

## High Quality System Integration

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### Introduction

Systems integration of infotainment systems continues to be a big challenge. The MOST standard has contributed, in no small way, to highly structured design and development and implementation according to the principles of a distributed network. Therefore, tools and processes for successful implementation are on a high level, today. Practical experience shows, however, that there is room for improvement as far as coordination of validation by car manufacturers and suppliers is concerned. In this paper, we shall present a critical evaluation of the current situation and show how issues can be resolved in a very practical manner and integrated into the current systems integration landscape, even in the short-term.

### Systems Integration - State-Of-The-Art Today

#### From A Supplier's Perspective

Nowadays, suppliers are more or less free to decide on implementation issues of required functionalities of control devices. This is mainly due to the fact that rapid prototyping and automatic code generation can only be partially combined with increasing complexity of multi-media control devices, and even then it is difficult to achieve. Detailed specifications which display requirements of car manufacturers in a sufficiently detailed manner have only been available more recently and have since been requested more often. A problem for suppliers is the absence of guidelines on how to provide evidence for implementation of the required scopes. This is not only true for applications but also for network functionality. It is often the case that while a lot of effort is put into development and validation by suppliers results do not conform with requirements by car manufacturers. Therefore subsequent improvements of essential functionalities are necessary, at a relatively late point in time. These subsequent improvements block developments of higher layers which would have been envisaged for that particular point in time.

Since suppliers are always at risk that their efforts are not recognized by car manufacturers and that they are faced with unexpected requirements and acceptance criteria it is not surprising that suppliers tune down their initial efforts and instead wait for the reaction of car manufacturers at the time of the first acceptance test in order to make improvements at that point in time.

Due to an increased emphasis on cost reduction validation measures are being reduced during early phases and errors are neither evaluated nor corrected until car manufacturers have detected these errors and requested remedy. If it is possible to redefine any remedial measures as a change request this may be beneficial in terms of cost-efficient work within a supplier's company but it is not consistent with high quality of a developed device and is therefore not in the interest of the end customer.

#### From A Car Manufacturer's Perspective

Currently, a car manufacturer cannot rely on the performance of a supplier without verification but has to make a significant investment to ensure validation of control devices. Validation also affects areas which do not necessarily contain the special scopes of car manufacturers but are contained within the network layer of MOST implementation. Reports by suppliers on validation scopes that were performed provide an overview of work done but do not provide an instant indication of the

quality of any supplied control device. This is why many essential test scopes are developed, performed and evaluated by car manufacturers, tying up valuable time of MOST systems integration experts. Beginners' mistakes in control devices supplied can lead to very late completion or non-completion of really important tasks of systems integration.

**From A Test House Perspective**

Currently, test houses support systems integration processes at the level of MOST compliance verification. Compliance verification constitutes an important part of ensuring network functionality and interoperability. However, it has only affected a small part of systems integration tasks so far. In order to deliver quality in terms of compliance verification and ISO 17025, test houses have gone to great lengths to develop an infrastructure, which often goes beyond what car manufacturers' and suppliers' test systems can deliver in terms of accuracy and reproducibility. Currently, test houses are only rarely given tasks beyond compliance processes. Test house expertise is often not taken seriously and compliance is often regarded as an inconvenient and bothersome issue. The reasons for this are often to be found in the costs involved and the mentality of suppliers to keep their cards close to their chests as well as a lack of confidence that test house expertise may also be valued by car manufacturers. This leads to test houses maintaining a cost-intensive infrastructure albeit with rather low capacity utilisation and insecure perspectives. The costs incurred have therefore got to be added to test orders. As a result, there is a lack of synergy effects.

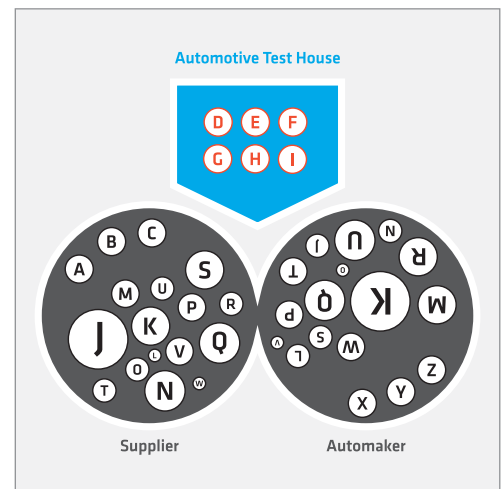


Fig. 1

System Integration State of the Art [Fig. 1]

**Vision**

Everyone focuses on their core task.  
Car manufacturers specify function scopes and check successful implementation.  
Suppliers develop control devices rather than specifications or test tools.  
Test houses concentrate on error recognition and support car manufacturers and suppliers with their know-how, with test specifications and tools.

Vision: Outsourcing of System Integration Testing [Fig. 2]

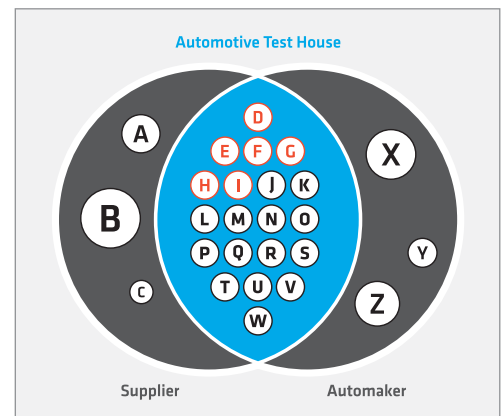


Fig. 2

**What Needs To Be Done To Achieve This?**

Firstly, we should not count on revolutionary structural changes taking place and therefore appropriate measures are required within today's structures or measures which constitute simple changes in the distribution of roles. There will always be pressure on costs for suppliers with simultaneous pressure on increased functionality. Whenever more functionality is requested without any regards to quality assurance, errors are produced which customers can subsequently see.

In order to improve the current situation the following measures are important:

**Definition Of Suitable Interfaces For Validation**

Clear communication not only in terms of requirements but also on acceptance criteria. Typically, this means that car manufacturers define their requirements and additionally request how completion of these requirements should be proven. Car manufacturers can check levels of implementation of a supplied device with appropriate documents / test reports. The test house helps with error recognition by employing appropriate, coordinated methods.

Car manufacturers and suppliers need to agree clearly which scopes should be implemented and how realisation of these scopes can be tested. Confidence in a supplier will only come about, in practice, if car manufacturers prescribe test processes to suppliers or at least have detailed knowledge of these and are able to comprehend the results. Experience shows that you cannot get around a detailed definition of test sequences. It is equally important to have a transparent test reporting system which will also give information on resilience of a control device.

### **Choosing Important Test Scopes And Making The Right Choices**

One quickly gains the experience that it would be too much effort to apply all kinds of possible tests for acceptance of a control device or an entire on board supply system. Even in chip production you no longer have a 100% test coverage since the effort involved, these days, would not justify the outcome.

It is therefore important to concentrate on the essential test sequences only, which can render a high error rate while involving a comparatively small effort. In the same way, defined test scopes should cover the requested requirements based on the stages of construction.

### **Standardisation Of Test Scopes**

In 10 years of MOST technology, many concepts and strategies have emerged to enable all but perfect validation. At the same time, many different varieties exist not only as far as different car makers are concerned but also with different suppliers. It is now time to evaluate these test scopes, to categorize them and to integrate them into one standard. Compliance test specifications are certainly a good basis for achieving this, even if these can only be a starting point in many ways.

### **Maintenance of Test Scopes**

Of course, systems will evolve over time and this is particularly the case for the world of infotainment for cars. In order to provide adequate validation for development, new scopes need to be taken into account as well as new findings. And the most important findings are made by testers. Minimal modification or combination with the right stress scenarios can give rise to surprising progress in error recognition rates. In order to make these findings known, testers have to be motivated and have to have the opportunity to give feedback in an uncomplicated fashion. This is particularly true for the role of suppliers.

### **How To Go About It?**

#### Application Recommendation

Application Recommendation for Core Compliance (see MOST Intranet) is an important step towards standardised procedure in defining test scopes and test reports. It defines necessary interfaces in form of test specifications. Test evaluation and test reporting: It defines processes such as how requirements can be displayed in test sequences and in this context it also collects test scenarios independent of particular car makers.

Application recommendation has already yielded results in the area of physical layers. Scope core is still at the beginning and refers to the testing of individual control devices, for now. In the medium term, application recommendation is certainly expandable to systems integration and application issues.

### **Executable Test Specifications**

Experience from projects and from compliance specifications work has shown that where specification is solely done at a document level, the display does not show sufficiently fine details which consequently leaves too much room for interpreting data. This was one of the reasons for switching from flow chart to MSC in core compliance specification. But even with MSC there is not always enough transparency. Above all, there are shortcomings in the specifications process which are due to the fact that tests are firstly developed on paper and in theory. First findings are gained quite late during implementation or test execution. Improvements are made at a late stage and are therefore difficult to plan. A solution is an executable test specification in form of a GFT, based on the test language TTCN-3. A theoretical design of a test sequence in a graph format can

be quickly realised and tested against a control device or a simulation. Since the test itself can be displayed as GFT, findings from practical experience can be integrated into the specifications phase.

### The Test House As An Independent Authority

It is first and foremost in the interest of a test house to find the largest possible number of errors in the most efficient way. Compared to the interest of suppliers, who want to integrate as many features as possible into their control devices while keeping development costs as low as possible, a test house can focus its efforts on a standardised test process with corresponding tooling and a high degree of automation and a high error recognition rate. Furthermore, a test house can support car makers in providing highly efficient and transparent validation. Success can be easily read off the key numbers which are part of the test reports.

## Benefits

### Cost Reduction

The most important test scopes can already be realised by suppliers, with the support of test house expertise, as the case may be. This leads to recognition of more errors at an earlier date.

Cost structures for the development of tests can be minimised by synergy effects such as standardisation independent of car manufacturers, good capacity utilisation, support for suppliers and rollout of test tooling to suppliers.

Test solutions can be standardised. Not every supplier needs to develop his own test tool, in order to cover validation scopes.

### Outsourcing Of Testing

In future, car manufacturers can concentrate on specifying function scopes and monitoring of developments. Validation can concentrate on sensitive issues of systems integration and provide quality assurance at the highest level.

### Greater Transparency For All

Suppliers: Will gain a better understanding of which mistakes they have made, what car makers are really interested in, and their problems will in turn be better understood by car makers. They will not have to invent large parts of the test scenarios and test tools but can buy in this service and / or supported tooling.

- Car Manufacturers: Can concentrate on their main task in systems integration.  
Will be able to trust suppliers more.  
Will have independent experts with clear key figures on error recognition rates.  
Will have a transparent overview of the state-of-the-art of technologies.  
Can place test orders in a cost-efficient way.
- Test Houses: Will be taken seriously and will no longer be seen as a necessary and expensive evil and will no longer only be consulted in the context of compliance testing when their expertise is absolutely indispensable. They will be able to participate fully in an ongoing process of maturation, which is very important for acceptance of MOST.
- MOST Technology: Efforts for standardisation will result in greater interoperability and will therefore generate a competitive advantage against competing technologies.

MOST Technology will again be seen as a module which can be integrated into the development of a control device without much effort and can now be validated at a high level.

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