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## Session 3: Business Models

# Business models for software components in the automotive industry

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### 1. Introduction

Electronic control units (ECUs) are today the standard solutions to manage and control highly complex control tasks in modern vehicles for applications like powertrain, security, comfort and car-multimedia. The increasing complexity of these applications generates continuously increasing requirements and demands regarding the performance and quality of these ECUs. One of the consequences is that the part of the requested embedded control software will increase at an over proportional rate. According to recent studies the relative part of software compared with the total value of a vehicle in 2010 will achieve 13% (HypoVereinsbank / Mercer Study, 2001).

Today the development and business processes for ECU hardware, sensors and actuators (or more generally for all material parts of this control system) are managed relatively well. On the other side the handling of the new and evolving processes for the development and especially the commercialization of embedded software are one of the major challenges for the automotive industry. The definition and implementation of adapted business models for "embedded software" is of interest for all companies that are involved in this business processes. The possible business models must not only cover the corresponding cost issues (e.g. for development, patents, production) but have to deal as well with a rather unclear legal situation and with the automotive specific warranty and liability aspects.

How shall in such an environment a manufacturer of software components earn enough money to run a profitable business: by directly selling this products, by giving this products away for free and earning money with associated services, by the exploitation of associated rights and patents or a with combination of all of this possibilities.

The most important European car manufacturers, suppliers and tool providers in this area (in total 23 partners from 4 European countries) have faced some of these technical and economical challenges in a common European project. This common project is the ITEA<sup>1</sup>-project: "EAST<sup>2</sup>-EEA<sup>3</sup> Embedded Electronic Architecture". The major objectives of this project are the definition of a common middleware and of a software architecture description language. A further workgroup in this project analyzed "Intellectual

<sup>1</sup> Information Technology for European Advancement

<sup>2</sup> Electronics Architecture and Software Technologies

<sup>3</sup> Embedded Electronic Architecture



Property Rights and Commercial Issues" related to the introduction of this new technologies. The knowledge acquired and the data collected in the context of this subproject had a high impact on the considerations presented in this paper.

These findings together with some general reflections about business models will lead to an evaluation of strengths and weaknesses of various commercial and financing models. This evaluation could become a guideline for establishing and improving ones own business models.

This paper will give in a first part an overview about the general structuring of an ECUs software and of a network of ECUs, as it is currently used in modern vehicles. The following part will present the needs of the European automotive industry concerning the new upcoming business models for exchanging and trading embedded software. Afterwards some general considerations about business models will be shown followed by an evaluation of different types of commercial models. The final part of this paper will present some aspects related to the dynamics of business models and give some recommendations as well as an outlook.

## 2. Embedded software in the automotive industry

Modern vehicles integrate today a high number of features and functionalities. The operation and control of this various subsystems is mainly ensured by electronic control units. Even if some applications are still operated by a single, independent ECU, the major part of a vehicles functionality is controlled by a network of ECUs (Figure 1). A good example for a networked operation is the TCS/ASR<sup>4</sup> system - a functionality ensured by the engine and the break control systems.

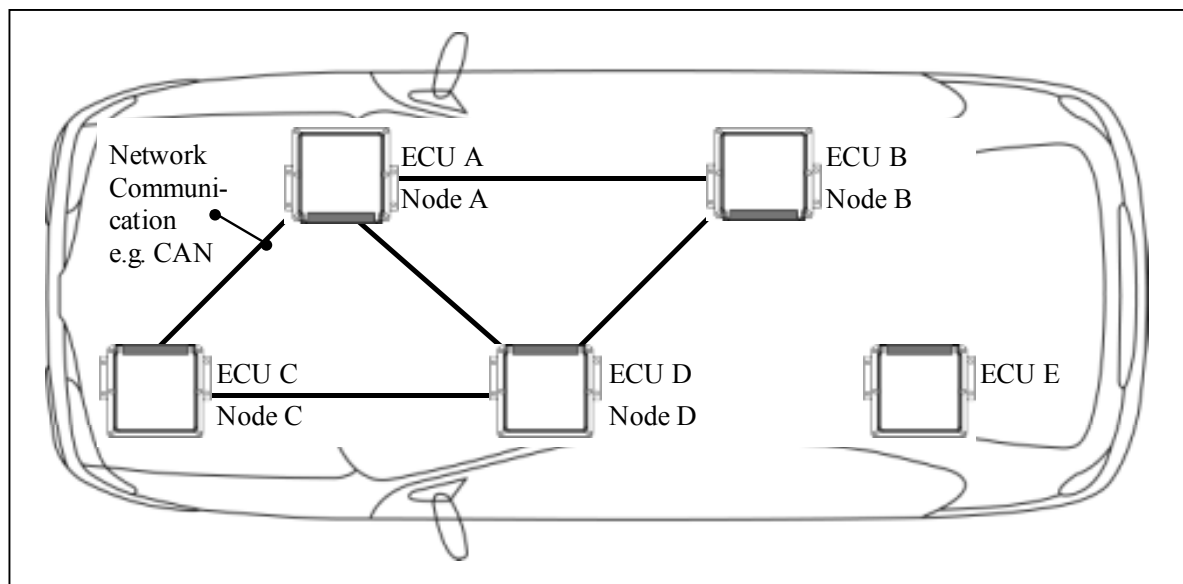


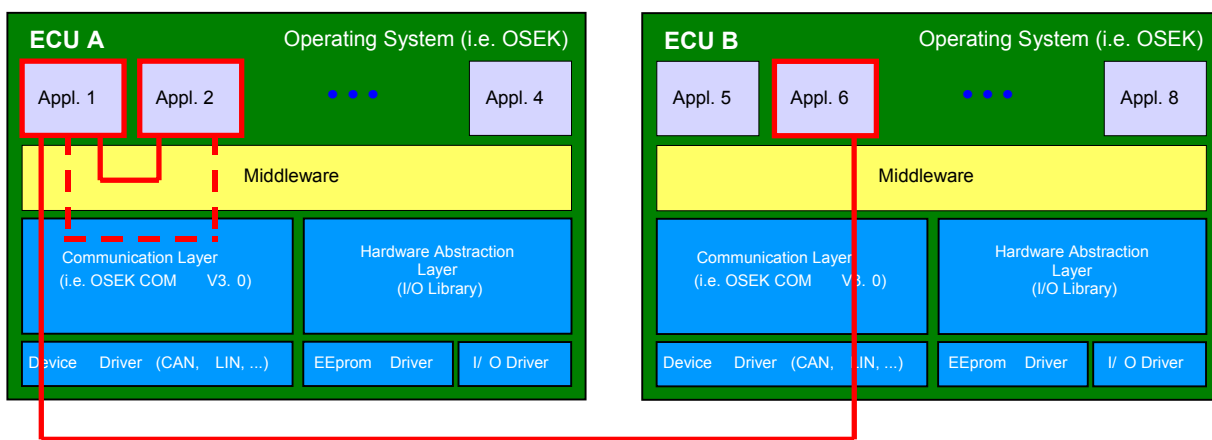
Figure 1 ECUs and network of ECUs in a today's vehicle

<sup>4</sup> TCS/ASR - Traction Control System (German term "Antriebsschlupfregelung")



The ECUs themselves have to ensure a complex interaction between electronics and software. A major part of control system innovations is realized today directly with a more and more complex software functionality. This ever increasing complexity requests a good structuring and organization of an ECUs software. Conventional programming techniques are replaced by modern approaches based on defined software architecture concepts.

When taking a deeper look into the embedded automotive software, one can identify blocks for basic functions like communication drivers or peripheral access routines as well as blocks for actual control-algorithms. Some other programs are ensuring the scheduling of functions and the exchange of data between the various software blocks. These different types of software components are shown in a typical representation for 2 networked ECUs in Figure 2.



**Figure 2 Types of software components in an ECU (network)**

The technical management of this software related aspects is quite complex and is requesting a close cooperation between all involved participants. Their objective is to establish a common software technology which is supported by corresponding processes and powerful development tools. One of the results of these activities is an increasing share of software components between applications, ECUs but as well between the different project participants. The first two mentioned software sharing aspects are of a rather technical nature and addressed by the previously mentioned activities. The share of software components between business participants is mainly driven by economic factors and asks therefore for a clarification and definition of the upcoming business processes.

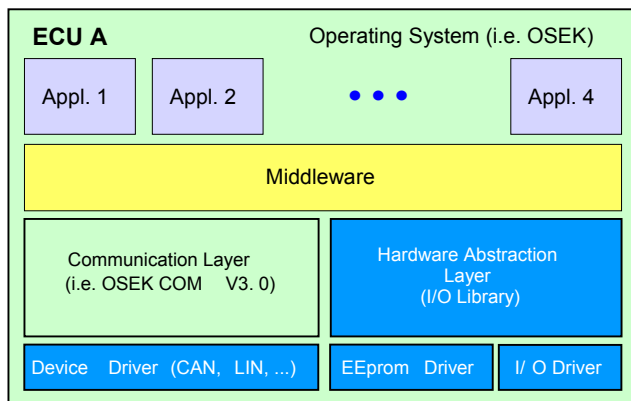
When concentrating on the details of this upcoming business processes it has to be mentioned that currently the business processes for ECU hardware, sensors and actuators (or more generally for all material parts of this control system) in the automotive industry are managed relatively well. On the other side the handling of the new and evolving processes for the development and especially the commercialization of embedded software are one of the major challenges this industry is facing.

The today's most common business model for selling embedded software in the automotive industry is to sell the software in combination with hardware, where the main value is attributed to the hardware components. Software is seen as a more or less necessary add-on. However things are changing and the value of software is being recognized more and more. But what is the appropriated value of such software components and



what kind of price model should be applied? Approaches based either on directly applying the software development costs to the final control unit price or using royalty price models have not shown the expected success in the automotive industry. Furthermore the software business models have to take into account that costs are mainly related to the development of the software whereas the corresponding production costs are very low and warranty costs could be quite significant.

Before further concentrating of the details of the various business model possibilities, a basic aspect has to be analyzed more in detail: the general architecture of the embedded software of an ECU (or of a group of ECUs) from an economic perspective. The structuring into different parts of this software will eventually determine which of the components could be traded independently of the ECU hardware. Figure 3 shows a possibility for structuring software components in an economic context based on the possible technical solutions presented previously in this paper.



**Figure 3 Categories of software Components - an economic / business perspective**

The different software categories according to this classification are:

- Hardware specific components (which will be provided mainly by the ECU or hardware suppliers, e.g. hardware abstraction layer - HAL, device drivers, I/O drivers)
- Standardized components (commodity like components which are available on the free market, e.g. operating system - OS, communication layer)
- Application software components (components that contain functionality and business differentiating elements and will be provided by vehicle manufacturers, ECU suppliers as well as third party suppliers)
- Middleware (a special type of software structure that enables the previously mentioned separation and by this the models in question, will not be considered for the business aspects - is rather an enabler for this)

These categories of software components will serve as a basis for the following considerations in this paper.

### 3. Needs of the European automotive industry

Before presenting different possibilities of business concepts and business models one should know what the needs and requests of the participants in the corresponding market are. The experience with trading



embedded software as a standalone product in the automotive industry is rather low. Some first experience was gathered in the context of the introduction of standardized OSEK<sup>5</sup> operating systems. The applied business model concepts, that were adapted from other industries did not show the expected success and put the software suppliers in a rather complicated situation.

As already mentioned the most important European participants in the automotive software business came together in the context of the ITEA-EAST project and analyzed the business requirements in a subproject called "Intellectual Property Rights and Commercial Issues". The main approaches applied in this subproject were surveys performed within the participating companies in order to evaluate their corresponding needs for the upcoming business models. The involved companies participated in the definition of the surveys (and by this in the identification of the most important issues) as well as in the following realization of these surveys.

The companies that are mainly driving the conditions and requirements in this business context are the vehicle manufacturers. The major findings regarding their needs and expectations will be presented in the following. In order to get a representative assessment of their needs various members of these companies were involved in the survey including technical persons but as well management and business representatives.

Considering the main objectives of the survey the various questions had to follow a certain logical flow. Firstly, it was important to clarify the motivation of and the value for a vehicle manufacturer to be involved in the development and trade of embedded software. Secondly the corresponding business position of the vehicle manufacturer had to be identified. E.g. whether he is interested in producing himself embedded software. Will he be involved in the trade of embedded software or is he considering that this is rather the task of the various suppliers? Depending on the result of these basic questions, further details had to be clarified. These are related to technical, organizational, financial, intellectual property, process and cooperation aspects. The basic structuring of the vehicle manufacturers survey was as follows:

- Motivation - reason why - value creator
- Business position

After this was clear:

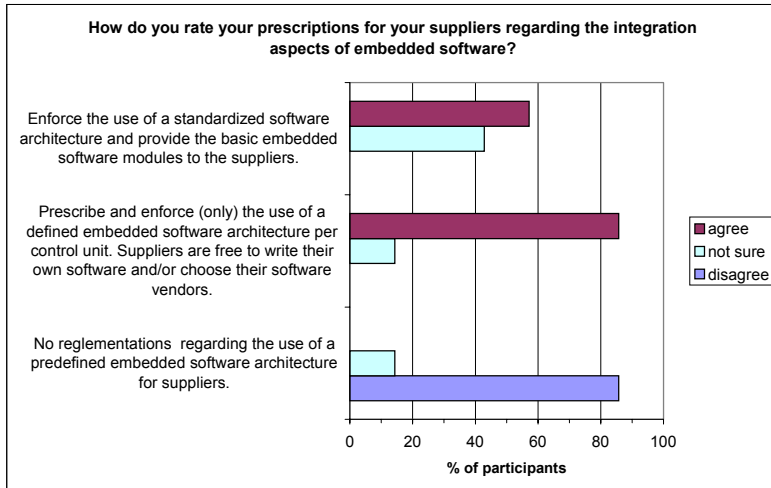
- Technical aspects
- Organizational aspects
- Financial / purchasing aspects
- Intellectual property (IP) related aspects
- Process aspects
- Supplier / partnership aspects

In the following some top findings of this survey will be presented. Starting with the motivation of vehicle manufacturers, they confirmed that they will participate themselves in all important activities regarding software components or would like at least to acquire the competences for specification, test and creation for embedded control systems processes. Their objective is to be able to take buy or make decisions according to their internal strategies.

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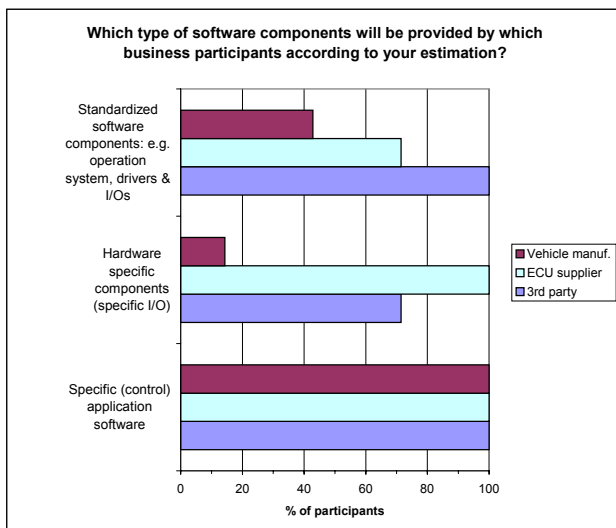
<sup>5</sup> OSEK is an abbreviation for the German term "Offene Systeme und deren Schnittstellen für die Elektronik im Kraftfahrzeug" (English "Open Systems and the Corresponding Interfaces for Automotive Electronics").

Figure 4 shows one of the findings concerning the business position vehicle manufacturers will adapt. Of very high importance are some forms of regulations in their relations with their suppliers.



**Figure 4 Prescription models for suppliers**

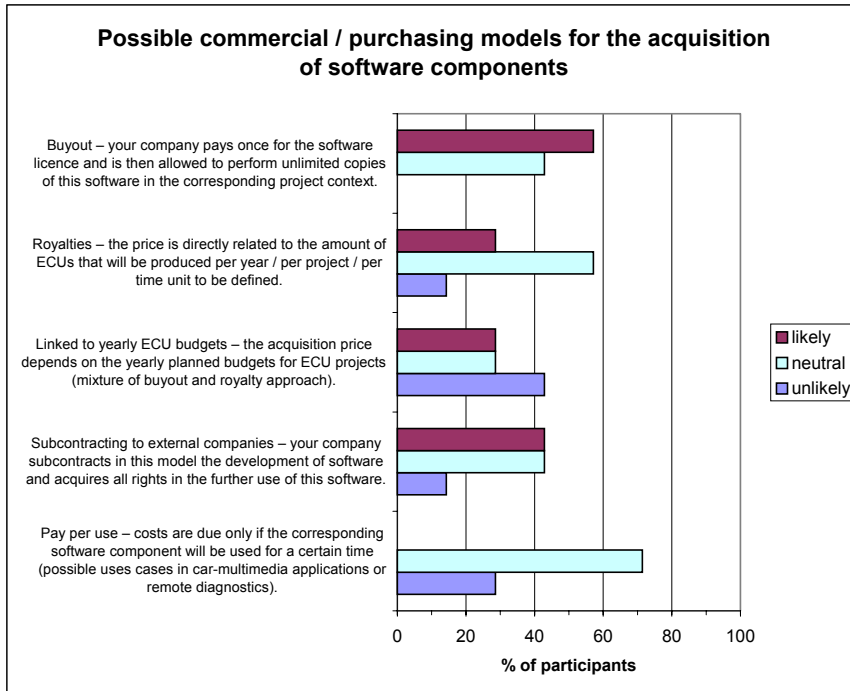
When looking more precisely at the technical aspects vehicle manufactures will mainly build software components in the application category but would like to be active as well in some further areas. Figure 5 shows the opinion of vehicle manufacturers concerning the responsibilities for providing different software component categories by the various business participants.



**Figure 5 Categories of software components offered by the various business participants**

Organizational aspects were considered as rather confidential and can not be presented in the context of this paper. Figure 6 gives some important indications about the interests of vehicle manufactures concerning commercial and purchasing aspects. The figures show that most companies are rather neutral concerning

these issues. However buyouts seem to tend in the direction of preferred models. According to the survey open source based business concepts seem to have little impact as possible business cases in the automotive industry.



**Figure 6 Commercial models for trading software components**

In the area of intellectual property related aspects vehicle manufacturers tend to patent protections and copyrights. Certification of software components and compliance with current and upcoming standards as well as standardized processes are the main issues concerning process aspects. Finally partnerships with clear responsibilities in business relationships are of very high importance for European vehicle manufacturers.

#### 4. Business models in general

The meteoric rise and fall of dot-com businesses during the past few years left markets reeling, analysts scratching their heads, and CEOs searching for answers. The most obvious candidate: bad business models. But what exactly is a "business model," anyway? No one ever defined the term precisely – it seemed to mean either "what we do" or "how we hope to make money someday" – but it always got tossed into conversations about new economy businesses (The HBR List, 2001).

The theory and literature about business models and pricing strategies is very generic. In order to apply them to the embedded software business in the automotive industry, a better understanding of some key concepts should be found. The term business model is very large. Several authors confirm this aspect in their work.





Michael Porter mentions in an article about "Strategy and the Internet": the definition of a business model is murky at best. Most often, it seems to refer to a loose conception of how a company does business and generates revenue. Yet simply having a business model is an exceedingly low bar to set for building a company. Generating revenue is a far cry from creating economic value, and no business model can be evaluated independently of industry structure. The business model approach to management becomes an invitation for faulty thinking and self-delusion (Porter, 2001).

Often confused are as well the terms "business model" and "strategy". People use them interchangeably to refer to everything — so they mean nothing. But no organization can afford fuzzy thinking about these fundamental concepts. A business model and a strategy are two different animals. One explains who your customers are and how you plan to make money by providing them with value; the other, how you'll beat competitors by being different (Magretta, 2002).

So what is now an appropriate definition of business models in this context? In general it can be said, that business models are the outline of all transactions needed to make a profitable business. Therefore they should be developed with all the stakeholders: shareholders, customers, suppliers, employees, financial institutions, government agencies, etc., regarding the most important business aspects. This most important business aspects concentrate on the following questions:

- Who are the customers
- What is going to be sold to them
- How to make a profit
- How do the customers decide to buy the product or service and to come back
- Why do customers buy and why they do not buy
- How to keep employees

Considering this various dimensions of business models it is quite difficult to find appropriate answers to all this issues. In the following considerations the focus will be on one important aspect of business models - the different commercial and trading models. However it has to be emphasized that the commercial and trading models are just one part of the general business models, even if in the day to day reflections the two aspects are often used (and confused) in the same context.

## 5. Types of commercial models for trading software components

As mentioned in the previous part of this paper, commercial models are one important aspect of business models. Some further expressions are often used in the same context and have more or less the same meaning: licensing models, pricing models, purchasing models, trading models and quite often the term business models in its reduced meaning.

In the past most often companies that used embedded software components have licensed technology on a project-by-project basis and for those vendors with a run-time royalty, negotiated royalty fees by project. Viewed as an industry over spanning problem, such commercial models have been described as complicated, full of restrictions and time-consuming.





Recently several providers of software components proposed new models with the intent of simplifying the way products are licensed. The trends to follow are standardization for embedded technologies, the leverage of technology investments corporate-wide, an increase of efficiency and cost reduction. As a result today users have more options when selecting embedded software solutions.

The today's available most important commercial models that can be applied for trading embedded software components can be structured as follows (non exhaustive list):

- Product packaging
- Classical software licensing
- Royalties
- Buyouts
- Development subcontracting
- Pay-per-use
- Subscription
- Time-limited (leasing)
- With indirect financing (free licenses, open source concepts)

In addition to this models - that are actually related to the acquisition of an initial right to use the corresponding software - special service agreements and update / upgrade possibilities are offered. One can easily imagine the variety of combination possibilities that result in the final business proposals.

The different commercial models will be described briefly in the following. The description will be accompanied by a short analysis of strengths and weaknesses of this various models.

Product packaging - the main characteristic of this commercial model is to group different products to one package, e.g. bundle the ECU hardware with some or all software components. It could of course be applied as well in the area of software only, e.g. bundle software development tools and software components. Major advantage of this approach is that it allows to respond to customer requests with a more or less complete solution. The biggest disadvantage is on the seller side, as it does not ensure a profitability tracking for the single products.

Classical software licensing - in this case a buyer acquires typically the right to use a software but not the actual product itself. There are various forms of use-case possibilities for software in question, e.g. for one product, for one person, etc., which have to be defined more in detail in corresponding contracts. Main advantage of this model is that the legal context is quite clear and it is widely used in the industry. The disadvantage is that this model is quite general and leaves some aspects (like the limitations in the use of software) unsolved.

Royalties - are actually a subtype of the classical software licensing model and refer to the financial parts of this approach. The rights for the use of the software are transferred as in the above presented model, the financing part itself is related to the amount of copies produced from the delivered original software. This model was used quite often in the past, especially outside of the automotive industry. Its disadvantage is the long negotiation needed to find a corresponding counting system, without putting the customers in the situation of a possible illegal use of software copies.





Buyout - the buyout model is as well a subtype of the classical software licensing model. In this case the right to produce copies from the acquired original software is not directly related to the amount of copies, but rather limited to a specific product group, department or eventually available for the whole company. The major advantage of this model is on the customer side as it is very flexible in its application. The problems are rather with the companies offering this approach as the price finding process is rather complicated. A special type of buyouts are site licenses.

Development subcontracting - in this case the development of a software component is financed by a customer in the context of an engineering contract. The customer typically acquires in this case as well all rights for the software in question. Relatively high costs are the disadvantage of this approach as the customer does not participate in the sharing of development costs that apply for the other models. On the other side he will get an absolutely customized solution that should perfectly fit his needs.

Pay-per-use - this model is rather unusual in the automotive industry, except for some cases in car-multimedia applications. The use can be applied to the actual activation of some software functions or to service functions that are enabled with the software in question. The biggest potential of this approach lies in its flexibility concerning the integration of various services - as done today in the telecommunication industry.

Subscription - the subscription model differs slightly from the models presented before as it takes into consideration as well software maintenance issues and future updates / upgrades. Customers pay a subscription fee every year and get access to all services and new versions of the software in question. The advantage of this method is that customers have at all the time the newest versions and bug fixes available. The disadvantage in the context of the automotive industry is with the financing possibilities that automotive customers currently have.

Time-limited (leasing) - this model is applied to some classical software licensing or buyouts models that are limited in time. Total cost reduction is the major advantage of this model - e.g. it could fit quite well in a time limited project context. The disadvantage is clearly the time limitation.

With indirect financing (free licenses, open source concepts) - in this case the actual software is offered for free - in source or object code form. The financing of development efforts has to be done via services or other related products. One disadvantage of this approach is the rather unclear responsibility in the use of this software.

## 6. Dynamics of business models

Even if one of the previously presented models should fit quite well to a specific business context or the current need of one's company, an important aspect of business models should never be neglected - most business models are not static. The technology on which they rest and the environments in which they operate continually change. The firms and competitors who design them, initiate or react to change. In responding to or initiating change to sustain or attain a competitive advantage, it is important to understand the nature of change so as to better take advantage of it in crafting and executing a business model.





Where that change is from a new technology, one of the first things to remember is that profiting from the new technology will take more than mastering the new technology. It also takes complementary assets. Imitable or not, being able to develop the new technology is important since many firms that fail to profit from a new technology, despite having complementary assets, do so because they do not know how to develop the new technology (Afuah, Tucci, 2003).

## 7. Conclusion and outlook

As a first conclusion it can be mentioned that for the automotive industry embedded software trading aspects are rather new and unusual. The typical business models in this rather conservative industry are based on the long-term experience in the classical automotive supply chain which relies mainly on the trade with material goods. The typical drivers in the automotive industry like the management of safety and environmental aspects, rather high production volumes, the high cost sensitivity and the ever increasing complexity of technical systems will finally determine which business models will be the most appropriate.

A further aspect that will have a major influence for the upcoming business models is the evolution of the today's rather unclear legal environment. Several important decisions were taken recently in the context of the general trade with software and intellectual property. These decisions together with the introduction of some new regulations (some already existing in the US market) will certainly change important parameters of current business models. The participants in the embedded software market are asking for some clarification in order to facilitate their business transactions.

Finally it can be mentioned that the increasing competition within the embedded software market and introduction of various business models have educated the users in the automotive industry in determining not only the most appropriate technology to acquire but also how much they will pay and how they want to pay for it. Whether one of the models presented previously will be successful in achieving standardization across the industry is yet to be seen as different groups wrestle with a "one size fits all" mentality in satisfying their technology needs.

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