Home Office

One Box: Single Vehicle Architecture
Test Protocols

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Contents

Introduction

Purpose

The purpose of the document is to define a set of test protocols which enable the verification of the Single Vehicle Architecture (SVA) system requirements.

This document should be read in conjunction with the SVA System Requirements [Ref 1] document which provides references to this document defining the intended test protocol to be used to satisfy each system requirement. A cross reference between the test protocols and the system requirements they satisfy is also provided in Appendix 1.

The test protocols provide high level guidance on a test use case for each system requirement. They are not designed to provide a list of proposed test equipment or define detailed test procedures as both of these should be developed as part of a SVA test methodology.

The Home Office would like to thank MASS Consultants Ltd and ACPO ITS for their work in developing this document.

Document Structure

This document is divided into the following sections:

- Section 0 – Introduction: Description of the document, its intended purpose and an overview of the SVA.
- Section 0 – Test Planning: Aspects to consider during the test planning process.
- Section 0 – Test Protocols: Detailed description of the test protocols required to verify the SVA system requirements.
- Appendix 1 – Test Protocol to System Requirement Cross Reference, detailing which system requirement is satisfied by each test protocol.

SVA Overview

The SVA is part of the One Box programme being run by Home Office CAST to develop a vehicle communications architecture to support emergency service equipment required by emergency service vehicles, while improving user efficiency, maintaining vehicle re-sell value and ensuring occupant safety. The SVA consists of a number sub-systems and communication networks which fall into the following SVA elements:

- Power management;
- Local Area Network (LAN);
- Emergency Services Controller Area Network (esCAN);
- RF Network cabling;
- esCAN control systems, if applicable (intelligent CAN nodes);
- Human-Machine Interface (HMI) (Emergency Warning Control Panel, Non-critical Controls)

The context of the SVA is shown in Figure 1.

The main objectives of the SVA are to:

- Provide a standardised in-vehicle power, control and communications infrastructure required by emergency service equipment;
- Improve user efficiency through the use of standard interfaces and controls;
- Ensure the SVA does not compromise vehicle occupant safety under any circumstances;
- Maximise emergency vehicle resell value by minimising the vehicle modifications required during SVA installation.

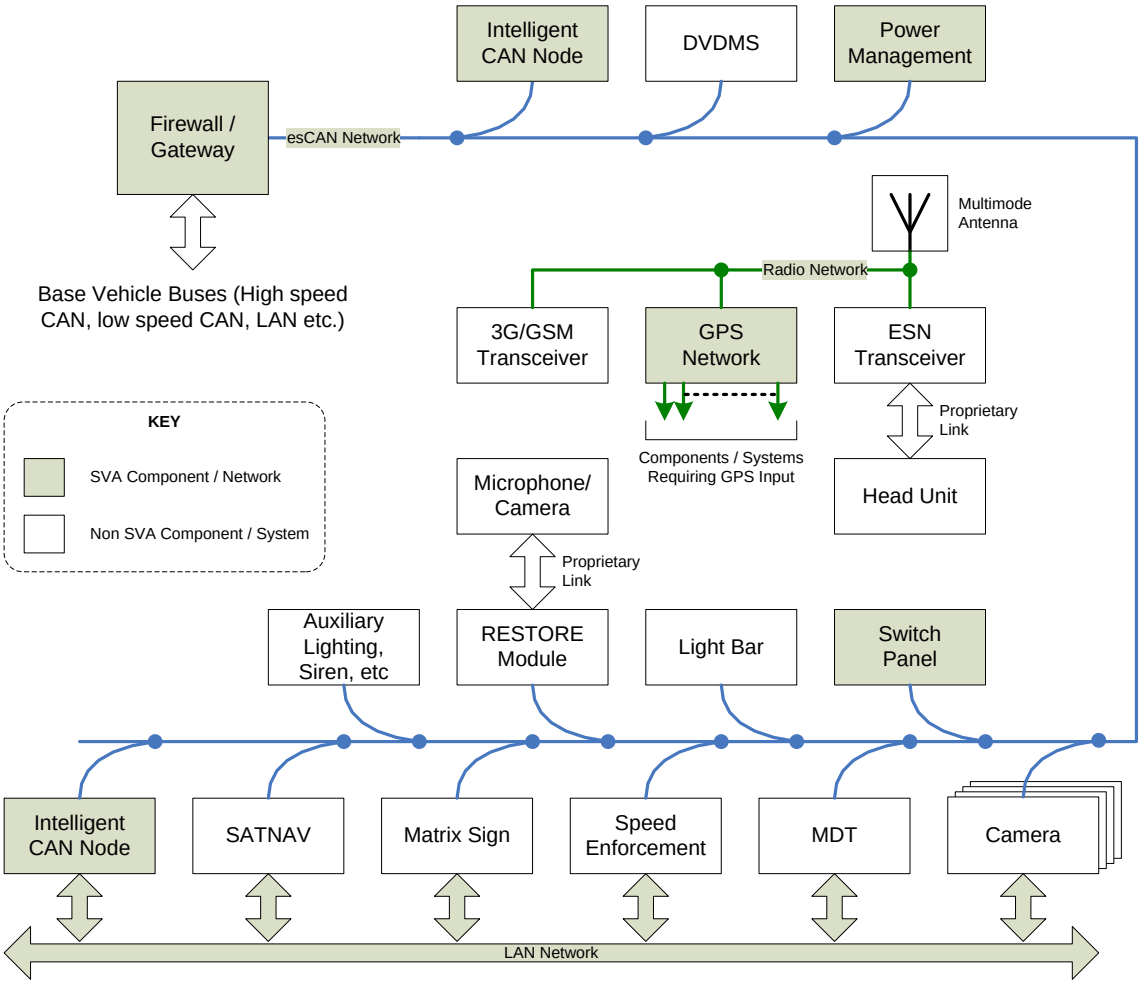

Figure 1: Single Vehicle Architecture Context

Key to Test Protocol Diagrams

For the block diagrams contained with section 0 of this document the following colour coding key applies:

- Test functions are represented in blue;
- Users or test operators are represented in green;
- The unit under test(s) is represented in grey;
- Organisations required for the test protocol are represented in red;
- Existing systems required for the test protocol are represented in purple.

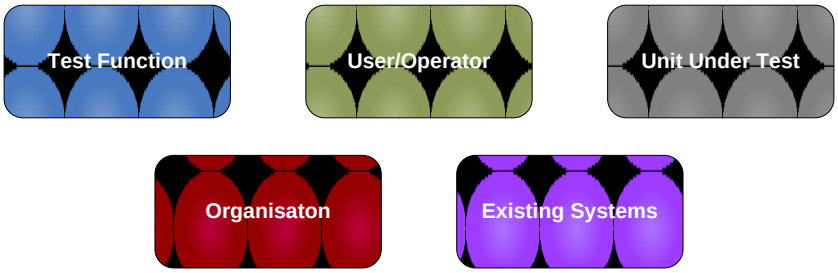

Figure 2: Colour coding key for block diagrams

References

[Ref 1] CAST Publication 25/14
SVA System Requirements

Glossary of Terms

3G	Third Generation
CAN	Controller Area Network
CAST	Centre for Applied Science and Technology
DVDMS	Driver and Vehicle Data Management System
EMC	Electromagnetic Compatibility
ENV	Environmental
esCAN	Emergency Services Controller Area Network
GPS	Global Positioning System
LAN	Local Area Network
MASS	Mass Consultants Ltd
OEM	Original Equipment Manufacturer
SVA	Single Vehicle Architecture
WiFi	Wireless Fidelity
VCRI	Verification Cross Reference Index

Test Planning

Once a requirement to test has been identified the test planning process should begin. This is of the utmost importance. A Functional Test Specification detailing: the tests to be carried out, the test environment, pass and fail criteria for each test and the equipment under test, should be produced. The Functional Test Specification will dictate the order of the tests, the configuration of the equipment under test and how the tests shall be carried out.

Testing will rigidly follow the Functional Test Specification. No testing outside of the specification will be carried out, but the order of the tests can, with the agreement of the Test Director and Observers, be changed if it is deemed to be beneficial and non disruptive to the overall process.

The following provides more information as to the sections that should be included in the Functional Test Specification.

Test Environment

The test architecture should be included, to show the relationship between the test equipment and the system under test. A description of the architecture and in particular its' connectivity requirements, should also be provided.

The personnel responsible for carrying out the tests should include as a minimum:

a) Test Director;

b) Test Operator(s);

c) Test Observer(s);

It should be assumed (and encouraged) that a representative from the User Organisation will be present during some of the testing to act as additional independent observers.

Schedule of Testing

These should include where possible and applicable:

- Date of test;
- Time of Pre Test meeting;
- Time of first test;
- Test finishing time;
- Post test wash-up meeting;
- Analysis and reporting dead lines, and where necessary date of discussion meeting;
- Outcome decision deadline;
- Date of test report meeting.

Test Identification

This should describe the total scope of the planned testing and the items to be tested. The items to be tested should be identified and uniquely identified test cases/scripts should be provided.

Test Inspection Analysis and Reporting

This should be performed by a Home Office approved test organisation, which for the purposes of the SVA could be equally be the supplier or vehicle manufacturer, that possesses the required credentials and expertise to perform the inspection in line with the required standard and provide an analysis report.

It may be necessary to schedule meetings to discuss the findings of the report, in fact it is highly likely that this will be the case should the test outcome not be favourable and subsequently promote contention between testers and equipment manufacturers. If this situation occurs, it is envisaged that the representative from the User Organisation would act as mediator.

Test Readiness Review, Pre and Post Test Meetings

Details of the Test Readiness Review (TRR), pre-test and post-test meetings should be included.

It is recommended that a Pre-Test meeting be convened with the test personnel. This would include any personnel without a specific role but expected to be in the same location as the test. The purpose of the meeting is to ensure everyone is agreed on how the test is expected to run, roles and responsibilities and what action is to be taken upon event deltas, which are seen to be unexpected events that are not part of the test.

It is also recommended that a Post-Test wash-up meeting be convened immediately following the final test. This should be used to gain the opinion from the test personnel on test performance, the need for any retest, assurance of post test timescales.

It is recommended that both meetings are kept as short as possible with a strict agenda.

The Test Director would chair the meetings.

Requirements Traceability

Traceability from each test identified in the Functional Test Specification to the requirements it addresses should be provided through a Verification Cross Reference Index (VCRI). The VCRI should have details of the unique test identifier from the Functional Test Specification against the requirement listed in the Requirements column. It is expected that in a number of cases a single test would satisfy more than one requirement on the VCRI.

Test Protocols

TP1 - Inspection

This test protocol verifies the SVA system requirement through inspection. Inspection will fall into one of the following categories:

1. Inspection of relevant documentation or correspondence to verify the details of the system requirements have been met. This inspection could be performed by either an Approved Test House or The Authority, which is CAST for the purposes of this document.
2. Physical inspection of a SVA component or installation to verify the system requirement has been satisfied. This inspection would normally be performed by a Home Office approved test organisation depending on the requirement and the expertise required to perform the inspection.

The output from this test protocol will be an inspection report(s) performed and witnessed by the appropriate personnel from the approved test organisation

TP2 - Analysis

This test protocol verifies the SVA system requirement through analysis. The analysis will fall into one of the following categories:

1. Analysis of design documentation, where the system requirement is satisfied by a particular element(s) of design. The Approved Test House or other suitable Home Office approved organisations will have to have the required expertise to pass judgement on whether design documentation satisfies the system requirement.
2. Analysis of previously conducted test results, where a supplier submitting a SVA for evaluation has conducted testing of the requirements. The Home Office approved test organisation will be required to analyse and verify the test specification, application of the test specification and ensure the test result evidence satisfies the intended system requirement.
3. Analysis of design statements, where the supplier may submit design statements declaring compliance with specific requirements. The Home Office approved test organisations will have to pass judgement on the suitability of the design statements, ensure they correspond with the design documentation and that satisfactory justification for compliance with the system requirement has been given.

The output from this test protocol will be an analysis report(s) performed and witnessed by the appropriate personnel from the Home Office approved test organisation.

TP3 - Demonstration

This test protocol verifies the SVA system requirement through demonstration. The demonstration will fall into one of the following categories:

1. Demonstration of a function or feature. This should only be used where the requirement cannot or is not economical to verify through test compliance. This should be demonstrated to the Home Office approved test organisation.

2. Demonstration of a procedure, where the requirement is procedural. Compliance should be demonstrated to The Home Office test organisation. It is anticipated that the procedure will be documented and the demonstration will then confirm that the anticipated outcome(s) are achieved by following the documented procedure.

The output from this test protocol will be an observation log performed and witnessed by the appropriate personnel from the Home Office approved test organisation.

TP4 - SVA Power Management System

This test protocol verifies the system requirements through test; the test will take the form of a bench test, testing the SVA Power Management System in isolation. A top level block diagram of the test protocol and possible test interfaces is given in Figure 3.

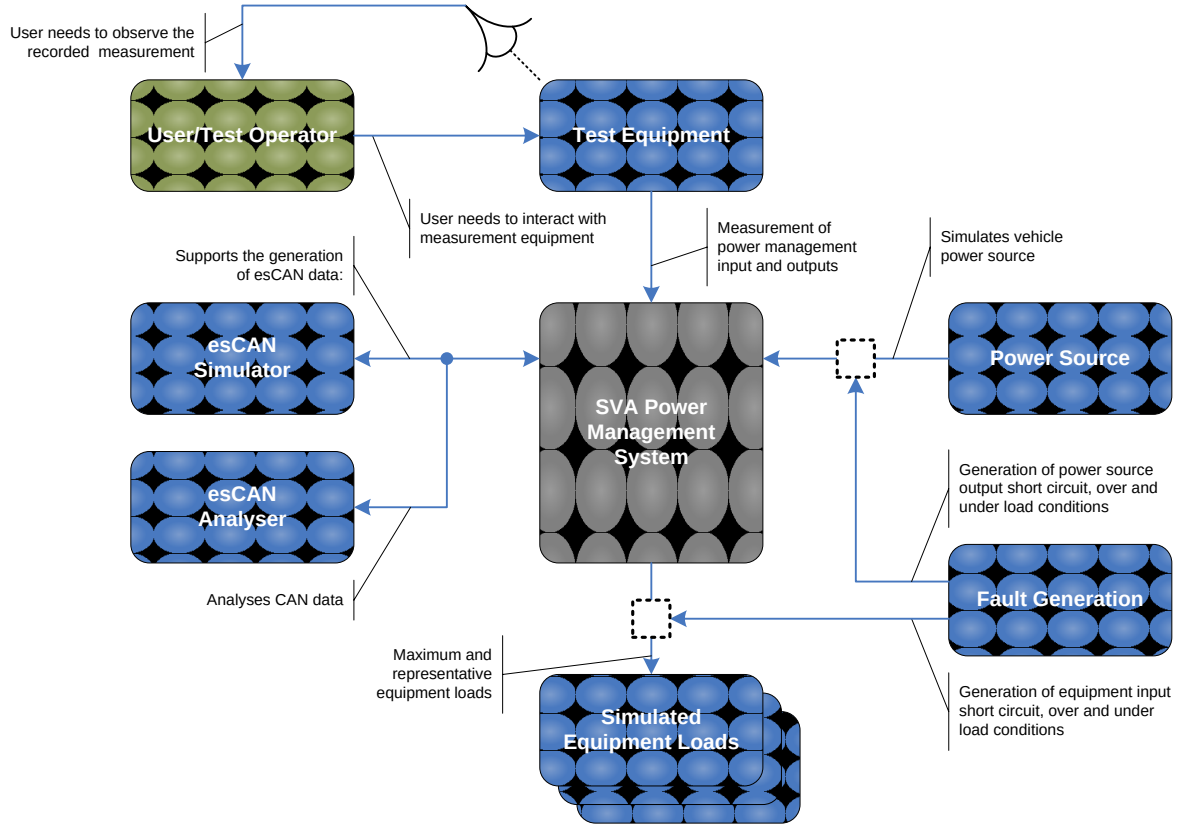

Figure 3: Bench testing of a SVA Power Management System

The following paragraphs define the function of each block in Figure 3, which are required to test the SVA Power Management System in isolation. For these tests it is important that the test configuration represents the exact configuration to be installed on the vehicle in terms of cable lengths and connector types.

esCAN Simulator – simulates the vehicle esCAN data generated by emergency service equipment present within the vehicle. The simulator needs to support the generation of esCAN data test parameters. For this test protocol the esCAN data test patterns need to stimulate esCAN control message to the SVA Power Management System. The output from the esCAN simulator itself needs to meet the functional and physical interface requirements of the Single Vehicle Architecture Criteria system requirements.

esCAN Analyser – monitors and analyses the esCAN data. Its primary functions are to record and verify the data being generated by the esCAN simulator is correct and verify status messages recorded from the Power Management System are compliant with the SVA System Requirements [Ref 1]. The esCAN analyser, although shown to be separate, could equally form

part of the esCAN Simulator and could also be capable of simulating and analysing OEM CAN data for other test protocols within this document.

Test Equipment – represents any equipment required to perform any power measurements needed to verify the SVA system requirements [Ref 1].

Power Source – provides an equivalent or the actual power source as provided by the vehicle. Its purpose is to provide the electrical power required by the Power Management System to operate itself and the equipment connected to the SVA.

Simulated Equipment Loads – provide representative and maximum load for each of the power outputs provided by the Power Management System. It is important that this test function is capable of loading the complete power management network to simulate an SVA at full load.

Fault Generation – provides the ability to alter the conditions of the power input and equipment loads, though application of short circuits, reverse polarity, over and under voltage/load conditions. This function could be incorporated into the simulated equipment loads and/or power source functions.

User/Test Operator – interacts with and observes the test equipment. It is also anticipated the user/test operator will have to interact with the fault generation and simulated equipment loads which at best would be to initiate an automated test sequence and at worst would be to manually configure and control the test functions for each test. Given the number of power management system connections to test and the type of tests to be conducted this test protocol merits consideration for automation between the test functions.

The output from this test protocol will be a test report(s) detailing test specification applied, test procedure used, resultant outcome and whether the outcome satisfies the pass/fail criteria. The test should be performed and witnessed by the appropriate personnel from the Home Office approved test organisation.

TP5 - SVA esCAN Network

This test protocol verifies the SVA system requirements through test. The test will take the form of a bench test, testing the SVA esCAN and associated sub-system components in isolation. A top level block diagram of the test protocol and test interfaces is shown in Figure 4.

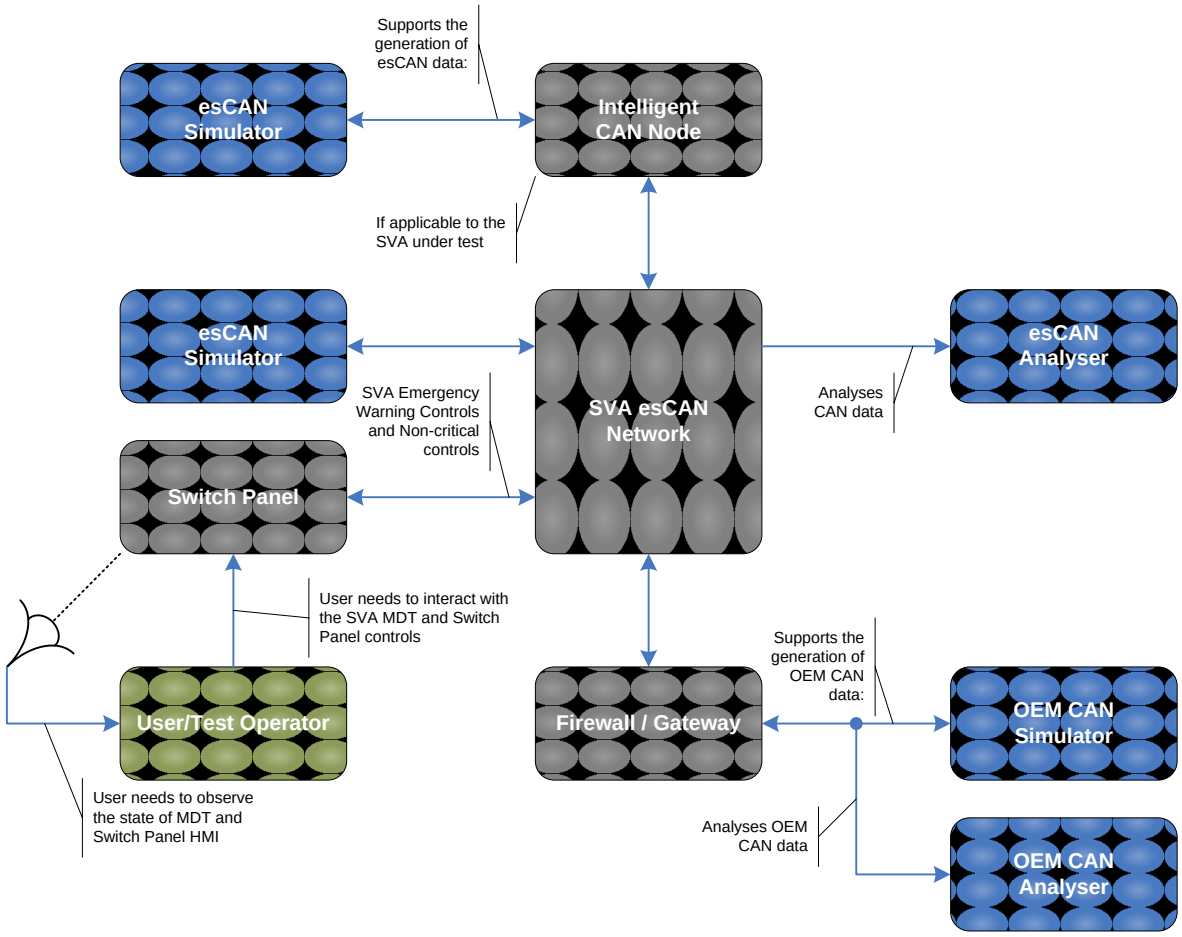

Figure 4: Bench testing of a SVA esCAN Network

The following paragraphs define the function of each block in Figure 4, which are required to test the SVA esCAN testing in isolation.

esCAN Simulator – simulates the vehicle esCAN data generated by emergency service equipment present within the vehicle. The simulator needs to support the generation of esCAN data test parameters. For this test protocol the esCAN data test patterns need to simulate any esCAN control messages that could be generated by emergency service equipment connected to the esCAN. The simulator should also be capable of generating traffic overload and errors conditions to verify the operation of the firewall and intelligent node. The output from the esCAN simulator itself needs to meet the functional and physical interface requirements of the Single Vehicle Architecture Criteria system requirements.

esCAN Analyser – monitors and analyses the esCAN data. Its primary functions are to record and verify the data being generated by the esCAN simulator is correct, verify status and control messages transmitted by other connected equipment, including the firewall/gateway. The esCAN analyser, although shown to be separate, could equally form part of the esCAN Simulator.

Original Equipment Manufacturer (OEM) CAN Simulator – simulates the vehicle OEM CAN data generated by equipment present within the vehicle. The simulator needs be capable of producing OEM CAN data parameter patterns (both representative and fault inducing) to simulate equipment operating on the esCAN. The purpose is to provide OEM CAN data patterns that are flowed through or blocked by the Firewall/Gateway to test functions of the esCAN equipment. The OEM CAN simulator needs to meet the functional and physical interface requirements of the vehicle OEM CAN.

OEM CAN Analyser – monitors and analyses the OEM CAN data. Its primary functions are to record and verify the data being generated by the OEM CAN simulator is correct, verify data

passed through or blocked by the Firewall/Gateway is correct. The OEM CAN analyser, although shown to be separate, could equally form part of the OEM CAN Simulator.

User/Test Operator – interacts with the SVA controls and HMI to initiate tests or verify functions through observation. It is also likely the user/ test operator will have to interact with other test functions as part of a manual test sequence or to initiate an automated test sequence.

TP6 - SVA EMC and Environmental Testing

This test protocol verifies SVA system requirements through test and will take the form of a bench test performed at a suitably accredited test house, testing the SVA in isolation against the Electromagnetic Compatibility (EMC) and Environmental (ENV) system requirements. A top level block diagram of the test protocol and test interfaces is shown in Figure 5.

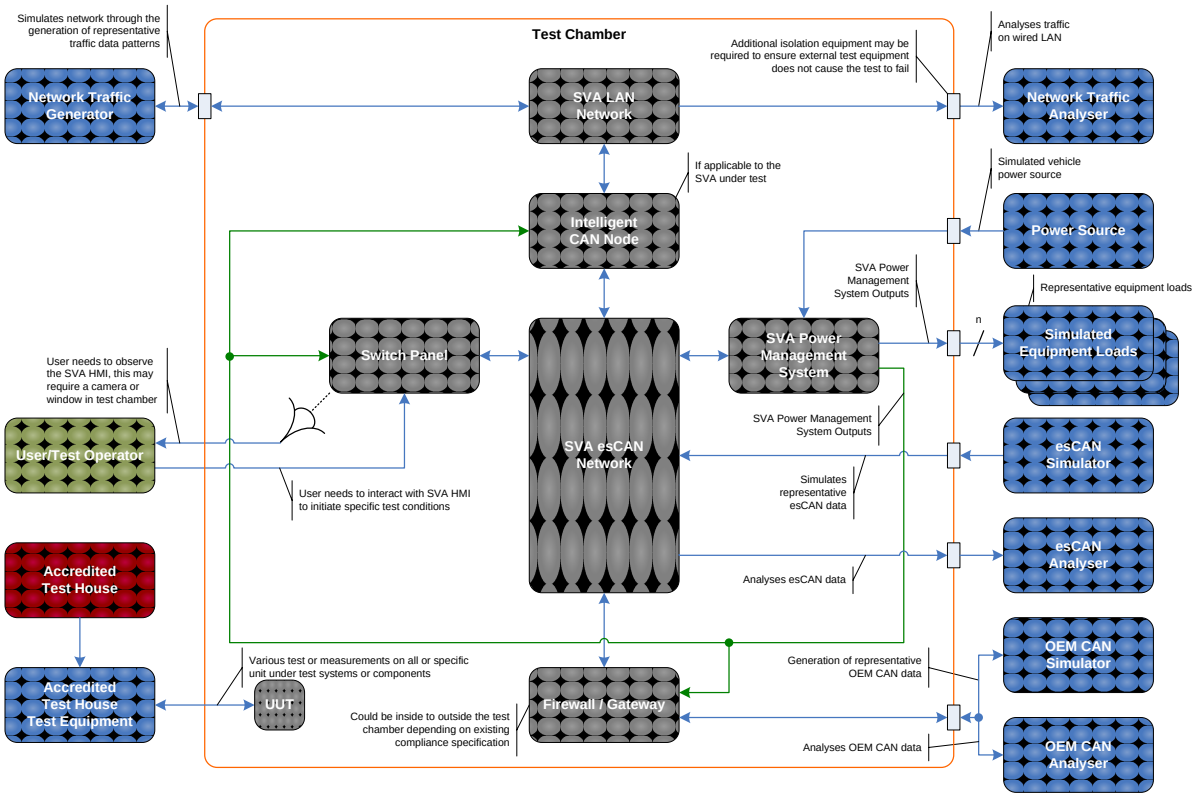

Figure 5: EMC and Environmental testing of the SVA

The following paragraphs define the function of each block in Figure 5, which are required to test the SVA against the EMC and ENV system requirements.

Network Traffic Generator – simulates operational representative network traffic on the LAN. In its simplest form this could be a laptop in conjunction with software applications simulating representative data test patterns.

Network Traffic Analyser – monitors and analyses the LAN traffic to provide a test recorded for the data patterns used during the testing and to support traffic comparisons with other network analysers within the test set-up.

esCAN Simulator – simulates operational representative vehicle esCAN data generated by emergency service equipment present within the vehicle. The simulator needs to support the generation of esCAN data test parameters. The output from the esCAN simulator itself needs to meet the functional and physical interface requirements of the SVA system requirements [Ref 1].

esCAN Analyser – monitors and analyses the esCAN data. Its primary functions are to record esCAN data traffic, to provide a test recorded for the data patterns used during testing and to support traffic comparison with other network analysers within the test set-up.

Power Source – provides an equivalent or the actual power source as provided by the vehicle. Its purpose is to provide the electrical power required by the Power Management System to operate itself and the equipment connected to the SVA power management network.

Simulated Equipment Loads – provides representative loads for each of the power outputs provided by the Power Management System. It is important that this test function is capable of loading the power management network at each connection point to simulate an SVA loaded with emergency service equipment.

OEM CAN Simulator – simulates the vehicle CAN data generated by equipment present within the vehicle. The simulator needs be capable of producing representative OEM CAN data parameter patterns that meets the functional and physical interface requirements of the SVA system requirements [Ref 1].

OEM CAN Analyser – monitors and analyses the OEM CAN data. Its primary functions are to record and verify the data being generated by the OEM CAN simulator is correct, verify data recorded from the OEM CAN bus matches the data recorded by the esCAN Analyser. The OEM CAN analyser, although shown to be separate, could equally form part of the OEM CAN Simulator.

User/Test Operator – interacts with controls on the SVA HMI to initialise the test set-up. It is also likely the user/ test operator will have to interact with the test functions to initiate an automated test sequence.

Accredited Test House – performs the EMC and ENV testing to the specification defined in the system requirements. The Accredited Test House is also required to meet any system requirements relating to accreditation to specific standards.

Accredited Test House Equipment – represents specific equipment held by the Accredited Test House to enable testing to the defined standards. This equipment maybe standard test equipment such as spectrum analyser, but may also represent specialised test equipment such as a vibration table.

Test Chamber – represents a boundary provided by the Accredited Test House to enable testing to the defined standard. This boundary represents an anechoic chamber for EMC testing and a temperature chamber for climatic tests, but could also represent the boundary for any specific environmental test equipment. Connections that go through the test chamber boundary may be further limited by the physical and electrical requirements of EMC and ENV test equipment. Furthermore it is important to realise that to ensure the tests do not fail because of the test function equipment, isolation equipment may be required at the chamber boundaries.

The output from this test protocol will be a test report(s) detailing test specification applied, test procedure used, resultant outcome and whether the outcome satisfies the pass/fail criteria. The test should be performed and witnessed by the appropriate personnel from the Accredited Test House.

TP7 - SVA Vehicle Testing

This test protocol verifies the SVA system requirements through test. The test will take the form of a vehicle test, testing the SVA connected to existing vehicle systems. The SVA may or may not be fully installed for this protocol. A top level block diagram of the test protocol and possible test interfaces is shown in Figure 6.

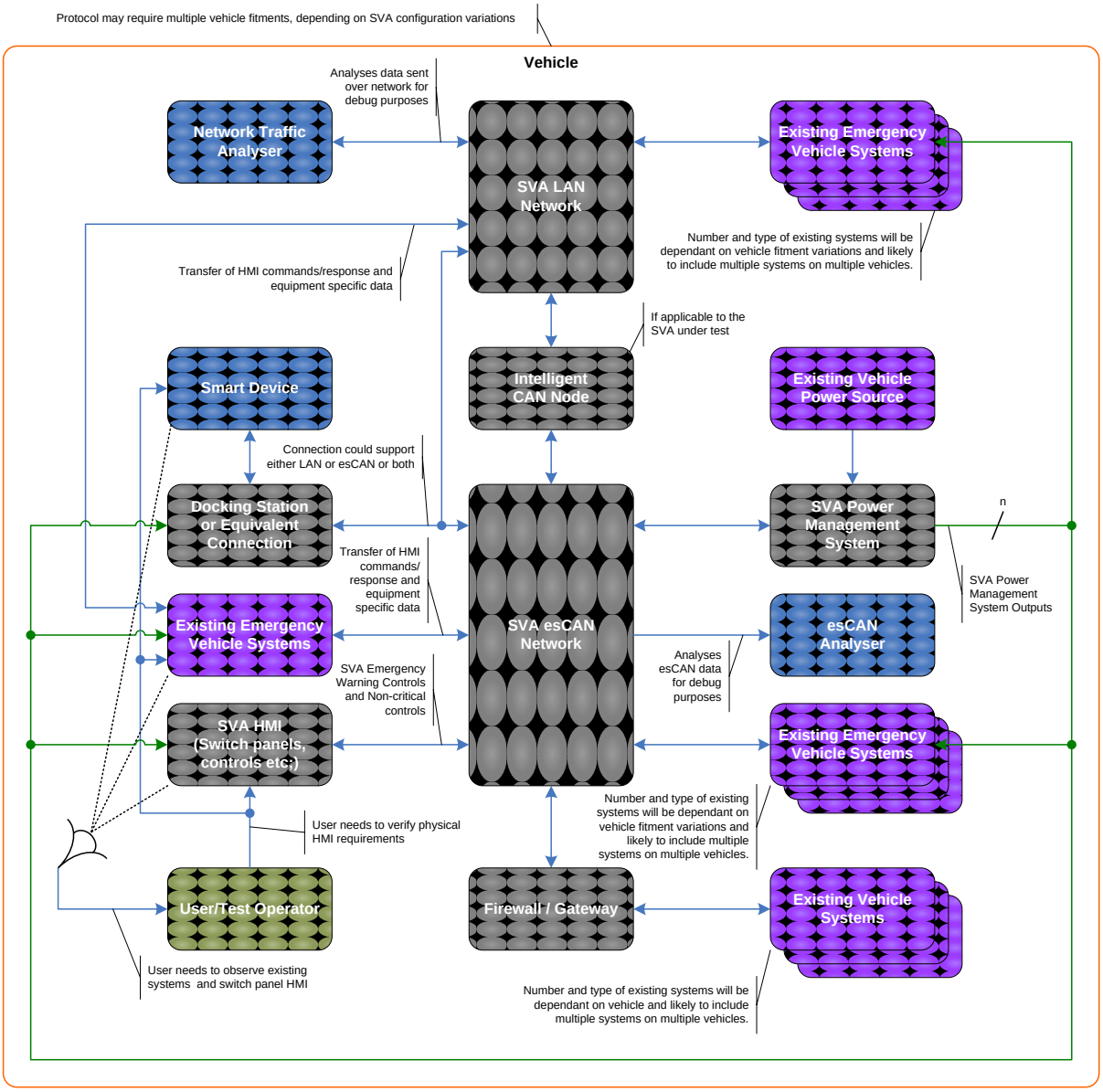

Figure 6: Vehicle testing of the SVA

The purpose is to verify system requirements that require existing systems within the vehicle. It is likely existing systems will require stimulating manually while verification of SVA functions and performance is verified. This test protocol will need a combination of static and operational vehicle test to verify associated SVA system requirements [Ref 1]. The following paragraphs define the function of each block shown in Figure 6.

Existing Vehicle Systems – provides real in car stimulus connecting to each of the interfaces provide by the SVA. It is expected to take one of the following forms:

- A vehicle power source, to provide electrical power to the power management system to allow operation of the SVA systems, networks and other existing emergency service equipment attaching to the SVA;
- Emergency service equipment attaching to either the esCAN or wired LAN which is outside the scope of the SVA e.g. light bars, ANPR cameras, matrix signs, DVDMS etc;
- OEM vehicle equipment provided as part of the vehicle attaching to the SVA via the firewall/gateway.

Network Traffic Analyser – monitors and analyses the LAN traffic to provide a test record for the data patterns used during the testing and to support traffic comparisons with other network analysers within the test set-up.

esCAN Analyser – monitors and analyses the esCAN data. Its primary functions are to record esCAN data traffic, to provide a test record for the data patterns used during testing and to support traffic comparison with the LAN network analyser within the test set-up.

Smart Handheld Device – provide the system to verify the functional and performance system requirements for the docking station or equivalent connection provided by the SVA.

User/ Test Operator – interacts with and observes the SVA HMI and potentially other existing vehicle systems. This test protocol may require more than one user to initialise the test set-up. It is also likely the user/ test operator will have to interact with the test functions.

The output from this test protocol will be a test report(s) detailing test specification applied, test procedure used, resultant outcome and whether the outcome satisfies the pass/fail criteria. The test should be performed and witnessed by the appropriate personnel from the Home Office approved test organisation.

APPENDIX 1 – Test Protocol/System Requirement Cross Reference

The following tables provide a cross reference between the test protocols defined in this document and the requirements as defined in [Ref 1] they satisfy.

TP1 - Inspection **(59 requirements)**			
SVA_R_0036	SVA_R_0630	SVA_R_0224	SVA_R_0322
SVA_R_0049	SVA_R_0634	SVA_R_0227	SVA_R_0323
SVA_R_0583	SVA_R_0637	SVA_R_0230	SVA_R_0685
SVA_R_0614	SVA_R_0646	SVA_R_0246	SVA_R_0328
SVA_R_0615	SVA_R_0650	SVA_R_0248	SVA_R_0686
SVA_R_0616	SVA_R_0188	SVA_R_0249	SVA_R_0330
SVA_R_0104	SVA_R_0664	SVA_R_0260	SVA_R_0335
SVA_R_0114	SVA_R_0201	SVA_R_0264	SVA_R_0336
SVA_R_0115	SVA_R_0203	SVA_R_0265	SVA_R_0338
SVA_R_0118	SVA_R_0204	SVA_R_0270	SVA_R_0339
SVA_R_0134	SVA_R_0209	SVA_R_0271	SVA_R_0342
SVA_R_0624	SVA_R_0211	SVA_R_0304	SVA_R_0693
SVA_R_0141	SVA_R_0217	SVA_R_0312	SVA_R_0694
SVA_R_0142	SVA_R_0222	SVA_R_0317	SVA_R_0519
SVA_R_0143	SVA_R_0223	SVA_R_0321	

TP2 - Analysis **(47 requirements)**			
SVA_R_0052	SVA_R_0136	SVA_R_0643	SVA_R_0296

SVA_R_0584	SVA_R_0625	SVA_R_0196	SVA_R_0298
SVA_R_0094	SVA_R_0626	SVA_R_0197	SVA_R_0300
SVA_R_0617	SVA_R_0159	SVA_R_0218	SVA_R_0302
SVA_R_0618	SVA_R_0168	SVA_R_0221	SVA_R_0684
SVA_R_0103	SVA_R_0688	SVA_R_0232	SVA_R_0314
SVA_R_0106	SVA_R_0175	SVA_R_0671	SVA_R_0696
SVA_R_0107	SVA_R_0701	SVA_R_0672	SVA_R_0344
SVA_R_0109	SVA_R_0178	SVA_R_0274	SVA_R_0345
SVA_R_0620	SVA_R_0631	SVA_R_0279	SVA_R_0697
SVA_R_0621	SVA_R_0702	SVA_R_0280	SVA_R_0516
SVA_R_0135	SVA_R_0639	SVA_R_0295	

TP3 - Demonstration **(6 requirements)**			
SVA_R_0184	SVA_R_0638	SVA_R_0690	SVA_R_0262
SVA_R_0636	SVA_R_0647		

TP4 - SVA Power Management System **(17 requirements)**			
SVA_R_0040	SVA_R_0125	SVA_R_0144	SVA_R_0148
SVA_R_0119	SVA_R_0132	SVA_R_0145	SVA_R_0150
SVA_R_0120	SVA_R_0133	SVA_R_0146	SVA_R_0628
SVA_R_0121	SVA_R_0138	SVA_R_0147	SVA_R_0154
SVA_R_0122			

TP5 - SVA esCAN (17 requirements)			
SVA_R_0582	SVA_R_0170	SVA_R_0183	SVA_R_0651
SVA_R_0156	SVA_R_0700	SVA_R_0642	SVA_R_0202
SVA_R_0161	SVA_R_0181	SVA_R_0644	SVA_R_0242
SVA_R_0164	SVA_R_0182	SVA_R_0645	SVA_R_0669
SVA_R_0629			

TP6 - SVA EMC and Environmental Testing (10 requirements)			
SVA_R_0675	SVA_R_0678	SVA_R_0681	SVA_R_0683
SVA_R_0676	SVA_R_0679	SVA_R_0682	SVA_R_0703
SVA_R_0677	SVA_R_0680		

TP7 - SVA Vehicle Testing (19 requirements)			
SVA_R_0619	SVA_R_0226	SVA_R_0275	SVA_R_0277
SVA_R_0623	SVA_R_0237	SVA_R_0276	SVA_R_0313
SVA_R_0153	SVA_R_0267	SVA_R_0674	SVA_R_0315
SVA_R_0167	SVA_R_0673	SVA_R_0691	SVA_R_0331
SVA_R_0632	SVA_R_0189	SVA_R_0281	

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