Artop – an ecosystem approach for collaborative AUTOSAR tool development

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Abstract: A successful approach to develop and evolve complex technologies is to establish an ecosystem around such a technology. The AUTOSAR Tool Platform (Artop) builds on this idea of an ecosystem and adapts it to the automotive domain in the field of AUTOSAR tool development. This paper explains how this idea has been implemented with Artop.

Artop is an implementation of common base functionality for creating tools used in designing and configuring AUTOSAR compliant E/E systems and electronic control units (ECUs). The platform is jointly developed in an active community of AUTOSAR members and partners.

Similar to Eclipse, a well established open source ecosystem, Artop propagates an ecosystem that is based on four principles which are: (1) low entry barriers; (2) commercially friendly licensing; (3) clear technical focus; and (4) awareness for the competitive differentiators.

Essentially the Artop ecosystem takes the well known AUTOSAR mission "Cooperate on standards, compete on implementation" one step further to: "Collaborate on commodities – compete on differentiating implementations".

Keywords: Artop, AUTOSAR Tool Platform, AUTOSAR tools, Eclipse, open source ecosystem

1. Introduction

In the IT industry today a variety of successful ecosystems have been established around complex technologies to develop and evolve such technologies. Lately this has also been a strong trend in the field of mobile communications and operating systems with the appearance of ecosystems like the Open Handset Alliance (Android), Symbian or Moblin/Meego.
With Artop the concept of an ecosystem has been applied to the field of AUTOSAR tool development. The idea of such a tool platform was first presented at the European Conference of Embedded Real-Time Software (ERTS) in 2008 with a platform which was then called ADP [1].

The term ecosystem as it is used throughout this paper refers to a concept where the value of the products and services of the ecosystem participants complement each other. A requirement for such ecosystems is that common technologies and standards are used.

This paper will explain how the ecosystem approach has been realized with Artop. Section 2 gives an overview of Artop itself and the underlying AUTOSAR standard. Section 3 presents the Eclipse ecosystem and its influence on Artop. Section 4 explains the four main principles of the Artop ecosystem. Finally the current challenges and an example for the successful exploitation of the approach are described.

2. Artop and AUTOSAR

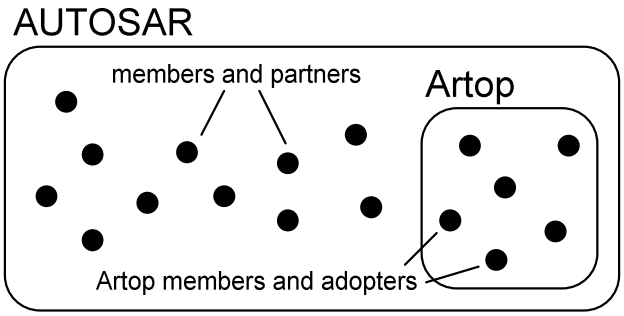

Figure 1: Relation between AUTOSAR and Artop

1.1 Artop and the Artop User Group

The Artop User Group is a group of licensed users of the AUTOSAR standard. It was launched in October 2008 and provides Artop, the AUTOSAR tool platform. Currently, there are approximately 500 registered individual Artop users from 120 different companies. It is run by the Artop Design Members which currently are BMW Car IT, Continental Engineering Services, Geensys and Peugeot Citroën Automobiles.

Some of the Artop Design Members are also active in the EDONA project [2] which had an influence on the technical background of Artop.

In addition to the contributions of the Artop Design Members more content of the platform is provided by the Contributing Members which currently are itemis, OpenSynergy and Tata Elxsi.

The third role of Artop User Group participants are the Artop adopters who consume the Artop platform but do not contribute back at this point of time.

1.2 AUTOSAR

AUTOSAR is a standardized software architecture for complex E/E systems. AUTOSAR has been launched by the automotive industry to handle the increased complexity of E/E systems needed to provide the functionality expected in modern vehicles. AUTOSAR defines standards on how to describe and configure software that runs on ECUs in the automotive domain. For the ECU description and configuration, formal models containing large amounts of data have to be handled by specialized tools.

The description of AUTOSAR systems is a multi step process that is described by the AUTOSAR methodology. Each step in the methodology involves the manipulation of the formal models which needs to be supported by an appropriate tool. Since each step operates on the same formal model, i.e. the AUTOSAR meta-model, there is a certain amount of commonality among the tools needed for each step.

Artop provides the common parts of AUTOSAR development tools that are outlined by the AUTOSAR methodology.

2. The Eclipse ecosystem as a blue print

Eclipse [3] is a prominent example of a successful ecosystem. It is an extensible open source platform for developing all kinds of software. It started as an IDE (integrated development environment) for Java programming in 2001 and through continuous extension and evolution it has emerged to a platform consisting of various open source frameworks for building almost every kind of software.

The Eclipse platform is provided under the Eclipse Public License (EPL), an open source licence that, in contrast to some other open source licenses like the GPL, allows users to build their software on top of Eclipse and commercially distribute it.

Eclipse was established in 2001 and from 2004 it has been managed by the Eclipse Foundation, a non-profit organisation that develops, hosts and maintains the Eclipse platform and drives an active open source community that is the basis of an ecosystem of complementary products and services.

The Eclipse Foundation has around 200 member companies, about 1000 committers and consists of more than 100 separate projects. It is estimated that Eclipse is used by more than 4 million developers worldwide.

Eclipse consists of many technology subprojects. One of them is the Eclipse Modelling Project, which supports model based development with powerful frameworks for graphical modelling, textual modelling, model to model transformations, code generation and many more which makes Eclipse the first choice in model based software development (MBSD). As AUTOSAR requires a lot of these modelling support features, Eclipse was predestined as a basic building block for AUTOSAR tools.

Eclipse also supports collaboration in vertical markets. Using Eclipse all players within one industry can work on one technical platform. This allows them to concentrate on their expertise and try to co-develop the rest, even if this means collaborating with competitors in that area. There are already working groups in Eclipse for the healthcare industry and mobile phone industry as well as others. An industry working group for the automotive industry is about to be founded.

The field of AUTOSAR in the automotive industry can also be seen as a vertical market and a corresponding ecosystem has been established by the AUTOSAR development cooperation. Even though AUTOSAR heavily depends on tool support the AUTOSAR development cooperation does not support the development of a tool platform implementation. This leaves room for an ecosystem approach for collaborative AUTOSAR tool development.

3. The Artop ecosystem principles

The Artop ecosystem approach is based on several principles which are crucial for the cultivation of a successful ecosystem and the attraction of a large community around Artop.

3.1 Low entry barriers

Artop is open to all AUTOSAR members and partners. That means Artop, including its source code, is available free of charge to the AUTOSAR community. Developers, engineers and other individuals in the AUTOSAR community can easily obtain Artop via the Artop website [4] after a simple registration step that is necessary to verify the AUTOSAR membership status. There is no extra formal membership or written agreement necessary

to use Artop besides the acceptance of the Artop software licenses.

Also the initial hurdles to participate in the development of Artop are low. Artop uses a transparent development process where all development artifacts like source code, bug reports documentation and build results can be accessed by all registered Artop users. This allows users to observe the development progress, to report bugs and feature requests and also to join development related discussions.

3.2 Commercially friendly licensing

The Artop software licenses (ASL) define the terms under which Artop can be used and distributed. It also defines how contributions back to Artop are handled. The licenses are modelled after the Eclipse Public License (EPL). Just like the EPL, the ASL allows the inclusion and exploitation of software developed by the Artop User Group in both commercial and non-commercial products. Separate Artop licenses are necessary to fulfil the terms and conditions of the licenses of AUTOSAR itself.

Since the ASL also regulates the contributions back to Artop it is also the basis for the collaboration in the Artop User Group. Essentially the ASL defines the terms that apply when a member in the Artop User Group contributes source code to Artop. Therefore the Artop User Group can easily accept contributions without additional regulatory steps.

The evolution and maintenance of Artop from a technical point of view, including feature expansion, increased quality and robustness, depends on the input by the users of Artop. To encourage such input the ASL asks licensed users to contribute modifications to Artop itself back to the Artop community. Of course this only applies to modifications and not to complementary additions or separate software modules that are shipped with Artop in a commercial product.

3.3 Clear technical focus

Artop and the Artop User Group was launched with a clear definition of the technical content of the tool platform. With this definition all members of the Artop User Group agreed on the technical direction of Artop and all development effort has been aligned to this direction.

A main aspect in the definition of the technical content has been the focus on *platform* functionality as opposed to *end-user* functionality. In the context of AUTOSAR tools the end-users are engineers that are directly involved with AUTOSAR-based system or ECU development. Platform functionality more precisely means APIs, frameworks and other infrastructure that tool developers need in order to build AUTOSAR tools for end-users.

In a different way the technical content [5] has also been defined to match the common needs of the different tools referenced by the AUTOSAR methodology. The basic common needs are: AUTOSAR meta-model APIs, AUTOSAR model XML serialization and workspace management. More advanced needs are support for model validation and different types of model viewers and editors, e.g. tree-based, form-based or diagram-based.

The development of a platform like Artop that is based on a collaborative development approach, is driven by continuously adding new contributions. Where these contributions can either enhance existing functionality or add new functionality. Basically each contribution has to be evaluated to determine if it is aligned to the technical content of Artop. This alignment ensures that the platform always provides a consistent set of features that is transparent to the Artop community.

The definition of Artop's technical content also helps contributors to plan their products as well as their contributions to the platform. More generally the Artop ecosystem participants are able to adjust their technical strategies to fit with the focus of Artop.

3.4 Awareness for competitive differentiators

As described in the previous section the technical content of Artop focuses on platform functionality. This has also been a consequence of the common understanding of the Artop User Group members that the competitive differentiator in the field of AUTOSAR tools is actually not the platform functionality.

An AUTOSAR tool differentiates itself with the value it represents towards the end-users, i.e. the AUTOSAR system and ECU engineers. Ideally this value is achieved with: (1) ergonomics and usability; (2) close support of the end-user's development practices and processes; and (3) finally mastering complex model transformations and processing steps. In the field of AUTOSAR examples for such steps are: (1) the creation of ECU extracts; (2) the system mapping; (3) RTE generation; and (4) even automated system generation. Also current series projects are often hindered by missing or incomplete integration to proprietary and non-proprietary backend systems and development practices used by OEMs and Tier-1s. For example:

- Integration with other frequently used exchange formats used for coding, diagnosis

and bus system design like CAF, ODX and Fibex.

- Integration with other engineering tools used for application development like Ascet and Matlab/Simulink.
- Coupling with other E/E description databases and PDM systems, that are often proprietary and OEM specific.

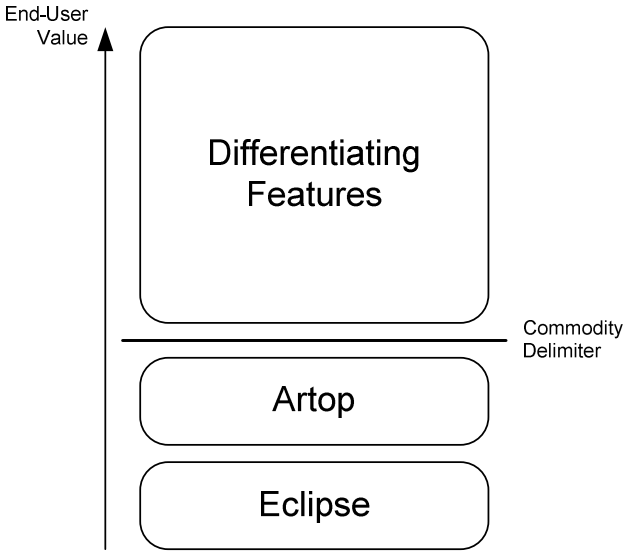

Figure 2: Distribution of end-user value

Since Artop provides the common parts of an AUTOSAR tool, the Artop ecosystem participants, like tool vendors and service providers, can focus their efforts on the mentioned differentiating end-user features. This is possible since the effort to develop the platform is shared among the Artop User Group members. Also the effort for the maintenance of Artop which heavily depends on the evolution of the underlying technologies is spread across many shoulders. The work to keep up with new versions of the AUTOSAR standard can be accomplished once in the community instead of several times in each company.

4. Challenges

In the previous chapter we showed the advantages of an ecosystem approach for AUTOSAR tools. Of course there are also challenges that need to be overcome.

4.1 Perception of commodity

The ecosystem approach builds on the thesis that a company should clearly define its core competencies and focus on that part and develop the rest of its product in a community approach. Of course the delimiter between commodity and differentiating feature is not a sharp line but can vary from company to company as well as it can move over time. Today's differentiating feature can easily become tomorrow's commodity.

On the one hand, this puts pressure on a company to constantly build new unique features that give their products an advantage over the products of its competitors. On the other hand, the rapid evolution of technology results in a constant need for new differentiating features which speeds up development and drives innovations.

This separation between commodity and differentiating feature is an important strategic decision. Artop attempts to provide guidance through a clear purpose and aim of the tool platform. However, the decision on what one should contribute to the Artop community ultimately rests with the contributing company. The decision consequently affects the success of a product and a company.

4.2 Different technical backgrounds

The decision to use an existing platform as a basis for a product or tool is quite easy if one starts developing a new product from scratch. One can simply evaluate candidates for such a platform and select the most suitable one from today's point of view. This is often the case for small niche products that are developed without a history.

But a lot of companies are already on the market with their tools for quite some time, which means they have already invested in their differentiating features as well as in functions that may be considered as commodity.

These existing solutions can be on a completely different technical background than Artop in terms of different programming language, different set of tools and libraries or simply different concepts for the realization of the base functionalities.

Of course the more an existing product differs from a considered platform in the technical background, the harder it to switch to such a platform. The "low entry barrier" is not that low in that case.

This does not necessarily mean that it does not pay to switch to a community platform. In general it still can be an advantage to consider changing the technical platform of a product to participate in development that is done in an ecosystem. Several large companies in the IT industry, like SAP [6] or Hewlett Packard [7] have announced that they successfully did so.

This is also true for some of the Artop members like Continental who switched their existing products to

Artop although some major changes to their technical platform had to be done.

5. Artop Exploitation

For Artop the benefits of an ecosystem do not only exist in theory. The investment into Artop is already paying off for the members of the Artop User Group and also for some of the other Artop adopters. Several commercial tools exist on the market that are based on Artop.

One example of such a commercial tool is Cessar-CT offered by Continental Engineering Services [8]. Cessar-CT has recently been migrated to use Artop. This migration goes along with added support for the new AUTOSAR 4.0 release. This support was not developed from the ground up but uses the existing broad AUTOSAR meta-model support in Artop. The example shows that a collaboratively developed, common base platform like Artop helps to keep up with the evolution of an underlying technology like AUTOSAR.

Cessar-CT is also a good example for another benefit enabled by the Artop ecosystem: tool interoperability. The end-user tools provided by Cessar-CT are focussed on specific development steps, which are basic software development and ECU integration. With Artop it is possible to tightly integrate other end-user tools with Cessar-CT, e.g. for application component development. Due to the nature of Artop this integration will be realized beyond the XML file level but on an in-memory model level which allows close interaction of the complementary integrated tools.

Another example of the exploitation of Artop is within the EDONA research project and by the commercial product AUTOSAR Builder from Geensoft. Here Artop is at the time used as the base platform for the research project and for a commercial tool. Within EDONA Artop is considered as the reference platform for all components that deal with AUTOSAR, e.g. timing extensions for AUTOSAR 3.0; or EAST-ADL2 transformer tools. AUTOSAR Builder realizes an end-user tool suite which is used in series projects. It includes among others, tools for application component development, for generic ECU configuration and for RTE generation.

6. Conclusion

In this paper we presented the approach of developing tools for AUTOSAR in a new way by establishing an ecosystem around a platform for these tools. We introduced the ideas of an ecosystem and gave an example of a successful existing ecosystem, namely Eclipse.

Artop is a similar approach for creating an ecosystem for AUTOSAR tools. We described the success factors for Artop, but also mentioned some of the challenges currently faced by the Artop designers and potential adopters.

Artop is already used in commercial products like Cessar-CT or AUTOSAR Builder. This indicates that an increasing number of companies are ready to exploit Artop as the benefits of this exploitation exceed the required effort. Also several other companies are already using Artop or are seriously investigating to adopt it.

We observe that the Artop community is growing. The more players decide to adjust their strategy to use the Artop platform, the more each individual company will gain from the expanding ecosystem.

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