SCADA Interface Specification

Version 00.60

ประวัติเอกสาร (Document Control)

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สารบัญ (Table of Contents)

หน้า

1 Introduction

1.1 Purpose of the document

This document defines the architecture and specifies all details about the interface between TIBCO and SCADA.

In order to fulfill the approved business processes of the CBS system, any future SCADA system that should be part of the integrated system of PEA has to fulfill these interface specifications. The data model of SCADA system has to be reviewed against the interface. It must be possible to map the SCADA data model against the data model described in the interface. Furthermore, the functionality of the future SCADA system must fully comply with the functionality of the interface.

Since the architecture of the future PEA SCADA system could be based on any technology standard. The SCADA Interface Specification is based on standardized, platform-independent technologies.
It consists of:

- SCADA architecture requirements
- An overview of the interface architecture
- A detailed specification of the used protocols and data structures

1.2 Definitions of terms and abbreviations

Abbreviation	Description
Application Interface	See *Interface*.
Application Service	An application exposes its functionality and data (independent of application-internal data structures) by *Application Services*. These services can be accessed via the *Application Interface*.
ADMS (SCADA)	Advanced Distribution Management System is an electric distribution management and optimization platform.
CBS	Core Business System for PEA that included SAP, OMS, BPM and ESB.
ESB	Enterprise Service Bus; see TIBCO

Inbound	Inbound and Outbound are used from the application point of view, therefore an inbound application service transports data from TIBCO to ADMS.
Outbound	Inbound and Outbound are used from the application point of view, therefore an outbound application service transports data from ADMS to TIBCO.
Interface	An interface provides access to an application's services and its data (see Application Services). It includes the communication protocol and the data structures. Examples for communication protocols are: RESTful, HTTP(s), ALE/BAPI, web services, JMS etc. Examples for data structures are: specific customized IDOCs, XML, JSON schemas etc.
TIBCO	Platform to integrate the CBS applications with PEA SCADA, GIS, Smart Plus and Call Centre systems.
REST	Representational State Transfer
JSON	JavaScript Object Notation
eRespond (OMS)	An outage management system that is developed by Trimble company.

1.3 Relationship with other documents

The following documents are related to this document. The ID is used to reference them in this document.

ID/Document	Version	Date	Author	Company/ Department
[1] Integration Architecture	Latest	Latest	Sarawoot	Portalnet
[2] RESTful https://www.ics.uci.edu/~fielding/pubs/dissertation/rest_arch_style.htm	Latest	Latest	Uci.edu	Uci.edu
[3] JSON https://www.json.org/json-en.html	Latest	Latest	Json.org	Json.org
[4] TIBCO BusinessWorks 6.6.0	Latest	Latest	TIBCO	TIBCO

[5]	eRespond_SCADA interface functional specification	3.6	March 2011	Trimble	Trimble
[6]	PEA_TDMS_ADD-Switching_Management	2.0	July 2021	Schneider	Schneider

2 Overview

The SCADA system supervises and controls the HV and MV power distribution network. It provides information about switch statuses, alarms and analogue measurement values to other applications.

2.1 Architecture

Figure 1 shows the SCADA architecture. Not all of these components are relevant for the SCADA interface; however this section should give the reader a general understanding of data storage and distribution in the SCADA system.

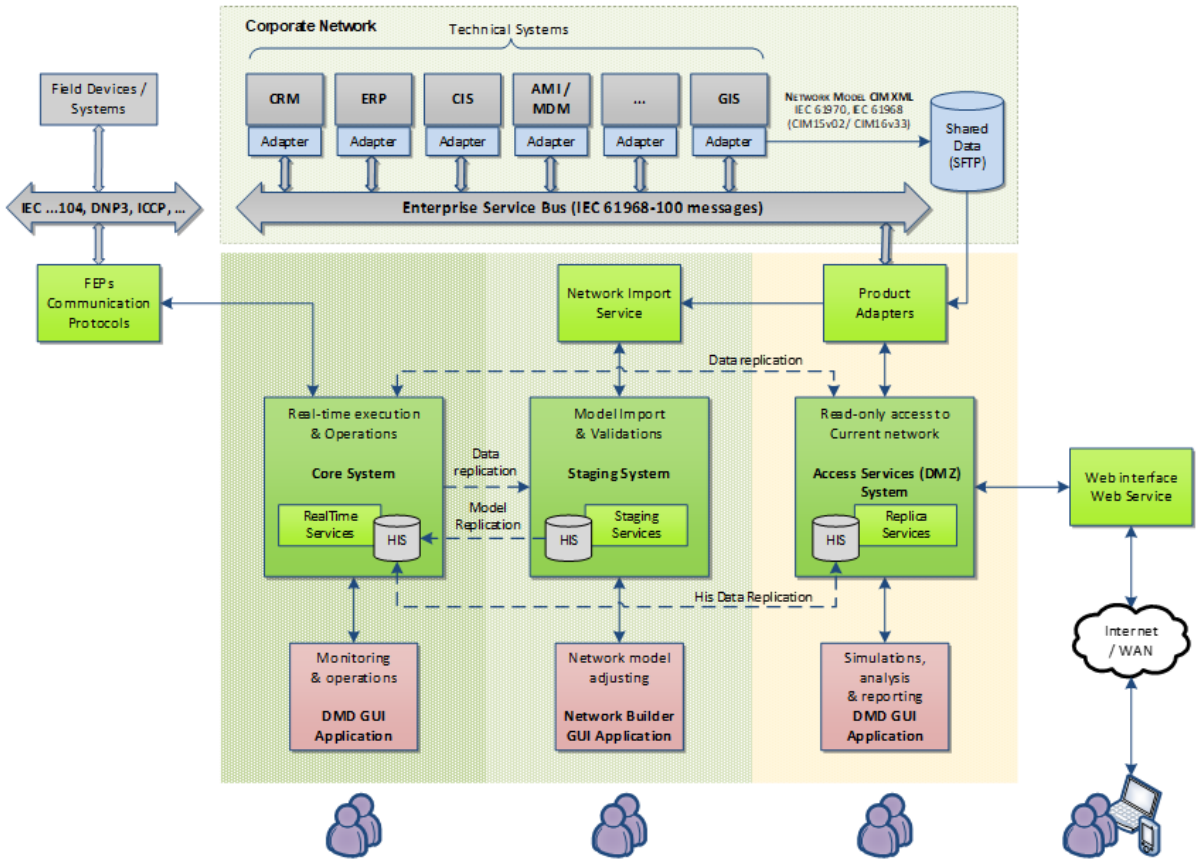


Figure 1: Overview of the SCADA Architecture

2.2 Application Services

The following table lists the application services that are provided for any SCADA. The application services provide data from the OMS, SAP, GIS and SCADA business domains.

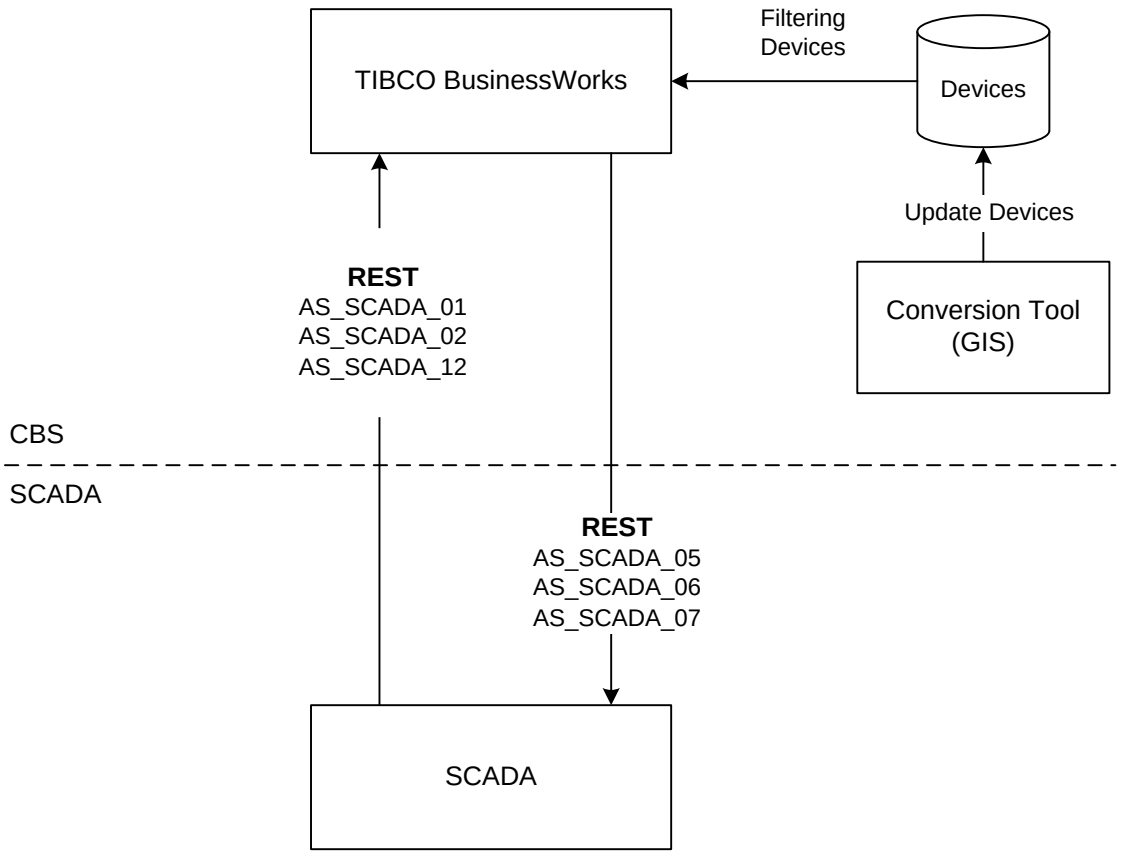
AS ID	Application Service Name	Protocol	Direction
AS_SCADA_01	Switching Order	REST	Outbound
AS_SCADA_02	Device Status Change	REST	Outbound
AS_SCADA_05	Snapshot of Analogue Values	REST	Inbound
AS_SCADA_06	Device Status Request	REST	Inbound
AS_SCADA_07	Planned Outage	REST	Inbound
AS_SCADA_12	Temporary Network Change	REST	Outbound

Table 1: Application service overview

3 Interfaces

REST/JSON technology will be used for SCADA integration.

The Figure 2 and following sections describe the architecture of SCADA interface:



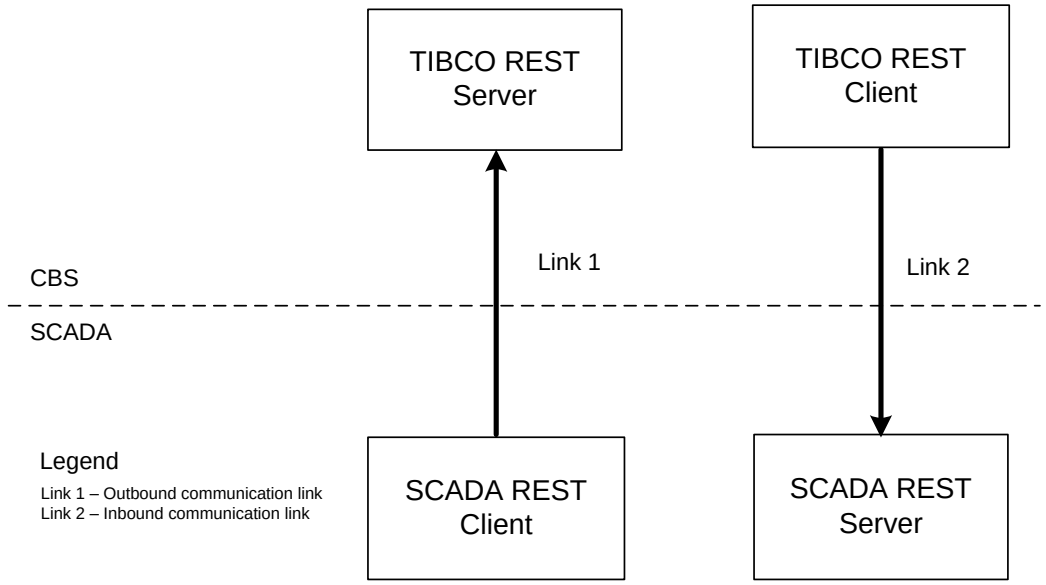
The Figure 2: SCADA Interfaces and Application Services

3.1 REST/JSON

REST is based on the web service protocol which is a standard for exchanging JavaScript-based JSON messages via a network. For the network layer JSON relies on various protocols and the common is TCP/IP protocol (see 3.1.1).

The interfaces are designed for centralized SCADA system.

An adequate network connection to the SCADA servers needs to be provided by PEA.



The Figure 3: CBS and SCADA Communication Links

3.1.1 Communication Protocol

The following protocols are used:

Type	Protocol	Description
Application	JSON	Is a Javascript-based protocol for the network-based exchange of information between applications See [3] for more information on the JSON standard
Application	HTTPS	This is used to transport JSON messages
Transport/Network	TCP/IP	TCP/IP is used as network protocol

Table 2: Communication protocols for REST

3.1.2 Data Format

The interfaces use JSON for its payload. For each application service, input and output schemas are defined in chapter 5.

Unicode/UTF-8 is applied for character encoding.

Timestamp format will be followed the XSD standard which is “xsd:datetime”

3.1.3 Error Handling

For the SCADA interfaces, there are two types of errors defined:

- Communication Error: HTTP connection exception. (e.g. because the network or the target server is down). The “Error” class is used as HTTP response status code standard.
- Application Error: The ADMS and TIBCO were connected and request was transmitted successfully but response message with an error (e.g. a query returns “record not found”). In this case, the error handling also differs depending on whether the application service is inbound or outbound.
  An application error is raised by standard SCADA or TIBCO error mechanisms.

3.1.4 Sequence of Delivery

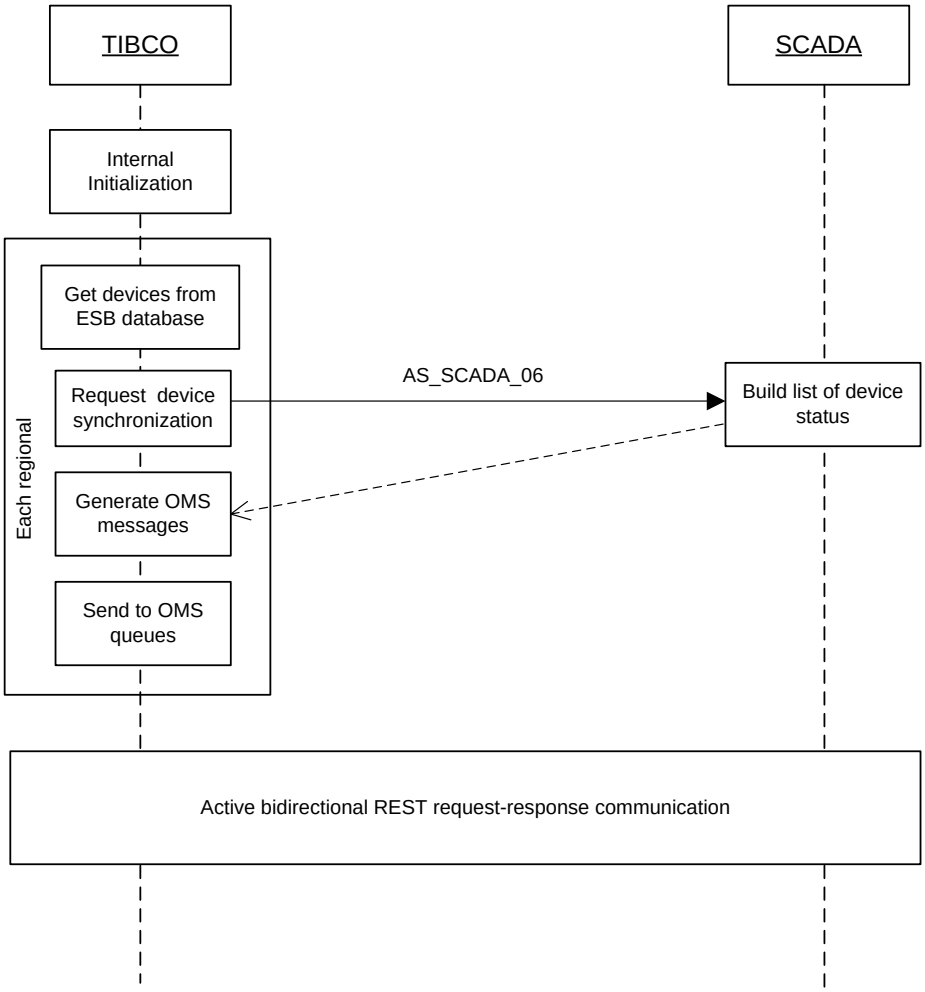
To guarantee that messages are delivered in the correct order no parallel processing may take place. For this the client is responsible, REST’s request of a device information to an application service may not be called twice or more times in parallel. Transaction ID (message ID) and Transaction ID Manager (TID) may be used for this manner.

This applies for both inbound and outbound messages; in both cases the respective client part (SCADA or TIBCO) is responsible.

3.2 Adapter Initializing Process

In order to start interfaces between SCADA and OMS, it is required to resynchronize device statuses. TIBCO REST Adapter will do this in the initialization process, everytime starting.

To optimize starting time of the adapter, the TIBCO REST adapter may provide multiple processes for device status request and provides separated message queue for each region. The number of devices per a request can be configurable to compromise between workloads and adapter start time.



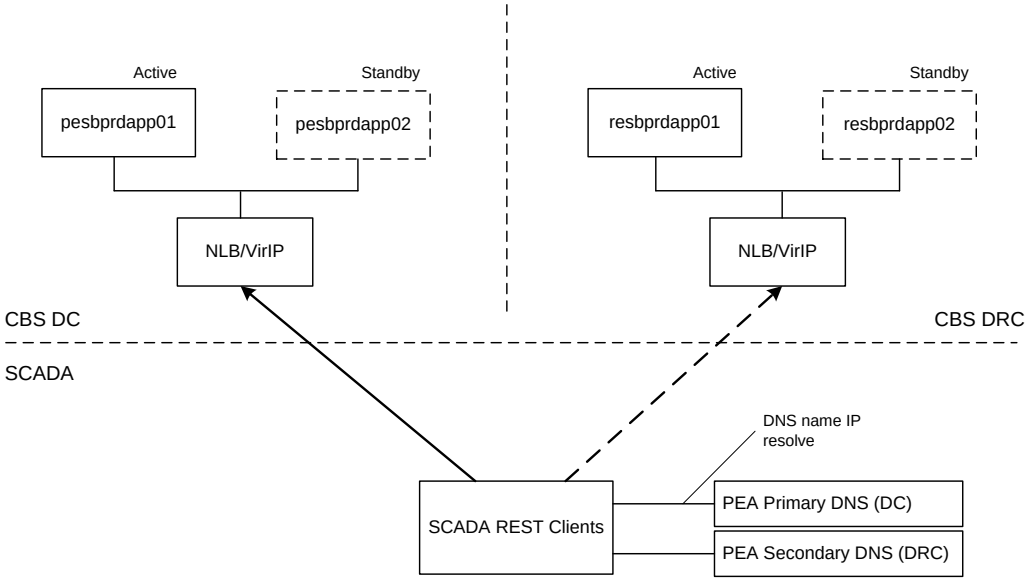
The Figure 4: TIBCO REST adapter initializing process

3.3 High Availability and Disaster Recovery (HADR)

TIBCO REST adapter is a program installed in every TIBCO server nodes. It serves all ESB's interfaces both inbound and outbound. The adapter has implemented a native TIBCO cluster technology that can be automatically failover and failback between servers running in the data centre.

For outbound interfaces (Figure 5), it uses Network Load Balancer (NLB) or virtual IP (VirIP) to provide a single access point for SCADA REST clients. Then SCADA can push outbound messages (REST request) to TIBCO. The single access point is formed by standard HTTP URL with DNS naming by PEA (see 4).

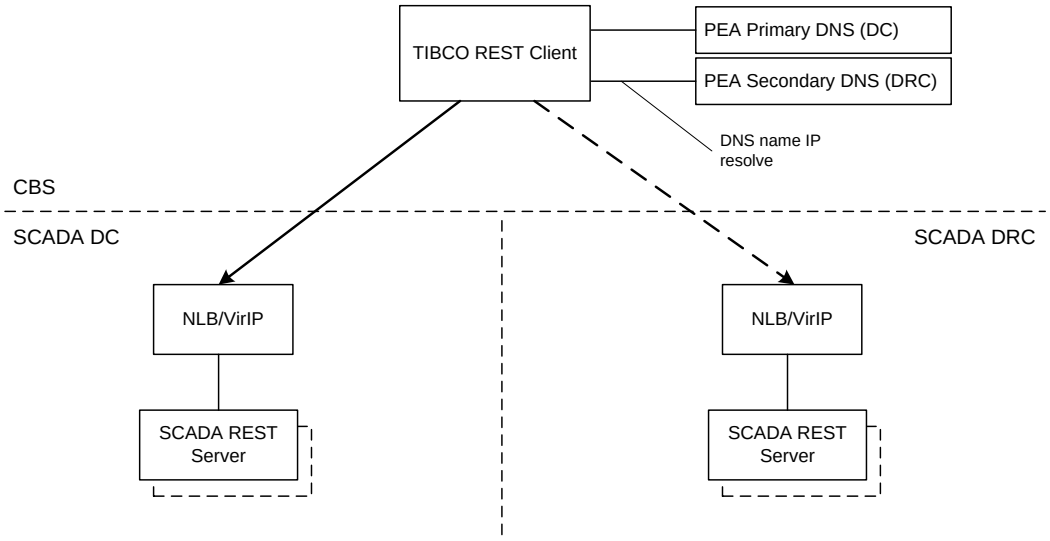
CBS system may switch-over to Disaster Recovery Centre (DRC) due to business continuity plan with or without notification to SCADA. Hence, SCADA clients have to resolve the requesting URL by using PEA DNS server to have the active IP address of the single access point.



The Figure 5: TIBCO HADR for Outbound interfaces

For inbound interfaces (Figure 6), SCADA must provide a single access point or virtual IP (VirIP) for TIBCO REST clients. The virtual IP encapsulates SCADA server's cluster from TIBCO. It is in form of standard HTTP URL with virtual IP address.

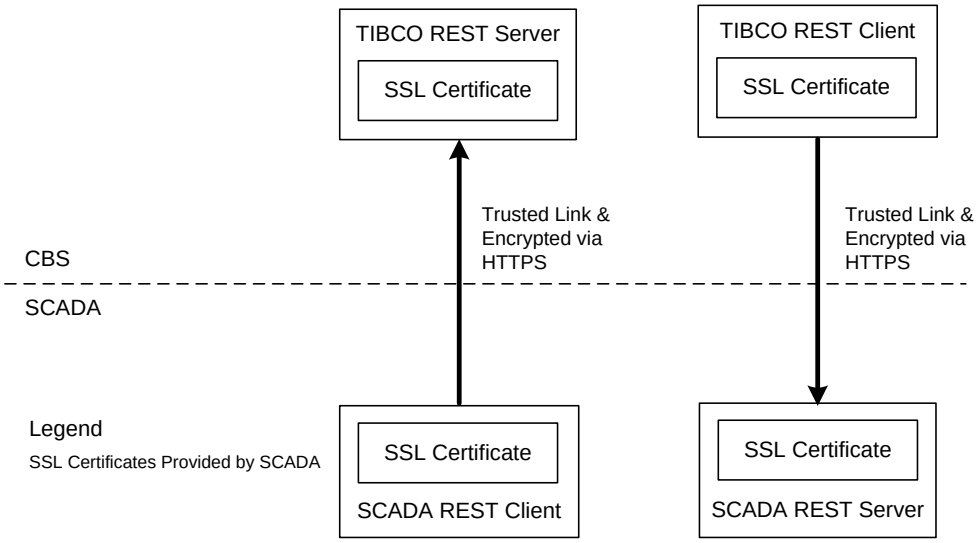
Also, SCADA system may switch-over to Disaster Recovery Centre (DRC) due to business continuity plan. TIBCO Clients are connected to PEA DNS to resolve the service URLs to the active SCADA virtual IP address.



The Figure 6: SCADA HADR for Inbound Interfaces

3.4 Security

RESTful/JSON invocation, both inbound and outbound services are granted by SSL certification. A pair of server/client is installed the same set of SSL certification to create a trust communication channel via HTTPS protocol. All interface messages are encrypted.



The Figure 7: Secured Communication Link

4 Application Services

The SCADA application needs to provide the following application services for the CBS project, and vice-versa. All application services are providing data in the network information business domain.

The network information can further be grouped as follows:

- Telemetry Data: Raw data that is generated by elements of the power grid
- Switching Order: Information on planned changes in the networks status
- Temporary Network Changes: Information on unplanned changes in the network Status
- Maintenance Data: Necessary information about outages for exchange between OMS and SCADA

4.1 AS_SCADA_01: Switching Order

4.1.1 General Information

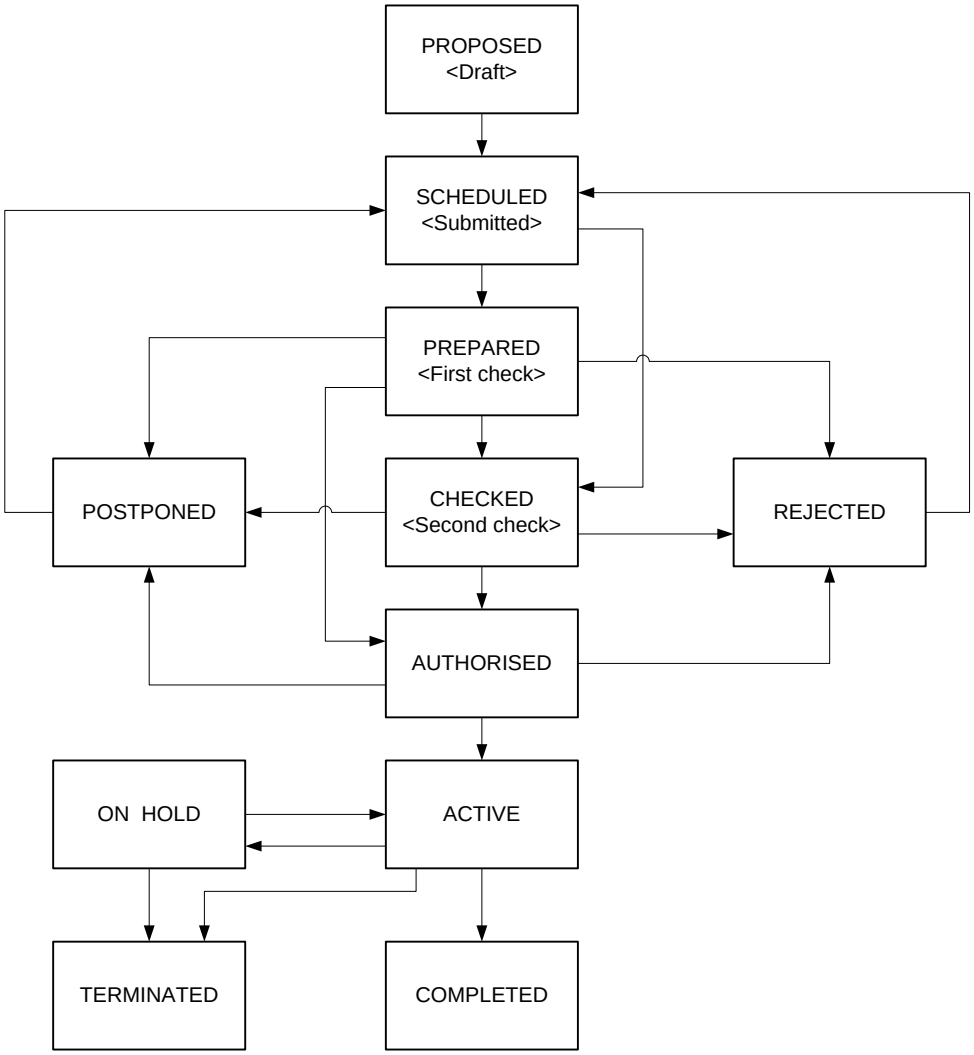
Description	This application service provides information about creation, update or deletion of SCADA switching orders.
Interface	REST
Direction	Outbound
Timing	Event-Driven
Trigger	Creation, change or deletion of a switching order or a switching item.
API endpoint	https://<esb-hostname>:7200/scada/as_scada_01
Filter	-
Constraint	Unique Identifier (Planned outage ID) is required as an integration key.

4.1.2 Interface specific information

Input Schema	SwitchingOrder
Output Schema	-

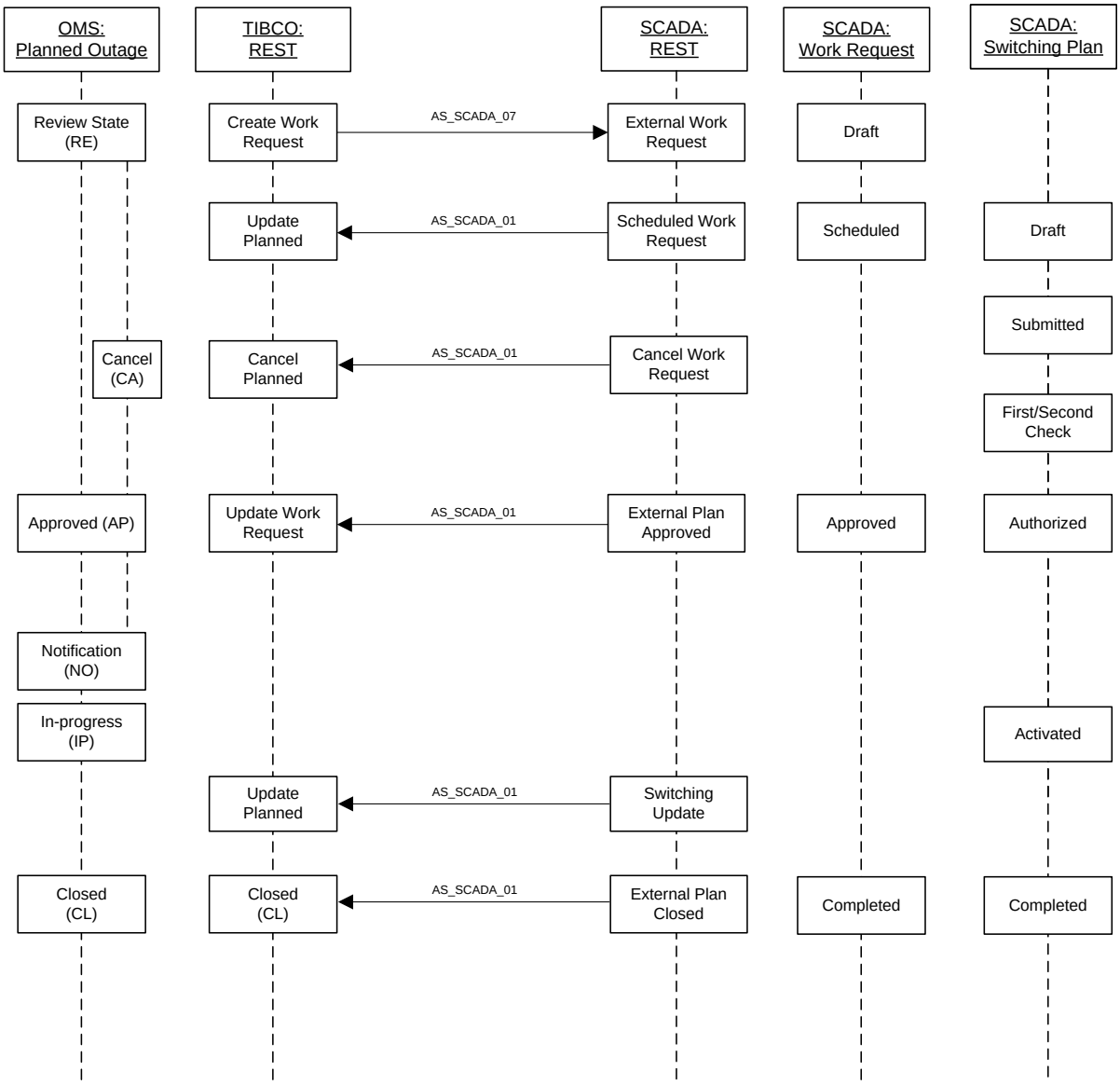
4.1.3 Switching Plan Lifecycle

When the switching plan is created, it can be transferred through different lifecycle states [6].



The Figure 8: Switching Plan lifecycle

4.1.4 Sequence of Delivery



The Figure 9: Switching order interfaces full sequence

4.2 AS_SCADA_02: Device Status Change

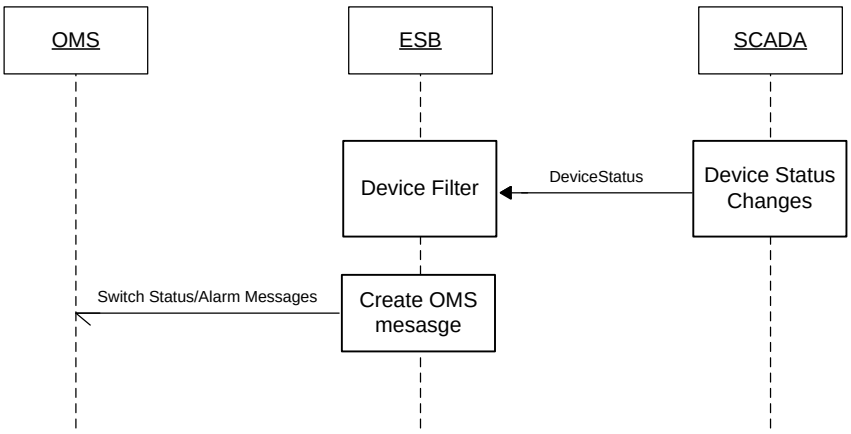
4.2.1 General Information

Description	This application service provides information about device status changes either through a protection action, remote control or manual control. Also provides trip alarms and non-outage high priority alarms. The second type includes transformer winding temperature alarms, substation intruder alarms. Note: Any single message instance must contain either status or alarms.
Interface	REST
Direction	Outbound
Timing	Event-Driven
Trigger	Change of a device status, alarm and/or switch status.
API endpoint	https://<esb-hostname>:7200/scada/as_scada_02
Filter	TIBCO, deviceName (TAG) filter list received from GIS. TIBCO, quality = “GD” (Good)
Constraint	The devices are uniquely identified by GIS Tag.

4.2.2 Interface specific information

Input Schema	DeviceStatus
Output Schema	-

4.2.3 Sequence of Delivery



The Figure 10: Device Status message sequence

4.3 AS_SCADA_05: Snapshot of Analogue Values

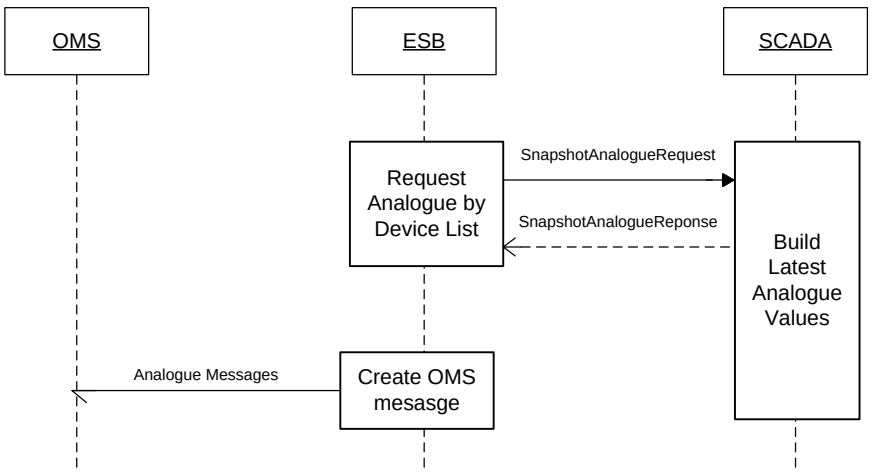
4.3.1 General Information

Description	This application service provides a list of analogue values, based on a direct measurement from a field sensor. This is triggered by a periodic refresh.
Interface	REST
Direction	Inbound
Timing	Scheduled
Trigger	TIBCO timer repeatedly
Filter	Request device list will be defined by TIBCO. SCADA returns the available device values.
API endpoint	https://<scada-hostname>:8443/<scada-service>
Constraint	The analogues are uniquely identified by GIS Tag and unit.

4.3.2 Interface specific information

Input Schema	SnapshotAnalogueRequest
Output Schema	SnapshotAnalogueResponse

4.3.3 Sequence of Delivery



The Figure 11: Snapshot Analogue message sequence

4.4 AS_SCADA_06: Device Status Request

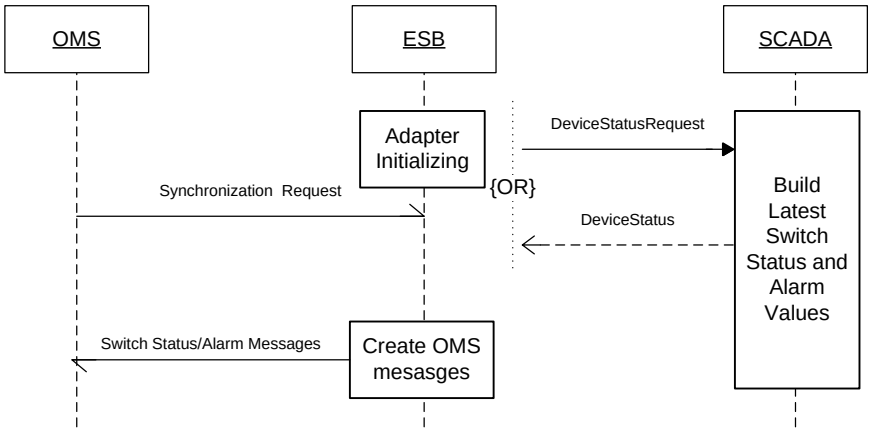
4.4.1 General Information

Description	This application service provides the possibility to synchronize OMS with the current status of all switches and all alarms to ensure that OMS has correct data. The result is sent also as an unsolicited message during failover and data transfer activation.
Interface	REST
Direction	Inbound
Timing	Event-Driven
Trigger	TIBCO REST adapter starts OMS sends request for synchronization
Filter	TIBCO, GIS Tag filter list received from GIS. TIBCO, quality = “GD” (Good)
API endpoint	https://<scada-hostname>:8443/<scada-service>
Constraint	The devices are uniquely identified by GIS Tag.

4.4.2 Interface specific information

Input Schema	DeviceStatusRequest
Output Schema	DeviceStatus

4.4.3 Sequence of Delivery



The Figure 12: Device Status message sequence

4.5 AS_SCADA_07: Planned Outage

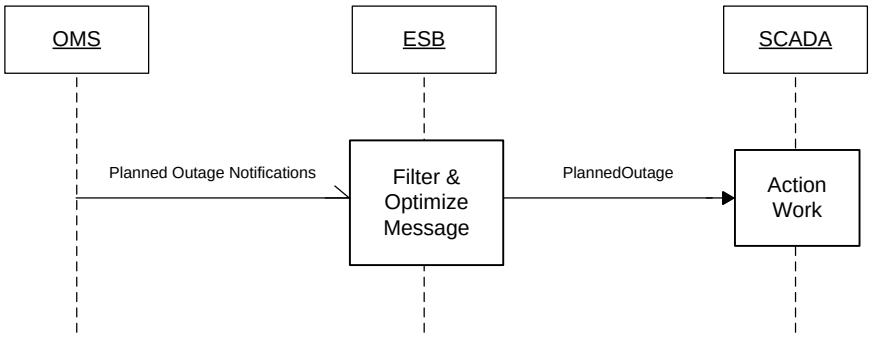
4.5.1 General Information

Description	Receive from OMS a planned switching, which have to be informed about details and statuses of planned outage(s). SCADA can be informed either manually or automatically (by this as) or by other communication method.
Interface	REST
Direction	Inbound
Timing	Event-Driven
Trigger	ETR or Status changed after planned outage creation in the OMS system.
Filter	Only verb “Create“ is sent to SCADA
API endpoint	https://<scada-hostname>:8443/<scada-service>
Constraint	-

4.5.2 Interface specific information

Input Schema	PlannedOutage
Output Schema	-

4.5.3 Sequence of Delivery



The Figure 13: Planned Outage message sequence

4.6 AS_SCADA_12: Temporary Network Change

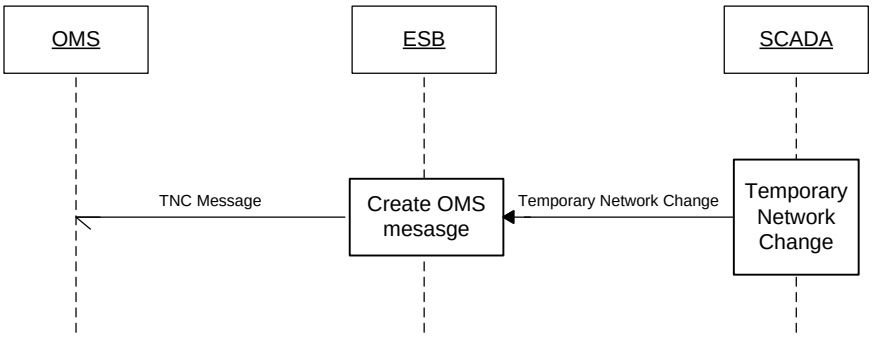
4.6.1 General Information

Description	This application service provides information on temporary network changes (Jumpers, cuts and grounds).
Interface	REST
Direction	Outbound
Timing	Event-Driven
Trigger	Temporary elements will be created by SCADA operators. SCADA sends temporary elements information to OMS.
Filter	-
API endpoint	https://<esb-hostname>:7200/scada/as_scada_12
Constraint	Terminal ID of operational device must exist in the OMS.

4.6.2 Interface specific information

Input Schema	Temporary Network Change
Output Schema	-

4.6.3 Sequence of Delivery



The Figure 14: Temporary Network Change message sequence

4.7 Heartbeat

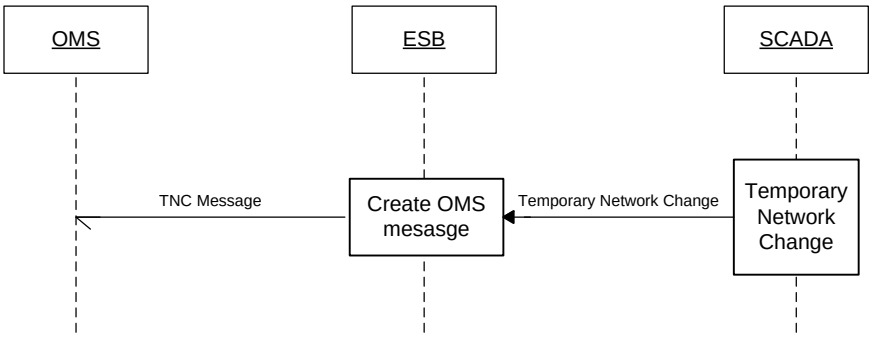
4.7.1 General Information

Description	Both SCADA and ESB should provide a REST get method for getting server datetime as a ping service for its partner. This method will be periodically called for make sure the target system is alive before starting to send message. If not alive, sending process is suspended.
Interface	REST
Direction	Inbound/Outbound
Timing	Scheduled
Trigger	TIBCO timer repeatedly
Filter	-
API endpoint	https://<esb-hostname>:7200/scada/getdate https://<scada-hostname>:8443/getdate
Constraint	All application services will be suspended if the heartbeat is lost

4.7.2 Interface specific information

Input Schema	Heartbeat
Output Schema	-

4.7.3 Sequence of Delivery



The Figure 14: Temporary Network Change message sequence

5 Data Model

This section documents the data model that is leveraged by the application services, that means that each schema that is named in chapter 4 maps to a class in the data model.

Attributes usually have a 0..1 or 1 multiplicity depending on whether they are optional or mandatory This is not stated explicitly, however if the multiplicity is 0..n or 1.n this is stated in the stereotype of the attribute.

The classes from the data model are implemented as XSD schemas. However, to ease of 3rd party interface implementation, the latest XSD file will be provided.

5.1 Switching Order

Name	Type	Description
SwitchOrder [1..1]		
EventTime	xsd:dateTime	SCADA server timestamp. Mandatory
SheetDisplayId	xsd:string	Displayed switching order identification. Used to OMS descriptions. Mandatory
Deleted	xsd:boolean	Indicates that the switching order has been deleted. (Y/N) Mandatory
SwitchHeader [1..1]		
AuthorisationNo	xsd:string	Used to OMS description Mandatory
WorkOrderNo	xsd:string	Work order number (Outage ID from OMS) Mandatory
Title	xsd:string	Used to OMS description Mandatory
SwitchState [1..1]		
State	xsd:string	The status of the switching order, i.e. 'PROPOSED', 'SCHEDULED', 'PREPARED',etc Mandatory
SwitchGeneral [1..1]		
AOJ	xsd:string	The local office/area of jurisdiction under which the outage falls, e.g. C1AYA etc. Mandatory
Description	xsd:string	Used to OMS description Mandatory
Locality	xsd:string	Officer location to be responsible (EO location)
WorkType	xsd:string	Switching order work type identification. The reason the outage is required. See work type DESCRIPTION in 7.4 Mandatory
FwdStartExpDate	xsd:dateTime	The time when the planned outage is expected to start.
RevEndExpDate	xsd:dateTime	The time when the planned outage is expected to end. Mandatory
SwitchItems [1..1]		
SwitchItem[1..n]		
ItemId	xsd:string	The unique id used for the switching item in the SCADA system. Mandatory
LineNo	xsd:string	Line number description. Mandatory
DisplayNo	xsd:integer	The position of the switching item in the sequence. Mandatory

	Locality	xsd:string	The unique id used for the switching item in the SCADA system. Mandatory
	AppName	xsd:string	DeviceName in Respond Mandatory
	StdStmtCode	xsd:string	The operation to be performed. See switching operation SHORT CODE in 7.3 Mandatory
	Executable	xsd:string	Is SwitchingItem can be excuted? *TRUE* or *FALSE* Mandatory
	SkippedFlag	xsd:string	Is SwitchingItem can be skipped? *TRUE* or *FALSE* Mandatory
	ExecutedFlag	xsd:string	The status of the switching item. Possible values are 'Instructed' or 'Not Instructed'. Create: *FALSE* Update: *TRUE* Mandatory
	TimeTag	xsd:dateTime	The time the switching step was performed. Mandatory
	WorkStartTimeTag	xsd:dateTime	The time the switching instruction was issued. Mandatory
	FormattedLocation	xsd:string	Any details associated with the switching item. Mandatory
	FormattedApparatus	xsd:string	Any details associated with the switching item. Mandatory
	FormattedStatement	xsd:string	Any details associated with the switching item. Mandatory
	FormattedPSRDesc	xsd:string	DeviceName in Respond Mandatory
SwitchHistory [0..1]			
	PerformedBy	xsd:string	The person who created/requested the outage Mandatory
SwitchHistoryLogEntry [1..n]			
	DateTime	xsd:dateTime	DateTime of Historical Switching Order Mandatory
	PerformedBy	xsd:string	The person who created/requested the outage Mandatory

5.2 Snapshot Analogue Request

Name	Type	Description
Analogue [1..1]		
Device [1..n]		
DeviceName	xsd:string	GIS Tag (unique identifier for network devices). e.g. G-1262XF000000745 Mandatory

5.3 Snapshot Analogue Response

Name	Type	Description
Analogue [1..1]		
Device [0..n]		
DeviceName	xsd:string	GIS Tag (unique identifier for network devices). e.g. G-1262XF000000745 Mandatory
Values [1..n]		
Unit	xsd:string	Short Code of the analogue value See 7.2 for details. Mandatory
Value	xsd:double	The analogue value.

			Mandatory

5.4 Device Status Request

Name	Type	Description
DeviceStatusRequest		
Device [1..n]		
DeviceName	xsd:string	GIS Tag (unique identifier for network devices). e.g. G-1262XF000000745 Mandatory

5.5 Device Status

Name	Type	Description
DeviceStatus [1..1]		
Device [0..n]		
DeviceName	xsd:string	GIS Tag (unique identifier for network devices). e.g. G-1262XF000000745 Mandatory
SwitchStatus [0..1]		
Status	xsd:string	Status of device "OP" = Open "CD" = Close Mandatory
QualityCode	xsd:string	Indicate the quality of the switch status value. Possible values are "GD" = Good "BD" = Bad Mandatory
Alarm [0..n]		
Status	xsd:string	Alarm status of the device. The possible values are "NO" = NORMAL "AB" = ABNORMAL When "AB", OMS will check if it is a part of a known outage, if not it creates a suspect outage on the device. When "NO", OMS will check if it is a part of a known outage, if yes it will generate a system alarm, if not it creates a telemetry alarm on the root device and it will be displayed in the event list. Mandatory
Type	xsd:string	Type of the alarm. Possible values are "TRIP" and "NON-TRIP". Mandatory
Priority	xsd:string	Priority of the alarm. Possible values are "HIGH", "MIDIUM" and "LOW". Mandatory
EventCondition	xsd:string	Event type description. See 7.1 Optional
QualityCode	xsd:string	Indicate the quality of the alarm value. Possible values are "GD" = Good "BD" = Bad Mandatory

5.6 Planned Outage

Name	Type	Description
PlannedOutage [1..1]		
TypeOfAction	xsd:string	'Create' Mandatory
OutageID	xsd:string	Identifier for the OMS event. Mandatory
DeviceID	xsd:string	The name of the root device associated with the fault.

			Mandatory
	CreatedDateTime	xsd:dateTime	Date and time when event was initially raised. Mandatory
	PlannedStartTime	xsd:dateTime	If this is a planned outage, the planned start date/time for work. Mandatory
	PlannedEndTime	xsd:dateTime	If this is a planned outage, the planned end date/time for work. Mandatory
	OutageType	xsd:string	The type of outage Mandatory
	OutageLevel	xsd:string	The level of the outage, e.g. LV, MV, etc. Possible values: it will be defined by OMS system. Optional
	LocalOffice	xsd:string	The name of the local office attending the fault. Mandatory
	ContactName	xsd:string	Name of contact person. Mandatory
	ContactAddress	xsd:string	Value of contact (e.g. address, phone no.) Optional

5.7 Temporary Network Change

Name		Type	Description
TNC [1..1]			
	EventTime	xsd:dateTime	Timestamp when the event occurred. Mandatory
	Device1	xsd:string	The GIS Tag (unique identifier for network devices) of the first device that is involved in the temporary network change. Mandatory
	Device1Terminal	xsd:string	The terminal of the first device that is involved in the temporary network change. Possible values are "1", "2" and "3". Mandatory
	Device2	xsd:string	The GIS Tag (unique identifier for network devices) of the second device that is involved in the temporary network change. Optional Mandatory in case the Operation Short Code(Op)* is PUT_TEMP_CUT or REM_TEMP_CUT * Operation Short Code(Op): The possible values for this field are listed in the eRespond/SCADA Interface Functional Specification [5].
	Device2Terminal	xsd:string	The terminal of the second device that is involved in the temporary network change. Possible values are "1", "2" and "3". Optional Mandatory in case the Operation Short Code(Op)* is PUT_TEMP_CUT or REM_TEMP_CUT * Operation Short Code(Op): The possible values for this field are listed in the eRespond/SCADA Interface Functional Specification [5].
	Op	xsd:string	A short code that identifies the type of the temporary network change. The possible values for this field are listed in the eRespond/SCADA Interface Functional Specification [5]. Mandatory
	SO	xsd:string	This field contains the number of the switching order that this network change is part of. The value has to correspond to the value transmitted in SwitchOrder.SheetDisplayId in the switching order. If this temporary network change is not part of a switching order, then the field has to be omitted.

			Optional

5.8 Heartbeat

Name	Type	Description
datetime	xsd:string	Current server time for destination server

6 Data Filtering

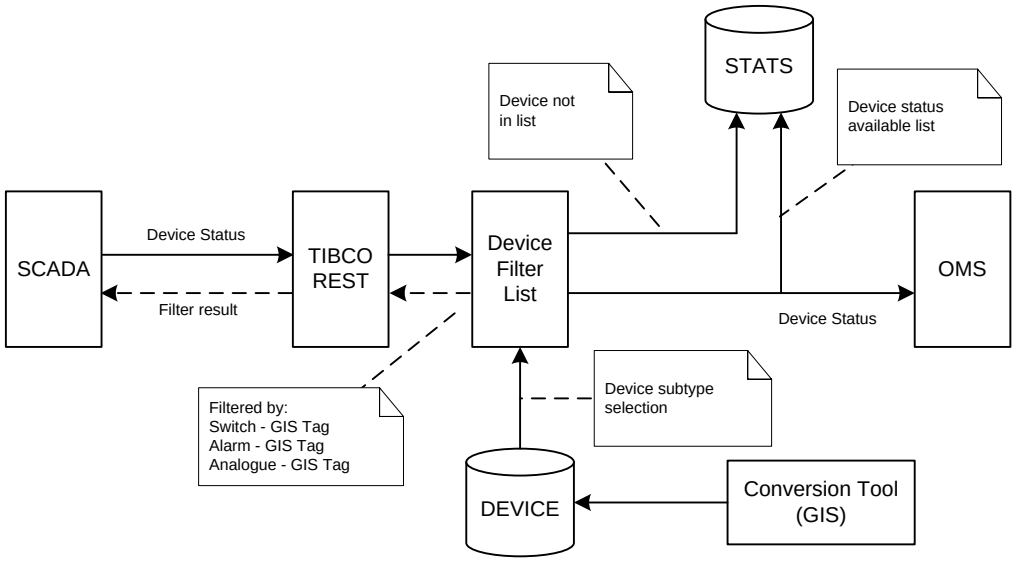
Data filtering is applied to outbound interfaces from SCADA to TIBCO. The devices in the OMS are from GIS system, but the device statuses are from SCADA. Therefore, those systems might be based on different set of devices and result in sending status that does not exist in the OMS. This is a reason to have an ESB data filtering mechanism to avoid unnecessary message processing in the OMS.

6.1 Mechanism

In the figure 15, DEVICE database is an in-memory mapping set of devices of PEA 12 regions. The set of devices are gathering from Conversion Tool that is periodically executed by GIS users. This is a lookup table for TIBCO REST adapter if device exists in the list, the device status will be sent to OMS and also save to STATS database for tracking latest received status. Then if device not exists in the list, it is saved to STATS database as device not in the list for future reporting.

- Device subtype selection list is in 6.2.
- Alarm type description is shown in 7.1.
- Analogue type is shown in 7.2.

Note: Device Filter List database will be reloaded by Conversion Tool. After reloading, ESB will resynchronize every devices in the list, per regional.



The Figure 15: SCADA data filtering flow

6.2 Device Subtype Selection List

This is a list of device subtypes that the Conversion Tool selects from GIS data to DEVICE database.

No.	ShortCode	Description
1	CB_EGAT_HV	Circuit Breaker_EGAT_HV
2	CB_EGAT_MV	Circuit Breaker_EGAT_MV
3	CB_HV	Circuit Breaker_HV
4	CB_MV	Circuit Breaker_MV
5	CB_MV_INC	Circuit Breaker_MV_Inc
6	CB_MV_TIE	Circuit Breaker_MV_TIE for Sub Station
7	RECLOSER	Recloser
8	SW_AIR	Air break Switch
9	SW_AIR_HV	Air break Switch_HV
10	SW_DIS	Disconnecting Switch
11	SW_DIS_HV	Disconnecting Switch_HV
12	SW_GAS	Gas Switch
13	SW_LB	Load Break Switch
14	SW_OIL_HV	Oil Switch_HV

7 Appendix

These are reference tables from [5]. To ease of document usage, it was copied to this section.

7.1 Alarm point types

No.	Point types that OMS will get for alarms	Point Section	Alarms Trip / Alarms Non-Trip
1	BUS - DIFF. OPERATED	115 KV Bay	Alarm Trip
2	BUS - DIFF.LOCKOUT RELAY OPERATED	115 KV Bay	Alarm Trip
3	LINE - DISTANCE TRIP	115 KV Bay	Alarm Trip
4	LINE - LINE AIDED TRIP	115 KV Bay	Alarm Trip
5	LINE - DISTANCE PHASE A TRIP	115 KV Bay	Alarm Trip
6	LINE - DISTANCE PHASE B TRIP	115 KV Bay	Alarm Trip
7	LINE - DISTANCE PHASE C TRIP	115 KV Bay	Alarm Trip
8	LINE - DISTANCE PHASE A-B TRIP	115 KV Bay	Alarm Trip
9	LINE - DISTANCE PHASE B-C TRIP	115 KV Bay	Alarm Trip
10	LINE - DISTANCE PHASE C-A TRIP	115 KV Bay	Alarm Trip
11	LINE - DISTANCE PHASE A-B-G TRIP	115 KV Bay	Alarm Trip
12	LINE - DISTANCE PHASE B-C-G TRIP	115 KV Bay	Alarm Trip
13	LINE - DISTANCE PHASE C-A-G TRIP	115 KV Bay	Alarm Trip
14	LINE - DISTANCE PHASE 3 PHASE TRIP	115 KV Bay	Alarm Trip
15	LINE - DISTANCE ZONE 1 TRIP	115 KV Bay	Alarm Trip
16	LINE - DISTANCE ZONE 2 TRIP	115 KV Bay	Alarm Trip
17	LINE - DISTANCE ZONE 3 TRIP	115 KV Bay	Alarm Trip
18	LINE - DISTANCE ZONE 4 TRIP	115 KV Bay	Alarm Trip
19	LINE - DISTANCE EARTH FAULT	115 KV Bay	Alarm Trip
20	TP - DIFFERENTIAL PHASE A TRIP	115 KV Bay	Alarm Trip
21	TP - DIFFERENTIAL PHASE B TRIP	115 KV Bay	Alarm Trip
22	TP - DIFFERENTIAL PHASE C TRIP	115 KV Bay	Alarm Trip
23	TP - OVERCURRENT PHASE A (HV) TRIP	115 KV Bay	Alarm Trip
24	TP - OVERCURRENT PHASE B (HV) TRIP	115 KV Bay	Alarm Trip
25	TP - OVERCURRENT PHASE C (HV) TRIP	115 KV Bay	Alarm Trip

26	TP - O/C TIME DELAY(HV)TRIP	115 KV Bay	Alarm Trip
27	TP - O/C INSTANTANEOUS(HV)TRIP	115 KV Bay	Alarm Trip
28	TP - O/C TIME GROUND TRIP	115 KV Bay	Alarm Trip
29	TP - RESTRICTED EARTH FAULT(HV)TRIP	115 KV Bay	Alarm Trip
30	TP - INSTANTANEOUS EARTH FAULT(HV)TRIP	115 KV Bay	Alarm Trip
31	TP - DIFFERANTIAL EARTH FAULT RELAY(LV)TRIP	115 KV Bay	Alarm Trip
32	GAS LOW PRESSURE ALARM	115 KV Bay	Alarm Non Trip
33	GAS LOW PRESSURE LOCKOUT	115 KV Bay	Alarm Trip
34	EARTH FAULT RELAY(BACK UP)TRIP	115 KV Bay	Alarm Trip
35	TIME DELAY - CB FAIL	115 KV Bay	Alarm Trip
36	INSTANTANEOUS - CB FAIL	115 KV Bay	Alarm Trip
37	TRIP CIRCUIT FAIL	115 KV Bay	Alarm Non Trip
38	PRESSURE RELIEF TRIP	Transformer	Alarm Trip
39	BUCHHOLZ TRIP	Transformer	Alarm Trip
40	WINDING TEMPERATURE TRIP	Transformer	Alarm Trip
41	DIVERTER SWITCH PRESSURE RELIEF TRIP	Transformer	Alarm Trip
42	OIL LEVEL (MAX) ALARM	Transformer	Alarm Non Trip
43	OIL LEVEL (MIN) ALARM	Transformer	Alarm Non Trip
44	OIL TEMPERATURE ALARM	Transformer	Alarm Non Trip
45	BUCHHOLZ ALARM	Transformer	Alarm Non Trip
46	WINDING TEMPERATURE ALARM	Transformer	Alarm Non Trip
47	OLTC OVER CURRENT	Transformer	Alarm Non Trip
48	O/C RELAY PHASE A	Bus section / 22 kV Bay	Alarm Trip
49	O/C RELAY PHASE B	Bus section / 22 kV Bay	Alarm Trip
50	O/C RELAY PHASE C	Bus section/ 22 kV Bay	Alarm Trip
51	O/C OR E/F RELAY TIME DELAY	Bus section / 22 kV Bay	Alarm Trip
52	O/C OR E/F INSTANTANEOUS	Bus section / 22 kV Bay	Alarm Trip
53	O/C RELAY ANY TRIP	Bus section / 22 kV Bay	Alarm Trip
54	E/F RELAY	Bus section / 22 kV Bay	Alarm Trip
55	TIME DELAY - CB FAIL	Bus section / 22 kV Bay	Alarm Trip
56	INSTANTANEOUS - CB FAIL	Bus section/ 22 kV Bay	Alarm Trip
57	ARC DETECTION SYSTEM OPERATED	Bus section / 22 kV Bay	Alarm Trip
58	LowBattVoltage	Load Break Switch	Alarm Non Trip

59	HighBattVoltage	Load Break Switch	Alarm Non Trip
60	ChargerOverVolt	Load Break Switch	Alarm Non Trip
61	ChargerGndBatt	Load Break Switch	Alarm Non Trip
62	GasLowPressure	Load Break Switch	Alarm Non Trip
63	DataQualityStatus	Load Break Switch	Alarm Non Trip
64	PhaseFaultDetected	Recloser	Alarm Trip
65	EarthFaultDetected	Recloser	Alarm Trip
66	PowerSupplyIndicator	Recloser	Alarm Non Trip
67	Batt/BattChargerFail	Recloser	Alarm Non Trip
68	DataQualityStatus	Recloser	Alarm Non Trip
69	RegBuchholzTrip	AVR	Alarm Trip
70	RegTempTrip	AVR	Alarm Trip
71	OvercurrentOLTC	AVR	Alarm Trip
72	RegBuchholzWarn	AVR	Alarm Non Trip
73	TapChangeProtection	AVR	Alarm Non Trip
74	XformerLiquidLevelMax	AVR	Alarm Non Trip
75	XformerLiquidLevelMin	AVR	Alarm Non Trip
76	OLTCLiquidLevelMax	AVR	Alarm Non Trip
77	OLTCLiquidLevelMin	AVR	Alarm Non Trip
78	RegTempWarn	AVR	Alarm Non Trip
79	Batt/BattChargerFail	AVR	Alarm Non Trip
80	N01DataQualityStatus	AVR	Alarm Non Trip
81	PowerSupplyIndicator	AVR	Alarm Non Trip

7.2 Analogue point types

OMS field (Interface)	SCADA Provides	Short Code	Description
Power Phase A	Power Total	MW	MW (Power Total)
Power Phase B	Currently unused	MW (CT_B)	MW
Power Phase C	Currently unused	MW (CT_C)	MW
Current Phase A	Current Phase A	A (CT_A)	A
Current Phase B	Current Phase B	A (CT_B)	A
Current Phase C	Current Phase C	A (CT_C)	A

Voltage Phase A	Voltage Phase A	kV (VT_AB)	kV
Voltage Phase B	Voltage Phase B	kV (VT_BC)	kV
Voltage Phase C	Voltage Phase C	kV (VT_CA)	kV

7.3 Switching Order Operation

No.	SHORT CODE	DESCRIPTION
1	CL_CB	Close circuit breaker
2	CL_RECL	Close line recloser
3	CL_SW	Close switch
4	OP_CB	Open circuit breaker
5	OP_RECL	Open line recloser
6	OP_SW	Open switch
7	PUT_TEMP_CUT	Make a temporary cut
8	PUT_TEMP_GND	Put a temporary ground
9	PUT_TEMP_JUMP	Put a temporary jumper across the device
10	PUT_TEMP_JUMP2	Put a temporary jumper between 2 devices
11	REM_TEMP_CUT	Remove temporary cut
12	REM_TEMP_GND	Remove temporary ground
13	REM_TEMP_JUMP	Remove temporary jumper from the device
14	REM_TEMP_JUMP2	Remove temporary jumper between 2 devices
15	OP_SW_LDBUSTER	Open switch (operate by LoadBuster)
16	CL_SW_LDBUSTER	Close switch (use LoadBuster when reopening)
17	CL_EARTH_SW	Close earth switch (Add ground action)
18	OP_EARTH_SW	Open earth switch (Remove ground action)
19	DISC_CAP_BANK	Open capacitor bank switch
20	CON_CAP_BANK	Close capacitor bank switch
21	CB_WITHDR_OUT *	Set withdrawn switch out of service on circuit breaker
22	CB_WITHDR_IN *	Set withdrawn switch in service on circuit breaker
23	SW_WITHDR_OUT *	Set withdrawn switch out of service
24	SW_WITHDR_IN *	Set withdrawn switch in service

* Note: These operation types are used for comment purpose only and do not change the network model in eRespond.

7.4 Switching Order Type from SCADA

SHORT CODE รหัสย่อ	DESCRIPTION คำอธิบาย
COMM	Commissioning
DECOM	Decommissioning
EMGCY	Emergency
ISOL	Isolation
ISOLR	Isolation & Reconnection
LDTFR	Load Transfer
OILSP	Oil Sampling
RECFG	Reconfiguration
SYSAL	System Alteration
TEST	Test and Maintenance
FISR1	FISR – Recommendations
FISR2	FISR - Return to normal
RESTO	Restoration