, there are several worrying aspects that need to be pointed out:

- There is, probably, not much protection against intrusion and malicious attacks from public networks to the system core. *Dynafleet* module seems to be connected to safety-critical components without any security check, even though it has an access to the Internet and other global networks as the GPS (Global Positioning System).
- J1939 and J1708/J1587 buses seem to be duplicated and, according to the system specification, data transmission should be possible in case of a single permanent fault occurrence. However, the duplication is done within one twisted pair cable. If the cable had been cut because of mechanical damage or there is a short circuit, the connection might be lost.
- There could be problems with scalability because a single bus can effectively handle only 7-10 components. As seen on Figure 1, the J1939-1 bus seems to have reached the limit of its capacity and the J1708/J1587 bus seems to be overloaded.

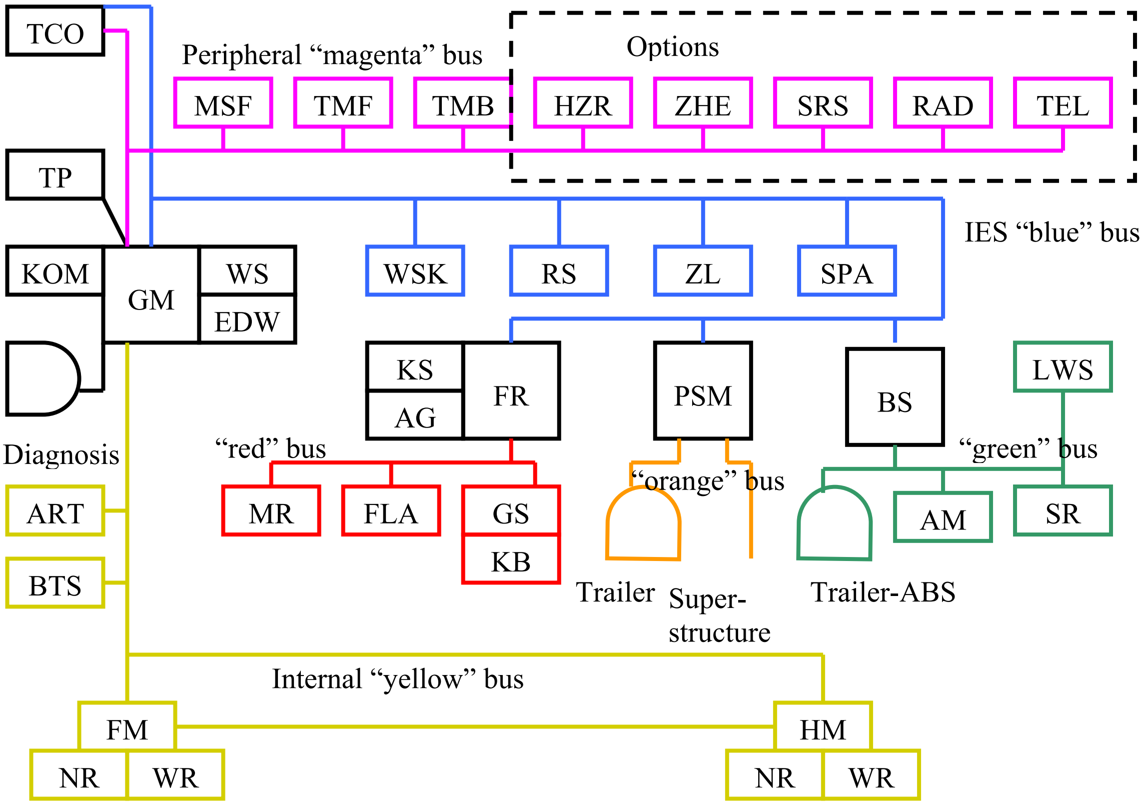
The final evaluation is presented in Table 1.

Table 1. Volvo FH Evaluation

Properties	Evaluation	Values
Structurability	👍👍👍👍👍	5.0
Scalability	👍👍	2.0
Accessibility	👍👍👍👍	4.0
Security and reliability	👍👍👍	3.0
Simplicity	👍👍👍👍	4.0
Cost	👍👍👍👍	4.0
Overall		3.67

2.2 Daimler Chrysler Architecture

The second architecture that we discuss was recently introduced for heavy vehicles in Daimler Chrysler. The Mercedes-Benz Actros architecture [4] is more detailed and better specified compared to the Volvo FH and presents a modification of older version, which was introduced in 1996.



Peripheral “magenta” bus:
MSF – controller of serial interfaces
TMF – driver’s side door module
TMB – passenger’ side door module
HZR – heating regulation
ZHE – additional heating
SRS – airbag control module
RAD – audio system
TEL – GSM phone module

“red” bus:
MR – engine regulation
FLA – engine ignition control
GS – gear control
KB – transmission functionality

Gateway and control modules:
GM – general module
FR – driving regulation
PSM – trailer special module
BS – braking system
TCO – tachograph

IES “blue” bus:
WSK – electronically-controllable transmission
RS – wheel steering system
ZL – additional steering system
SPA – driver assistance system

Internal “yellow” bus:
ART – collision-avoidance system
BTS – power management system
FM – front module
HM – rear module
NR – level regulation
WR – balance regulation

“green” bus:
LWS – back sensors
AM – control of the rear wheels
SR – shock absorption regulation

Other modules:
TP – telematics platform
KOM – communication gateway
WS – servicing system
EDW – central lock and intrusion detection system
KS – transmission control
AG – automatic injection control

Figure 2. Mercedes-Benz Actros Architecture [4]

The new Actros architecture, illustrated on Figure 2, consists of several separated networks marked with different colors: blue, magenta, greed, red, orange, and yellow. Distribution of components among these networks depends very much of their criticality in terms of safety.

The "magenta" or Peripheral bus includes modules responsible for doors' functionalities (*TMF* and *TMB*). Several "optional" components can additionally be attached, which includes heating regulation modules (*HZR* and *ZHE*), airbag (*SRS*), radio and telephone (*RAD* and *TEL*). The "blue" or *IES (Integrated Electronic System)* bus contains modules such as steering systems (*RS* and *ZL*) and cruise-controller (*SPA*). The "green" bus is responsible for transmitting data between back sensors (*LWS*), balancing module (*SR*), and control of the rear wheels (*AM*). Modules controlling an engine are attached to the "red" bus. Such highly critical modules as a collision-avoidance system (*ART*) and a gear regulation (embedded into *FM* and *HM*) communicate via the "yellow" or Internal buses.

Truck's trailer exchanges data with main truck's modules through the "orange" bus. The driving regulation module (*FR*), trailer special module (*PSM*) and braking system (*BS*) are a sort of gateways between "red", "orange", and "green" bus, respectively, and the Internal bus, although they perform their own functionalities as well.

Peripheral, IES, and Internal buses are connected through the general central module (*GM*), which seems to be a sort of "heart" of the truck. However, IES and Peripheral buses can directly access *Tachograph*, or control panel's indicators. The *GM* module is accessible from outside for maintenance and upgrade. The *GM* module includes a central lock and intrusion detection system (*EDW*), communication gateway (*KOM*), and servicing module (*WS*).

All the buses are replicated, however, we could not find exact and proven information how many replicas they contain. The Peripheral bus implements a low-speed CAN protocol (WELL 1054) with a speed of 125 Kbit/s. The Internal bus uses a newer protocol, namely ISO 11898, and provides a speed of 500 Kbit/s.

2.2.1 Analysis and Conclusions

Compared to the Volvo FH architecture, the Actros has one very important advantage. Modules required different levels of dependability are clearly separated from each other. E.g., engine control functions are mapped on the "red" bus. Braking systems, cruise controller and other crucial models for truck functioning are assigned to the IES "blue" bus. Radio, audio, logistics modules belong to the Peripheral "magenta" bus and are strictly detached from the safety-critical part.

However, there are several disadvantages. The IES-bus components connect the Internal-bus components through only one unit, the GM, a general module. This makes the GM very critical for right functioning of the truck. Except providing a crucial connection between IES and Internal bus, the module is also responsible for dealing with external information exchange. Well, intrusion detection and a central lock are also integrated at the same module. Even though these mechanisms can protect system against some eventualities, damaging one of the units might consequently lead to an easy access to others, including module's gateway functionalities as a drawback of tight coupling. Integration of critical and non-critical functionalities could make the GM module Achilles' heel of the system.

The complexity seems to be the main concert about this architecture. Although it provides a number of benefits mentioned above, it increases the costs of the final product. Additionally, the IES and Peripheral buses seem to have reached the limit of their capacity, which could make scalability questionable.

The final results can be found in Table 2.

Table 2. Actros Evaluation

Properties	Evaluation	Values
Structurability	👍👍	2.0
Scalability	👍👍👍👍	4.0
Accessibility	👍👍👍👍	4.0
Security and reliability	👍👍👍	3.0
Simplicity	👍	1.0
Cost	👍👍👍	3.0
Overall		2.83

2.3 Scania Architecture

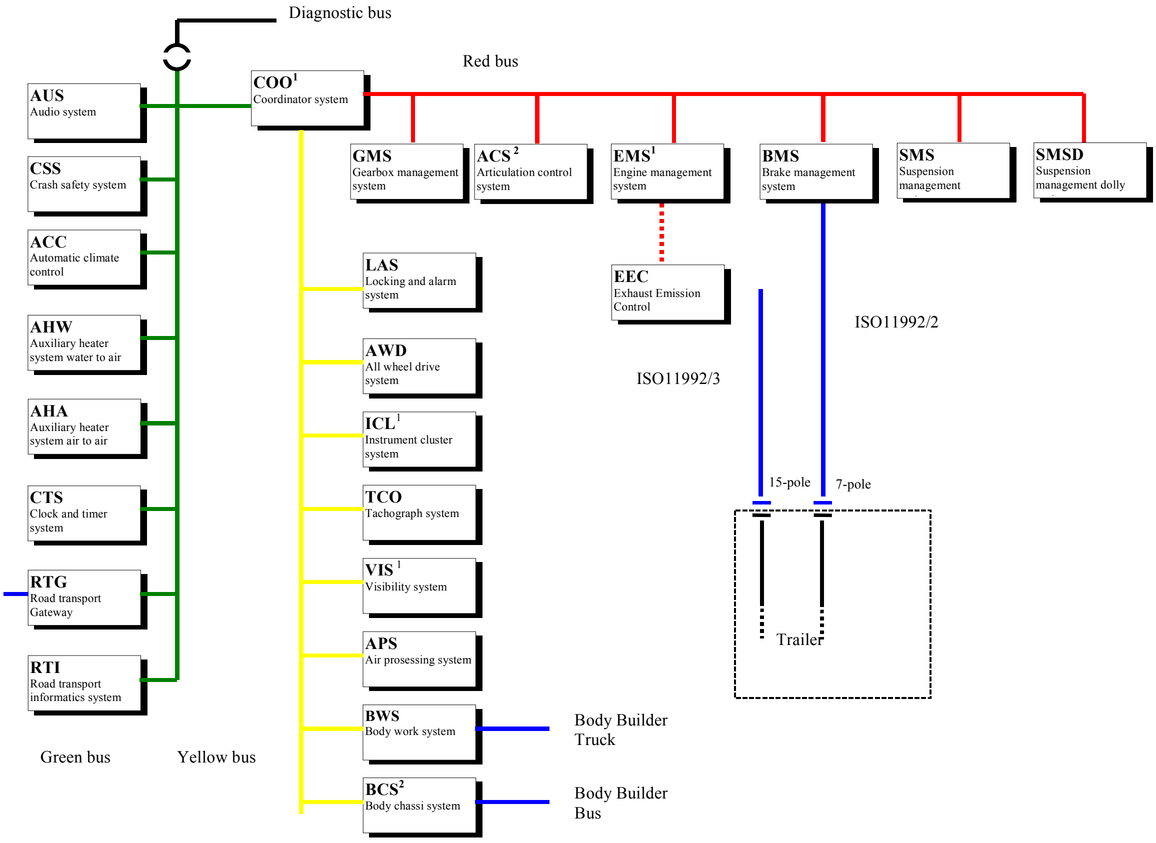
The last but not least architecture is distributed control architecture for a Scania truck [5], illustrated on Figure 3. Scania trucks are multifunctional and can be configured dependently on customers' wishes. To achieve this flexibility, all the functionalities are clearly indicated and grouped according to their criticality into three buses denoted as "red", "greed", and "yellow".

The "red" bus includes functionalities related to control, braking, and engine management. It includes, for example, Gearbox Management System (GMS), Brake Management System (BMS), and Exhaust Emission Control (EEC). Less critical "yellow" bus connects systems that are not directly responsible for truck control such as Locking and Alarm System (LAS), Visibility System (VIS), All Wheel Drive system (AWD), and others. Infotainment and comfort components, such as audio system, logistics, and climate control are attached to the "green" bus.

These three buses communicate via the Coordinator system (COO) that performs gateway functionalities. The truck can be accessed for maintenance, upgrade, and diagnosis through the diagnostic bus connected to the "green" bus. All three buses use CAN-based J1939 protocol with duplication on the same twisted pair as in the Volvo FH.

2.3.1 Analysis and Conclusions

Scania architecture continues a good tradition of the Actros and provides a clear separation between components dependently on their level of criticality. Compared to Volvo FH and Actros, Scania's architecture fascinates by its simplicity yet supporting all the required functionalities. This architecture was developed with respect to concepts of component-based design. It does not have the disadvantage of Actros, where all functions related to external information exchange were grouped together with critical parts (*GM* module, see Figure 2). In a Scania truck, even a diagnostic bus for maintenance and upgrade, which, strictly speaking, can be used for intrusion and hijacking, is logically and structurally separated from safety-critical components.



Green bus

AUS – Audio system
CSS – Crash safety system
ACC – Automatic climate control
AHW – Auxiliary heater water-to-air
AHA – Auxiliary heater air-to-air
CTS – Clock and timer system
RTG – Road transport info gateway
RTI – Road transport info system

Yellow bus

LAS – Locking and alarm system
AWD – All wheel drive system
ICL – Instrument cluster system
TCO – Tachograph system
VIS – Visibility system
APS – Air processing system
BWS – Body work system
BCS – Body chassis system

Red bus

GMS – Gearbox management system
ACS – Articulation control system
EMS – Engine management system
EEC – Exhaust emission control
BMS – Brake management system
SMS – Suspension management system
SMD – Suspension management dolly

COO Coordinator system

1 Mandatory systems
2 Bus specific systems

Figure 3. Scania Architecture [5]

However, there are several drawbacks that can, partially, be a result of the simplicity. *COO (Coordinator system)* that connects the buses seems to be a weak place in the architecture. Any physical damage or malicious actions against this component could easily lead to malfunctioning of the whole system. All three buses seem to have reached the limit of their capacity. This might be a significant drawback since the amount of electronics in trucks is growing rapidly and introducing a couple of new modules might become a reality in relatively short time.

Additionally, we would like to point on the fact that duplication in done on the same twisted pair. If the cable had been cut because of a mechanical damage or there is a short circuit, the connection might be lost. This means that not all single permanent faults can be tolerated.

The reader can find the final evaluation of Scania's architecture in Table 3.

Table 3. Scania Architecture Evaluation

Properties	Evaluation	Values
Structurability	👍👍👍👍👍	5.0
Scalability		0.0
Accessibility	👍👍👍👍👍	5.0
Security and reliability	👍👍👍	3.0
Simplicity	👍👍👍👍👍	5.0
Cost	👍👍👍👍👍	5.0
Overall		3.83

3 PROGTAR Architecture

As clearly seen from our previous discussions, all three architectures have several drawbacks and disadvantages. However, there are also several strong positive points in each of them. In this paper, we attempt to combine the corporate architectures in order to design a generalized prototype that keeps advantages while eliminating drawbacks. Volvo, Scania, and Daimler Chrysler to successfully compete on the international market, could potentially jointly develop this prototype.

Our first task is to choose an appropriate general structure of components. From our point of view, both Volvo FH and Scania have clear and understandable structure of components and distributions of functionalities among them. However, compared to Scania, Volvo FH architecture is fully decentralized and contains modules responsible for a distributed control of the system. We consider decentralization as a strong point and, therefore, choose Volvo FH structure as a basis for our generalized architecture.

The next step would be to decide upon the network infrastructure. Volvo FH is not suitable since it seems to have problems with security and difficulties against accessibility. Actros is too complicated and, therefore, cannot be used due to its high cost. However, Scania has simple and understandable communication infrastructure without any security or accessibility problem. Therefore, we compile Volvo's components with Scania's infrastructure as shown on Figure 4.

However, coming back to our analysis of Scania, we can see two main drawbacks, e.g. problems with scalability and vulnerability to single permanent faults in communication. To solve these problems, we split the "red" bus into two clusters and duplicate the bus at each of them as illustrated on Figure 5. As the result, there are always two communication channels available at each cluster. (In case of a short circuit, one cable can be lost, while another one can operate with two wires available. In case of a single permanent fault occurrence at a single wire, three other wires will be available.) Therefore, we can basically have two buses at the cluster and each the "red" cluster can support up to 14-18 nodes (7-10 per a single bus). This duplication does not increase cost of the architecture compared to Volvo FH. The cable of J1708/J1587 bus in Volvo FH goes in parallel with the cable of J1939-1 bus (see Volvo FH architecture, Figure 1). Also it is cheaper than to have 7 buses as in the Actros architecture.

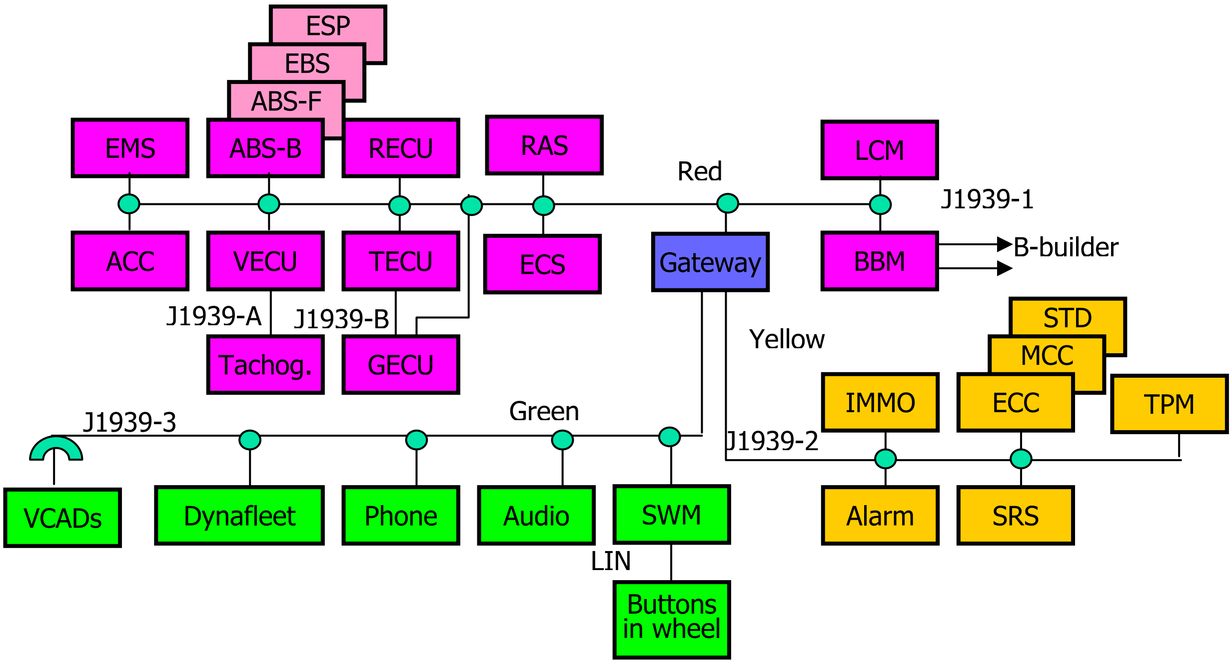


Figure 4. The PROGTAR: First Transformation

Although we have solved problems with scalability and reliability, the *Gateway* separated two "Red" clusters is a weak point. Additionally to gateway functionality, it also needs to perform firewall functions to filter out malicious packets and viruses. This brings us back to the discussions about the *GM* module in the Actros (see Figure 2) and criticality of the *COO* module in Scania's architecture (see Figure 3). Therefore, to avoid possible affections from firewall and intrusion detection on safety-critical components, we separate a firewall from the *Gateway*. To increase robustness, we additionally duplicate the *Gateway*, so that malicious actions or faults in one gateway will not affect another one and communication between the "Red" clusters will be possible (as shown on Figure 5). Therefore, compared to Scania architecture, PROGTAR has two more nodes targeted to handling communication. However, this is the price that we pay to improve reliability (by duplication of *Gateway*) and security (by having separated firewall).

We decided do *not* duplicated cables[2] for clusters with infotainment (J1939-3) and comfort, passive safety and security systems and (J1939-4) since transmitting information at the "Green" cluster is not critical and communication exchange inside the "Yellow" cluster is very low. For example, *SRS (Airbag)* operates independently although it might need some data from *ACC (Active Cruise Controller)*. In case of short circuit, we assume that an airbag, immobilizer, and a climate control should be able to operate in autonomous mode until the truck reaches the first service station and cables will be replaced. Information from TPM (Time-Pressure Monitoring) module is not very critical although can be important to prevent sideslips.

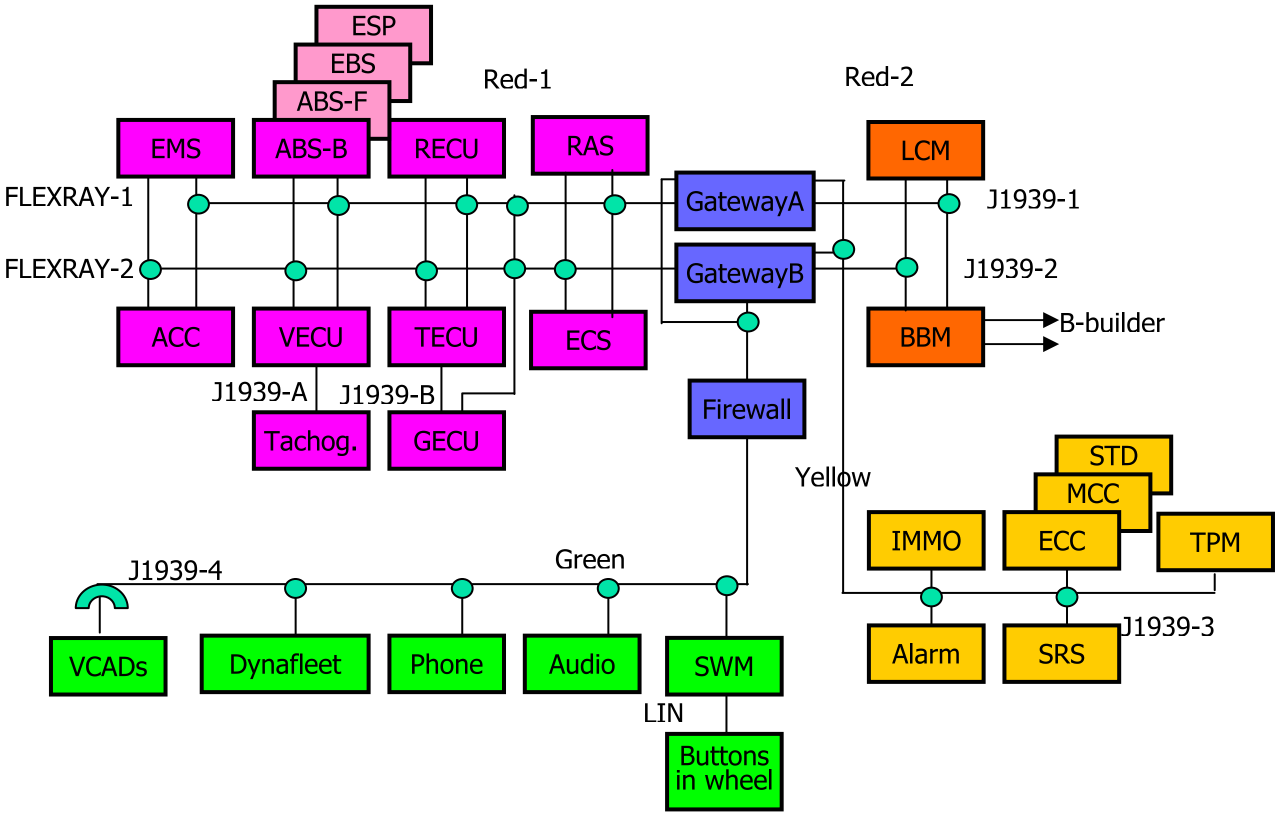


Figure 5. The PROGTAR: Final Design

To improve flexibility of the PROGTAR architecture and additionally increase predictability of safety-critical components, we have replaced CAN-based J1939 protocol in the leftmost "Red" cluster with FlexRay [8]. FlexRay is one of the most promising protocols in automotive industry and its support will allow to add FlexRay components to the architecture without the need of redesign and adaptation. FlexRay is a time-triggered protocol and, therefore, will increase predictability of safety-critical functions in the PROGTAR. Running distributed applications in a multi-cluster heterogeneous environment is not problematic and researchers have intensively studied this issue during past years [9].

In the PROGTAR architecture we have addressed dependability and scalability issues lacking in the corporate architectures, while keeping low cost on the level comparable with Volvo FH yet with two more nodes. However, since PROGTAR is a generalized architecture that can be used

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[2] However, there is duplication inside one cable by transmitting high and low frequency signal on the same twisted pair.

by three companies the production volume will be increased. The cost of adding two more nodes will be negligible according to the formula 3.1 of cost-efficiency [1]:

$$\text{[Cost-efficiency]} = \text{[Accumulated product value]} / \text{[Overall cost]} \qquad (3.1)$$

At the same time larger volume of product will result in demand on higher levels of dependability and security, which is already captured by the PROGTAR. PROGTAR components are easily accessible as in Scania and the architecture is well structured as Volvo FH or Scania. We improve flexibility of PROGTAR by introducing an alternative FlexRay protocol into one of the “Red” clusters. The overall evaluation of the PROGTAR is presented in Table 4.

Table 4. PROGTAR Evaluation

Properties	Evaluation	Values
Structurability	👍👍👍👍	4.0
Scalability	👍👍👍👍👍	5.0
Accessibility	👍👍👍👍👍	5.0
Security and reliability	👍👍👍👍👍	5.0
Simplicity	👍👍👍	3.0
Cost	👍👍👍👍	4.0
Overall		4.33

4 Summary

In this paper, we evaluated three corporate truck architectures, a Scania truck, Volvo FH, and Mercedes-Benz Actros, and proposed a prototype of generalized platform that combines advantages of them. According to our results, none of discussed architectures seems to provide required level of dependability. Scania, Actros and Volvo FH can be considered as “acceptable” in these terms. Out of all, the Scania architecture showed excellent results in terms of simplicity and cost. However, this architecture is not scalable.

We believe that only combining Scania, Volvo and Daimler Chrysler architectures into one platform can significantly improve competitive abilities of these three companies on the international market and reduce costs of production and maintenance. To cast the first stone, we developed a prototype of the generalized architecture, the PROGTAR. PROGTAR outperformes corporate architectures in the overall evaluation in terms of dependability characteristics and scalability while its cost could be equal or lower since the production volume will be as much as Scania, Volvo Trucks and Daimler Chrysler together.

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