
GENIVI
CHANGING THE IN-VEHICLE INFOTAINMENT LANDSCAPE
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THE MOTIVATION BEHIND GENIVI - THE NEED FOR CHANGE.

The investigation phase started in mid-2006, following the realisation that the delivery of increased functionality in automotive infotainment solutions, particularly in the area of device and services connectivity, was becoming unsustainable. The development and validation costs were spiralling upward as the amount of software required rocketed. At the same time, infotainment in the car had become important and a differentiator in the car-buying decisions. The successes of companies like Apple with its powerful developer kit and app-store model, Google with its connected services, and Personal Navigation Device leaders like TomTom created a situation where car drivers and passengers wanted to access the same functionality in their car. OEM Automotive infotainment had become a difficult equation to resolve, faced with the challenges of complexity and cost, aggressive competition from the consumer sector, and an apparently insatiable customer appetite for functionality in the car strongly influenced by the "high street".

At the heart of any automotive solution is the "headunit". This device is the most complex component in a modern automobile by software volume. In a high-end device, approximately 70% of the total code in a car will be in that single device. The headunit is no longer just a radio; it provides the logical interface between the car and consumer space. Increasingly, the functionality it delivers defines the user experience in the car. The environment created in the car is a key differentiator for the OEMs compared to aftermarket solutions, and it's not a domain that the OEMs can afford or intend to surrender.

The car and its infotainment use cases do not fit comfortably into any of the traditional consumer or IT categories. As a mobile device itself, it must function as a master for communication with portable consumer devices and as a client for connection to the cloud. It must avoid driver distraction through its ease of use; it must have the speed and reliability of an embedded device, but the rich user functionality and ecosystem support of a PC. At the heart of the answer is the middleware. The middleware provides the hardware and software abstraction for the applications whilst providing the services upon which the applications depend.

ACCESS TO AN ECOSYSTEM CAPABLE AND MOTIVATED TO SUPPLY APPLICATIONS AND SERVICES TO THE AUTOMOTIVE INDUSTRY.

BENEFIT

- Reduction in the cost of application and services development by licensing from available and relevant solutions.
- Increased innovation rate and feature content by tracking the consumer sector.
- Reduced time to market.

PRECONDITIONS

- A middleware solution must be created that meets the "automotive requirements" and at the same time provides a consistent target for a developer community, employing technology, tools and methods that are known to the target developer community.
- The volume of products using the middleware platform must be sufficient to incentivise the developer community.

ENABLE MULTIPLE COMPLIANT MIDDLEWARE SOLUTIONS AS THE BASIS FOR PRODUCT DEVELOPMENT.

BENEFIT

- Managed validation cost.
- Reduced software platform development cost.
- Commercial competition.

PRECONDITION

- A compliance programme is required to ensure the required compatibility between instances of the middleware solution.

The automotive infotainment middleware solution must effectively merge the feature-rich aspects of consumer products whilst preserving the enhanced quality and robustness requirements of automotive. Historically, automotive infotainment solutions are based on small real-time operating systems that are extended in an attempt to support the required functionality. This is a continually evolving target that leaves the industry constantly playing catch up. The problem is compounded by the fact that the industry exists within its own little bubble. Each participating Tier 1 develops complete solutions, competing at every level in the architecture to deliver relatively low-volume bespoke devices. The scale of the task is reflected in the required investment levels. Costs in excess of 100 million Euros are not uncommon for the development of a new Tier 1 platform.

THE PAST – THE ROAD TO GENIVI ALLIANCE LAUNCH.

THE INVESTIGATION PHASE - THE SEARCH FOR A SOLUTION

As you might expect, the search began by investigating the available software solutions and most likely candidates: Microsoft CE and QSS QNX. Something that became clear very quickly was that the solutions available in the open market were little more than operating systems. The necessary middleware was being produced by each of the automotive Tier 1s. Each middleware solution was different, although each was fundamentally delivering the same functionality. The differentiation was in the quality of the implementation, not in the base functionality. There were, at the time, attempts by some Operating System Vendors (OSVs)—for example, Microsoft—to move up the stack, but this remained only a partial solution and meant any Tier 1 that employed the middleware still had a significant amount of work to do to deliver a headunit product.

The scale of the software development necessary at the Tier 1 meant that even products built on the same middleware platform were very different; each required comprehensive validation, and there was not sufficient consistency to enable a developer community across the products. There was also a clear reluctance from the OSVs to extend their scope and reduce the required Tier 1 contribution.

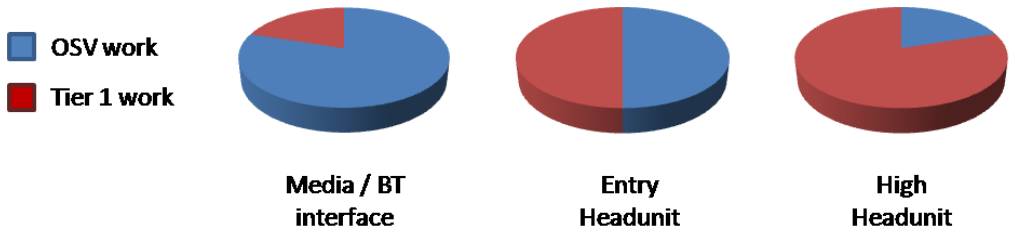

Figure 1 - Estimated OSV versus Tier 1 contribution within the current headunit development model.

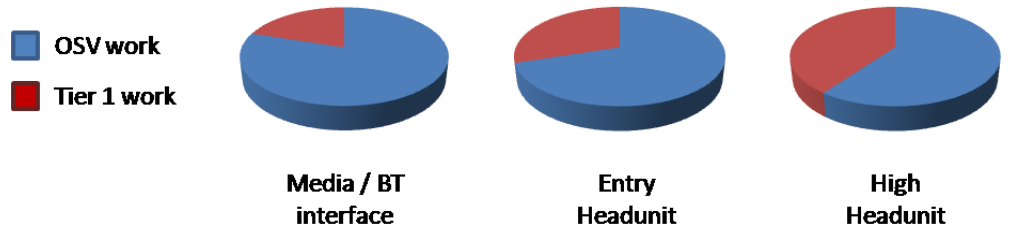

Figure 2 - Targeted OSV versus Tier 1 contribution for a GENIVI-based headunit development model.

The problem was compounded further by the inconsistency of requirements supplied by the Automotive OEMs. OEMs are unnecessarily different in areas that add no differential value for the car owner.

The investigation confirmed the original suspicion that there was no solution available that would meet the success factors we set out to achieve. Analysis of the available operating system and middleware options available in 2007 brought us to the conclusion that, particularly in the area of entry and high-end headunits, the OSV platforms where not rich enough and left too much of the implementation of "commodity" functionality to the Tier 1.

Coincident with our search, a new consumer-device category was emerging. The netbook has now become commonplace. This small footprint device is designed primarily as a device for consuming content and is intended to be always online. The device shares some striking similarities with the direction the car is expected to take. The car is, in the context of infotainment, also a consumption device. The primary purpose of the car is transportation; the data supplied by the infotainment system is used to entertain and to facilitate decisions that may need to be taken during the journey. The car and netbook are converging on display technology and a simplified approach to the user interface. The car also aspires to be always online. The delivery of the netbook necessitated significant developments of both silicon and software to enable a scaled solution. This scaling potentially brought the technology within the reach of automotive infotainment, and offered access to a new developer ecosystem. This was the point at which BMW and Intel joined forces to test the theory.

The decision was taken to turn the traditional model on its head, and to start with an operating system that was both consumer-product friendly and had the potential to scale across the target product portfolio from a connected radio to a high-end system. It was felt that adding the automotive enhancements to a "consumer OS" would present less of a challenge than repeatedly adding consumer enhancements to an

"automotive OS". The automotive domain is comparatively very stable and, therefore, much easier to maintain once established.

Drawing parallels from other industries like carrier-grade telephony, automation, and consumer electronics, it became clear that the use of open source and Linux had proven to be successful and had the potential to provide an excellent start point. A further significant advantage is the access to source code, which meant that initially it would not be necessary to convince anyone of the logic of the approach in order to realise it; the involved parties would be able to do what they felt to be necessary to achieve the required result. The question to be answered was: is the use of open source in the automotive industry a realistic option? The use of open source brings with it a set of challenges that are completely new to the automotive industry and its supply chain. A step in this direction would require a proof on many levels.

THE EVALUATION PHASE – THE VALIDATION OF AN OPEN SOURCE APPROACH.

Many consumer products are already available based on open source code: set-top boxes, TVs, portable media players, navigation devices, phones, routers, printers, and so on. In theory, the wealth of available open source code should provide an excellent springboard for automotive headunit development, but for a traditional industry like automotive to convince itself that open source is viable, a number of key technical and commercial questions must be answered.

The evaluation was conducted by engaging four companies as incubation partners for an A Sample development. BMW played the role of the OEM; Magneti Marelli, the Tier 1; Wind River, the OSV; and Intel, the silicon provider. This configuration was required to validate the new development approach. The outcome of the study would prove that the role of each of the players was different to that in a "normal" project, but nonetheless viable.

PARTNER ROLES:

BMW – in the role of the automotive OEM, supplied the requirements to be satisfied by the A Sample. The functional requirements took the form of 23 use cases, which targeted a combination of traditionally difficult consumer functions and automotive specifics. Within the project, the user interface for the device was delivered as binary code by BMW.

Magneti Marelli – in the role of the tier 1 was responsible for system integration, validation and application development. In addition, they developed the solutions for any OEM specific requirements and the glue code to the user interface and middleware.

Wind River – in the role of the OS + middleware supplier provided an early commercial version of the automotive platform and acted as the integrator of Independent Software Vendors (ISVs) code.

Figure 3 - The BMW A sample

Intel – in the role of the silicon vendor supplied the hardware reference and Board Support Package (BSP) upon which the A sample was based.

The traditional OEM to Tier 1 supplier relationship was maintained as it would be in a product development project. The Tier 1 is ultimately responsible for the headunit delivery, its functionality, stability, performance, and so on. The scale of the OS + middleware platform eliminated many tasks that would normally be carried out by the Tier 1 and consequently increased the role of the OSV—in this case Wind River. Wind River took responsibility for the pre-integration of the involved ISVs, while Marelli and Wind River worked closely to integrate the middleware exposing the platform services to the applications. Wind River and Intel worked to integrate the BSP into the OS and Middleware.

The project lasted six months and employed an average of 40 engineers. The engineers were spread across six countries. The use of PCs running Linux drastically reduced the need for target hardware as a development platform; the system integration was carried out using just two target benches. Over 3 million lines of code were delivered in the software release including the open source code used. The final number of features implemented and delivered was greater than originally requested. This must be a first for an automotive headunit development project!

The project set out to test the technical and organisational feasibility of developing a headunit base on open source code. The results exceeded target expectations whilst at the same time highlighting that the true potential of the approach could only be realised if it were to be adopted as a broader industry approach. It was felt that the development of a headunit based on open source code was clearly possible, but the use of Linux could only be justified based on a common platform implementation that would provide the pull required to incentivise the application providers to develop against the platform. The target was not simply product development, but to enable the creation of multiple differentiated products on the basis of a common middleware core. The middleware core would be the key to accessing the ecosystem required by the automotive industry.

The incubation partners recognised that in order to take the approach further, more like-minded companies were required. It was no longer logical to continue in the small group; the proof of technical concept and business model had been tested as far as it was possible. It was time to form the GENIVI Alliance.

THE PRESENT – GENIVI ALLIANCE FORMATION & EARLY ACTIVITY

WHY CREATE AN ALLIANCE?

GENIVI was launched to serve three primary purposes:

1. To provide the forum within which the required **critical mass** would be established. The product demand is necessary to kick start the approach and create momentum behind the alignment of the ecosystem.
2. To host the **technical programmes** within which the open infotainment platform would be developed, maintained, and promoted and its users protected.
3. To establish a **compliance programme** that would enable GENIVI-based products to be obtained from multiple open source and commercial sources.

CREATING CRITICAL MASS AROUND GENIVI

Infotainment in the automotive industry is unnecessarily fragmented. Each OEM and Tier 1 competes at each architectural level producing proprietary solutions. No single OEM or Tier 1 is influential enough in the consumer space to attract application developers to their proprietary solution. Collaboration between influential OEMs and Tier 1s has the potential to establish an infotainment platform that has sufficient volume to motivate consumer-space developers, especially when the platform is using technologies that they are familiar with and have direct access to. For GENIVI to be successful, it must become an influential body in both the automotive and consumer spaces.

This need resulted in the unique organisational set-up of GENIVI. GENIVI is both an open source project and a standards body. To connect to the consumer industry, GENIVI will participate in and contribute to open source, adopting, adapting, and creating code. To gain credibility within the open source community, the Alliance must build on the significant open source contributions of some of its members (i.e. Intel in PC industry, Nokia in mobile devices, ISVs in popular applications). GENIVI must build relationships with established open source organisations (e.g., The Linux Foundation) and projects (e.g., MeeGo).

To maintain connection to the automotive industry, GENIVI will collaborate with established automotive alliances to ensure the integration of their specifications through code. GENIVI members will only specify and create code where they have sufficient influence or control and it is logical to do so. This pragmatic "re-use" approach means that GENIVI members will build the platform from existing software components and standards, only creating or modifying code where it is necessary, and thereby drastically reducing the scale of the task. The approach means a strong dependency on both open source and the relevant standards bodies.

GENIVI IN OPEN SOURCE.

To succeed, GENIVI must work effectively with the open source community. Open source will provide the vast majority of the code and functionality required within the platform. The GENIVI operation principal is defined by three terms that must be used consistently within the Alliance.

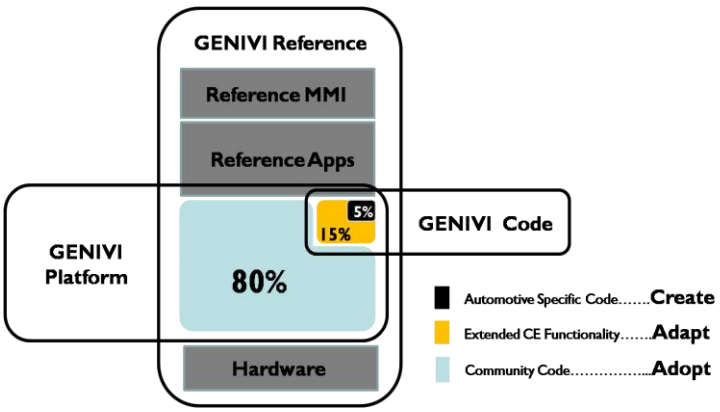

Figure 4 - Adopt. Adapt. Create.

GENIVI Code – this is the code that is either *created* by GENIVI as an original piece of work or is taken from open source and *adapted* to meet automotive requirements. Code will only be specified and/or created were it is necessary to do so because it doesn't already exist in open source. Examples of this in GENIVI v1.0 are in the area of automotive networks—for example, AUTOSAR, MOST. Code that is adapted is ideally "upstreamed" to the mainstream maintainer, so that the modifications adopted in the broader open source community, and no longer need to be maintained separately by GENIVI.

The use of the adapted code in mainstream open source would mean that applications developed using the code would inherit the automotive functionality introduced by the GENIVI members. An example of this in GENIVI v1.0 would be the indexing engine. In this example, Tracker (from the open source project Meta Tracker) has been enhanced to support automotive requirements. The patches currently reside in the GENIVI repository and will be offered to the upstream maintainer for inclusion in the mainstream project. If successfully integrated upstream, the new version of the component would satisfy the requirements of both user groups.

GENIVI Platform – GENIVI is not a distribution. The addition of "GENIVI Code" to a distribution creates the GENIVI Platform. The GENIVI Platform can be created in either an open source or commercial context, depending on the distribution selected. For the first open source incarnation of the GENIVI Platform, the open source GENIVI Code has been integrated with the MeeGo distribution to create MeeGo-IVI.

GENIVI Reference – the GENIVI Reference is the method employed to showcase the GENIVI Platform within open source. The intention is to enable open source and commercial developers to access GENIVI Code via an integrated open source headunit. This is the basis upon which we plan to build the required ecosystem. The GENIVI "headunit" with integrated reference applications and a GENIVI user interface can be modified and enhanced by the developer community without GENIVI intervention. The goal is that they will enhance the reference and offer the results to the Alliance and its members, either via open source or by commercial license for product development.

For GENIVI to benefit from the open source community, it must be present, and, therefore, much of the Alliance operation must take place in open source. For each technical programme that GENIVI sponsors, the Alliance must decide whether it will be hosted as an open source project or as a GENIVI member project. By restricting access to the GENIVI members, we enhance the value of membership but deny access to the broader ecosystem. This balancing act will be governed by the Board of the GENIVI Alliance.

GENIVI IN AUTOMOTIVE

The automotive industry is historically specification-based. If an OEM requires something, they will specify, tender, and nominate the product. This model works if the group specifying is in control of the required functionality or technology, and knows what they need. Unfortunately, for automotive infotainment, this cannot be the case. In future, an automotive infotainment solution must be based on an integration of the best in the consumer sector (derived from open source) with the best in automotive. This means that the GENIVI Platform must enable the use of the output from the successful automotive alliances—for example, AUTOSAR, MOST, CE4A. These alliances have focussed on automotive requirements and resolved them to a specification that meets the needs of the involved community. In the automotive context, GENIVI is the logical basis upon which to convert the specifications to code. In terms of its network and diagnostic behaviour, it is important that an infotainment headunit is AUTOSAR compliant. To enable this, the GENIVI Platform will provide the glue code that enables the integration of AUTOSAR specified modules and an implementation of the modules themselves. The challenge to be addressed is how to manage the policies surrounding the AUTOSAR intellectual property (IP). The GENIVI solution is to manage the potentially conflicting philosophies via the companies that are active in both alliances. For example, BMW as a member of both GENIVI and AUTOSAR has access to the assets of both organisations. BMW, along with other AUTOSAR members, is able to prepare the GENIVI Platform to receive AUTOSAR code, and able to provide an implementation of the AUTOSAR modules that will be used in an infotainment solution. BMW is

able and willing to make the modules available to other AUTOSAR members so that they can integrate the modules into their instance of the GENIVI Platform. In this way, the industry will be able to benefit from GENIVI / AUTOSAR collaboration without compromising the IP obligations of the member companies. The disclosure of specifications will continue to be managed by the originating alliance, and, as they mature from private to public specifications, the specifications will become available to a broader audience.

GENIVI TECHNICAL PROGRAMMES

GENIVI is primarily a technical alliance. The **Strategy Council** and its working groups are intended to facilitate the creation of the technical platform by providing planning, process and legal support functions to the Technical Council.

The **Planning Working Group** co-ordinates the identification, description, prioritisation, and realisation of the stakeholder needs. The stakeholder needs are the customer-based requirements that will be reflected in the *GENIVI Reference*, and that must be supported by the *GENIVI Platform*. These needs will describe the functionality that will be supported by subsequent GENIVI Code and GENIVI Platform releases.

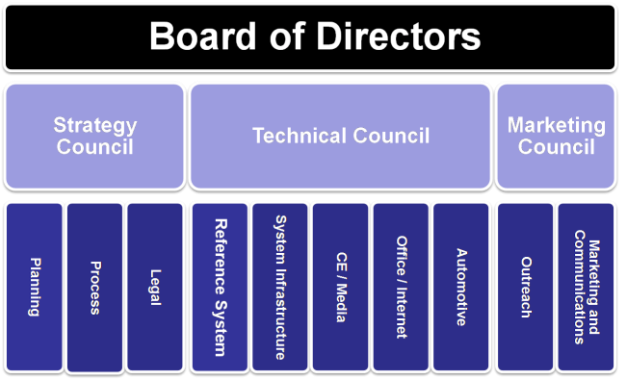

Figure 5 - The GENIVI Alliance Structure November 2009

During the definition of the Stakeholder needs, the Planning Working Group will define the "commodity" element that any OEM / Tier 1 would expect to see in a modern headunit. The headunits are catagorised into four profiles, ranging from a high-end solution to a telematics device. The initial activity is targeting the entry nav profile. This is the first point at which the group will attempt to remove and resolve any unnecessary inconsistencies between the OEM Tier 1 participants. The Planning Working Group will project manage the delivery of future GENIVI Alliance releases and manage any technical contracts awarded by GENIVI.

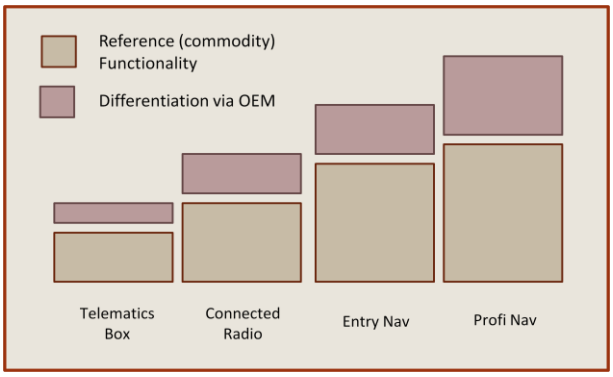

Figure 6 - GENIVI headunit profiles

The **Process Working Group** is defining the processes and development methods to be applied across the Alliance. The GENIVI Component Development (GCD) process provides step-by-step guidance for all GENIVI members involved in the technical development.

The **Legal Working Group** ensures that the Alliance remains compliant to intellectual property and licensing policies. The group has defined the incoming and outgoing licensing policy for the Alliance and the release procedure for the GENIVI Code. The group will provide support for the technical programmes and for the GENIVI Board prior to the release approval of GENIVI Code.

The **Technical Council** provides the technical governance for the GENIVI Alliance. The Technical Council provides the interface between the Planning Working Group and the working groups of the Technical Council. The Technical Council defines and maintains the GENIVI system architecture and facilitates the decomposition of the stakeholder needs to use cases and software platform requirements. With the support and guidance of the Technical Council, the working groups will propose technical solutions to meet the software platform requirements. This is where the adopt-adapt-create philosophy of GENIVI is brought to life. *Adopt* identifies the open source components that will become part of the GENIVI Platform. *Adapt* and *create* define the activity necessary to produce the GENIVI Code and make the platform automotive compliant.

Once the GENIVI Code is defined, there are three ways to provide a code implementation. Ideally, a GENIVI member company will take responsibility for the implementation of the specification. This activity will take place outside of the working group with the resulting code being delivered back to the group for review, test and approval. If a member company is unable to take on the implementation task, then the Technical Council will seek to place an external implementation contract via the Planning Working Group. More than 70% of GENIVI Alliance funds are identified for such implementation projects. The third route is for an OEM to take on the implementation task as part of a product-development programme, the code being returned to GENIVI after completion..

The first new working group to be added since the launch of the Alliance is the Reference System Working Group. The charter for this group is quite different to the other working groups. The Reference System Working Group acts as GENIVI's virtual Tier 1, integrating and testing the code adopted, adapted, and created via the other working groups to create the GENIVI Platform. This group will construct the GENIVI Reference, collaborating with other open source projects and distributors and commercial ISVs to add applications and a reference human-machine interface (HMI). As the number of hardware references supporting the GENIVI stack expands beyond the Atom-based Russelville, the Reference System Working Group has the important task of demonstrating the GENIVI Platform across multiple hardware architectures. This will be achieved by the Technical Council ensuring the consistency and applicability of the software components it identifies or creates.

CONCLUSION

The GENIVI Alliance has taken great strides in its short history. It already has presence across the automotive industry and increasingly in the consumer space. Its rate of growth continues to validate the logic behind the approach that GENIVI represents. As GENIVI matures, it must consolidate its position by addressing the challenges outlined within the body of this paper. The growing strength of the GENIVI community and the diversity of its members mean that each of the challenges can be overcome through continued collaboration and a strengthening of the links to both open source and automotive alliances. Much of the organisational ground work is complete and, as the GENIVI Alliance enters its next phase of evolution; its members will determine the direction and rate of development.

For more information or a listing of current GENIVI Members please go to: www.genivi.org.

Founded by BMW, GM, Intel and Wind River, plus several other charter companies, today's GENIVI membership crosses all levels of the automotive electronics supply chain including key innovation leaders. Over 75 members are active in the alliance as of August 2010, just 15 months after launch.