Paper for Consideration by the S-100 TSM

Proposed Alerts and Indications Model for S-100

Submitted by:	SPAWAR Atlantic
Executive Summary:	A proposed model for S-100 alerts and indications is presented
Related Documents:	S-100 Part 9, TSMAD28_DIGWG6_12.4A, TSM3 5.3, S-100WG01-10.12A, MSC.302(87), IMO A.1021(26), IEC 61174:2015, IEC 62288
Related Projects:	Development of S-100 and S-1XX product specifications

1 Introduction / Background

As presented by Hannu Peiponen / Furuno Finland at TSMAD28 and TSM3, there is a need for an alert model defined within S-100 which will allow fielded ECDIS systems to conform to changing alert requirements without software upgrades. Some examples include:

- A new S-100 based product type which should participate in alert processing
- New feature type(s) added to an existing product where the new feature type(s) should participate in alert processing (feature catalog updated)
- Changes to the alert processing rules for an existing feature type within an existing product type (new alert catalog)

This paper is a continuation of work presented at S-100WG1 in paper S-100WG01-10.12A. As noted in that paper the alert model can be based on the existing portrayal model as many commonalities exist between generation of alerts and portrayal of features.

Whereas a portrayal catalog translates an encoded dataset into drawing instructions, an alert catalog will translate an encoded dataset into alert instructions. These alert instructions will identify which spatial elements from an encoded dataset should be evaluated by the alert processing implemented within an ECDIS, and will provide all required information needed by the ECDIS to raise the alert. The ECDIS will be responsible for implementing the spatial evaluation.

Changes to the alert catalog will be managed in the same manner as the portrayal catalog, allowing the ECDIS to update machine readable files in-lieu of software upgrades.

2 Requirements

As an initial step in developing an Alerts and Indications model the following references were reviewed:

- IEC 61174:2015 – ECDIS performance requirements
- IEC 62288:2008 – Presentation of navigation information on shipborne navigational displays (*note: IEC 62288:2014 is the current edition*).
- IMO A.1021(26) – Code on alerts and indicators, 2009
- MSC.232(82) – Revised performance standards for ECDIS
- MSC.252(83) – Revised performance standards for INS
- MSC.302(87) – Adoption of Performance Standards for Bridge Alert Management

The following references are also relevant but were not part of the review:

- IEC 62616:2010 – Bridge navigational watch alarm system (BNWAS)

IEC 61174 ed4.0 provides some changes to previous requirements for alerts. In particular, the alert classification of Appendix 5 of IMO MSC.252(83) is used; ref. IEC 61174:2015 Table D.1 – Alerts and indications resulting from IMO requirements.

IEC 61174 also defines / requires alerts and indications in addition to those resulting from IMO requirements; ref. IEC 61174:2015 Table D.2 – Alerts and indications defined in [the IEC 61174] standard.

Table 1 contains definitions from MSC252(83) applicable to this paper.

Table 1: Applicable definitions from MSC252(83)

Alert	Alerts are announcing abnormal situations and conditions requiring attention. Alerts are divided in three priorities: alarms, warnings and cautions.
Alarm	An alarm is the highest priority of an alert. Condition requiring immediate attention and action by the bridge team, to maintain the safe navigation of the ship.
Warning	Condition requiring no-immediate attention or action by the bridge team. Warnings are presented for precautionary reasons to make the bridge team aware of changed conditions which are not immediately hazardous, but may become so, if no action is taken.
Caution	Lowest priority of an alert. Awareness of a condition which does not warrant a alarm or warning condition, but still requires attention out of the ordinary consideration of the situation or of given information.
Indication	Display of regular information and conditions, not part of alert management.
Category A alerts	Alerts where graphical information at the task station directly assigned to the function generating the alert is necessary, as decision support for the evaluation [of] the alert related condition.
Category B alerts	Alerts where no additional information for decision support is necessary besides the information which can be presented at the central alert management HMI.

2.1 Required Alert Model Components

In order to model an alert the following components are required:

- Identification of the condition which triggers the alert.
- Mechanism to disable the alert trigger.
    - e.g. anchor watch alert is disabled when ship is not at anchor.
    - Identify whether active alerts should be cleared when trigger is disabled.
        - e.g. disabling the anchor watch alert clears active alerts.
- The priority of the alert. One of:
    - Alarm
    - Warning
    - Caution
    - *Note: Emergency alarm is not listed because navigational alerts can not generate an emergency alarm (ref. IMO A.1021(26) 3.2).*
- The category of the alert. One of:

    - Category A
    - Category B
- The alert message - displayed when the alert is active
    - e.g. "Outside anchor watch area"
    - A location for the message
        - e.g. Alerts management dialog
    - Optionally, an icon to display with or instead of the message
- A graphical highlight to display when the alert is active
    - A fill symbol (for areas)
    - A line style (for areas and lines)
    - A point symbol (for points)
    - The geometry of the highlight – e.g. "Intersection with feature and route"
    - *Note: Display plane and drawing priority could be included here, but are not currently. In order to prevent chart redrawing highlights will be drawn above all drawing instructions in the top-most display plane*.
- Mechanism to disable the graphical highlight
    - An indication (to display when the highlight is disabled)
- Display on demand components
    - e.g. crossing safety contour requires that "feature and highlight" be displayed on demand.

In order to model an indication the following components are needed:

- A message to display when the indication is triggered
    - Optionally, an icon to display with or instead of the indication
- Type of the indication.
    - One of: Permanent Indication or Indication
- A location for the indication.
    - In the requirements this is generally not specified; overlaying the chart is assumed.
    - Some required indication locations are imprecise
        - e.g. "Close to north arrow" for non-uniform chart orientation.
- Display on demand components
    - e.g. the AIS target filter criteria is a display on demand requirement when the AIS target filter is enabled.
- The following components are needed because the route planning checks treat "Indication" as an alert priority:
    - A graphical highlight and its required sub-components.
    - Mechanism to disable the graphical highlight

3 Design

3.1 Goals

A simplistic model would restrict itself to providing a mechanism to identify the alert triggers which exist within an encoded S-100 dataset, along with the resulting message and graphical highlight symbol(s). That model was presented in S-100WG01-10.12A. The primary limitation of the simplistic model is that the ECDIS / application would need to hard-code all of the other required alerts (i.e. alerts not associated with features in a dataset), increasing the likelihood of future software updates due to changing requirements.

The primary purpose of the model is to eliminate the need for software changes and hard-coding of requirements. Therefore, all required alerts and indications along with their required components should be included in the model.

Alerts and indications which are not triggered by an encoded feature / spatial should be modeled so that the ECDIS can respond to future requirements changes (e.g. a change in alert priority), and so that various implementations are consistent in the generated alerts and indications. This also allows the alerts and indications which are triggered by user-drawn no-go areas (ref. IEC 61174:2015 Annex N) to be consistent with alerts and indications triggered by features within a dataset.

All text generated by the model and intended for presentation to the user should be language independent. Icons should be used to minimize the screen real-estate required to display alerts and indications.

3.2 Limitations

Because the alerts and indications requirements have evolved over time, and because a formal framework was not used to establish the requirements, there are requirement components which were not modeled. Those components are:

- Display on demand:
    - The requirement to display unrelated items with no limitations placed on what future display on demand requirements could be imposed makes this component impossible to model in a way that is future-proof.
    - Currently modeled as strings. Consideration should be given to defining the existing display on demand requirements within the model and agreeing on limiting future display on demand requirements.
- The model requires software implemented within the ECDIS to associate each alert with its trigger condition.
    - Alerts triggered by a spatial encoded within a dataset can share a single software module within the ECDIS. New alerts can be added without modifying the ECDIS software; instead the alert catalog and portrayal rules will be modified.
    - Other alerts, such as "deviation from route" require individual software implementations of the trigger condition. New alerts may require ECDIS software changes if new trigger conditions are added. As noted in 3.1, a goal of the model is to make the alert available to the ECDIS – only the trigger and association need to be hard-coded into the ECDIS software.
- It may be desirable to model the audible signal of an alert. Audible signals are not part of the model presented.
- It may be desirable to have interoperability modify the alerts and / or highlights. Interoperability is not addressed by this paper.

3.3 Design Approach

The approach presented in S-100WG01-10.12A proposed the following:

- Add a new part to S-100 for alerts.

- Modify S-100 Part 4 to permit delivery of an alert catalogue.
- Modify S-100 Part 4 to permit association of an alert catalogue with the appropriate feature catalogue and / or portrayal catalogue.

Initially, the previous design approach was carried forward and extended to meet the design goals specified in 3.1. As a notional model was developed it proved challenging to provide for alerting on abstract concepts which are created within the portrayal – e.g. the safety contour (composed of geometries associated with multiple features) or soundings (augmented geometries created within the portrayal).

In order to ensure consistency between portrayal and alerts a synchronization mechanism was needed. For instance, the context parameters controlling Safety Depth and Safety Contour must remain synchronized between portrayal and alerts. As the model was developed portrayal components were being duplicated within the alert model.

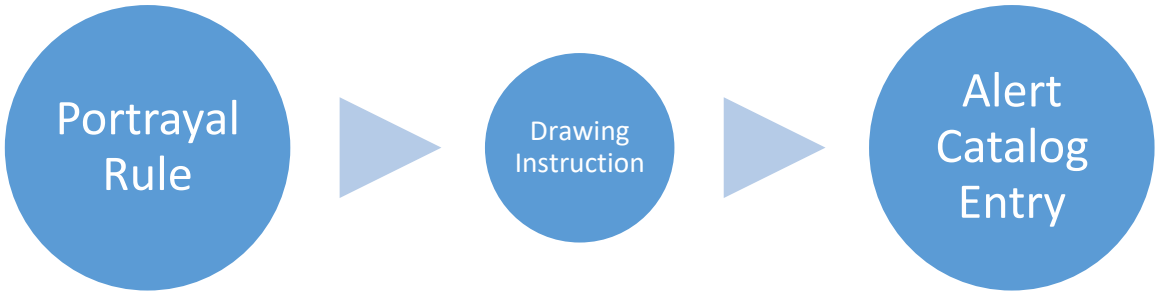
Rather than implement a synchronization mechanism and re-implement large parts of the portrayal inside of the alert model, the approach presented models alerts and indications as part of the portrayal (notionally: the alert package). This has the following advantages:

- Doesn't require a new S-100 part.
- Leverages the portrayal for delivery of the alert catalog.
- Can use existing portrayal mechanisms to provide symbols and line styles required for highlighting.
- Generation of alert instructions requires only minor additions to existing portrayal rules.
- Doesn't require a new builder tool – only minor changes to the portrayal catalogue builder are needed (to associate a feature with an alert catalog entry).
- Requires only minor differences in the model for XSLT and Lua (only the alert instruction is different).

In order to make alerts available to the ECDIS which are not triggered by an encoded feature or spatial, and in order to avoid having disparate Lua and XSLT models, it was decided to provide as much of the model as possible within a catalogue. This approach is similar to the approach used by interoperability.

3.4 Overview

All alerts, indications and required components are specified in an alert catalogue provided as part of the portrayal catalogue. The portrayal rules will generate drawing instructions which can associate features or spatials with a catalogued alert.



The alert catalog references are generated along with the portrayal as part of the drawing instruction(s). Each alert is associated with geometries via either the feature reference, spatial reference, or augmented geometry specified in the drawing instruction. Each catalog reference is an association to a catalog entry; the entry provides all the information necessary for the ECDIS to implement the alert.

Minor changes to the portrayal schema are needed to provide the alert catalog as part of the portrayal catalog. The portrayal drawing instruction schema must also be modified to optionally include a reference to an entry in the alert catalog.

3.4.1 Changes to Part 9 Portrayal

Add *alertCatalog* to 9-13.3.25 *FileType* enumeration:

Role Name	**Name**	**Description**
Type	FileType	The type of an external file
…	…	…
Enumeration	alertCatalog	A catalog of alerts and indications

Add *alertCatalog* to the 9-13.3.1 *PortrayalCatalog*

Role Name	**Name**	**Description**	**Mult.**	**Type**
Class	PortrayalCatalog	A container of all the catalogue items	-	-
…	…	…	…	…
Role	alertCatalog	A container of alerts and indications	0..1	ExternalFile

Add class *AlertReference* to 9-11.2 Model of the Drawing Instruction Package *(S100Presentation.xsd)*.

Role Name	**Name**	**Description**	**Mult.**	**Type**
Class	AlertReference	A reference to an alert catalog entry.	-	-
Attribute	reference	The identifier of the alert catalog entry.	1	string (Reference)
Attribute	highlightSelector	A reference to a selector in the alert catalog. Provides for disabling the graphical highlight on a per-feature basis.	0..1	string (Reference)

Add *alertReference* to the 9-11.2.2 *DrawingInstruction* class.

Role Name	**Name**	**Description**	**Mult.**	**Type**
Class	DrawingInstruction	Abstract base class for all drawing instructions	-	-
…	…	…	…	…
Role	alertReference	A reference to an alert catalog entry indicating that the featureReference and spatialReference participate in alerts checking and trigger the referenced alert catalog entry.	0..1	AlertReference

3.4.2 Changes to Part 9a Lua Portrayal

9a-11.2.x Alert Commands

Alert commands are used to indicate a feature instance or spatial elements of the feature instance should be checked by alerts processing. They are analogous to realizations of the 9-11.2 *AlertReference* class. Alert commands are only modified by preceding Geometry state commands.

Command	Parameters	Parameter Type	Part 9 Reference
AlertInstruction	alertReference	string	9-11.2
	highlightSelector	string	

AlertInstruction:*alertReference[,highlightSelector]*

Instructs the host to include the referenced geometries in alert processing.

alertReference Reference to an alert in the alert catalog.

highlightSelector If present, specifies a selector used to disable the graphical highlight.

3.5 Model of the Alert Catalog

The alert catalog provides all the components identified in 2.1 other than the trigger condition. There is a single trigger condition for alerts associated with alert instructions generated by the portrayal. This trigger condition can be associated with any number of catalog entries based on rules implemented within the portrayal.

The trigger condition for alerts not associated with an alert instruction must be implemented within the ECDIS. The alert catalog provides all additional required components, but since there is no dataset feature to trigger the alert the ECDIS must be responsible for looking up the entry associated with the trigger condition. An example of this type of alert is "positioning system failure".

Figure 1 - Model of the Alert Catalog presents the UML model of the alert catalog.

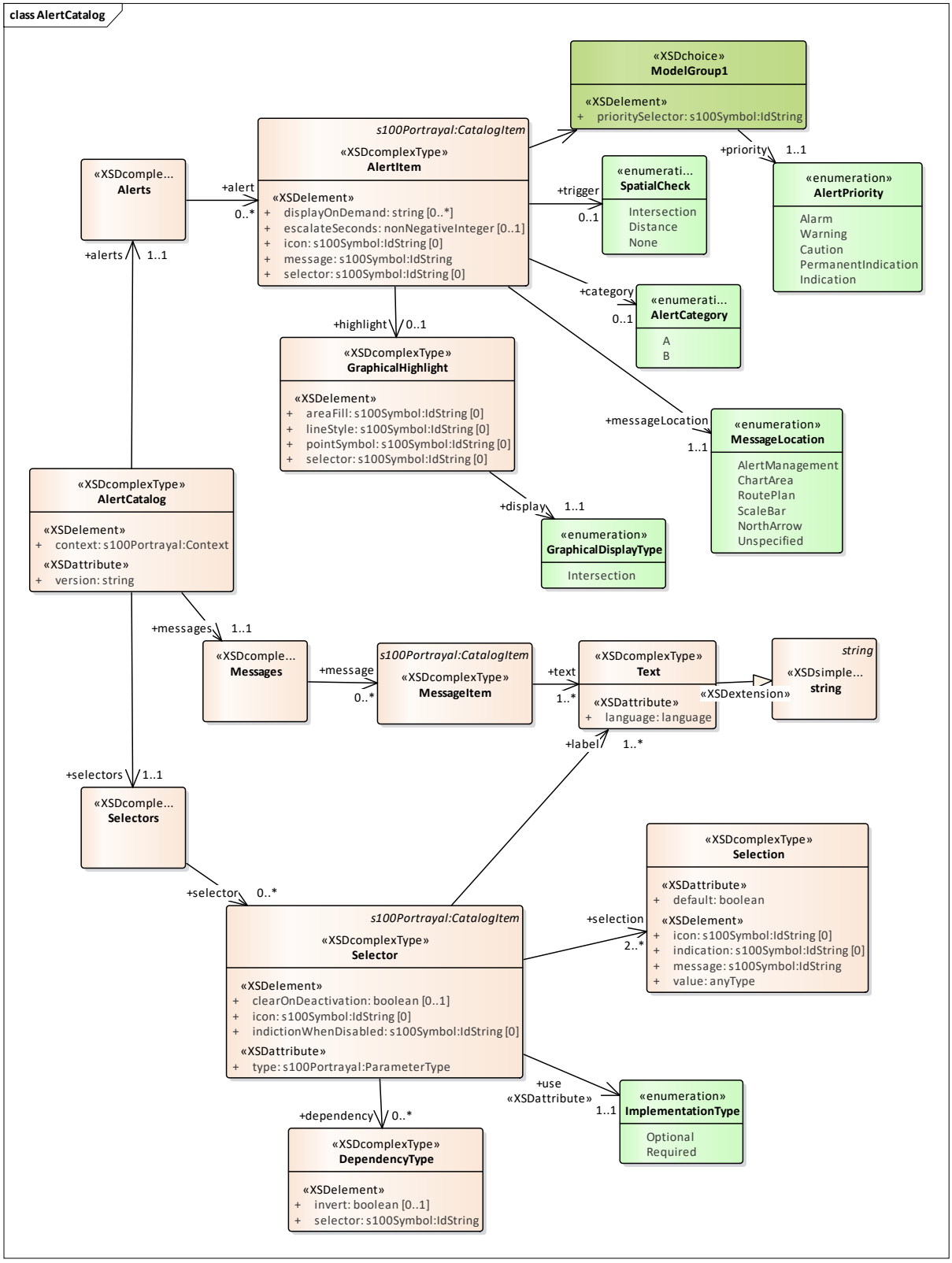


Figure 1 - Model of the Alert Catalog

3.5.1 AlertCatalog

Role Name	Name	Description	Mult.	Type
Class	AlertCatalog	Container of the alert catalog components	-	-

Role	context	Container of context parameter definitions	1	*Context*
Role	messages	Container of messages	1	Messages
Role	selectors	Container of selectors	1	Selectors
Role	alerts	Container of alerts	1	Alerts

3.5.2 Context

See S-100 4.0.0 9-13.3.19 *Context*. A container of context parameters which affect the generation of alerts and indications. Every effort should be made to avoid using context parameters. Any change in a context parameter requires re-generating the portrayal.

The sample alert catalog does not use context parameters, but they are included in the model to allow for possible use by products other than S-101.

3.5.3 Messages

Role Name	Name	Description	Mult.	Type
Class	Messages	Container of messages	-	-
Role	message	Definition of a language independent message	0..*	MessageItem

3.5.3.1 MessageItem

Role Name	Name	Description	Mult.	Type
Class	MessageItem	Defines a language independent message	-	-
Subtype of	CatalogItem	See 9-13.3.2 *CatalogItem*	-	-
Role	text	The language independent text of the message.	1..*	Text

3.5.3.2 Text

Role Name	Name	Description	Mult.	Type
Class	Text	Language independent text	-	-
Attribute	language	Language identifier code. Default is "eng"	0..1	string
Role	text	Language specific text	1	string

3.5.4 Selectors

Role Name	Name	Description	Mult.	Type
Class	Selectors	Container of selectors	-	-
Role	selector	Definition of a selector	0..*	Selector

3.5.4.1 Selector

Role Name	Name	Description	Mult.	Type

Class	Selector	Defines a component used to select one of multiple options.	-	-
Subtype of	CatalogItem	See 9-13.3.2 *CatalogItem*	-	-
Attribute	use	Indicates whether the selector is required to be exposed to the user.	1	ImplementationType
Attribute	type	The data type of the values stored within each selection.	1	*ParameterType*
Role	icon	Reference to a portrayal catalog symbol for use as an icon.	0..1	Reference
Role	label	Language independent text.	1..*	Text
Role	indicationWhenDisabled	A reference to an indication triggered when the selector is disabled.	0..1	Reference
Role	clearOnDeactivation	Indicates that when disabled any alerts associated with the selector should be cleared.	0..1	Boolean
Role	dependency	Indicates that this selector can only be enabled when other selectors are enabled.	0..*	DependencyType
Role	selection	Specifies the values which can be selected.	2..*	Selection

3.5.4.2 ImplementationType

Role Name	Name	Description
Type	ImplementationType	Choice of implementation types
Enumeration	Optional	Implementation is optional.
Enumeration	Required	Implementation is mandatory.

3.5.4.3 ParameterType

See 9-13.3.23 ParameterType. Consideration should be given to adding support for the following types: *anyURI*, *time*, *dateTime*, *duration*, *language*.

3.5.4.4 DependencyType

Role Name	Name	Description	Mult.	Type
Class	DependencyType	Specifies dependency for a selector.	-	-
Role	invert	Invert the state of the referenced selector.	0..1	Boolean
Role	selector	Reference to a selector.	1	Reference

3.5.4.5 Selection

Role Name	Name	Description	Mult.	Type
Class	Selection	A selection item of a selector.	-	-
Attribute	default	If true, this is the default selection.	0..1	Boolean
Role	icon	Reference to a portrayal catalog symbol for use as an icon.	0..1	Reference
Role	message	Reference to a MessageItem.	1	Reference
Role	value	The value of the selection.	1	anyType
Role	indication	Reference to an indication (entry in alerts section) to display when the value is selected.	0..1	Reference

3.5.5 Alerts

Role Name	Name	Description	Mult.	Type
Class	Alerts	Container of alerts	-	-
Role	alert	Definition of an alert or indication	0..*	AlertItem

3.5.5.1 AlertItem

Role Name	Name	Description	Mult.	Type
Class	AlertItem	Describes an alert	-	-
Subtype of	CatalogItem	See 9-13.3.2 *CatalogItem*	-	-
Role	selector	A reference to a selector used to enable or disable the alert.	0..1	Reference
Role	priority	The alert priority	1	AlertPriority
	prioritySelector	Reference to a selector whose selection identifies the alert priority.		Reference
Role	category	Identifies the alert category. Provided for completeness, however the presence of a highlight can also be used to determine the category.	0..1	AlertCategory
Role	escalateSeconds	Ref. MSC252(83) 20.5 Alert Escalation. Specifies escalation time in seconds per performance standards. Unacknowledged alarms escalate to the BNWAS, if available. Unacknowledged warnings escalate to alarms. It is unclear if escalated warnings should be further escalated to the BNWAS.	0..1	nonNegativeInteger
Role	trigger	Spatial check which triggers the alert	0..1	SpatialCheck

Role	icon	An icon to display with or instead of the message. If only the icon is shown there should be a way for the user to see the message, e.g. by hovering over the icon.	0..1	Reference
Role	message	A reference to the message to display when the alert is active	1	Reference
Role	messageLocation	Where to show the message and/or icon	1	MessageLocation
Role	highlight	Describes how to highlight the source of the alert.	0..1	GraphicalHighlight
Role	displayOnDemand	The user should have the option to display the listed item(s) on demand.	0..*	string

3.5.5.2 AlertPriority

Role Name	Name	Description
Type	AlertPriority	Enumerates the allowed priorities of an alert. Indications are included for convenience.
Enumeration	Alarm	Indicates conditions requiring immediate attention and action by the bridge team (ref. MSC.252(83) 19.1.2).
Enumeration	Warning	Indicates changed conditions and should be presented for precautionary reasons which are not immediately hazardous but which may become so, if no action is taken (ref. MSC.252(83) 19.1.3).
Enumeration	Caution	Indicates a condition which does not warrant an alarm or warning condition, but still requires attention and out of the ordinary consideration of the situation or of given information (ref. MSC.252(83) 19.1.4).
Enumeration	PermanentIndication	Indication that is displayed visually and continuously and cannot be removed from the display other than by eliminating the cause of the indication (ref. IEC 61174 ed4.0 3.1.27).
Enumeration	Indication	Display of regular information and conditions (ref. MSC.252(83) appendix 1).

3.5.5.3 AlertCategory

Role Name	Name	Description
Type	AlertCategory	Enumerates the allowed categories of an alert.
Enumeration	A	Danger of collision / grounding. Graphical information is necessary as decision support (ref. MSC.252(83) 19.3.1.1).
Enumeration	B	All non-A. No additional information is necessary for decision support (ref. MSC 252(83) 19.3.1.2).

3.5.5.4 SpatialCheck

Role Name	Name	Description
Type	SpatialCheck	Enumerates the allowed modes for checking the geometries associated with an alert item.
Enumeration	Intersection	Check for intersection with geometries.
Enumeration	Distance	Check for less than user-specified distance from geometries.
Enumeration	None	No spatial check is performed.

3.5.5.5 MessageLocation

Role Name	Name	Description
Type	MessageLocation	Enumerates the possible locations for display of alert / indicator text and / or icons.
Enumeration	AlertManagement	User dialog area of the alert management (ref. IEC 61174:2015 4.10.3)
Enumeration	ChartArea	
Enumeration	RoutePlan	User dialog area of the route plan (ref. IEC 61174:2015 4.10.2.1).
Enumeration	ScaleBar	Near the scale bar (ref. IEC 61174:2015 5.2.1).
Enumeration	NorthArrow	Near the north arrow (ref. IEC 61174:2015 5.8.1).
Enumeration	Unspecified	Location is not specified by the relevant document.

3.5.5.6 GraphicalHighlight

Role Name	Name	Description	Mult.	Type
Class	GraphicalHighlight	Describes how to graphically highlight an alert or indication.	-	-
Role	display	How the highlight should be displayed.	1	GraphicalDisplayType
Role	pointSymbol	Reference to a portrayal catalog symbol used to highlight point(s).	0..1	Reference
Role	areaFill	Reference to the portrayal catalog id of an areaFill used to fill the highlighted area. If not present, transparent fill should be used.	0..1	Reference
Role	lineStyle	Reference to the portrayal catalog id of a lineStyle used to highlight curves and surfaces.	0..1	Reference
Role	selector	Reference to a selector used to enable or disable the graphical highlight.	0..1	Reference

3.5.5.7 GraphicalDisplayType

Role Name	Name	Description

Type	GraphicalDisplayType	Enumerates the methods of combining the source (e.g. look-ahead or route plan area) and alert / indication geometries (e.g. sounding) to generate a highlight.
Enumeration	Intersection	Highlight the intersection of the source with the geometries (ref. IEC 62288:2014, Table A.3)

4 Discussion

As a companion to this paper a package including the following is provided separately:

- Excel Spreadsheets
  - AlertRequirements.xlsx – Used to capture requirements.
- XML files
  - AlertCatalog.xml – A partial implementation of an alert catalog for S-101, provided as a sample implementation of the model.
- XML schema definitions
  - AlertCatalog.xsd - Defines the model of the alert catalog as presented in 3.5.
  - S100PresentationChanges.xsd – A summary of the changes required to the S100Presentation schema.
  - S100Presentation.xsd – Full schema modified to support alerts.
  - S100PortrayalCatalogChanges.xsd – A summary of the changes required to the PortrayalCatalog schema.
  - S100PortrayalCatalog.xsd – Full schema modified to support alerts.
  - S100SymbolDefinition.xsd – Unchanged, provided for validation purposes.
  - S100CSL.xsd – Unchanged, provided for validation purposes.
- UML
  - AlertCatalog.EAP – Enterprise architect file generated from AlertCatalog.xsd.
  - AlertCatalog.svg – Interactive UML model generated from AlertCatalog.xsd. Can be viewed using Google Chrome.

Examining the "Requirements" tab of the provided spreadsheet will show that before a full S-101 alert catalog can be generated many details will need to be resolved. However, this can be accomplished through iterative refinement of the catalog once a model is agreed upon.

4.1 Action Required of S-100WG

The S-100 working group is invited to:

a. note the paper

b. provide feedback on the proposed model