Smart Rural Grid

"Smart ICT-enabled Rural Grid innovating resilient electricity distribution infrastructures, services and business models"

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Executive summary

This deliverable describes test strategy and validation procedures, based on the use cases defined in WP2, in order to validate the capabilities of the developed system.

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T 5.3, 5.4	KISTERS
T 6.1	CGA
T 8	SMARTIO

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Abbreviations and Acronyms

Acronym	Description
CA	Consortium Agreement
CFS	Certificate on the financial statements
CHP	Combined Heat and Power
CIM	Common Information Model (IEC)
CO	Dissemination Confidential, limited to project participants
D	Deliverable
EMS	Energy Management System
EC	European Commission
FDR	Final financial distribution report
GA	Grant Agreement
GEMS	Global Energy Management System
ID	Internal discussion or report
IDPR	Intelligent Distributed Power Router
LC	Local Controller
LLD	Low level devices
LV	Low Voltage level (<= 400V)
MV	Medium Voltage level (>400V, e.g. 10kV voltage level)
PC	Project Coordinator
PFR	Project Final Report
PMC	Project Management Committee
PO	Project Officer
PP	Dissemination restricted to other FP7 Programme participants
PPR	Partner's periodic report (contractual, M12, M24, M36)
PR	Partner's progress report (internal, at M6, M18, M30)
PT	Project presentation
PU	Dissemination Public
QM	Quality Management
QR	WPL Quarterly report
RE	Dissemination restricted to a group specified by the consortium
RTU	Remote terminal unit
TC	Transformer Controller
TMT	Technical Management Team

Acronym	Description
ToC	Table of Contents
SCADA	Supervisory Control and Data Acquisition
UML	United Modelling Language
VSC	Voltage source converter
WP	Work Package

1 Introduction

The project proposal requires that the System Integration and Validation Test Plan, D6.1 should identify and define test procedures and validation criteria for our system. Due to the complexity of the complete system, the testing and validation exercise will require a number of test specifications building up to a system test specification that will validate the system based upon the usage cases developed in WP2.

The purpose of this document is to identify the strategy to be taken during this integration and test activity, identify which test specifications are required and to associate responsibility for their production.

As a precursor to this task, a number of project participants have been engaging in an activity to define the system architecture. This has resulted in the production of the internal document “D6.1a Smart Rural Grid System Architecture”. This document is presented as an appendix to this deliverable.

2 Test Strategy

The purpose of this section is to consider the system to be tested and propose the best strategy to test and validate its operation.

2.1 Sub-Systems

The exercise undertaken to determine the architecture of the system (see appendix A) has identified the following sub-systems:

- IDPR
- Distributed Generation and Electrical Switching/Measurement Elements
- Communications
- RTU (Local Controller and Transformer Center)
- SCADA
- Local EMS
- Global EMS

These sub-systems will exchange data to realise the final functionality of the system.

2.2 Test Specification Classification

For a system of this complexity, there should be a hierarchical arrangement of formal testing beginning with the low-level interfaces between the various sub-systems building up to the overall system test specifications that will demonstrate compliance with the system level requirements that are described in WP2.

There should be three basic types of test specification:-

1. *Standalone Test Specification* – These specifications will concern themselves with a single sub-system and concentrate on standalone functionality. These specifications would typically be used where a sub-system design and realisation is unique to the system. In this case, at least the IDPR (WP3/D3.3) and Communications sub-system would fit into this category. However it may be necessary to test more subsystems as standalone.

2. *Interface Test Specification* – These specifications will test and validate the data exchanges between sub-systems. A given sub-system may have a number of different interfaces depending on its role within the complete system.

3. *System Test Specification* – These specifications will exercise and validate the system in terms of the modes of operation and electrical characteristics that have been already been defined within WP2. In this case there will be two system test specification documents. One should be associated with the Lab based validation to be carried out in task T6.4, the other with the pilot site validation to be carried out in task T6.5.

2.3 Test Specification Identification

The following test specification documents have been identified.

2.3.1 Standalone Test Specifications

Test Specification Title	Purpose
IDPR – Standalone Test Specification	Test the internal functionality of the IDPR device according to deliverable D3.3
Communications – Standalone Test Specification	Test the capability of the communications sub-system to deliver the connectivity and throughput required by the system.
Local EMS-Standalone Test Specification	Test the internal functionality of the Local EMS with use cases like • Import data from RTU LC • Run the local EMS and verify that the optimal algorithm can be fit within the required times for controlling the LLDs • Generate set points • Export data to RTU LC
Global EMS – Standalone Test Specification	Test the internal functionality of the Global EMS with use cases like: • Import historical load and generation data / time series from the SCADA • Generate updated forecasts

	• Calculate new Optimal Power Flow • With OPF and forecasts as new inputs, rerun optimization to get new schedules as a result • Export these schedules to the SCADA

2.3.2 Interface Test Specifications

The third column within the table contains references to the architecture document in appendix A.

Test Specification Title	Purpose	Reference to D6.1a Data Processes
IDPR - RTU TC Interface Test Specification	Test the interface between the IDPR and the Transformer Center RTU located within the downstream substations	b.4, d.3, f.1
RTU TC - ESE/EMU interface Test Specification	Test the capability of the Transformer Center RTU to operate the electrical switching elements and recover values from electrical measurement devices	d.3, f.1
RTU TC - DG Interface Test Specification	Test the capability of the Transformer Center RTU to operate and recover values from distributed generation devices	b.4, d.3, f.1
RTU LC - RTU TC Interface Test Specification	Test the interface between Local Controller RTU located within SS 010 and the downstream Transformer Center RTU's	b.3, d.2, e.1, f.2
SCADA - RTU LC Interface Test Specification	Test the interface between the SCADA master station and the Local Controller RTU located in SS-010.	a.2, c.1, d.1, e.2
RTU LC - Local EMS Interface Test Specification	Test the interface between the Local Controller RTU and the Local Energy Management System	a.3, b.1, b.2
Global EMS - SCADA Interface Test Specification	Test the interface between the Global Energy Management System and the SCADA system.	a.1, a.4

2.3.3 System Test Specifications

The following system test specifications have been identified:-

Test Specification Title	Purpose
System Validation Test Specification (LAB based)	Test the operation and performance of the entire system end to end in a Lab environment. This must draw upon the usage cases defined in WP2. It will be necessary to simulate the SCADA interface during these tests.
System Validation Test Specification (Site based)	Test the operation and performance of the entire system end to end at the pilot site. This again must draw upon the usage cases defined in WP2.

2.4 Test Specification Allocation to Task

The production and execution of the various specifications identified within section 2.3 above can be allocated to the project tasks as follows:-

T6.2 System Integration Phase A (Level 1-2)

1	IDPR - RTU TC Interface Test Specification	Test the interface between the IDPR and the Transformer Center RTU located within the downstream substations
2	RTU TC - ESE/EMU interface Test Specification	Test the capability of the Transformer Center RTU to operate the electrical switching elements and recover values from electrical measurement devices
3	RTU TC - DG Interface Test Specification	Test the capability of the Transformer Center RTU to operate and recover values from distributed generation devices
4	IDPR – Standalone Test Specification	Test the internal functionality of the IDPR device.
5	Global EMS Standalone Test Specification	Test the internal functionality of the global EMS.

6	Local EMS Standalone Test	Test the internal functionality of the Local EMS.

T6.3 System Integration Phase B (Level 3-4)

5	RTU LC - RTU TC Interface Test Specification	Test the interface between Local Controller RTU located within SS-010 and the downstream RTU Transformer Center RTU's
6	SCADA - RTU LC Interface Test Specification	Test the interface between the SCADA master station and the Local Controller RTU located in SS 010.
7	RTU LC - Local EMS Interface Test Specification	Test the interface between the Local Controller RTU and the Local Energy Management System
8	Global EMS - SCADA Interface Test Specification	Test the interface between the Global Energy Management System and the SCADA system.

T6.4 System Validation Phase

9	Communications – Standalone Test Specification	Test the capability of the communications sub-system to deliver the connectivity and throughput required by the system.
10	System Validation Specification Test Specification (LAB based)	Test the operation and performance of the entire system end to end in a Lab environment. This must draw upon the usage cases defined in WP2.

T6.5 System Interoperability with Pilot Sites Specific Interfaces

11	System Validation Specification Test Specification (Site based)	Test the operation and performance of the entire system end to end at the pilot site. This again must draw upon the usage cases defined in WP2.

3 Test Specification Format

The document "Test Specification Sample" within appendix B provides a pro-forma format for the test specifications that should be used where possible to ensure that the various test specification follow a common fixed format.

It also includes documentation to cover the recording and subsequent processing of any non-conformances that may occur during the testing.

4 Test Coverage

The purpose of this section is to provide guidance in developing the test specifications with regard to functionality to be tested.

We must consider each test specification identified in section 2 above and provide instruction for what behaviour should be tested and verified.

4.1 System Level Testing

At this level we must test the system to ensure compliance with the test cases outlined in WP2.

4.1.1 Network Modes of Operation

We must consider the network modes of operation as outlined in D2.2 "Specification of the operation environment".

- Operation connected on grid. (mode 1)
- Operation on isolated mode under planning selected. (mode 2)
- Operation on isolated mode as result of an external electrical failure (mode 3)
- Operation partially on grid and on isolated mode as result of an internal electrical failure from study case network. (mode 4)

As we have seen there are further six sub modes to consider that are associated with mode 4 operation above.

- Operation sub mode when there is a failure of the medium voltage line, of the transformer of the SS 730 or the SS 734, or of the low voltage bar of the SS 734 (sub mode 4.1)
- Operation sub mode when there is a failure of the transformer of the SS 928 (sub mode 4.2)
- Operation sub mode when there is a failure of the transformer of the SS 010 (sub mode 4.3)
- Operation sub mode when there is a failure of the low voltage bar of the SS 010 (sub mode 4.4)
- Operation sub mode when there is a failure of the low voltage bar of the SS 730 (sub mode 4.5)

- Operation sub mode when there is a failure of the low voltage bar of the SS 928 (sub mode 4.6)

We must ensure that each of these operating modes is exercised.

4.1.2 Local EMS Estimation of Optimal Power Flow

We must ensure that the calculations for reducing the losses and improving the power quality of the pilot network performed by the Local EMS are consistent with the current prevailing network conditions and the forecast load provided by the system EMS.

4.1.3 Communications Failover and Performance

The capability of the communications network to perform to specification on both power line and wireless including fail-over to each should be tested.

The capability of the system to operate under a communication failure with long time forecasting provided by the GEMS.

4.1.4 Use Cases for the Control Room

We must consider the control room modes of operation as outlined in D2.4 “Data and values specifications, managing procedures”.

For the control room there are four main use cases associated with the Smart Rural Grid.

- Reconnecting with the SRG
- Monitoring and operating the grid
- Setting operating parameters
- Planned isolated mode

Each of these cases should be exercised within the specification.

4.1.5 EMS - Resilient Electrical Operation

We must consider the operation limits for the operation of the EMS as outlined in D2.3 “Specifications for a resilient electrical operation”.

- Maximum time to operation

- Distributed generation capabilities
- Number of retries
- Minimum battery availability

4.2 Integration Level Testing

It is important to exercise all elements of the interfaces between subsystems. This will involve both positive and negative testing and testing to all limit values. The facility schedule or interface definition documentation should be used as an input into this testing and can be ticked off as each variable or I/O point is exercised.

4.3 Standalone Testing

It is important to ensure that the elements of our system that are unique and have been designed specifically for our purpose are tested for intrinsic functionality. The purpose of this testing is to ensure correct internal operation as expected by the relevant design authority.

Appendix A - Smart Rural Grid System Architecture

Introduction

The aim of this sub-document is to facilitate and finalise the discussion about the role of each of the devices used in the Smart Rural Grid Project and how they interact with each other both in terms of hardware connections and software protocols and interfaces. Note that each partner will contribute to the creation of this sub-document and will carefully describe and review the capabilities and functionality of their product in the context of the said Project. A key goal of this sub-document is to identify and define the outline system architecture and detailed data exchanges taking place within the proposed system. Based upon this document and other discussions, we will need to design and develop the functionality required to realise the proposed solution.

System components

This diagram below shows the various devices being used in the design of the Smart Rural Grid system including the partners who are responsible for them.

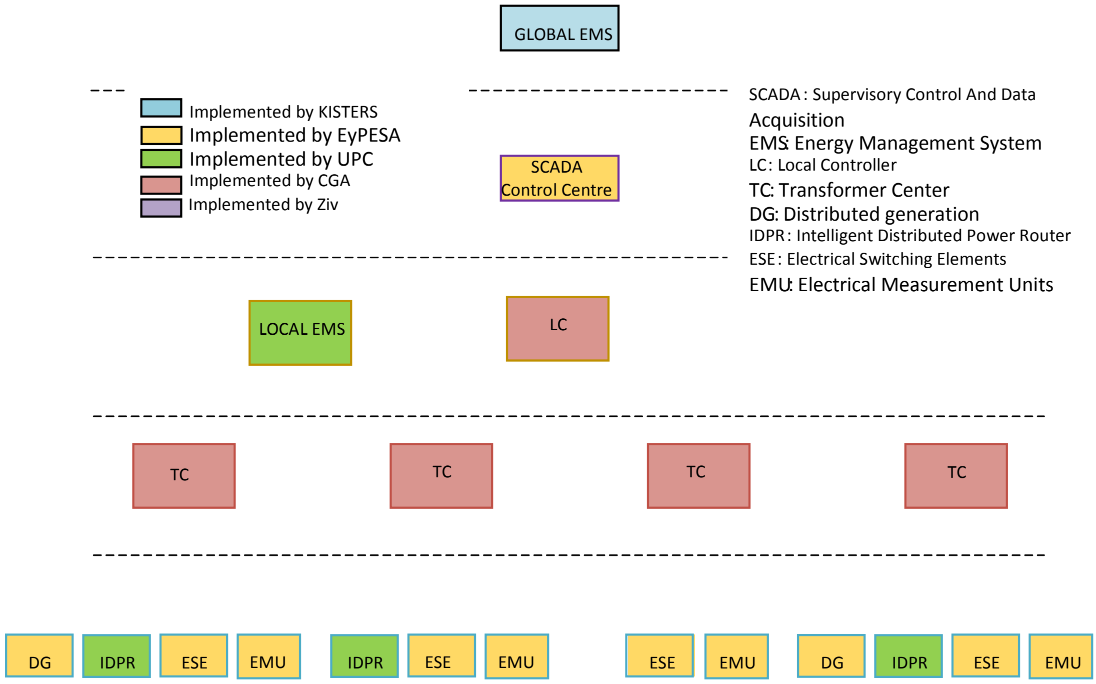

Figure 1 Responsibilities

Hierarchy of the devices

In this section, the hierarchy of the devices is briefly defined. At the lowest level, there is the Distributed generation (DG), Intelligent Distribution Power Router (IDPR), Electrical Switching Elements (ESE) and Electrical Measurement Units (EMU). All these elements are slaves to the Transformer Center (TC), as can be seen in the following figure.

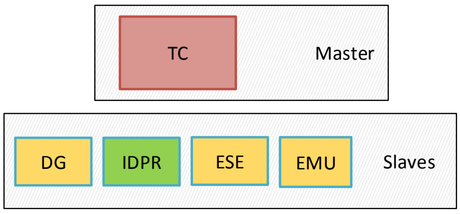

Figure 2 The lowest hierarchy level.

At the same time, all the TCs are slaves to the Local Controller (LC).

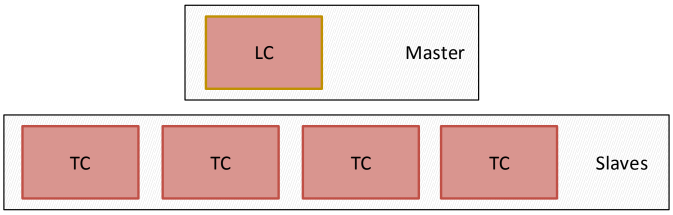

Figure 3 The second hierarchy level

Finally, the LC in turn is the slave to the Supervisory Control and Data Acquisition (SCADA) Control Center. In addition, the Local Energy Management System (Local EMS) also acts as a master for the LC, as can be seen in the next figure.

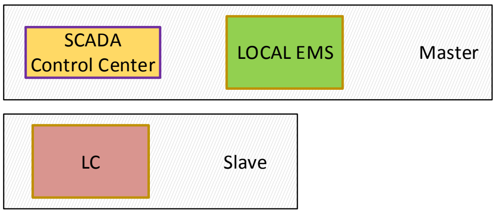

Figure 4 The third hierarchy level

The exchange between the SCADA control centre and the Global EMS is in the form of .csv files. The Global EMS will send 1 day setpoint profiles to the SCADA control centre which in turn will pass it on to the Local Controller maybe after modification. The Local Controller will in turn pass it to the Local EMS.

Data flow in the system

This section defines the different data information modes, which are based on the pilot network needs. **Note that the following diagrams do not show the hierarchy and protocol rules, but they only represent the flow of data information**. In particular, there are four data information modes. Also note that depending on the functionality, there are synchronous and asynchronous modes. In general, the asynchronous data information modes have more priority than synchronous data information.

Data information mode 1: Update forecasts and refresh state

The first data information mode is based on providing the forecast each 15 minutes to the Local EMS. And also the Local Controller via the SCADA sends the required pilot network information to the Global EMS (**All information has to be defined in the following section**).

(a.1)The Global EMS sends to SCADA the .csv file with the forecasts and quarterly set points.

(a.2)The SCADA selects the specific pilot network forecast and forwards it to the Local Controller as a file via Secure FTP. It also reads the file to extract some of the information for its own use or modify the file if necessary.

(a.3)The Local controller accepts the file and forwards it to the Local EMS via FTP (secure FTP not required in the internal network).

(a.4) Finally, the SCADA has to send periodically the required information to Global EMS.

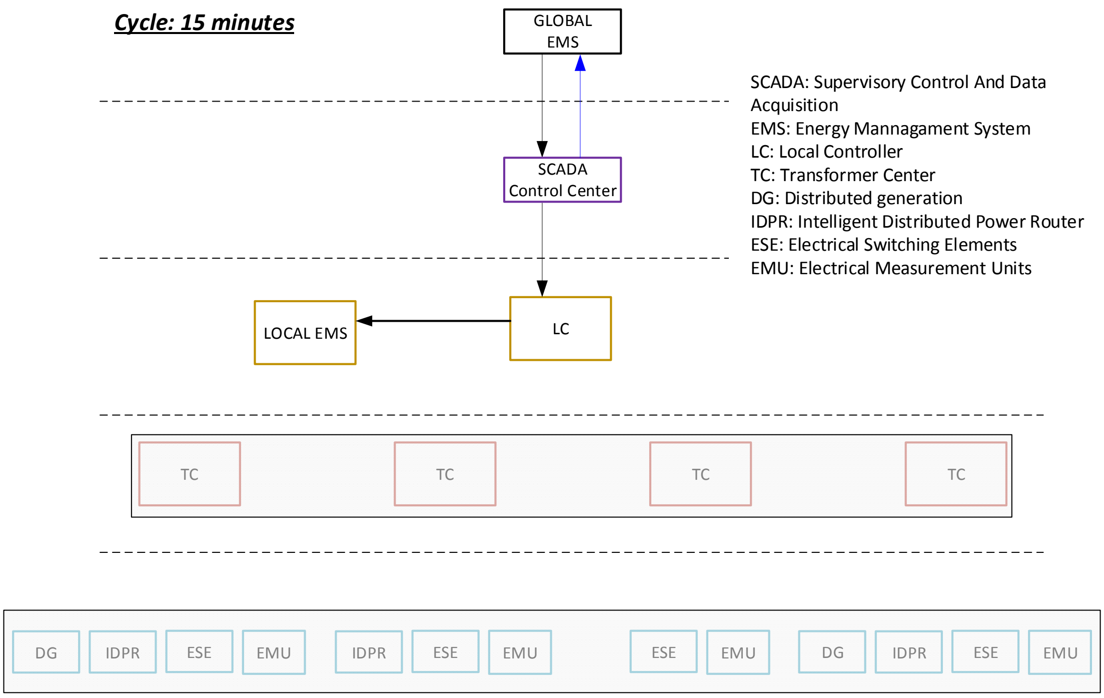

Figure 5 Data information mode 1

Data information mode 2: Energy local management

The second data information mode is based on batteries, distributed generation, IDPRs management and refreshing the Local Controller database. Note that, the Local EMS has a limited capacity for acting to the IDPRs. (**All information has to be defined in the following section**).

(b.1)The Local Controller sends to the Local EMS the specific data information for the management.

(b.2)From the provided forecast, quarterly set points, and specific pilot network information the Local EMS determines the set points for IDPRs, distributed generation and batteries and then send these to the Local Controller.

(b.3)The Local Controller resends these set points to each Transformer Center.

(b.4)Each Transformer Center sends to its associated IDPR, battery and distributed generators, the specific set points.

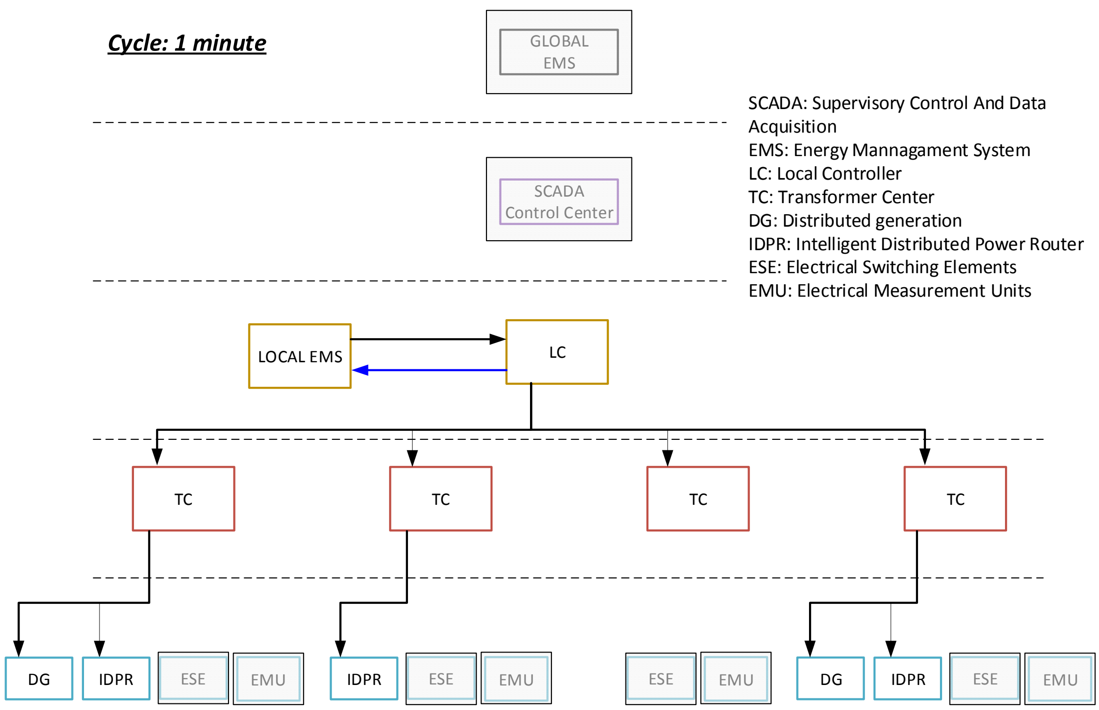

Figure 6 Data information mode 2

Data information mode 3: SCADA refresh

The third mode is based on refreshing the SCADA with the pilot network information when SCADA requires. Note that this mode is asynchronous. (**All information has to be defined in the following section**).

(c.1) The Local Controller sends for SCADA when it requires the pilot network information.

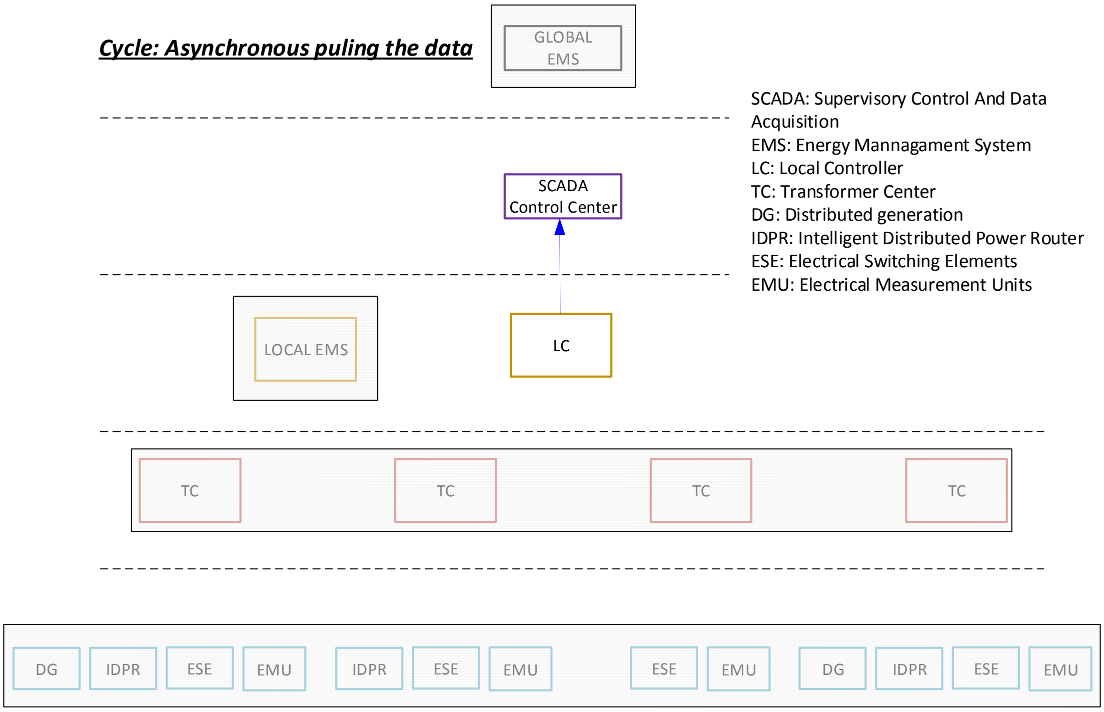

Figure 7 Data information mode 3

Data information mode 4: Remote operation

The fourth data information mode is based on the remote operation for continued operations. Note that this mode is asynchronous. In addition this data information mode **cannot modify the operation mode of IPDR** but can only modify the set points for a determinate operation mode (**All information has to be defined in the following section**).

(d.1)SCADA sends an order to the Local Controller

(d.2)The Local Controller processes it and resends to the specific Transformer Center

(d.3)The Transformer Center forwards the order to low level device.

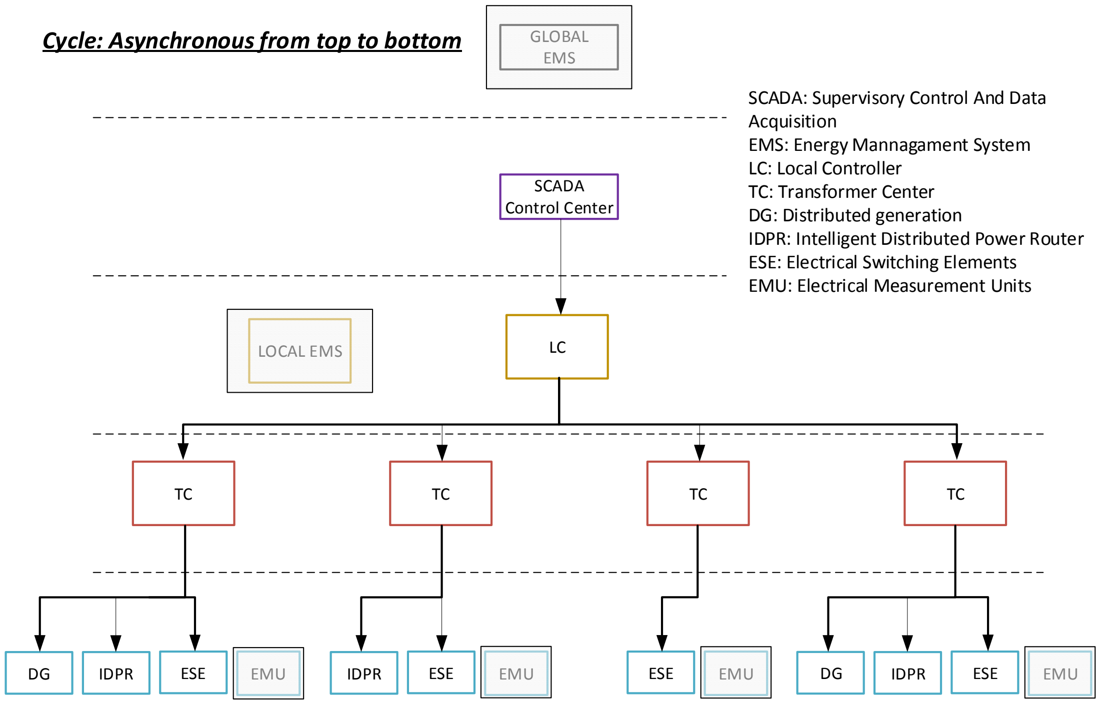

Figure 8 Data information mode 4

Data information mode 5: Alert notification

The fifth data information mode is based on passing an alarm, alert, etc. to higher levels. Note that this mode is asynchronous. (**All information has to be defined in the following section**).

(e.1)The Transformer Center detects an alarm or alert and sends it to Local Controller.

(e.2)Finally the Local Controller forwards this alert to the SCADA.

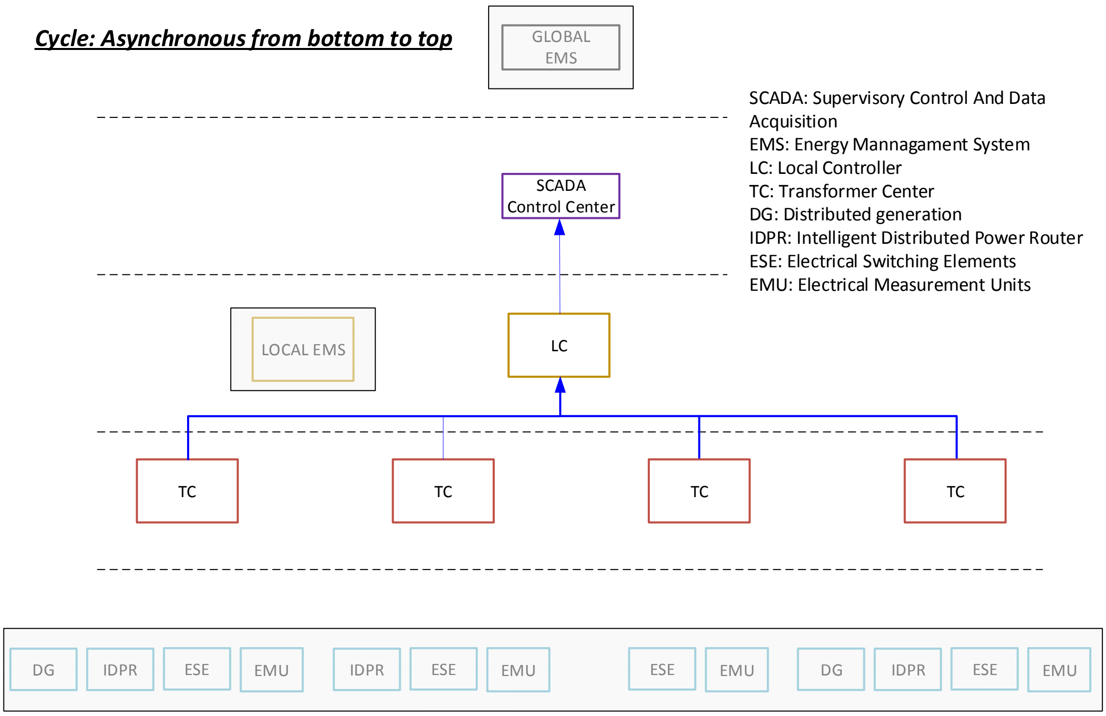

Figure 9 Data information mode 5

Data information mode 6: Local Control data refresh

The seventh data information mode is based on updating in real time the data of the Local Control.

(f.1)The Transformer Center request for the Low Level Devices information, in order to know the powers, voltages, currents, status, etc.

(f.2)The Transformer Center groups this information and sends it to the Local Controller.

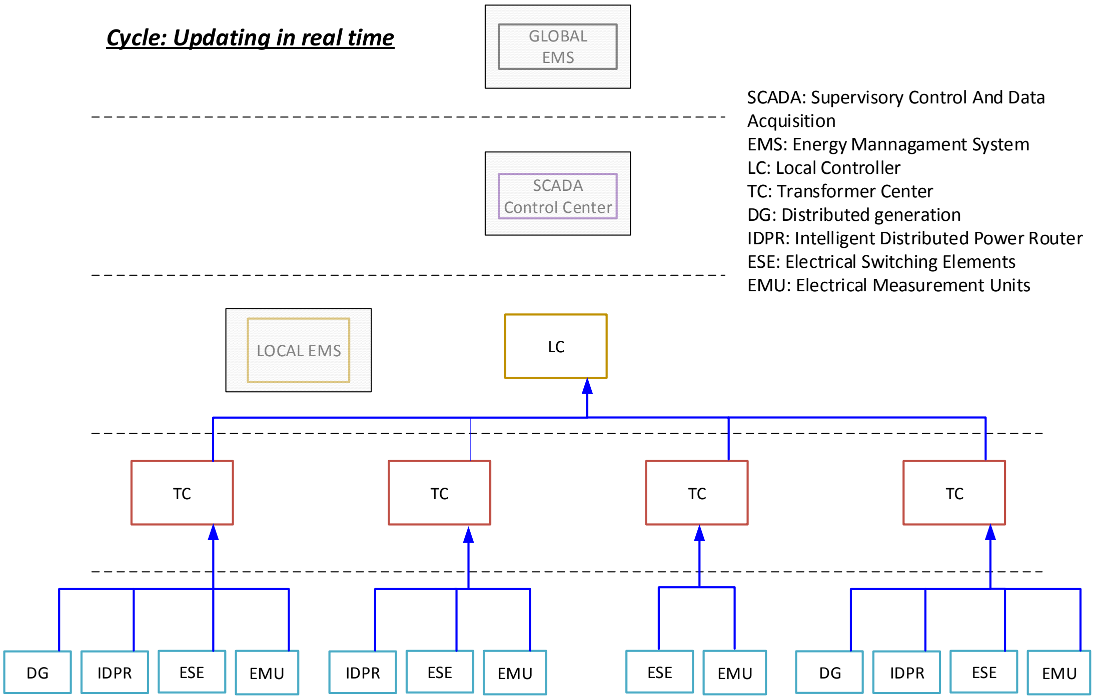

Figure 10 Data information mode 6

Cyber Security

As any power grid is modernized, it relies more on automation and communications, and leverages standard information technology. It will generally manage energy from a variety of distributed sources. Therefore, this "smarter" grid contains more interconnections and access points, all of which can be potential portals for intrusions, malicious attacks, and other threats. Most people are familiar with the potential of cyber threats on their personal computers and in their business environment with virus scanners, Trojans, firewalls, threats from individual hackers or automated hacking software. To-date this has mainly been an issue at enterprise level for most utilities and plant interfaces have been mostly on internal private systems with a lower probability of threat. However, with the opening of communications to the use of Ethernet and IT technology it is critical for utilities to ensure the security of these links. Therefore, security must be an integral part of the Rural Smart Grid solution, both from an operational and maintenance perspective.

Due to the remote rural location of the substations and the lower levels of physical security it has been decided to ensure that all external communications are subject to an appropriate level of security. Therefore the LC and TC RTUs will become the secure data gateway into the remote substations from the outside world.

To this end, it is important that the devices installed support standard encryption mechanisms and provide end to end application security. Encryption involves encoding the messages/information during transmission and ensuring that it can only be read by the intended recipient. This requires support for Public-key encryption (asymmetric-key encryption) and Symmetric-key encryption (less computationally intensive).

System diagnostics for ongoing maintenance of the system should be provided remotely to avoid unnecessary travel to remote rural locations and expedite the diagnostic process. As this will be available remotely it is important that it uses secure access to avoid cyber attacks on the system. Therefore, Secure Shell (SSH) will be provided for interrogating internal system diagnostic information and Secure Web access using HTTPS will be provided within the RTUs for viewing the local input data and internal diagnostic information. Going forward it is envisaged that minor modifications may be required to the delivered system. Due to the remote location it may be advantageous to permit these changes to be made remotely. Additionally in the event of system failure it may be necessary to collect diagnostic information remotely.

In addition, Simple Network Management Protocol (SNMP) should be provided for system network diagnostics. It will be useful to develop metrics on the operational performance of the system over a protracted period of time. Using SNMP will allow the RTU's to become part of the IT reporting infrastructure in the same was at a network switch / router or PC.

In order to facilitate the various security related developments outlined above, the basic building blocks of secure socket layer (SSL) and transport layer security (TLS) will need to be integrated into the RTU firmware libraries especially protocols.

Finally since the IT policies of Eypesa specify secure remote authentication using RADIUS servers, a RADIUS client will have to be incorporated in the RTU.

Interface summary

In this section, a summary table is presented. This table will form the basis of the discussions regarding the interfaces.

DIM	Process	Information/data	GEMS	SCADA	LC	LEMS	TC	LLD
2.1 (each 15 min) *Update forecast and refresh status*	**a.1**	IDPR, DG (except CHP) setpoint and forecast for 1 day scheduled in periods of 15 min.	**Protocol:** FTP (tcpip based) **Role:** Producer / / FTP Client / **Process**: creates and sends the csv format file for the LLD.	**Protocol:** FTP (tcpip based) **Role:** / Consumer / FTP Server… **Process**: receives, and process the CSV file. The SCADA might modify the file before sending it to the Local EMS.				
	a.2	IDPR, DG (except CHP) setpoint and forecast for 1 day scheduled in periods of 15 min.		**Protocol:** SFTP **Role:** SFTP client **Process**: the setpoints schedule is sent to the LC. The data in the file received due to a.1 process might be used or modified by the SCADA	**Protocol:** SFTP **Role:** SFTP server **Process**: receive the scheduled setpoints and forecast in the CSV file and pass it on as is			
	a.3	IDPR, DG (except CHP) setpoint and forecast for 1 day scheduled in periods of 15 min.			**Protocol:** ftp **Role:** FTP Client **Process**: send the scheduled setpoints and forecast CSV file.	**Protocol:** ftp **Role:** FTP Server **Process**: receive and process the scheduled setpoints and forecast in the CSV file		
	a.4	EMUs averaged powers, for the last 15 min. and present devices status (IDPR, DG, ESE) – Averaged data from the network.	**Protocol:** FTP (tcpip based) **Role:** / Consumer / **Process**: receives and process the network data	**Protocol:** FTP (tcpip based) **Role:** Producer / **Process**: averages realtime data from the LC and sends it to the GEMS.				
2.2 (each 1 min) *Energy local management*	**b.1**	IDPR and DG status and present values.			**Protocol:** Modbus TCP/IP **Role:** Slave **Process**: send requested data provided, from the field in the form of modbus packets	**Protocol:** Modbus TCP/IP **Role:** Master **Process**: request data to the LC via Modbus read services. Data will be obtained in realtime and will be used by the LEMS when required to run the EMS algorithms		

	b.2	IDPR and DG setpoint (real time)		.	**Protocol:** Modbus TCP/IP **Role:** Slave **Process**: receive data that is used to manage new targets.	**Protocol:** Modbus TCP/IP **Role:** Master **Process**: EMS algorithms end computation. Then, LEMS sends new data.		
	b.3	IDPR and DG setpoint (real time)			**Protocol:** IEC 104 over TCP/IP **Role:** Master **Process**: send data to the TCs. Each TC only receives data concerning the devices connected to itself.		**Protocol:** IEC 104 over TCP/IP **Role:** Slave **Process**: receive data concerning its LLDs from the LC.	
	b.4	IDPR and DG setpoint (real time)					**Protocol:** Modbus over RS-485 **Role:** Master **Process**: send data to its LLD via Modbus write services.	**Protocol:** Modbus over RS-485 **Role:** Slave **Process**: each receive data from its local TC. .
2.3 (polling.) *SCADA refresh*	**c.1**	EMUs averaged powers, RMS voltages and currents, present devices status (IDPR, DG, ESE)		**Protocol:** IEC 104 over TCP/IP, with FTP **Role:** Master **Process**: request data from the overall process.	**Protocol:** IEC 104 over TCP/IP, with FTP **Role:** Slave **Process**: send all aggregated data.			
2.4 (async.) *Remote operation*	**d.1**	Commands to manage LLDs (DG, IDPR, ESE)		**Protocol:** IEC 104 over TCP/IP, with FTP **Role:** Master **Process**: the SCADA supervisor decides to change the status of some LLD. Thus, the SCADA system sends the corresponding command to the LC.	**Protocol:** IEC 104 over TCP/IP, with FTP **Role:** Slave **Process**: receive one command to a specific LLD.			
	d.2	Commands to manage LLDs (DG, IDPR, ESE)			**Protocol:** IEC 104 over TCP/IP **Role:** Master **Process**: send data to the proper TC depending on the destination LLD of the command.		**Protocol:** IEC 104 over TCP/IP **Role:** Slave **Process**: receive data	

	d.3	Commands to manage LLDs (DG, IDPR, ESE)					**Protocol:** Modbus over RS-485 **Role:** Master **Process**: send data to the proper LLD via Modbus write services.	**Protocol:** Modbus over RS-485 **Role:** Slave **Process**: receive data from its TC.
2.5 (async.) *Alarms*	**e.1**	Notification of alarm, abnormal situation, unexpected event… This implies information about either the device and the event itself.			**Protocol:** IEC 104 over TCP/IP **Role:** Master **Process**: receives an alarm message (Does 104 supports it?).		**Protocol:** IEC 104 over TCP/IP **Role:** Slave **Process**: the TC polls all its LLD status and alarms registers due to f.1. With this information, the TC identifies one abnormal occurrence. Thus, it generates an alarm message (Does 104 supports it?)	
	e.2	Notification of alarm, abnormal situation, unexpected event… This implies information about either the device and the event itself.		**Protocol:** IEC 104 over TCP/IP **Role:** Master **Process**: receives an alarm message (Does 104 supports it?).	**Protocol:** IEC 104 over TCP/IP **Role:** Slave **Process**: the LC has received an alarm message from, at least, one TC (Does 104 supports it?)			
2.6 (determined by f.x) *Local control data refresh*	**f.1** (polling.)	EMUs averaged powers, RMS voltages and currents, present devices status (IDPR, DG, ESE)					**Protocol:** Modbus over RS-485 **Role:** Master **Process**: the TC polls all its LLD status, magnitudes and alarms registers.	**Protocol:** Modbus over RS-485 **Role:** Slave **Process**: the polled LLD answers with the requested information.
	f.2 (each 1 min.)	EMUs averaged powers, RMS voltages and currents, present devices status (IDPR, DG, ESE)			**Protocol:** IEC 104 over TCP/IP **Role:** Master **Process**: request data to all TC.		**Protocol:** IEC 104 over TCP/IP **Role:** Slave **Process**: answers requested data.	

Sample File Formats

Below are the Sample file formats for transferring data between GEMS, SCADA and LEMS

The 2 file formats that may be used are:

1. MV_CSV-Format for Measured Values-CSV for transferring data from SCADA → GLOBAL EMS
   which will comprise of Measurements, Set points, IDPR states, Switching states
2. OPT_CSV-Fomat for Optimization files for transferring results from GLOBAL EMS → SCADA → LC → LOCAL EMS
   which will comprise of OPF results: new set points, forecasts.

<u>Measured values to be exchanged (from SCADA to GEMS)</u>

Which information do we need?

-measurements: P, Q, (float), SOC

-switching states (also the IDPR internal switches)

- 0 intermediate (old state is still valid)
- 1 for off
- 2 for on
- 3 disturbed

- IDPR mode (MASTER/SLAVE)

<u>Optimal values to be exchanged (from GEMS to SCADA)</u>

-Set points (e.g. P, Q, (float))

-Suggestion for switching states (also the IDPR internal switches)

- 0 intermediate (not used)
- 1 for off
- 2 for on
- 3 disturbed (not used)

-Suggestion for IDPR mode (MASTER/SLAVE)

<u>Time ranges</u>

-Data files from SCADA to GLOBAL EMS: every 15min, but not shorter

-Results: on demand (shortest time range is 15min)

-OPF forecast: max. 3 days (min. 24h ahead) with values for every 15min

-Measurement files may contain

- only changed data (small files)

File name

<SOURCE_NAME>_<DATE_TIME>.csv

ESTABANELL_2010−05−11T15: 31.301Z.csv

Attribute definition

File format: CSV

File encoding: UTF-8 (or plain ASCII without fancy characters)

Column separator: ‘,’ (comma)

First line: Header

Floats: using English format (Locale.English)

Col.	Column	Description	Mandatory defaults	Sample
1	Name	Hierarchical name of the measurement	yes	IDRP-01_SetPoint_ActivePower
2	Time	UTC time according to ISO 8601:2004	No Actual time	2010−05−11T15:25:31.301Z YYYY-MM-DD hh:mm:ss.f ‘Z’ is used to declare UTC time
3	Value	Float or integer (decimal point is ‘.’ a dot)	yes	50.0
4	Unit		As defined by static data model	kW
5	Quality	To be discussed: OK/NOK TEST	Default: OK	
6	Sign	Only if the sign shall be reversed		-1
7	Info	Additional information (plain text)		

Appendix B – Sample Test Specification Format

Introduction

This document describes the tests to be performed……………….. It also provides the test sheets and lists, on which the test results are recorded.

B.1 References

- *Ref A*
- *Ref B*

B.2 Test Location

This test will be carried out at the following location:

Location of testing

B.3 Goal of Test

The goal of the Testing is to verify the following listed items to establish a reasonable level of confidence in the correctness and functioning of the …………

B.4 Non-Conformances

Where discrepancies occur between the expected result and the actual result, they may be noted on the relevant test sheet, but they must be individually entered on the Non-Conformance Summary (Appendix B) where each non-conformance is given a unique reference number.

Subsequently a Non-Conformance Report (NCR) will be generated for each Non-Conformance (see Appendix C for blank), which may happen during the FAT. Any such NCR's become part of the FAT documentation and should be attached to it.

When a non-conformance has been rectified, the appropriate test is repeated to verify the correction.

B.5 Test Sheets

Test Sheets should contain the following information:

1. Project Details
2. Test Category (general description of test section)
3. Unique test reference number
4. Brief description of the test
5. Actions required to perform the test
6. Expected results
7. Pass/fail criteria
8. Sign-off section
9. Comment section

B.6 List of Tests to be Performed

	Category	**Test**	**Procedure Reference**
1	Inspection Tests	*Test A*	A1.1
2	Functional Tests	*Test B*	A1.2
3	Functional Tests	*Test ……*	A1…….

B.7 Setup of Equipment under Test

Provide a brief description of the test arrangement.

B.8 Firmware and Software Verification

Provide a list of firmware revisions used in the testing.

Sample Test Sheet

Single Digital Input Channel Verification - Virtual

Project:	**Smart Rural Grid**
Category:	**Functional Test**
Test Item:	**Input Channels - Virtual**
Test Reference:	**Functional 1. 2**

Test Objectives:	To verify inputs activate the correct IEC points through the RTU config to the HMI
Test Configuration:	Refer to Section 1.
Initial Conditions:	1. Ensure workbench is connected to processor 1 over UIP.
	2. Ensure the HMI is communicating correctly to the RTU.
	3. Select the appropriate display group on the front panel of the appropriate CPR to display Digital Inputs.

Actions		**FAT Pass / Fail**	**NCR**
1	Ensure that the CGAS Workbench Database Messages are enabled and a full update scan has completed prior to proceeding to next step.		
2	Using RTU live Simulate a change on the first virtual point via the DNP or MK2A as applicable and as per the facility schedule.		
3	Verify that a corresponding change event is seen within the RTU Live display on workbench.		
4	Verify that the HMI sees the corresponding state and generates an alarm as expected on all relevant screens, i.e. Annunciator, Alarm Bay, Alarm list, events List.		
5	De-activate the input.		
6	Verify that a corresponding change event is seen within the RTU Live display on workbench.		
7	Verify that the HMI sees the corresponding state and de-activates the alarm as expected on all relevant screens, i.e. Annunciator, Alarm Bay, Alarm list, events List.		
8	Repeat for each Virtual SDI Input as per the facility schedule.		
Comments:			

TEST RESULT:	**PASS/FAIL**
Signed for CG AS UK Ltd:	Date:
Signed for Witness	Date:

Non Conformance Record Summary

NCR No.	Description	Actioned by	Date
Signed for Customer:		**Date:**	
Signed for CG AS UK Ltd:		**Date:**	

Non Conformance Report

NCR No		Project		
Customer			Date	
Test Reference				
Fault type	Software ☐	Hardware ☐	System ☐	

Description

Analysis

Action

Signed		Date	

Test Equipment Record

ITEM	Description	Model No.	Serial No.	Calibration Due Date
TEST RESULT:		**PASS/FAIL**		
Signed for Witness:		**Date:**		
Signed for CGAS UK Ltd:		**Date:**		

Signature Log Sheet

Date	Name	Company	Signature