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The Network Trouble Ticket Data Model (NTTDM)

Abstract

Handling multiple sets of network trouble tickets (TTs) originating from different participants' inter-connected network environments poses a series of challenges for the involved institutions. A Grid is a good example of such a multi-domain project. Each of the participants follows different procedures for handling trouble in its domain, according to the local technical and linguistic profile. The TT systems of the participants collect, represent, and disseminate TT information in different formats.

As a result, management of the daily workload by a central Network Operation Centre (NOC) is a challenge on its own. Normalization of TTs to a common format at the central NOC can ease presentation, storing, and handling of the TTs. In the present document, we provide a model for automating the collection and normalization of the TT received by multiple networks forming the Grid. Each of the participants is using its home TT system within its domain for handling trouble incidents, whereas the central NOC is gathering the tickets in the normalized format for repository and handling. XML is used as the common representation language. The model was defined and used as part of the networking support activity of the EGEE (Enabling Grids for E-sciencE) project.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for examination, experimental implementation, and evaluation.

This document defines an Experimental Protocol for the Internet community. This is a contribution to the RFC Series, independently of any other RFC stream. The RFC Editor has chosen to publish this document at its discretion and makes no statement about its value for implementation or deployment. Documents approved for publication by the RFC Editor are not a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6137.

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1. Introduction

Problem-impact assessment, reporting, identification, and handling, as well as dissemination of trouble information and delegation of authority, are some of the main tasks that have to be implemented by the members of a Grid in order to successfully manage the network and maintain operational efficiency of the services offered to their users.

Different TT systems are used by each network domain, delivering TTs in alternate formats, while the TT load is growing proportionally with network size and serviced users.

We hereby define a data model for TT normalization -- the Network Trouble Ticket Data Model (NTTDM) -- initially targeted for network providers serving EGEE [8]. The model is designed in accordance with RFC 1297 [11] and meets requirements of the multiple TT systems used.

The NTTDM

- is both effective and comprehensive, as it compensates for the core activities of the Network Operation Centres (NOCs). It is also dynamic, allowing additional options to be included in the future, according to demand.

- provides an XML representation for conveying incident information across administrative domains between parties that have an operational responsibility of remediation or a "watch-and-warn" policy over a defined constituency.

- encodes information about hosts, networks, and the services running on these systems; attack methodology and associated forensic evidence; impact of the activity; and limited approaches for documenting workflow.

- aims to simplify TT exchange within the boundaries of a Grid and to enhance the functional cooperation of every NOC and of the Grid Operation Centre (GOC). Community adoption of the NTTDM enhances trouble resolution within the Grid framework and imparts network status cognizance by modeling collaboration and information exchange among operators.

- provides a common format that allows GOCs as well as all participating NOCs to store, exchange, manage, and analyze TTs (assessment of TT impact).

- provides increased automation in handling a TT, since the network operators have a common view of the incident.

The model was designed and used as part of the networking support activity of the EGEE project; one of the subtasks of this support activity was to enhance the ENOC (EGEE Network Operation Centre) [9] procedures for better overall network coordination of the Grid.

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [1].

The NTTDM uses specific keywords to describe the various data components. These keywords are:

Defined, Free, Multiple, List, Predefined String, String, Datetime, Solved, Cancelled, Inactive, Superseded, Opened/Closed, Operational, Informational, Administrative, and Test.

These keywords as used in this document are to be interpreted as described in Section 2.

Acronyms:

TT: Trouble Ticket

NTTDM: Network Trouble Ticket Data Model

DB: Database

EGEE: Enabling Grid for E-sciencE

ENOC: EGEE NOC

NOC: Network Operation Centre

GOC: Grid Operation Centre

NREN: National Research and Educational Network

QoS: Quality of Service

UML: Unified Modeling Language

XML: Extensible Markup Language

1.2. Notations

The NTTDM is specified in two ways: as an abstract data model and as an XML Schema. Section 3 provides a Unified Modeling Language (UML) [10] model describing the individual classes and their relationship with each other. The semantics of each class are discussed and their attributes explained. In Section 6, this UML model is converted into an XML Schema [2] [3] [4] [5]. A specific namespace [6] is also defined.

The term "XML document" refers to any instance of an XML Document. The term "NTTDM document" refers to specific elements and attributes of the NTTDM Schema. Finally, the terms "class" and "element" are used interchangeably to reference either a given UML class in the data model or its corresponding Schema implementation.

1.3. About the Network Trouble Ticket Data Model

The NTTDM is a data representation that provides a framework for normalizing and sharing information among network operators and the GOC regarding troubles within the Grid boundaries. There has been a lot of thought processing during the design of the data model:

- The data model serves as a common storage and exchange format.
- Every NOC still uses its home TT system for network management within its area of control.
- As there is no universally adopted definition for a trouble, in the NTTDM definition, the term is used with a comprehensive meaning to cover all NOCs.
- Handling every possible definition of a trouble incident would call for an extremely expanded and complex data model. Therefore, the NTTDM’s purpose is to serve as the basis for normalizing and exchanging TTs. It is flexible and expressive in order to ensure that specific NOC requirements are met. Specific NOC information is kept outside the NTTDM, and external databases can be used to feed it.

- The domain of managing the information is not fully standardized and must rely on free-form textual descriptions. The NTTDM attempts to strike a balance between supporting this free-form content, while still allowing automated processing of incident information.

The NTTDM is only one of several feasible TT data representations. The goal of this design was to be as effective and comprehensive as these other representations and to account for the management of a general Grid environment. The already used TT formats influenced the design of the NTTDM.

1.4. About the Network Trouble Ticket Implementation

Here we describe an example of a typical use case.

The Grid project EGEE manages its infrastructure as a network overlay over the European National Research and Educational Networks (NRENs) and wants to be able to warn EGEE sites of the unavailability of the network. Thanks to collaboration with its network provider, the EGEE NOC receives a high volume of TTs (800 tickets/month, 2500 emails/month) from 20 NRENs and should always be able to cope with such a heavy load. Thanks to the NTTDM, the EGEE NOC can automate the TT workflow:

- The TT is filtered, sorted, and stored in a local database (DB).
- The TT’s impact on the Grid is assessed.
- The TT is pushed to an ENOC dashboard application and other tools (EGEE TT system, statistics, etc.).

1.5. Future Plans

Since this is an Experimental document, operational experience will be used to expand the subsections of Section 3.2.3, "Ticket Origin Information", below. The current specification is already used within EGEE. Other Grids are free to use it and report comments to the authors. After enough experimentation, we would like to advance it to the Standards Track.

2. NTTDM Types and Definitions

The various data elements of the TT data model are typed. This section discusses these data types. When possible, native Schema data types were adopted, but for more complicated formats, regular expressions or external standards were used.

2.1. Types and Definitions for the TYPE Attribute

These types are used to describe the TYPE attribute.

2.1.1. Defined

The Defined data type means that the data model provides a means to compute this value from the rest of the fields.

The Defined data type is implemented as "Defined" in the Schema.

2.1.2. Free

The Free data type means that the value can be freely chosen.

All Free strings SHOULD have as an attribute the language used.

The Free data type is implemented as "Free" in the Schema.

2.1.3. Multiple

The Multiple data type consists of one value among multiple fixed values.

The Multiple data type is implemented as "Multiple" in the Schema.

2.1.4. List

"List" means many values among multiple fixed values. The List data type is implemented as "List" in the Schema.

2.2. Types and Definitions for the VALID FORMAT Attributes

2.2.1. Predefined String

A Predefined String means the different values are predefined in the data model.

Each field that requires a Predefined String contains a specific value. Figure 1 shows the allowed values for such fields.

FIELD NAME	VALUES
TT_TYPE	Operational, Informational, Administrative, Test
TYPE	Scheduled, Unscheduled
TT_PRIORITY	Low, Medium, High
TT_SHORT_DESCRIPTION	Core Line Fault, Access Line Fault, Degraded Service, Router Hardware Fault, Router Software Fault, Routing Problem, Undefined Problem, Network Congestion, Client Upgrade, IPv6, QoS, VoIP, Other
TT_IMPACT_ASSESSMENT	No impact, Reduced redundancy, Minor performance impact, Severe performance impact, No connectivity, On backup, At risk, Unknown
TT_STATUS	Opened, Updated, Closed, Solved, Inactive, Cancelled, Reopened, Superseded, Opened/Closed
TT_SOURCE	Users, Monitoring, Other NOC

Figure 1. Allowed Predefined String Values

The Predefined String data type is implemented as "xs:string" in the Schema with a sequence of enumerations for the allowed values.

2.2.1.1. Definitions of the Predefined Values

TT_TYPE

- Operational: for network incident and maintenance only.
- Informational: information about the TT system or the exchange interface (maintenance, upgrade).
- Administrative: information about the access to the TT system (credentials) or the exchange interface.
- Test: to test the TT system or the exchange interface, etc.

TYPE

- Scheduled: the incident was scheduled to happen.
- Unscheduled: the incident was unscheduled.

TT_PRIORITY

- Low: the TT priority is low.
- Medium: the TT priority is medium.
- High: the TT priority is high.

TT_SHORT_DESCRIPTION

- Core Line Fault: malfunction of a high-bandwidth core line.
- Access Line Fault: malfunction of a medium-bandwidth access line.
- Degraded Service.
- Router Hardware Fault: malfunction of the router hardware.
- Router Software Fault: malfunction of the router software.
- Routing Problem: incident regarding the routing service.
- Undefined Problem: nature of the problem not identified.
- Network Congestion: problem due to traffic at the network (blocked).
- Client Upgrade: incidents regarding client/services upgrade.

- IPv6: incident regarding the IPv6 network.
- QoS: incident regarding the Quality of Service (QoS) of the network.
- VoIP: incident regarding Voice over IP (VoIP).
- Other: non-listed incident.

TT_IMPACT_ASSESSMENT

- No impact: the incident does not cause any impacts.
- Reduced redundancy: the incident reduces network redundancy.
- Minor performance impact: the incident causes a minor performance impact.
- Severe performance impact: the incident causes a severe performance impact.
- No connectivity: the incident causes connectivity failure.
- On backup: the incident causes a malfunction of backup services.
- At risk: the incident should not have any impact but could possibly cause some trouble.
- Unknown: the nature of the impact is not identified.

TT_STATUS

- Opened: the ticket is opened.
- Closed: the ticket is closed.
- Updated: the ticket’s contents have been updated.
- Cancelled: the ticket has been opened twice; one of the tickets is cancelled, and a relationship between them is defined via the RELATED_ACTIVITY field.
- Solved: the incident is solved, but the team prefers to monitor/check for future issues.
- Opened/Closed: the ticket was opened only to report an incident that has already been solved.

- Inactive: the ticket is under the responsibility of an external domain and is no longer under the reporting domain’s control.

- Reopened: the ticket was closed by error, or the problem was erroneously declared to be solved. Data in the History field are very important in this case.

- Superseded: the ticket has been superseded by another one (for example, a bigger problem that had resulted in many tickets was later merged into a single incident/ticket). The RELATED_ACTIVITY field SHOULD include the master ticket reference.

Allowed transitions for TT_STATUS are only those indicated in Figure 2. Possible final states are indicated with (X).

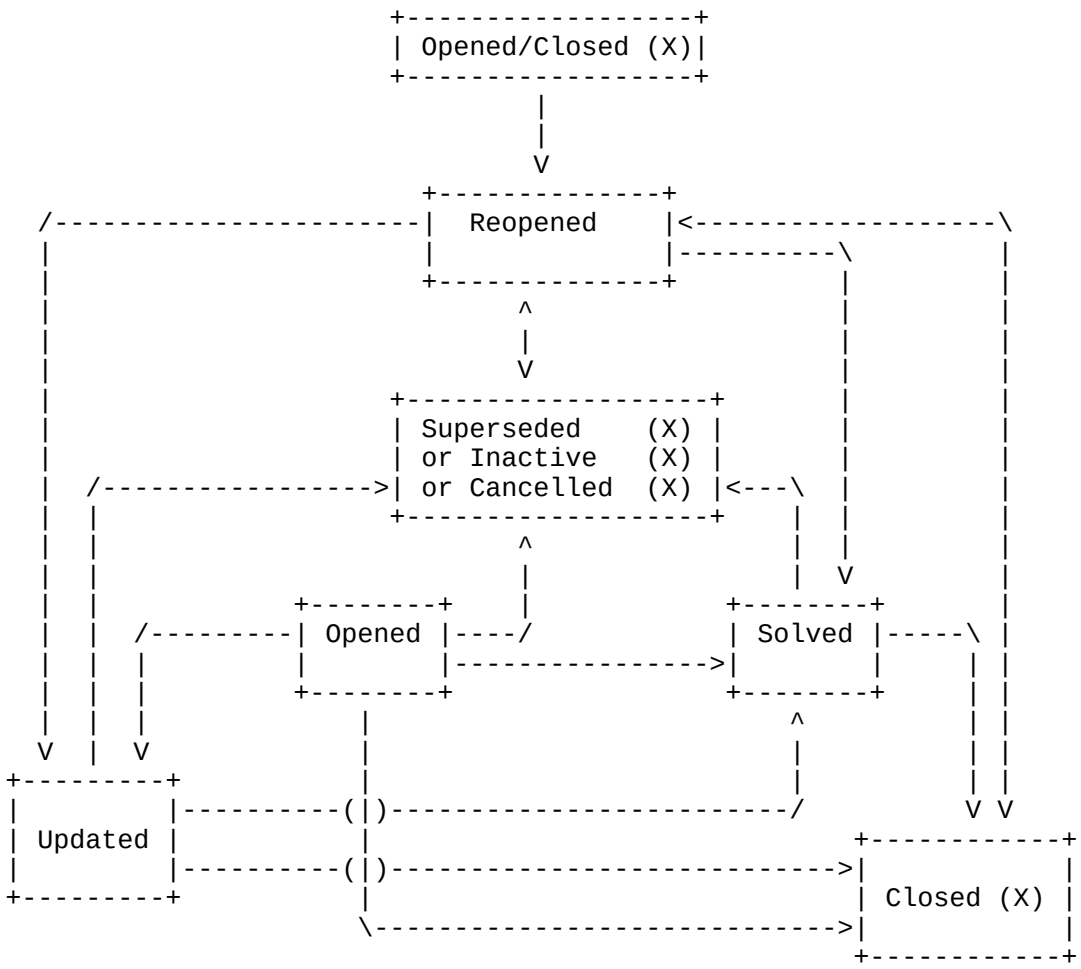

Figure 2. TT_STATUS Transition Diagram

2.2.2. String

The String value is defined by the user of the model. The String data type is implemented as "xs:string" in the Schema.

2.2.3. Datetime

Date-time strings are represented by the Datetime data type. Each date-time string identifies a particular instant in time; ranges are not supported.

Date-time strings are formatted according to a subset of ISO 8601:2000 as documented in RFC 3339.

The Datetime data type is implemented as "xs:dateTime" in the Schema.

3. NTTDM

In this section, the individual components of the NTTDM will be discussed in detail. This class provides a standardized representation for commonly exchanged Field Name data.

3.1. NTTDM Components

3.1.1. NTTDM Attributes

The Field Name class has four attributes. Each attribute provides information about a Field Name instance. The attributes that characterize one instance constitute all the information required to form the data model.

DESCRIPTION

This field contains a short description of the Field Name.

TYPE

The TYPE attribute contains information about the type of the Field Name it depends on. The values that it may contain are:

Defined, Free, Multiple, and List.

VALID FORMAT

This attribute contains information about the format of each field. The values that it may contain are:

Predefined String, String, and Datetime.

MANDATORY

This attribute indicates whether the information of each field is required or optional. If the information is required, the MANDATORY field contains the word "YES". If the information is optional, the MANDATORY field contains the word "NO".

3.2. NTTDM Aggregate Classes

3.2.1. NTTDM-Document Class

The NTTDM-Document class is the top-level class in the NTTDM. All NTTDM documents are an instance of this class.

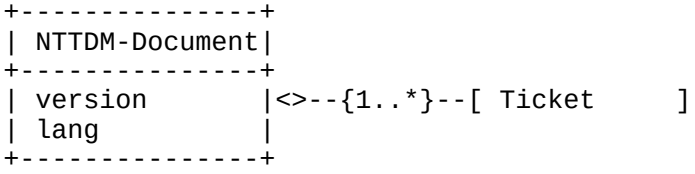

Figure 3. NTTDM-Document Class

The aggregate class that constitutes an NTTDM-Document is:

Ticket

One or more. The information related to a single ticket.

The NTTDM-Document class has two attributes:

version

STRING. The value of this attribute MUST be "1.00".

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Required.

3.2.2. Ticket Class

Every ticket is represented by an instance of the Ticket class. This class provides a standardized representation for commonly exchanged TT data.

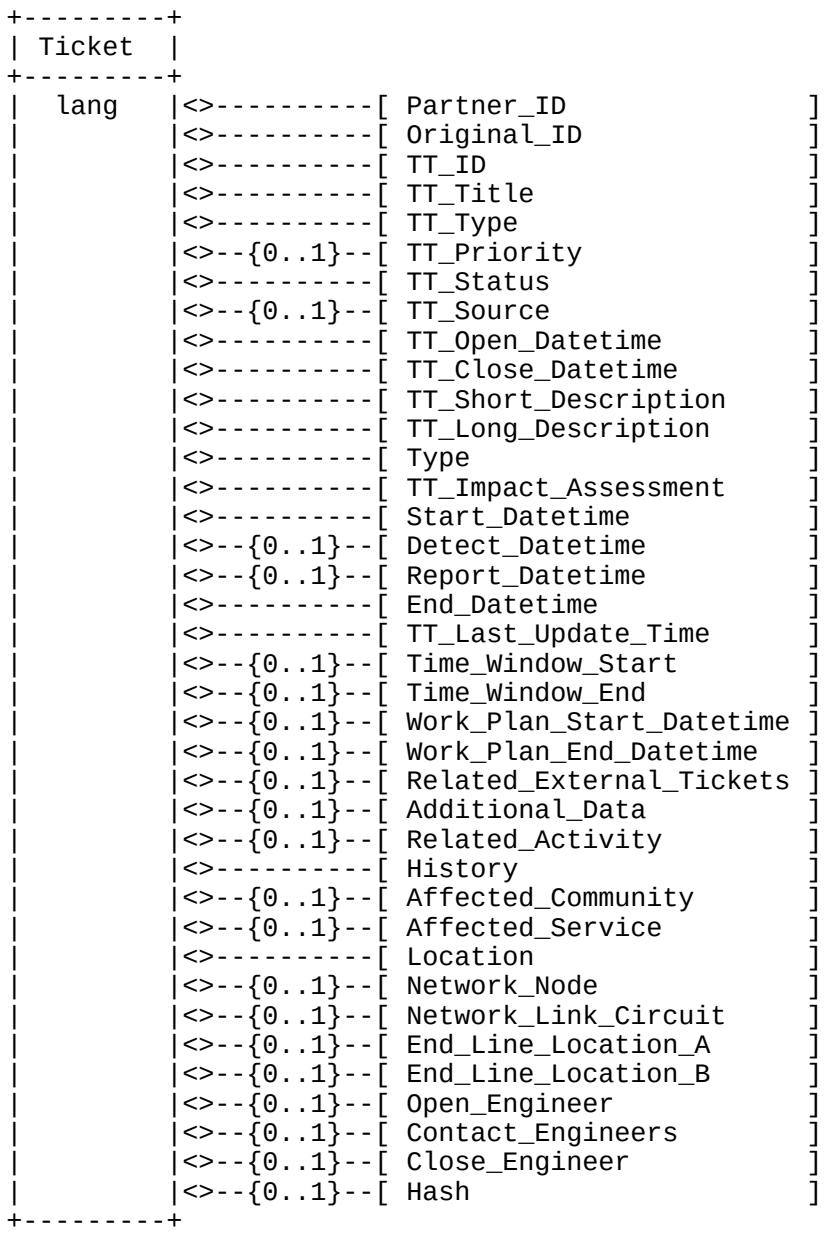

Figure 4. The Ticket Class

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Required.

The Field Names are the Aggregate Classes that constitute the NTTDM, and each of them is an element that is characterized by a quadruple (DESCRIPTION, TYPE, VALID FORMAT, MANDATORY).

3.2.3. Ticket Origin Information

3.2.3.1. PARTNER_ID

PARTNER_ID	
DESCRIPTION	The unique ID of the TT source partner.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 5. Partner_ID Class

3.2.3.2. ORIGINAL_ID

ORIGINAL_ID	
DESCRIPTION	The TT ID that was assigned by the party.
TYPE	Free.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 6. Original_ID Class

3.2.4. Ticket Information

3.2.4.1. TT_ID

TT_ID	
DESCRIPTION	The unique ID of the TT.
TYPE	As defined below.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 7. TT_ID Class

TYPE is constructed as "PARTNER_ID"_"ORIGINAL_ID". PARTNER_ID and ORIGINAL_ID therefore MUST NOT contain an underscore character.

3.2.4.2. TT_TITLE

TT_TITLE	
DESCRIPTION	The title of the TT.
TYPE	Defined.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 8. TT_Title Class

3.2.4.3. TT_TYPE

TT_TYPE	
DESCRIPTION	The type of the TT.
TYPE	Multiple.
VALID FORMAT	Predefined String.
MANDATORY	Yes.

Figure 9. TT_Type Class

3.2.4.4. TT_PRIORITY

TT_PRIORITY	
DESCRIPTION	The TT priority.
TYPE	Multiple.
VALID FORMAT	Predefined String.
MANDATORY	No.

Figure 10. TT_Priority Class

3.2.4.5. TT_STATUS

TT_STATUS	
DESCRIPTION	The TT status.
TYPE	Multiple.
VALID FORMAT	Predefined String.
MANDATORY	Yes.

Figure 11. TT_Status Class

3.2.4.6. TT_SOURCE

TT_SOURCE	
DESCRIPTION	The source of the ticket.
TYPE	Multiple.
VALID FORMAT	Predefined String.
MANDATORY	No.

Figure 12. TT_Source Class

3.2.4.7. TT_OPEN_DATETIME

TT_OPEN_DATETIME	
DESCRIPTION	The date and time when the TT was opened.
TYPE	Multiple.
VALID FORMAT	Datetime.
MANDATORY	Yes.

Figure 13. TT_Open_Datetime Class

3.2.4.8. TT_CLOSE_DATETIME

TT_CLOSE_DATETIME	
DESCRIPTION	The date and time when the TT was closed.
TYPE	Multiple.
VALID FORMAT	Datetime.
MANDATORY	Yes.

Figure 14. TT_Close_Datetime Class

3.2.5. Trouble Details

3.2.5.1. TT_SHORT_DESCRIPTION

TT_SHORT_DESCRIPTION	
DESCRIPTION	The short description of the trouble.
TYPE	Multiple.
VALID FORMAT	Predefined String.
MANDATORY	Yes.

Figure 15. TT_Short_Description Class

3.2.5.2. TT_LONG_DESCRIPTION

TT_LONG_DESCRIPTION	
DESCRIPTION	The detailed description of the incident/maintenance reported in the TT.
TYPE	Free.
VALID FORMAT	String.
MANDATORY	No.

Figure 16. TT_Long_Description Class

3.2.5.3. TYPE

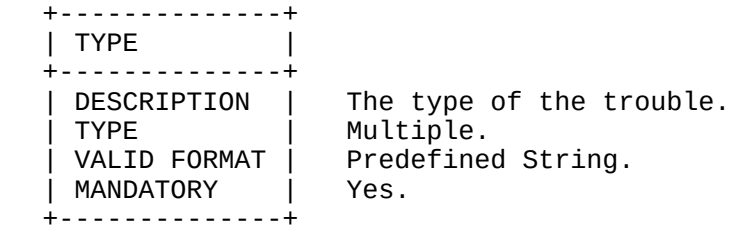

Figure 17. Type Class

3.2.5.4. TT_IMPACT_ASSESSMENT

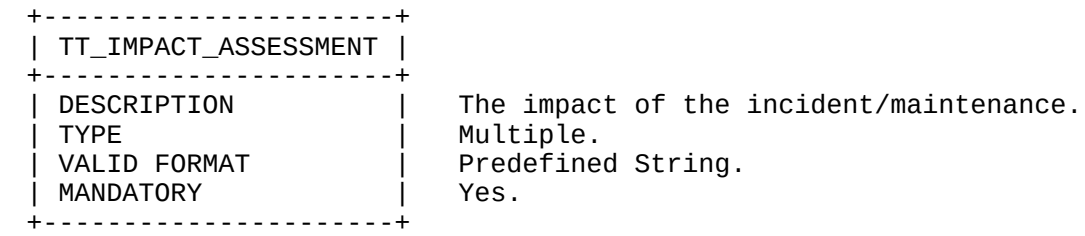

Figure 18. TT_Impact_Assessment Class

3.2.5.5. START_DATETIME

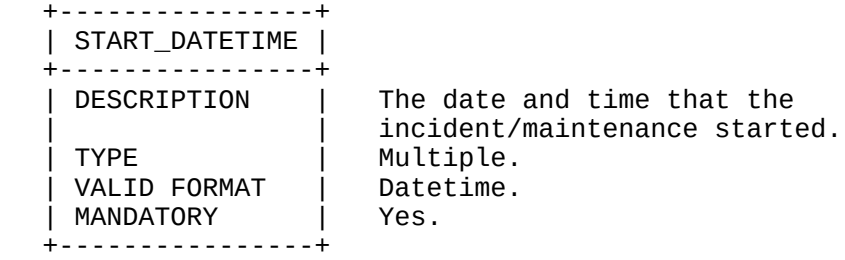

Figure 19. Start_Datetime Class

3.2.5.6. DETECT_DATETIME

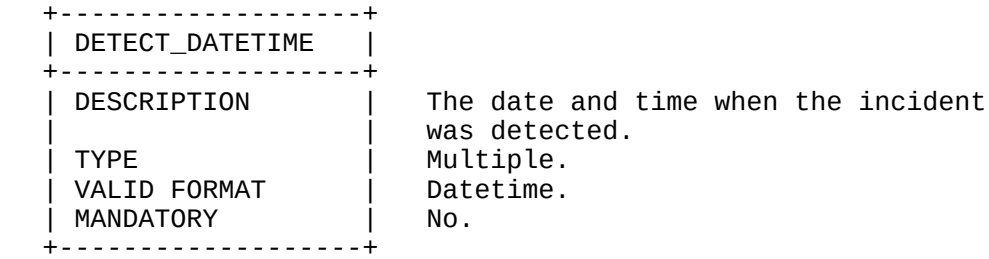

Figure 20. Detect_Datetime Class

3.2.5.7. REPORT_DATETIME

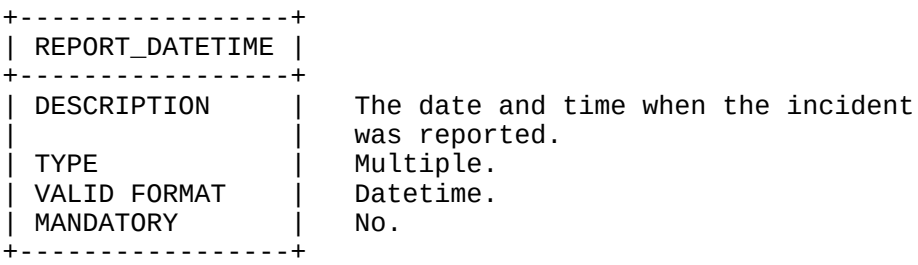

Figure 21. Report_Datetime Class

3.2.5.8. END_DATETIME

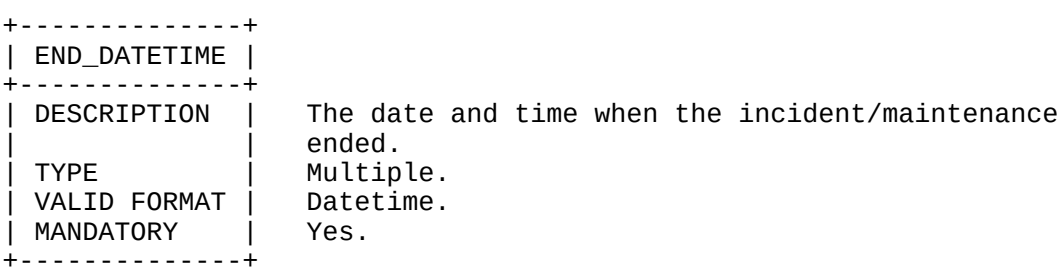

Figure 22. End_Datetime Class

3.2.5.9. TT_LAST_UPDATE_TIME

TT_LAST_UPDATE_TIME	
DESCRIPTION	The last date and time when the TT was updated.
TYPE	Multiple.
VALID FORMAT	Datetime.
MANDATORY	Yes.

Figure 23. TT_Last_Update_Time Class

3.2.5.10. TIME_WINDOW_START

TIME_WINDOW_START	
DESCRIPTION	The window start time in which planned maintenance may occur.
TYPE	Multiple.
VALID FORMAT	Datetime.
MANDATORY	No, unless TYPE is "Scheduled".

Figure 24. Time_Window_Start Class

3.2.5.11. TIME_WINDOW_END

TIME_WINDOW_END	
DESCRIPTION	The window end time in which planned maintenance may occur.
TYPE	Multiple.
VALID FORMAT	Datetime.
MANDATORY	No, unless TYPE is "Scheduled".

Figure 25. Time_Window_End Class

3.2.5.12. WORK_PLAN_START_DATETIME

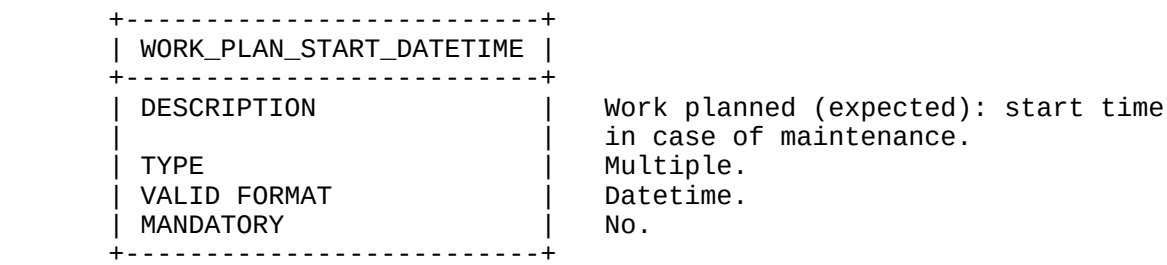

Figure 26. Work_Plan_Start_Datetime Class

3.2.5.13. WORK_PLAN_END_DATETIME

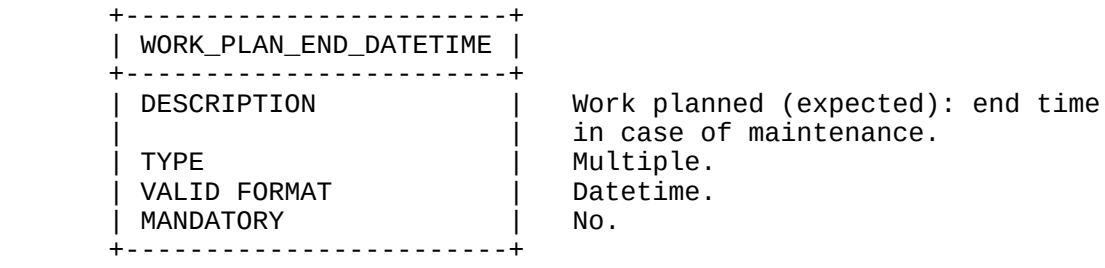

Figure 27. Work_Plan_End_Datetime Class

The period delimited by WORK_PLAN_START_DATETIME and WORK_PLAN_END_DATETIME MUST be included in the period delimited by TIME_WINDOW_START and TIME_WINDOW_END, and duplicated with {START, END}_DATETIME, even in case of maintenance.

3.2.6. Related Data

3.2.6.1. RELATED_EXTERNAL_TICKETS

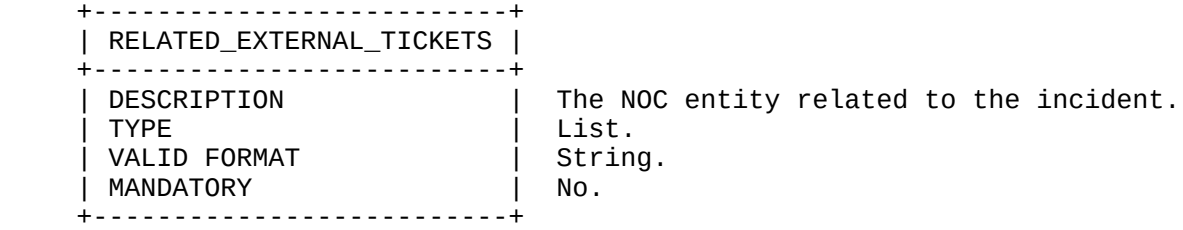

Figure 28. Related_External_Tickets Class

3.2.6.2. ADDITIONAL_DATA

ADDITIONAL_DATA	
DESCRIPTION	Additional information.
TYPE	Free.
VALID FORMAT	String.
MANDATORY	No.

Figure 29. Additional_Data Class

3.2.6.3. RELATED_ACTIVITY

RELATED_ACTIVITY	
DESCRIPTION	The TT IDs of the related incidents.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	No.

Figure 30. Related_Activity Class

3.2.6.4. HISTORY

HISTORY	
DESCRIPTION	The necessary actions/events log.
TYPE	Free.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 31. History Class

Note: This field MUST NOT be empty when the VALID FORMAT attribute of the TT_STATUS field is anything other than "OPENED" or "OPENED/CLOSED".

3.2.7. Localization and Impact

3.2.7.1. AFFECTED_COMMUNITY

AFFECTED_COMMUNITY	
DESCRIPTION	Information about the community that was affected by the incident.
TYPE	Free.
VALID FORMAT	String.
MANDATORY	No.

Figure 32. Affected_Community Class

3.2.7.2. AFFECTED_SERVICE

AFFECTED_SERVICE	
DESCRIPTION	The service that was affected by the incident.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	No.

Figure 33. Affected_Service Class

3.2.7.3. LOCATION

LOCATION	
DESCRIPTION	The location (Point of Presence (POP) site, city, etc.) of the incident/maintenance.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	Yes.

Figure 34. Location Class

3.2.7.4. NETWORK_NODE

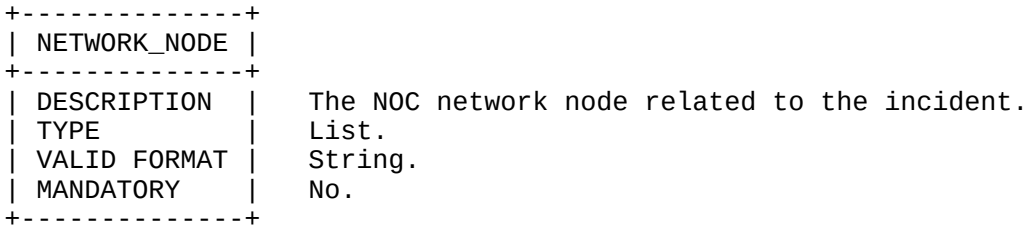

Figure 35. Network_Node Class

3.2.7.5. NETWORK_LINK_CIRCUIT

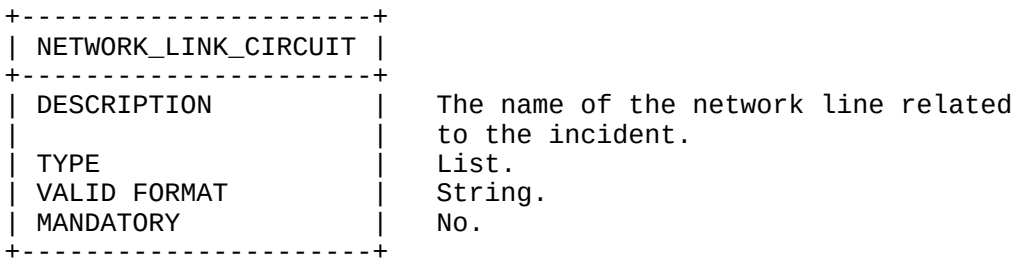

Figure 36. Network_Link_Circuit Class

3.2.7.6. END_LINE_LOCATION_A

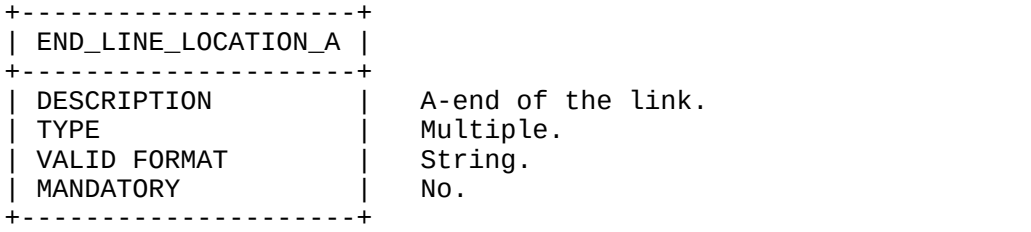

Figure 37. End_Line_Location_A Class

3.2.7.7. END_LINE_LOCATION_B

END_LINE_LOCATION_B	
DESCRIPTION	B-end of the link.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	No.

Figure 38. End_Line_Location_B Class

3.2.8. Contact Information

3.2.8.1. OPEN_ENGINEER

OPEN_ENGINEER	
DESCRIPTION	The engineer that opened the ticket.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	No.

Figure 39. Open_Engineer Class

3.2.8.2. CONTACT_ENGINEERS

CONTACT_ENGINEERS	
DESCRIPTION	The engineers responsible for the incident settlement.
TYPE	List.
VALID FORMAT	String.
MANDATORY	No.

Figure 40. Contact_Engineers Class

3.2.8.3. CLOSE_ENGINEER

CLOSE_ENGINEER	
DESCRIPTION	The engineer that closed the ticket.
TYPE	Multiple.
VALID FORMAT	String.
MANDATORY	No.

Figure 41. Close_Engineer Class

3.2.9. Security

3.2.9.1. HASH

HASH	
DESCRIPTION	Encrypted message hash.
TYPE	Defined.
VALID FORMAT	String.
MANDATORY	No.

Figure 42. Hash Class

3.3. NTTDM Representation

The collected and processed TTs received from multiple telecommunications networks are adjusted in a normalized NTTDM. Figure 43 shows the representation of this normalized data model. The "DESCRIPTION" attribute is implied.

FIELD NAME	TYPE	VALID FORMAT	MANDATORY
PARTNER_ID	MULTIPLE	STRING	YES
ORIGINAL_ID	FREE	STRING	YES
TT_ID	DEFINED	STRING	YES
TT_TITLE	DEFINED	STRING	YES
TT_TYPE	MULTIPLE	PREDEFINED STRING	YES
TT_PRIORITY	MULTIPLE	PREDEFINED STRING	NO
TT_STATUS	MULTIPLE	PREDEFINED STRING	YES
TT_SOURCE	MULTIPLE	PREDEFINED STRING	NO
TT_OPEN_DATETIME	MULTIPLE	DATETIME	YES
TT_CLOSE_DATETIME	MULTIPLE	DATETIME	YES
TT_SHORT_DESCRIPTION	MULTIPLE	PREDEFINED STRING	YES
TT_LONG_DESCRIPTION	FREE	STRING	NO
TYPE	MULTIPLE	PREDEFINED STRING	YES
TT_IMPACT_ASSESSMENT	MULTIPLE	PREDEFINED STRING	YES
START_DATETIME	MULTIPLE	DATETIME	YES
DETECT_DATETIME	MULTIPLE	DATETIME	NO
REPORT_DATETIME	MULTIPLE	DATETIME	NO
END_DATETIME	MULTIPLE	DATETIME	YES
TT_LAST_UPDATE_TIME	MULTIPLE	DATETIME	YES
TIME_WINDOW_START	MULTIPLE	DATETIME	NO
TIME_WINDOW_END	MULTIPLE	DATETIME	NO
WORK_PLAN_START_DATETIME	MULTIPLE	DATETIME	NO
WORK_PLAN_END_DATETIME	MULTIPLE	DATETIME	NO
RELATED_EXTERNAL_TICKETS	LIST	STRING	NO
ADDITIONAL_DATA	FREE	STRING	NO
RELATED_ACTIVITY	MULTIPLE	STRING	NO
HISTORY	FREE	STRING	YES
AFFECTED_COMMUNITY	FREE	STRING	NO
AFFECTED_SERVICE	MULTIPLE	STRING	NO
LOCATION	MULTIPLE	STRING	YES
NETWORK_NODE	LIST	STRING	NO
NETWORK_LINK_CIRCUIT	LIST	STRING	NO
END_LINE_LOCATION_A	MULTIPLE	STRING	NO
END_LINE_LOCATION_B	MULTIPLE	STRING	NO
OPEN_ENGINEER	MULTIPLE	STRING	NO
CONTACT_ENGINEERS	LIST	STRING	NO
CLOSE_ENGINEER	MULTIPLE	STRING	NO
HASH	DEFINED	STRING	NO

Figure 43. The Field Name Class

4. Internationalization Issues

Internationalization and localization are of specific concern to the NTTDM, since it is only through collaboration, often across language barriers, that certain incidents can be resolved. The NTTDM supports this goal by depending on XML constructs, and through explicit design choices in the data model.

The main advantage of the model is that it provides a normalized data type that is implemented fully in the English language and can be used conveniently. It also supports free-formed text that can be written in any language. In the future, it will provide translation services for all such free-formed text.

5. Example

5.1. Link Failure

In this section, an example of network TTs exchanged using the proposed format is provided. This is an actual GRNet ticket normalized according to the NTTDM. Fields that were not included in the ticket are left blank.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- This example describes a link failure that was detected -->

<NTTDM-Document version="1.00" lang="el"
                xmlns="urn:ietf:params:xml:ns:nttdm-1.0">
<Ticket>
 <Original_ID>5985</Original_ID>
 <Partner_ID>01</Partner_ID>
 <TT_ID>01_5985</TT_ID>
 <TT_Title>Forth Link Failure</TT_Title>
 <TT_Type>Operational</TT_Type>
 <TT_Status>Closed</TT_Status>
 <TT_Open_Datetime>2008-12-16T10:01:15+02:00</TT_Open_Datetime>
 <TT_Short_Description>Core Line Fault</TT_Short_Description>
 <TT_Long_Description>Forth Link Failure</TT_Long_Description>
 <Type>Unscheduled</Type>
 <TT_Impact_Assessment>No connectivity</TT_Impact_Assessment>
 <Start_Datetime>2008-12-16T09:55:00+02:00</Start_Datetime>
 <TT_Last_Update_Time>2008-12-16T15:00:34+02:00</TT_Last_Update_Time>
 <Location>HERAKLION</Location>
 <History>Optical transmitter was changed</History>
 <TT_Close_Datetime>2008-12-16T15:05:00+02:00</TT_Close_Datetime>
 <End_Datetime>2008-12-16T15:01:21+02:00</End_Datetime>
```

```
    <Network_Node>
     <Node>FORTH</Node>
    </Network_Node>
    <Network_Link_Circuit>
     <Link_Circuit>FORTH-2</Link_Circuit>
    </Network_Link_Circuit>
    <Open_Engineer>Dimitris Zisiadis</Open_Engineer>
    <Close_Engineer>Guillaume Cessieux</Close_Engineer>
    <Contact_Engineers>
     <Engineer>Spyros Kopsidas</Engineer>
     <Engineer>Chrysostomos Tziouvaras</Engineer>
    </Contact_Engineers>
    <TT_Priority>High</TT_Priority>
   </Ticket>
   </NTTDM-Document>
```

6. Sample Implementation: XML Schema

This section provides a sample XML Schema of the NTTDM.

```
   <?xml version="1.0" encoding="UTF-8" ?>
   <xs:schema xmlns="urn:ietf:params:xml:ns:nttdm-0.1"
    xmlns:nttdm="urn:ietf:params:xml:ns:nttdm-1.0"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:ietf:params:xml:ns:nttdm-1.0"
    elementFormDefault="qualified"
    attributeFormDefault="unqualified">
    <xs:annotation>
     <xs:documentation
         >Trouble Ticket Data Model v-1.0</xs:documentation>
    </xs:annotation>

    <!--
    ================================================================
    == NTTDM-Document Class                                       ==
    ================================================================
    -->
    <xs:element name="NTTDM-Document">
     <xs:complexType>
      <xs:sequence>
       <xs:element ref="nttdm:Ticket" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="version" type="xs:string" fixed="1.00"/>
      <xs:attribute name="lang" type="xs:language" use="required"/>
     </xs:complexType>
    </xs:element>
```

```
    <!--
    ================================================================
    ==  Ticket Class                                               ==
    ================================================================
    -->
    <xs:element name="Ticket">
      <xs:complexType>
       <xs:all>
        <xs:element ref="nttdm:Partner_ID"/>
        <xs:element ref="nttdm:Original_ID"/>
        <xs:element ref="nttdm:TT_ID"/>
        <xs:element ref="nttdm:TT_Title"/>
        <xs:element ref="nttdm:TT_Type"/>
        <xs:element ref="nttdm:TT_Priority" minOccurs="0"/>
        <xs:element ref="nttdm:TT_Status"/>
        <xs:element ref="nttdm:TT_Source" minOccurs="0"/>
        <xs:element ref="nttdm:TT_Open_Datetime"/>
        <xs:element ref="nttdm:TT_Close_Datetime"/>
        <xs:element ref="nttdm:TT_Short_Description"/>
        <xs:element ref="nttdm:TT_Long_Description"/>
        <xs:element ref="nttdm:Type"/>
        <xs:element ref="nttdm:TT_Impact_Assessment"/>
        <xs:element ref="nttdm:Start_Datetime"/>
        <xs:element ref="nttdm:Detect_Datetime" minOccurs="0"/>
        <xs:element ref="nttdm:Report_Datetime" minOccurs="0"/>
        <xs:element ref="nttdm:End_Datetime"/>
        <xs:element ref="nttdm:TT_Last_Update_Time"/>
        <xs:element ref="nttdm:Time_Window_Start" minOccurs="0"/>
        <xs:element ref="nttdm:Time_Window_End" minOccurs="0"/>
        <xs:element ref="nttdm:Work_Plan_Start_Datetime" minOccurs="0"/>
        <xs:element ref="nttdm:Work_Plan_End_Datetime" minOccurs="0"/>
        <xs:element ref="nttdm:Related_External_Tickets" minOccurs="0"/>
        <xs:element ref="nttdm:Additional_Data" minOccurs="0"/>
        <xs:element ref="nttdm:Related_Activity" minOccurs="0"/>
        <xs:element ref="nttdm:History"/>
        <xs:element ref="nttdm:Affected_Community" minOccurs="0"/>
        <xs:element ref="nttdm:Affected_Service" minOccurs="0"/>
        <xs:element ref="nttdm:Location"/>
        <xs:element ref="nttdm:Network_Node" minOccurs="0"/>
        <xs:element ref="nttdm:Network_Link_Circuit" minOccurs="0"/>
        <xs:element ref="nttdm:End_Line_Location_B" minOccurs="0"/>
        <xs:element ref="nttdm:Open_Engineer" minOccurs="0"/>
        <xs:element ref="nttdm:Contact_Engineers" minOccurs="0"/>
        <xs:element ref="nttdm:Close_Engineer" minOccurs="0"/>
        <xs:element ref="nttdm:Hash" minOccurs="0"/>
        <xs:element ref="nttdm:End_Line_Location_A" minOccurs="0"/>
       </xs:all>
```

```
      <xs:attribute name="lang" type="xs:language"/>
     </xs:complexType>
    </xs:element>

    <!--
    ================================================================
    ==  Partner_ID Class                                          ==
    ================================================================
    -->
    <xs:element name="Partner_ID" type="nttdm:string_no_underscore"/>

    <!--
    ================================================================
    ==  Original_ID Class                                         ==
    ================================================================
    -->
    <xs:element name="Original_ID" type="nttdm:string_no_underscore"/>

    <!--
    ================================================================
    ==  TT_ID Class                                               ==
    ================================================================
    -->
    <xs:element name="TT_ID" type="xs:string"/>

    <!--
    ================================================================
    ==  TT_Title Class                                            ==
    ================================================================
    -->
    <xs:element name="TT_Title" type="xs:string"/>

    <!--
    ================================================================
    ==  TT_Type Class                                             ==
    ================================================================
    -->
    <xs:element name="TT_Type" type="nttdm:eTT_Type"/>

    <!--
    ================================================================
    ==  TT_Priority Class                                         ==
    ================================================================
    -->
    <xs:element name="TT_Priority" type="nttdm:eTT_Priority"/>
```

```
    <!--
    ================================================================
    ==  TT_Status Class                                           ==
    ================================================================
    -->
    <xs:element name="TT_Status" type="nttdm:eTT_Status"/>

    <!--
    ================================================================
    ==  TT_Source Class                                           ==
    ================================================================
    -->
    <xs:element name="TT_Source" type="nttdm:eTT_Source"/>

    <!--
    ================================================================
    ==  TT_Open_Datetime Class                                    ==
    ================================================================
    -->
    <xs:element name="TT_Open_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  TT_Close_Datetime Class                                   ==
    ================================================================
    -->
    <xs:element name="TT_Close_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  TT_Short_Description Class                                ==
    ================================================================
    -->
    <xs:element name="TT_Short_Description"
                type="nttdm:eTT_Short_Description"/>

    <!--
    ================================================================
    ==  TT_Long_Description Class                                 ==
    ================================================================
    -->
    <xs:element name="TT_Long_Description" type="xs:string"/>
```

```
    <!--
    ================================================================
    ==  Type Class                                                 ==
    ================================================================
    -->
    <xs:element name="Type" type="nttdm:eType"/>

    <!--
    ================================================================
    ==  TT_Impact_Assessment Class                                 ==
    ================================================================
    -->
    <xs:element name="TT_Impact_Assessment"
             type="nttdm:eTT_Impact_Assessment"/>

    <!--
    ================================================================
    ==  Start_Datetime Class                                       ==
    ================================================================
    -->
    <xs:element name="Start_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Detect_Datetime Class                                      ==
    ================================================================
    -->
    <xs:element name="Detect_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Report_Datetime Class                                      ==
    ================================================================
    -->
    <xs:element name="Report_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  End_Datetime Class                                         ==
    ================================================================
    -->
    <xs:element name="End_Datetime" type="xs:dateTime"/>
```

```
    <!--
    ================================================================
    ==  TT_Last_Update_Time Class                                 ==
    ================================================================
    -->
    <xs:element name="TT_Last_Update_Time" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Time_Window_Start Class                                   ==
    ================================================================
    -->
    <xs:element name="Time_Window_Start" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Time_Window_End Class                                     ==
    ================================================================
    -->
    <xs:element name="Time_Window_End" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Work_Plan_Start_Datetime Class                            ==
    ================================================================
    -->
    <xs:element name="Work_Plan_Start_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Work_Plan_End_Datetime Class                              ==
    ================================================================
    -->
    <xs:element name="Work_Plan_End_Datetime" type="xs:dateTime"/>

    <!--
    ================================================================
    ==  Related_External_Tickets Class                            ==
    ================================================================
    -->
    <xs:element name="Related_External_Tickets"
                type="nttdm:eRelated_External_Tickets"/>
```

```
    <!--
    ================================================================
    ==  Additional_Data Class                                     ==
    ================================================================
    -->
    <xs:element name="Additional_Data" type="xs:string"/>

    <!--
    ================================================================
    ==  Related_Activity Class                                    ==
    ================================================================
    -->
    <xs:element name="Related_Activity"
                type="nttdm:eRelated_Activity"/>

    <!--
    ================================================================
    ==  History Class                                             ==
    ================================================================
    -->
    <xs:element name="History" type="xs:string"/>

    <!--
    ================================================================
    ==  Affected_Community Class                                  ==
    ================================================================
    -->
    <xs:element name="Affected_Community" type="xs:string"/>

    <!--
    ================================================================
    ==  Affected_Service Class                                    ==
    ================================================================
    -->
    <xs:element name="Affected_Service" type="xs:string"/>

    <!--
    ================================================================
    ==  Location Class                                            ==
    ================================================================
    -->
    <xs:element name="Location" type="xs:string"/>
```

```
    <!--
    ================================================================
    ==  Network_Node Class                                        ==
    ================================================================
    -->
    <xs:element name="Network_Node" type="nttdm:eNodes"/>

    <!--
    ================================================================
    ==  Network_Link_Circuit Class                                ==
    ================================================================
    -->
    <xs:element name="Network_Link_Circuit"
                type="nttdm:eNetwork_Link_Circuit"/>

    <!--
    ================================================================
    ==  End_Line_Location_A Class                                 ==
    ================================================================
    -->
    <xs:element name="End_Line_Location_A" type="xs:string"/>

    <!--
    ================================================================
    ==  End_Line_Location_B Class                                 ==
    ================================================================
    -->
    <xs:element name="End_Line_Location_B" type="xs:string"/>

    <!--
    ================================================================
    ==  Open_Engineer Class                                       ==
    ================================================================
    -->
    <xs:element name="Open_Engineer" type="xs:string"/>

    <!--
    ================================================================
    ==  Contact_Engineers Class                                   ==
    ================================================================
    -->
    <xs:element name="Contact_Engineers" type="nttdm:eEngineers"/>
```

```
    <!--
    ================================================================
    ==  Close_Engineer Class                                      ==
    ================================================================
    -->
    <xs:element name="Close_Engineer" type="xs:string"/>

    <!--
    ================================================================
    ==  Hash Class                                                ==
    ================================================================
    -->
    <xs:element name="Hash" type="xs:string"/>

    <!--
    ================================================================
    ==  Custom types definition                                   ==
    ================================================================
    -->
    <xs:simpleType name="string_no_underscore">
     <xs:restriction base="xs:string">
      <xs:pattern value="[^_]*"/>
     </xs:restriction>
    </xs:simpleType>

    <xs:complexType name="eRelated_External_Tickets">
     <xs:sequence>
      <xs:element name="TTid" type="xs:string" minOccurs="0"
                  maxOccurs="unbounded"/>
     </xs:sequence>
    </xs:complexType>

    <xs:complexType name="eRelated_Activity">
     <xs:sequence>
      <xs:element name="TT" type="xs:string" minOccurs="0"
                  maxOccurs="unbounded"/>
     </xs:sequence>
    </xs:complexType>

    <xs:complexType name="eNodes">
     <xs:sequence>
      <xs:element name="Node" type="xs:string" minOccurs="0"
                  maxOccurs="unbounded"/>
     </xs:sequence>
    </xs:complexType>
```

```
    <xs:complexType name="eNetwork_Link_Circuit">
     <xs:sequence>
      <xs:element name="Link_Circuit" type="xs:string"
                  minOccurs="0" maxOccurs="unbounded"/>
     </xs:sequence>
    </xs:complexType>

    <xs:complexType name="eEngineers">
     <xs:sequence>
      <xs:element name="Engineer" type="xs:string" minOccurs="0"
                 maxOccurs="unbounded"/>
     </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="eTT_Type">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Operational"/>
      <xs:enumeration value="Informational"/>
      <xs:enumeration value="Administrative"/>
      <xs:enumeration value="Test"/>
     </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="eType">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Scheduled"/>
      <xs:enumeration value="Unscheduled"/>
     </xs:restriction>
    </xs:simpleType>

   <xs:simpleType name="eTT_Priority">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Low"/>
      <xs:enumeration value="Medium"/>
      <xs:enumeration value="High"/>
     </xs:restriction>
    </xs:simpleType>
```

```
    <xs:simpleType name="eTT_Short_Description">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Core Line Fault"/>
      <xs:enumeration value="Access Line Fault"/>
      <xs:enumeration value="Degraded Service"/>
      <xs:enumeration value="Router Hardware Fault"/>
      <xs:enumeration value="Router Software Fault"/>
      <xs:enumeration value="Routing Problem"/>
      <xs:enumeration value="Undefined Problem"/>
      <xs:enumeration value="Network Congestion"/>
      <xs:enumeration value="Client Upgrade"/>
      <xs:enumeration value="IPv6"/>
      <xs:enumeration value="QoS"/>
      <xs:enumeration value="VoIP"/>
      <xs:enumeration value="Other"/>
     </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="eTT_Impact_Assessment">
     <xs:restriction base="xs:string">
      <xs:enumeration value="No impact"/>
      <xs:enumeration value="Reduced redundancy"/>
      <xs:enumeration value="Minor performance impact"/>
      <xs:enumeration value="Severe performance impact"/>
      <xs:enumeration value="No connectivity"/>
      <xs:enumeration value="On backup"/>
      <xs:enumeration value="At risk"/>
      <xs:enumeration value="Unknown"/>
     </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="eTT_Status">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Opened"/>
      <xs:enumeration value="Updated"/>
      <xs:enumeration value="Closed"/>
      <xs:enumeration value="Solved"/>
      <xs:enumeration value="Opened/Closed"/>
      <xs:enumeration value="Inactive"/>
      <xs:enumeration value="Cancelled"/>
      <xs:enumeration value="Reopened"/>
      <xs:enumeration value="Superseded"/>
     </xs:restriction>
    </xs:simpleType>
```

```
    <xs:simpleType name="eTT_Source">
     <xs:restriction base="xs:string">
      <xs:enumeration value="Users"/>
      <xs:enumeration value="Monitoring"/>
      <xs:enumeration value="Other NOC"/>
     </xs:restriction>
    </xs:simpleType>
   </xs:schema>
```

7. Security Considerations

The NTTDM data model defines a data model and the relevant XML Schema for trouble ticket normalization; as such, the NTTDM itself does not raise any security concerns. However, some security issues SHOULD be considered as network TTs could carry sensitive information (IP addresses, contact details, authentication details, commercial providers involved, etc.) about flagship institutions (military, health centre...).

The security considerations MAY involve measures during the exchange as well as during processing of the information.

The HASH field is intended to provide an integrity insurance attribute within the exchanged tickets; however, it alone does not ensure integrity.

Confidentiality MAY be ensured by encrypting whole tickets or only some parts of them. This could permit meaningful tickets to be disclosed, while only sensitive information would be protected.

Peer entity authentication SHOULD be provided in order to establish a session with data origin authentication, regardless of the form in which the TTs are exchanged -- being delivered either through email, web forms, or through a Simple Object Access Protocol (SOAP) service. SOAP is considered the better choice; the model itself, though, does not specify the communications requirements.

The underlying communications service MUST provide guarantees to properly address integrity, confidentiality, and peer entity authentication. The selection of the enforcing mechanisms is not in the scope of this document, and the choice is up to the implementers.

For data processing security, each participating organization MAY use its own privacy policy, as part of its own data processing system. This approach avoids any interoperability issues and does not pose any extra burden for the adoption of the current scheme into the operational procedures of the NOCs. Unauthorized and inappropriate usage MUST be avoided.

8. IANA Considerations

This document uses URNs to describe an XML namespace and Schema conforming to a registry mechanism described in [7].

Registration for the NTTDM namespace:

- URI: urn:ietf:params:xml:ns:nttdm-1.0
- Registrant Contact: See the first author listed in the "Authors' Addresses" section of this document.
- XML: None. Namespace URIs do not represent an XML specification.

Registration for the NTTDM XML Schema:

- URI: urn:ietf:params:xml:schema:nttdm-1.0
- Registrant Contact: See the first author listed in the "Authors' Addresses" section of this document.
- XML: See the XML Schema in Section 6 of this document.

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- Karin Schauerhammer and Robert Stoy (DFN)

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