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eTIR conceptual, functional and technical documentation version 4.3: eTIR technical specifications

Technical requirements of the eTIR international system and implementation and tests of the eTIR messages

Revision

Note by the secretariat

I. Mandate

1. The Inland Transport Committee (ITC), at its eighty-second session (23–28 February 2020) approved (ECE/TRANS/294, para. 84[1]) the establishment of the Group of Experts on Conceptual and Technical Aspects of Computerization of the TIR Procedure (WP.30/GE.1) and endorsed its Terms of Reference (ToR)[2] (ECE/TRANS/WP30/2019/9 and ECE/TRANS/WP.30/2019/9/Corr.1), pending approval by the United Nations Economic Commission for Europe (ECE) Executive Committee (EXCOM). EXCOM during its remote informal meeting (20 May 2020) approved the establishment of WP.30/GE.1 until 2022, based on the ToR included in document ECE/TRANS/WP.30/2019/9 and Corr.1, as contained in document ECE/TRANS/294 (ECE/EX/2020/L.2, para. 5(b)).[3]

[1] Decision of the Inland Transport Committee para. 84 / ECE/TRANS/294 www.unece.org/fileadmin/DAM/trans/doc/2020/itc/ECE-TRANS-294e.pdf

[2] Terms of reference of the newly established Group approved by the Inland Transport Committee and the Executive Committee (EXCOM) of UNECE www.unece.org/fileadmin/DAM/trans/bcf/wp30/documents/2019/ECE-TRANS-WP30-2019-09e.pdf and corrigendum www.unece.org/fileadmin/DAM/trans/bcf/wp30/documents/2019/ECE-TRANS-WP30-2019-09c1e.pdf

[3] Decision of EXCOM, ECE/EX/2020/L.2 / para. 5(b) www.unece.org/fileadmin/DAM/commission/EXCOM/Agenda/2020/Remote_informal_mtg_20_05_

2. The ToR of the Group stipulate that the Group should focus its work on preparing a new version of the eTIR specifications, pending the formal establishment of the Technical Implementation Body (TIB). More specifically, the Group should (a) prepare a new version of the technical specifications of the eTIR procedure, and amendments thereto, ensuring their alignment with the functional specifications of the eTIR procedure; (b) prepare a new version of the functional specifications of the eTIR procedure, and amendments thereto, ensuring their alignment with the conceptual specifications of the eTIR procedure; (c) prepare amendments to the conceptual specifications of the eTIR procedure, upon requests by WP.30.

3. This document presents the technical requirements of the eTIR international system. It also describes the aspects related to the implementation and tests of the eTIR messages. All these aspects will be part of the eTIR technical specifications document.

II. eTIR international system

A. Technical requirements

1. Introduction

4. This section describes the technical requirements – or non-functional requirements – which must be met by the eTIR international system. Technical requirements specify criteria that can be used to judge how well a system performs its operations and fulfils its mission. These criteria are as important as functional requirements and will drive the architecture and design principles of the system.

5. Each following sub-section describes the requirements of a particular non-functional criterion. These requirements can be qualitative (e.g. the source code must be versioned on Git) and/or quantitative (e.g. the eTIR international system must be available 24 hours per day and 365 days per year). All requirements are given a unique identifier for ease of reference.

6. Quantitative requirements need metrics to be collected to be able to assess whether these requirements are met. Provided these metrics can be revealed without posing a security issue, they may be communicated on a periodic basis to TIB for its information.

7. Given the fact that the eTIR system is based on an exchange of messages using web services and that no user interface is expected to be developed for the eTIR international system (except for internal purposes related to its administration), the following criteria are therefore not applicable and will not be described: accessibility, compatibility and usability.

8. Several quantitative targets will be periodically assessed by ECE and reported to TIB, along with proposals to correct potential deficiencies and further increase the targets. TIB shall then decide whether to apply these proposals or recommend their application to AC.2.

9. Finally, when products, software, frameworks and libraries used to fulfil the requirements, are mentioned, ECE reserves the right to modify its selection later on, as long as there are no costs implications, in order to accrue additional benefits for the eTIR system. The information about these new selections would be communicated to TIB and the next version of the eTIR specifications would be updated accordingly.

2. Availability

10. The availability of the eTIR international system represents the state when it is fully accessible and operable by its authorized users (ECE and all eTIR stakeholders connected to it).

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11. The availability of the eTIR international system will be critically important for the proper functioning of the whole eTIR system from the beginning and even more when the number of TIR transports carried under the eTIR procedure will increase. The following tables describe both the qualitative and quantitative aspects of the availability requirements. Several of them will be part of the service level agreement (SLA) to be signed with the United Nations hosting provider (hereafter the hosting entity) which will be selected to host the eTIR international system.

Table 1
Qualitative availability requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
AV.1	Normal maintenance operations for the software and systems components of the eTIR international system are performed transparently as the service remains available.	Design the eTIR international system in a way that avoids single points of failure (SPOF), using several front-end web servers to share the workload, database clustering, duplication of application components, and by possibly using high-availability proxies and orchestration of containers

Table 2
Quantitative availability requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
AV.2	General availability of the eTIR international system	Host the eTIR international system in a UN organization that proposes this level of availability and include it in the SLA.	24 hours per day, each day of the year.
AV.3	Percentage of uptime of the eTIR international system	Normal maintenance operations for the software and systems components of the eTIR international system are performed transparently as the service remains available. Issues with the system are quickly identified and dealt with using SOPs and escalation mechanism.	Greater than 99% (i.e. a maximum of 3d 15h 39m 29s of downtime per year).
AV.4	Maximum consecutive eTIR international system downtime in case of a major issue	Monitoring of services, software components and virtual servers is configured and agreed with the hosting provider. Procedures are prepared and agreed in the SLA.	4 hours during weekdays and 24 hours during weekends, per occurrence.

12. Once the eTIR international system starts to be used in production, following the study on measures collected and on the feedback from eTIR stakeholders, ECE or TIB may wish to propose to improve the target values of requirements AV.3 and AV.4 to increase the availability of the service. In this case, ECE would submit to TIB a proposal to improve the above-mentioned target values, along with possible budget implications.

3. Backup

13. A backup is a copy of eTIR related data made and stored elsewhere, in a secured location, so that it can be used to restore them after a data loss event.

14. Each storage location (i.e. eTIR database, eTIR logs and eTIR documents) will be backed up to ensure the requirements are met. The ones indicated in the following table will be part of the SLA to be signed with the hosting entity.

Table 3
Backup requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
BK.1	Frequency of backup of eTIR data	Information stored in the eTIR database, the eTIR logs and the eTIR documents is backed up twice per day and this backed up data is stored in a secured location.	12 hours
BK.2	Maximum time to restore backed up data following a data loss event	Restore procedures are prepared and agreed in the SLA with the hosting provider. Tests are regularly carried out.	6 hours

15. Once the eTIR international system starts to be used in production, ECE or TIB may wish to propose to improve the target values of requirements BK.1 and BK.2. In this case, ECE would submit to TIB a proposal to improve the above-mentioned target values, along with possible budget implications.

4. Capacity and scalability

16. There are basically two aspects to take into consideration regarding capacity management: the throughput of the system (i.e. its ability to process incoming messages and send responses) and the storage of the various pieces of information received. The scalability of the eTIR international system is its capability to handle a growing amount of workload by adding resources to the system.

17. The figures in the following table are based on an analysis performed to determine the needs in terms of capacity and scalability for the eTIR international system and available in annex VI.C. As mentioned in its conclusions, the estimates and forecast in terms of throughput and volume of data are only as good as the various assumptions they are based on. Since the eTIR international system is not yet in operation, this analysis lacks actual data. For this reason, the eTIR international system should be designed while considering the capacity and scalability requirements for the first two years only, as there is a high probability that real data will correct several assumptions, which would change the calculation result and forecast for the next years.

Table 4
Capacity and scalability requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
CP.1	Maximum number of messages to be processed	A queuing component stores incoming messages. Several front-end web servers then pop messages from the queue to be processed under timeout thresholds.	2021: 12 messages per minute 2022: 78 messages per minute 2023: 270 messages per minute 2024: 570 messages per minute 2025: 1200 messages per minute
CP.2	Maximum storage dedicated to the eTIR logs	eTIR logs are directly saved on the front-end web servers. On a daily basis, they are moved to a central, secured location which will have enough storage space to aggregate them all.	2021: 371 GB per year 2022: 1.2 TB per year 2023: 4.9 TB per year 2024: 17.1 TB per year 2025: 36.1 TB per year
CP.3	Maximum storage dedicated to the eTIR database	Depending on the actual data received and on regular performance measurements, only the most recent data (last six months for instance) may be kept in the clustered database (while older data is regularly offloaded to a secondary database) to ensure the size of the main database does not negatively impact its performance.	2021: 1.4 GB per year 2022: 4.3 GB per year 2023: 17.9 GB per year 2024: 62.6 GB per year 2025: 133.3 GB per year

Identifier	*Description*	*How to achieve the target*	*Target value*
CP.4	Maximum storage dedicated to the eTIR documents	eTIR documents are not stored in the database but on a central, secured, file system which will have enough disk space to gather them all.	2021: 100 GB per year 2022: 315 GB per year 2023: 1.3 TB per year 2024: 4.6 TB per year 2025: 9.8 TB per year
CP.5	Maximum size of the messages	Messages need to have a maximum size to prevent degrading the performance of the information systems exchanging and processing them.	20 MB

18. As mentioned in the conclusions of the analysis presented in annex VI.C, ECE shall perform the same analysis six months after the eTIR international system is deployed in production in order to submit to TIB a revision of the above mentioned target values, along with a possible budget proposal.

5. Configuration management

19. Configuration management is the process that tracks all of the individual configuration items of the eTIR international system. A configuration item is an IT asset or a combination of IT assets that may depend on and/or have relationships with other IT processes (e.g. source code, configuration files, procedures, internal documentation, etc.).

20. An appropriate number of measures and procedures related to configuration management is the only effective and sustainable way to develop and maintain a major information system like the eTIR international system and ECE will ensure that the following technical requirements are properly addressed.

Table 5
Configuration management requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
CM.1	The source code of all modules of the eTIR international system should be versioned using a version control system (VCS) to allow for an effective management of this asset.	The source code of all modules of the eTIR international system is versioned using Git and hosted within UN premises.
CM.2	All changes related to the eTIR database should be versioned using a VCS to allow for an effective management of this asset.	All changes related to the eTIR database are versioned using Liquibase and Git and hosted within UN premises.
CM.3	All assets related to the documentation of the eTIR system should be versioned using a VCS to allow for an effective management of this asset.	All assets related to the documentation of the eTIR system are versioned using various VCS depending on their nature and hosted within UN premises.
CM.4	All assets related to the internal documentation of the eTIR international system should be versioned and accessible to ECE using a collaboration software to allow for an effective sharing of knowledge and improved productivity.	All assets related to the internal documentation of the eTIR international system are versioned and accessible to ECE on a knowledge management system (KMS) that acts as a secured and versioned collaboration platform hosted within UN premises.
CM.5	All bug reports, feature requests and other issues are logged, managed and eventually addressed using an issue tracking system to ensure that the issues raised by all eTIR stakeholders are properly evaluated and treated with the appropriate level of priority.	All bug reports, feature requests and other issues are logged, managed and eventually addressed using an issue tracking system hosted within UN premises.

6. Data Retention

21. Data Retention defines the policies related to persistent data and records management for meeting legal and business data archival requirements, such as the ones listed in Annex 11. The following table lists the requirements in terms of data retention for the eTIR international system.

Table 6
Data Retention requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
RE.1	Availability of the information stored in the eTIR international system	Information stored in the eTIR database, the eTIR logs and the eTIR documents are backed up on a daily basis and additional copies are made and kept on tapes stored in a separate, secured location, resistant to most disasters.	10 years[4]
RE.2	Retrieval of information requested by contracting parties for verification purposes[5]	Retrieval procedures are prepared and agreed in the SLA with the hosting provider.	Maximum of three days to retrieve the information

7. Disaster recovery

22. Disaster recovery involves a set of policies, tools and procedures to enable the recovery or continuation of the eTIR international system following a natural or human-induced disaster. Disaster recovery focuses on the IT or technology systems supporting critical business functions and can therefore be considered as a subset of business continuity planning.

23. Usually, disaster recovery assumes that the primary site is not recoverable (at least for some time) and represents the set of processes needed to restore the services to a secondary site. In the scope of version 4.3 of the eTIR specifications, it is assumed that only a secondary site of type “warm site” is available for disaster recovery purposes, principally for costs reasons.

24. A “warm site” contains the equipment and data circuits necessary to rapidly establish operations. This equipment is usually preconfigured and ready to install appropriate applications to support an organization’s operations. However, is this secondary site is to be used because the primary site is no longer available because of a disaster, all software components still have to be installed and configured on the servers of the “warm site”. Furthermore, live data from the primary site is not replicated on this type of secondary site in real time but data transactions are only copied on a regular basis.

25. The impact of a disaster is high because it brings the eTIR international system down for an unusual long period of time (typically more than one day). However, the probability of such a disaster occurring is extremely low. The resulting risk is minor in the context of version 4.3 of the eTIR specifications as the number of TIR transports using the eTIR procedure will be low at first and only progressively increase as additional contracting parties interconnect their national customs systems to the eTIR international system. Furthermore, the fallback procedures described in the eTIR functional specifications act as mitigating measures for this risk.

26. The following table lists the disaster recovery requirements for the eTIR international system.

[4] As per paragraph 1 of article 12 of Annex 11 of the TIR Convention
[5] As per paragraph 3 of article 12 of Annex 11 of the TIR Convention

Table 7
Disaster recovery requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
DR.1	The recovery time objective (RTO)[6] of the eTIR international system, after a disaster.	Prepare a disaster recovery plan with all procedures detailing how to recover the eTIR international system and execute regular tests of this plan.	48 hours
DR.2	The recovery point objective (RPO)[7] of the eTIR international system.	Regularly and securely send copies of eTIR related data to the warm site. Perform recovery tests.	4 hours

27. Once the eTIR international system starts to be used in production, ECE or TIB may wish to propose to improve the target values of requirements DR.1 and DR.2. In this case, ECE would submit to TIB a proposal to improve the above-mentioned target values, along with possible budget implications.

8. Fault tolerance

28. Fault tolerance is the property that enables a system to continue operating properly in the event of the failure of (or one or more faults within) some of its components. Modern information systems architectures and infrastructure take into account usual technical failures of components like hard disk drives, network connections, power failures and can provide a level of fault tolerance which is transparent to the end users.

29. The requirements listed in the following table provide a first level of technical fallback which does not need to be activated by the eTIR stakeholders. These requirements are mostly fulfilled by the underlying infrastructure and will be part of the SLA to be signed with the hosting entity.

Table 8
Fault tolerance requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
FT.1	Gracefully handle the failure of a physical server, which can be due to a piece of equipment (CPU, memory, motherboard, HDD, network card, etc.) to avoid the eTIR international system becoming unavailable.	An infrastructure based on a virtual server farm relying on several physical servers which manage hot swapping of virtual machines to mitigate such a failure. Architecture based on computer cluster to avoid any SPOF.
FT.2	Gracefully handle the failure of a piece of equipment used by the storage locations (HDD, SSD) to avoid the eTIR international system becoming unavailable.	An infrastructure based on a SAN using a redundant architecture for the disk drives (RAID). Architecture based on computer cluster to avoid any SPOF.
FT.3	Gracefully handle the loss of internet connectivity to avoid the eTIR international system becoming unavailable.	Double internet connection with two different providers.
FT.4	Gracefully handle power failures to avoid the eTIR international system becoming unavailable.	Racks of uninterruptible power supplies (UPS) and emergency fuel generators to power the data centre with enough fuel in reserve to wait for the power to come back to be refilled with more fuel.

[6] The RTO is the amount of time in which it should be feasibly to recover the IT service in the event of a disaster.

[7] The RPO is the maximum targeted period in which data (transactions) might be lost from an IT service due in the event of a disruption.

9. Internationalization and localization

30. Internationalization and localization are means of adapting computer software to different languages, regional peculiarities and technical requirements of a target locale. Internationalization is the process of designing a software application so that it can be adapted to various languages and regions without engineering changes. Localization is the process of adapting internationalized software for a specific region or language by translating text and adding locale-specific components.

31. Since the eTIR international system does not have a user interface, the requirements in terms of internationalization are limited to the eTIR messages and how data is stored in the various storage locations. Several approaches have been taken to limit the needs in terms of localization:

- Most of the attributes in the eTIR messages are using code lists. These code lists detail all the possible codes that an attribute can take, which facilitates the transfer of information from one system to another, since all systems are aligned on the same set of code lists. Furthermore, this method avoids having to translate values which therefore do not need to be localized;
- Numbers are expressed using fixed patterns which are clearly defined in the XML Schema Definitions of the eTIR messages. This approach clears any potential ambiguity related to decimal and thousands separators;
- Dates are also expressed using specific patterns either for a date only or for a date and time, including a Coordinated Universal Time (UTC) offset;
- Text fields are kept to a minimum and are used most of the time to represent words that are usually not translated like: identifiers, proper nouns and addresses. A few text fields are used to hold sentences in a given language and the sub attribute “Language, coded” can be used to define the language of the values stored in these text fields.

32. The following table lists the requirements in terms of internationalization and localization

Table 9
Internationalization and localization requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
IL.1	The eTIR messages should be able to handle text values in French, English and Russian.	The character set of the eTIR messages exchanged in SOAP/XML is UTF-8, the content type is “application/soap+xml”.
IL.2	The eTIR database should be able to store text values (from the eTIR messages) in French, English and Russian.	The character set of the eTIR database is UTF-8.
IL.3	The eTIR logs should be able to store the entire eTIR messages as they are received.	The character set of the files stored in the eTIR logs is UTF-8.
IL.4	The eTIR documents should be able to store the attached documents in various languages in addition to French, English and Russian.	The character set of the files stored in the eTIR documents is UTF-8.
IL.5	The language of the text values held in the eTIR messages should be identifiable.	The text values are characterized with the “Language, coded” sub attribute which uses a code list to specify the language name.

10. Interoperability

33. Interoperability is a characteristic of a system, whose interfaces are comprehensively detailed, to work with other systems, at present or in the future, in either implementation or access, with full compatibility.

34. The eTIR system is based on machine to machine communication triggered by specific events. Therefore, the interfaces between the various eTIR stakeholders must be clearly defined to ease the interconnection between the systems. Also, in order to further facilitate this interconnection, the interfaces should be based on worldwide renowned standards.

Table 10
Interoperability requirements

Identifier	*Description and objectives*	*How to fulfil the requirement*
IT.1	The eTIR data model should be aligned with a worldwide renowned data model to facilitate the connection between the eTIR international system and the information systems of the other eTIR stakeholders.	The eTIR Data Model is fully aligned with the World Customs Organization (WCO). Data maintenance requests (DMR) are submitted by ECE to continuously adapt the WCO data model to the needs of the eTIR procedure.
IT.2	The format and technical specifications of the eTIR messages are following strict guidelines to ensure the electronic exchange of messages is interoperable between information systems.	The eTIR message specifications are following the WCO XML guidelines. Automated compliance tests are also performed to validate this aspect.
IT.3	Information exchanged in the eTIR messages is standardized as much as possible to facilitate their processing by all eTIR stakeholders.	The attributes of the eTIR messages rely as much as possible on code lists from renowned standards (UN/EDIFACT and ISO).
IT.4	eTIR stakeholders should have sufficient time to migrate to the next version of the eTIR specifications while continuing to use the current version of the eTIR specifications.	The eTIR international system will be able to receive, process and send eTIR messages using two versions of the eTIR specifications: the current one and the next one proposed for implementation to all eTIR stakeholders during a specific migration time window which details are described in the release management processes.

11. Maintainability

35. Maintainability is the ease with which a product can be maintained in order to (inter alia): correct defects[8], meet new requirements, make future maintenance easier and cope with a changing environment.

36. A usual pitfall in software engineering and software management is to underestimate the need to continuously invest a reasonable amount of money to maintain and upgrade an information system, in order to prevent having to pay a very high amount of money to refactor it completely because it has not been properly maintained over the years.

37. The IT industry also recognizes that a large portion of the total cost of ownership (TCO) of an information system is spent during the maintenance phase of its lifecycle: usually between 50% to 80%. This highlights the importance of taking the appropriate preventive measures to keep the costs of maintenance of an information system to a reasonable level while ensuring that all exigencies on maintainability are met.

38. In particular, measures should be taken to avoid building a technical debt. Technical debt is a concept in software development that reflects the implied cost of additional rework caused by choosing a poor decision that might yield benefits in the short-term but will increase the costs of maintenance in the long term. Indeed, as with monetary debt, if technical debt is not repaid, it can accumulate 'interest', making it harder to implement changes in the future.

39. The following table lists the requirements in terms of maintainability.

[8] See the definition of « defect » in the technical glossary

Table 11
Maintainability requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
MT.1	Technical debt should not accumulate on the programming languages, frameworks and libraries used to build the eTIR international system.	The latest stable versions of the underlying programming languages, frameworks and libraries used to build the eTIR international system are regularly reviewed and updates or upgrades are regularly planned. Recurrent reviews of the emerging trends are also performed, and appropriate actions are taken to migrate to better options before a component becomes deprecated.
MT.2	Technical debt should not accumulate on the source code of the eTIR international system.	A static code analysis tool is used to measure the maintainability index of the source code and regular attention is given to reduce the number of issues flagged by this tool. Regular code refactoring activities are also performed to reduce the *software entropy*[9] of the source code.
MT.3	Knowledge is retained to properly maintain and improve the eTIR international system	The internal documentation of the eTIR international system is managed on a KMS that acts as a secured and versioned collaboration platform between the members of ECE. One of the roles of the IT coordinator is to ensure that the appropriate level of documentation (including SOPs) is prepared and remains updated on the KMS in order to mitigate the risks of turnover and key person.[10]

12. Performance

40. Performance is the numerical indication, measuring the maximum or optimal possibilities of a hardware, software, system or technical process to perform a given task. In the case of the eTIR international system, the requirements are focused on the response time and the throughput characteristics.

41. Requirements on the throughput of the eTIR international system are already detailed in the section devoted to capacity, respectively with CP.1 and CP.2. Requirements on the response times are detailed in the following quantitative table, while additional requirements related to performance are listed in the qualitative table below.

Table 12
Quantitative performance requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
PE.1	Average response time involving short messages (up to 10KB) measured by the sender from sending the request message to receiving the response message.	The eTIR international system is properly designed and free of any logical or technical bottlenecks that could be a performance issue. The management of the eTIR database, writing information to the eTIR logs and connecting to the ITDB are all optimized operations.	1 second
PE.2	Maximum response time involving short messages (up to 10KB) measured by the sender from sending the request message to receiving the response message.	Enough nodes are provisioned for the eTIR web services software components to be able to cope with all requests. Enough nodes are provisioned for the eTIR database to be able to cope with all requests.	10 seconds

[9] See a definition in the Technical Glossary.

[10] Key person risk: risk carried by an organization that depends to a great extent on one individual for its success.

PE.3	Maximum response time measured by the sender from sending the request message to receiving the response message.	The maximum size of the eTIR messages is set to 20 MB. The connection of the eTIR international system to the Internet has a high bandwidth (over 100 megabits per second).	The timeout is set to 60 seconds

Table 13
Qualitative performance requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
PE.4	Performance metrics of the eTIR international system should be monitored to identify any potential problem.	Metrics related to performance are logged at different key points during the reception of a request message, its processing, recording and sending of the response message. These metrics are monitored to raise an issue for ECE to investigate when their values increase above specific thresholds.
PE.5	Performance metrics of the eTIR international system remain stable or get better over time.	A load testing tool is used to perform automated load tests when new developments are introduced in the eTIR international system to ensure no sensible regression – in terms of performance – is introduced.

13. Reliability

42. Reliability is the ability of an information system to cope with errors during execution and cope with erroneous input. It also encompasses the set of practices followed to ensure that the objectives in terms of quality are met. Maximizing the reliability of the eTIR international system is the essence of the second guiding principle that is followed by ECE.

43. In order to ensure this objective and a high overall quality for the eTIR international system, the following proactive practices are put in place:

- Guidelines are established within ECE on the following aspects of the eTIR international system: development, deployment, operation and maintenance. These guidelines form a common set of rules and practices that ensure predictable, high-quality results;
- Strict versioning procedures exist to ensure that all changes brought to the source code of the eTIR international system and the structure and contents of the eTIR database can be traced back to a requirement entered in the issue tracking system;
- Code reviews are performed to decrease the probability of adding unwanted side-effects (defects) to the source code and to ensure that the coding guidelines are followed;
- All changes to the source code (either to introduce a feature or correct a defect) are accompanied by the appropriate automated tests to ensure that no regression is introduced in the source code;
- The source code is regularly checked by a static code analysis tool to determine several indicators related to maintainability, reliability, security, code coverage and code duplication. The issues raised by this tool are addressed by ECE to meet quality objectives (quality gates) previously set;
- A continuous integration pipeline is in place to automatically perform several operations during the development of the eTIR international system to ensure a high level of reliability and quality.

44. In addition to proactive practices, the following reactive practice is also put in place to be able to identify issues and solve them as soon as possible:

- The monitoring system continuously watches several indicators and metrics associated with the software and systems components of the eTIR international system to detect any issue and raise the appropriate alerts for a quick resolution of the issue (depending on its severity).

45. The following tables list the requirements in terms of reliability.

Table 14
Quantitative reliability requirements

Identifier	*Description*	*How to achieve the target*	*Target value*
RL.1	Number of remaining issues with the highest severities found by the static analysis tool	Check the source code using the static analysis tool on a regular basis and correct any issue with the highest severities as a high priority.	0 (all issues of this kind should be corrected)
RL.2	Number of remaining issues with a normal severity found by the static analysis tool	Include checking the source code using the static analysis tool in the continuous integration pipeline to provide a quick feedback and improve the ways of working.	Less than 150
RL.3	Percentage of functional source code covered by automated tests (code coverage)	Code reviews and development guidelines ensure that any change to the source code is accompanied by the appropriate number of automated tests.	More than 60%
RL.4	Percentage of duplicated source code (code duplication)	Regular reviews of the code to ensure no code duplication is introduced.	Less than 3%

46. ECE will regularly review and restrict the targets set for the quantitative reliability requirements listed in the above table to continuously increase the overall quality of the source code of the eTIR international system.

Table 15
Qualitative reliability requirements

Identifier	*Description and objective*	*How to fulfil the requirement*
RL.5	All changes to the source code are made in a way that decreases the probability to introduce issues.	Specific guidelines and best practices are followed by ECE while developing the eTIR international system. Automated tests allow to immediately flag any regression introduced. Commits which do not pass specific quality gates are rejected.
RL.6	All changes to the source code are linked to a requirement to ensure proper traceability.	The VCS used for the source code and the issue tracking system are connected. It is possible to find the issue related to a specific commit in the VCS and all commits need to reference an issue.
RL.7	Eliminate as many redundant, manual and error-prone tasks from the development procedures.	Put in place a continuous integration pipeline that relieves IT experts from mundane tasks and allow to give them a quick feedback on the quality of the change they bring to the source code.

14. Reusability

47. Reusability is the use of existing assets in some form within the software product development process. These assets are products and by-products of the software development life cycle and include code, software components, test suites, designs and documentation.

48. The main objective of reusability is to stop “reinventing the wheel”. In modern software engineering and with the use of object-oriented programming languages, it is easy to reuse existing software components. In addition, this approach is pertinent not only for software components but also for methods and frameworks as a lot of experience and good practices have been used to formulate these standard approaches. Here are the ones used in the development of the eTIR system:

- Project management: The UN secretariat has selected the PRojects IN Controlled Environments - PRINCE2® project methodology and ECE has tailored this method to apply it to the management of its projects;
- Enterprise architecture: ECE is using several aspects of The Open Group Architecture Framework - TOGAF® for its needs in terms of architecture;
- Software development: ECE is following an Agile methodology to develop and maintain the eTIR international system and apply several DevOps practices;
- Service management: ECE is using several aspects of the Information Technology Infrastructure Library - ITIL® for its procedures related to the eTIR service desk and its relationship with the UN entity hosting the eTIR international system;
- Security awareness: ECE is using several aspects of the Open Web Application Security Project - OWASP® to learn about the latest security threats and best practices.

49. Most of the times, selecting an element to be reused should be preferred rather than develop it oneself. Indeed, if the scope of functionality matches the requirements, it is usually quicker and less costly to select an existing element to be reused. In terms of software component or product, this can either be a piece of Open Source Software (OSS) or some proprietary software. In the decision-making process, the following aspects should be considered: TCO (including training and support), maturity and sustainability of the solution, advantages and disadvantages.

50. The following table lists the requirement in terms of reusability.

Table 16
Reusability requirement

Identifier	*Description and objective*	*How to fulfil the requirement*
RU.1	Reuse existing methods, frameworks, software and systems components to save time and achieve higher quality outputs	In case of a new requirement or during the regular assessment performed on currently reused elements, ECE looks for available options and applies its decision-making approach to select the best option.

15. Security

51. All security related aspects and technical requirements of the eTIR international system are described in the dedicated part “Security of the eTIR system” later in the document.

III. Communication between eTIR stakeholders and the eTIR international system

A. Implementation and tests of the eTIR messages

1. Recommended general approach

52. This section describes the guidelines to be followed by the eTIR stakeholders to implement and test the eTIR messages. This includes translating the information entered by the users of the information systems of the eTIR stakeholder (e.g. customs officers using the national customs systems) into eTIR messages and sending them to the eTIR international system. This also includes validating and processing incoming messages, storing values embedded in them, and presenting the information needed to the customs officers.

53. This section only covers the aspects related to the eTIR messages and does not provide guidelines on how to update the information systems of the eTIR stakeholders to adapt to the eTIR procedure. This aspect, and related decisions, are under the sole responsibility of the eTIR stakeholders and are addressed during the design stage of the

interconnection project, especially during the gap analysis.[11] However, the general recommendations given in terms of development and maintenance processes can be applied to this scope as well.

54. ECE describes the processes its IT experts follow for the development and maintenance of the eTIR international system in the part of this document dedicated to the latter.[12] This includes the following practices summarized below:

- Adopt an Agile approach and development by iteration, which allows embracing change and delivering constant value by deploying new versions of the software regularly;
- Configure a Knowledge Management System (KMS) featuring a collaboration platform to host the internal documentation, describing all development, managerial and operational aspects; and an issue-tracking system to manage all tasks to be done;
- Have a good traceability by versioning all assets using a Version Control System (VCS) including the source code, database schema and all other configuration items needed for the development and maintenance of the software;
- Log and monitor as much information as possible to gain insight in the functioning of the software in production and detect issues early on, to be able to react quickly;
- Focus on quality assurance and keep a high reliability of the system by investing in automated tests, static code analysis and setting up a mature continuous integration pipeline;
- Set up several environments for the different stages of the Software Development Life Cycle (SDLC) and have clear procedures on how to promote new releases of the system;
- Have clear and comprehensive guidelines on how to manage issues and incidents while maintaining the system;
- Consider Information Security in all aspects of the development and maintenance processes, putting in place tools and procedures to decrease the probability of having to face cybersecurity issues.

55. eTIR stakeholders are welcome to adopt all or part of these processes for the development and maintenance of their own information systems and ECE welcomes any feedback from eTIR stakeholders to improve these processes in order to better fulfil the three guiding principles.

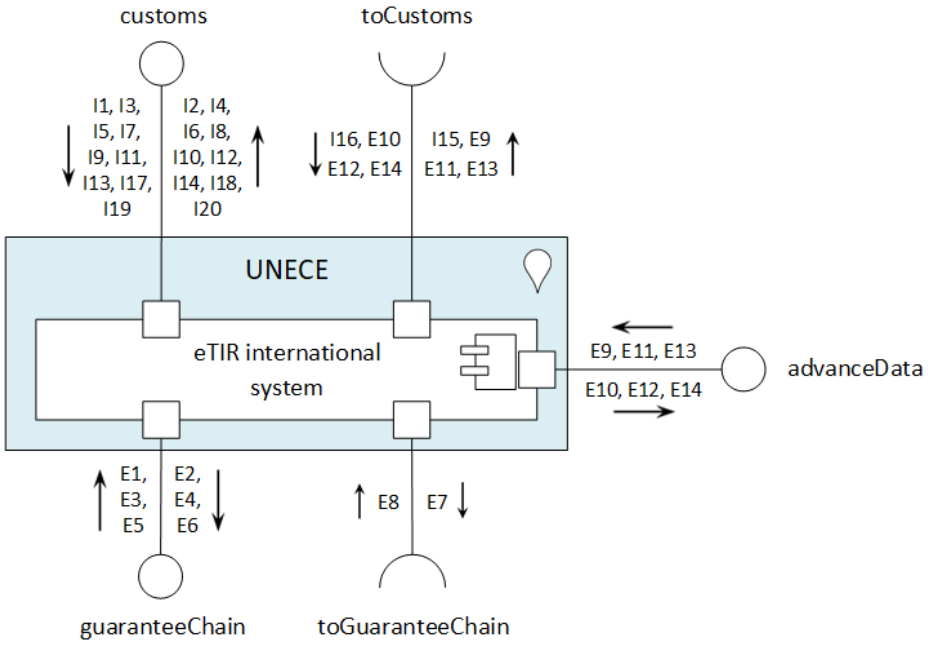
2. The eTIR web services

56. The eTIR messages are exchanged between the information systems of the eTIR stakeholders using web services. This “machine-to-machine” way of exchanging information does not rely on a human being to trigger the sending of the messages, although most of them will be sent as a result of actions performed by an end user on the various information systems taking part in the eTIR system.

57. When an information system sends or receives a message from the eTIR international system, this is done using the eTIR web services that are exposed through several endpoints to authorized eTIR stakeholders, as depicted in the following figure and detailed below.

[11] See section A. Interconnection projects in the same part of this document
[12] See ECE/TRANS/WP.30/GE.1/2021/33

Figure I
Endpoints of the eTIR web services



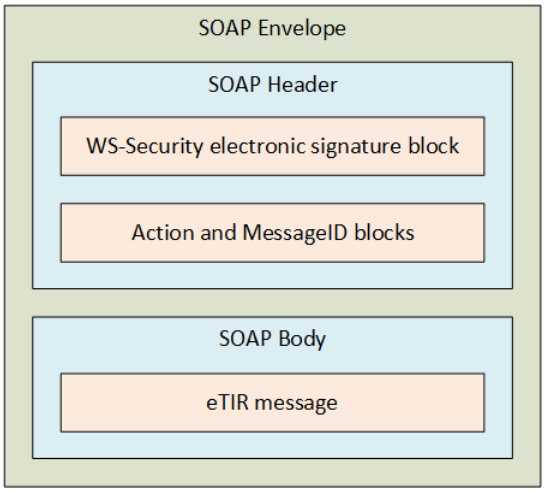
- The endpoint “customs” is exposed for customs authorities to send to the eTIR international system the following messages: I1, I3, I5, I7, I9, I11, I13, I17 and I19. After having processed the incoming message, the eTIR international system returns the associated message in response: I2, I4, I6, I8, I10, I12, I14, I18 or I20.
- The endpoint “toCustoms” which should be exposed by each and every customs authority so that the eTIR international system can send them the following messages: I15, E9, E11 and E13. Customs can choose the name of this endpoint. After having processed the incoming message, the customs authorities return the associated message in response: I16, E10, E12 or E14.
- The endpoint “advanceData” is exposed for all eTIR stakeholders who wish to send advance data to customs authorities via the eTIR international system with the following messages: E9, E11 and E13. After having forwarded the incoming message to the relevant customs authorities, the eTIR international system returns their associated message in response to the original sender: E10, E12 or E14.
- The endpoint “guaranteeChain” is exposed for guarantee chains to send to the eTIR international system the following messages: E1, E3 and E5. After having processed the incoming message, the eTIR international system returns the associated message in response: E2, E4 or E6.
- The endpoint “toGuaranteeChain” which should be exposed by guarantee chains so that the eTIR international system can send them the message E7. After having processed the incoming message, the guarantee chains return the message E8 in response.

58. These endpoints are specified and described using WSDL files[13] available at URLs depending on the environments, as listed in the technical guides[14]. These WSDL files describe the communication protocol, the format of the messages, and the methods that web service users/consumers can call (the actions associated to the eTIR messages). The communication protocol used is Simple Object Access Protocol (SOAP) v1.2[15].

[13] See en.wikipedia.org/wiki/Web_Services_Description_Language
[14] See etir.org/documentation
[15] See en.wikipedia.org/wiki/SOAP

59. A SOAP message is an XML document featuring an envelope which contains a header and a body as shown in the following figure. The SOAP header includes the action name (referencing which eTIR message is sent) and a security object, following the specifications of the WS-Security SOAP extension, which is used to integrate the electronic signature of the message. How to format the SOAP header is detailed in the dedicated section of the "Introduction to the eTIR web services" technical guide. The SOAP body contains the eTIR message, which includes the metadata information.

Figure II
Structure of SOAP messages in the eTIR system



60. As specified in the part of this document related to Information Security[16], access to the various environments of the eTIR international system is limited to eTIR stakeholders who have communicated their servers' IP addresses, which are then whitelisted by the United Nations hosting entity. Therefore, in order to gain access to the eTIR web services, the eTIR stakeholders need to communicate these IP addresses to ECE, in the context of their interconnection projects.

61. In addition, in order to establish a connection with the eTIR international system, the following information needs to be exchanged:

- A unique identifier which will be defined by ECE and recorded in the eTIR database to uniquely identify the eTIR stakeholder. This identifier is used in the metadata class included in all eTIR messages to identify the sender and recipient of the message. Eventually, different identifiers will be set for the eTIR stakeholders for the various environments of the eTIR international system (User Acceptance Tests and Production);
- As specified in the part of this document related to Information Security[17], the eTIR stakeholder should generate an X.509 certificate and send the certificate (public key) to ECE so that it can be registered in the trust store of the eTIR international system. In return, ECE will also send the certificate (public key) of the eTIR international system (for the relevant environment) to the eTIR stakeholder so that it can be registered in their trust store.

62. Once these prerequisite tasks are completed, the eTIR stakeholder can manually start testing the connection, using software like SoapUI, as described in the "Introduction to the eTIR web services" technical guide. Once the interconnection is successfully tested, the project team of the eTIR stakeholder can start implementing and testing the eTIR messages and the required software component needed to interconnect their information systems with the eTIR international system.

[16] See section II.D.4 of document ECE/TRANS/WP.30/GE.1/2021/34
[17] See section II.D.3 of document ECE/TRANS/WP.30/GE.1/2021/34

3. Specific implementation details

63. This chapter describes how to implement and format the various types of attributes that are used in the eTIR messages. This section is to be read in conjunction with the tables describing the description and usages of these attributes in the list of eTIR messages in the following section. Explanations are provided for each data type and also for specific attributes.

(a) Metadata fields

64. Each eTIR message starts with a set of attributes that are used to indicate metadata information characterizing the message. This information includes the specifications to which the message belongs and follows, their versions and the entity in charge of managing them. It also indicates at which date and time the message was prepared, the entity that sent it and the entity that should receive it.

65. Except for the date and time of the preparation of the message, which is an optional attribute, all other metadata attributes are mandatory. As they are part of the eTIR message, they belong to the SOAP body and are mentioned before the fields (classes and attributes) of the eTIR message, as per the WCO Data Model XML Guidelines 2nd edition[18].

66. The following two tables list first the details of the fields (classes and attributes) of the metadata section and then their descriptions and usages.

[18] See section 6 of document available at wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/data-model/wco_xml_guidelines_2012.pdf

Table 17
Metadata - field list

eTIR field name	*Mapping to the XML element (XPATH)*	*Status*	*Format*	*Code lists*	*Conditions*	*Rules*	*WCO ID*
├ Responsible agency, coded	ResponsibleAgencyCode	R	an..2	CL28			
├ Specifications name, coded	AgencyAssignedCustomizationCode	R	an..6	CL29			
├ Specifications version, coded	AgencyAssignedCustomizationVersionCode	R	an..3	CL30			
├┬ COMMUNICATION METADATA	CommunicationMetaData	R					
│ ├ Preparation date and time	CommunicationMetaData/PreparationDateTime	O	an..35				
│ ├┬ RECIPIENT	CommunicationMetaData/Recipient	R					
│ │ └ Identifier	CommunicationMetaData/Recipient/Identifier	R	an..35				
│ └┬ SENDER	CommunicationMetaData/Sender	R					
│ └ Identifier	CommunicationMetaData/Sender/Identifier	R	an..35				

Table 18
Metadata - field description

eTIR field name	*Mapping to the XML element (XPATH)*	*Description*	*Usage*
├ Responsible agency, coded	ResponsibleAgencyCode	Code of the agency controlling the specifications of the message	The value should be the code "AJ" (UN/ECE/TRANS) representing the agency responsible for the eTIR specifications from the list Controlling agency (UN/EDIFACT 0051)
├ Specifications name, coded	AgencyAssignedCustomizationCode	Code of the name of the specifications of the message	The value should be the code "1" (eTIR) representing the name of the specifications followed by this message from the list Specifications name (eTIR)
├ Specifications version, coded	AgencyAssignedCustomizationVersionCode	Code of the version of the specifications of the message	The value should be the code representing the version of the specifications followed by this message from the list Specifications version (eTIR)
├┬ COMMUNICATION METADATA	CommunicationMetaData	Class giving additional information on the metadata of the message	
│ ├ Preparation date and time	CommunicationMetaData/PreparationDateTime	Date and time when the message has been prepared by the sender	The value should be a date to be provided following the EDIFACT 208 format CCYYMMDDHHMMSSZHHMM For Example: 20200820145600+0100 represents 20 August

eTIR field name	*Mapping to the XML element (XPATH)*	*Description*	*Usage*
			2020 at 14:56 UTC+01:00.
├┬ RECIPIENT	CommunicationMetaData/Recipient	Class giving additional information on the recipient of the message	
│└ Identifier	CommunicationMetaData/Recipient/Identifier	Unique identifier of the recipient of the message	The value should be the unique identifier of the eTIR stakeholder to whom to the message is sent
└┬ SENDER	CommunicationMetaData/Sender	Class giving additional information on the sender of the message	
└ Identifier	CommunicationMetaData/Sender/Identifier	Unique identifier of the sender of the message	The value should be the unique identifier of the eTIR stakeholder who sent the message

(b) Conventions on numerical attributes

67. The eTIR messages feature several attributes that should contain numerical values. Here is the list of specifications that are required for this type of attributes:

- All numeric attributes are either a cardinal value (positive integer value) or a decimal value;
- The decimal separator is the decimal point "." and no other symbols are permitted as decimal separator;
- Thousands separators, such as a comma or a space character, shall not be used;
- Signs, whether positive or negative, shall not be used (all values are intrinsically positive);
- For numerical values, leading and trailing zeroes shall not be used;
- If the decimal point is present, at least one digit shall be present before the decimal point;
- If the decimal point is present, at least one digit shall be present after the decimal point.

68. The table below shows the results of the validation mechanism applied to several examples of numerical values that follow the data type "n..11,3" which describes a decimal number with a total number of digits of eleven maximum and a decimal part of three digits maximum.

Table 19
Validation of numerical values for type "n..11,3"

Value	*Validation result*	*Reason for the result of the validation*
12345678.123	Valid	
123456789.123	Invalid	Too many digits in total
1234567.1234	Invalid	Too many digits after the decimal point
0123	Invalid	Leading zeros are not allowed
+123	Invalid	The plus sign is not allowed
-123	Invalid	The minus sign is not allowed
1,234	Invalid	Thousands separators are not allowed
.3	Invalid	A digit is missing before the decimal point
12345.	Invalid	A digit is missing after the decimal point
0.3	Valid	
1.3E1	Invalid	Only digits and the decimal point are allowed
12345678901	Valid	The type "n..11,3" can have maximally 11 digits

(c) Conventions on text attributes

69. The eTIR messages feature attributes that should contain free text values (that are not codes or identifiers). Here is the list of specifications that are required for this type of attributes:

- All text attributes' values are case sensitive (i.e. uppercase and lowercase letters are treated as distinct);
- Leading and trailing spaces (both normal spaces and non-breaking spaces) shall not be used within text attributes. If it's the case, they will be trimmed;
- It is recommended for all XML elements representing eTIR text attributes to also feature an optional XML attribute named "languageID" whose value represents the language used for the value of eTIR text attribute. The value of the XML attribute

"languageID" is the code of the language from code list 20 (Language name - ISO 639-1). In case this XML attribute is omitted, the text is considered to be in English.

70. Certain characters cannot be used in XML messages because they have a special meaning. Using these characters can cause the parser to misinterpret the resulting data. The solution is to replace the characters by other expressions so that the parser can interpret them correctly as data, and not confuse them for XML markup. The following table lists all these substitutions.

Table 20
Characters to be replaced with predefined expressions

Character	*Expression to be used instead*
& (ampersand)	&amp;
> (greater-than character)	>
< (greater-than character)	<
" (straight double quotation mark)	"
' (straight single quotation mark)	'

71. While validating the length of a text value, the system must count each substituted character as 1 character (i.e. "&" is 1 and not 5 characters). For example, if the format of an attribute is "an..100", the following text should be valid: *This string of 100 'characters' must be <always> valid & not rejected, also with format "an..100" !*

(d) Conventions on coded attributes

72. The eTIR messages feature attributes that should contain codes from given code lists (see annex VI.F of this document). Codes are alphanumerical values and are, therefore, considered as text (and not numerical values). Here is the list of specifications that are required for this type of attributes:

- All coded attributes should feature a code that belongs to the code list to which the attribute is bound;
- If restricted codes are specified for a given coded attribute in the eTIR specifications (functional or technical), then the value of this attribute should only be one of these restricted codes.

(e) Conventions on "date only" attributes

73. The eTIR messages contain several attributes in which dates only have to be entered. The format of these types of attributes is aligned on the UN/EDIFACT format code 102 - CCYYMMDD with:

- CCYY: the year in four digits. Examples: 1979, 2020;
- MM: the month in two digits from 01 to 12, starting with 01 for January;
- DD: the day of the month in two digits from 01 to 31.

74. Samples of valid "date only" attributes include:

- 01 January 1970 is coded as "19700101";
- 29 February 2020 is coded as "20200229";
- 31 December 2045 is coded as "20451231".

75. Date attributes also feature a required XML attribute, named "formatCode", whose value is, therefore, always set at "102" for "date only" fields. With this format, there is no notion of time zone and the date has to be regarded as valid in all time zones. The figure below gives, as an example, the XML code of how the Validity attribute of the eTIR message E1 is formatted.

Figure III
Expiration of a guarantee on 01 August 2024

```
<ExpirationDateTime formatCode="102">20240801</ExpirationDateTime>
```

76. It is recommended for all eTIR stakeholders to validate “date only” fields by using the regular expression available in the XSD type “EtirDateType” defined in the Data sets XSD file.

(f) Conventions on “date and time” attributes

77. The eTIR messages contain attributes in which date and time have to be entered. The format of these types of attributes is aligned on the UN/EDIFACT format code 208 - CCYYMMDDHHMMSSZHHMM with, defined sequentially:

- CCYY: the year in four digits. Examples: 1979, 2020;
- MM: the month in two digits from 01 to 12 starting with 01 for January;
- DD: the day of the month in two digits from 01 to 31;
- HH: the hour of the day in two digits from 00 (for midnight) to 23 (for eleven PM);
- MM: the minutes of the day in two digits from 00 to 59;
- SS: the seconds of the day in two digits from 00 to 59. 60 is also allowed in the case of a leap second;
- Z: the introduction of the time zone with either a '+' or a '-'. If the time zone has no offset, then either '+' or '-' can be used;
- HH: the hours of the offset of the time zone from 00 to 14;
- MM: the minutes of the offset of the time zone from 00 to 59.

78. Samples of valid “date and time” attributes include:

- 01 January 1970 00:00:00 in London, UK (Time offset: +00:00) is coded as "19700101000000+0000";
- 29 February 2020 09:45:36 in New York, USA (Time offset: -05:00) is coded as "20200229094536-0500";
- 31 December 2045 22:06:59 in South Tarawa, Kiribati (Time offset: +14:00) is coded as "20451231220659+1400".

79. Date attributes also feature a required XML attribute named “formatCode” whose value is, therefore, always set at "208" for “date and time” fields. With this format, as there is a notion of time zone, it is up to the eTIR stakeholder to select whether they wish to use daylight saving time as it will point to the same absolute time in any case. The figure below gives, as an example, the XML code of how the Acceptance date attribute of the eTIR message I1 is formatted.

Figure IV
Acceptance of a guarantee on 01 July 2021 10:03:42 in Istanbul (Time offset +03:00)

```
<AcceptanceDateTime formatCode="208">20210701100342+0300</AcceptanceDateTime>
```

80. It is recommended for all eTIR stakeholders to validate “date and time” fields by using the regular expression available in the XSD type “EtirDateTimeType” defined in the Data sets XSD file.

(g) Message Identifier and Original Message Identifier attributes

81. All messages sent and received are uniquely identified using the “Message Identifier” attribute. This attribute must be set by the sender in the request message. The receiver will set another unique value for the “Message Identifier” attribute in the response

message. In addition to that, the receiver will also set the "Original Message Identifier" attribute of the response message with the value of the "Message Identifier" attribute of the related request message. This method allows a proper traceability of the request/response messages.

82. The value of the "Message Identifier" attribute of the message should be set at a universally unique identifier (UUID) following the specifications version 4 detailed in RFC 4122[19] which is based on pseudorandom numbers. The main programming languages provide native helper classes to generate a UUID v4 as shown in the following two figures.

Figure V
Generate a UUID in Java

```
java.util.UUID.randomUUID();
```

Figure VI
Generate a UUID in C#

```
System.Guid.NewGuid();
```

(h) Sequence number attributes

83. "Sequence number" attributes are sometimes used in classes that are represented as lists in the eTIR messages. These attributes are needed to express a specific sequence between the elements of these lists. For example, the "Sequence number" attribute in the "TransportMeans" class is used to determine the order of the means by which the goods will be transported.

84. Here is the list of specifications that have to be applied to the "Sequence number" attributes, knowing that they represent the 1-based index[20] of the parent class in the list:

- The value of this attribute should always be superior or equal to 1;
- The value of this attribute is unique in the same sequence;
- Except when otherwise specified by the description of the field or by rules, the values of the "Sequence number" attributes of the same list should start with 1 and should be incremented without leaving any gap in the sequence.

(i) Measurement attributes

85. Several attributes are used to contain measurement values: "Total gross weight", "Gross weight" and "Size". These eTIR attributes also feature a required XML attribute named "unitCode" which value represents the unit used for the measurement value. The value of the XML attribute "unitCode" is the code of the measurement unit from code list 21 (Measurement unit – UNECE Recommendation 20).

86. The possible codes used for the "Size" attribute belonging to the "BinaryFile" class are restricted to the following:

- AD: byte;
- 2P: kilobytes;
- 4L: megabytes.

87. It is recommended to use the following codes for the "Total gross weight" and "Gross weight" attributes:

- GRM: gram;

[19] See datatracker.ietf.org/doc/html/rfc4122
[20] Indexing an array (or list), beginning with 1.

- KGM: kilogram;
- DTN: decitonne (quintal);
- TNE: tonne (metric ton).

4. Validation mechanism

88. When the eTIR international system receives and processes a message, it first performs a series of validations on the message itself, in the context of the related guarantee, holder or transport. As mentioned in the part dedicated to Information Security of this document[21], the following layers of validation are applied to ensure the correctness of the message, its alignment with the specifications and its pertinence:

1. A layer validating the structure and the values of the message, capturing all errors found and returning them as a list in the response message. Values of attributes which are bound to code lists are also checked against the possible values of the current versions of the relevant code lists: any value out of the code lists (or the list of restricted codes, if applicable) would raise an error. All these errors are part of the first family of errors (1XX – Validation[22]);
2. A generic layer validating the message as a whole, using the XSD file defining the type of message. Potential errors detected are also part of the first family of errors (1XX – Validation);
3. Then, the message starts to be processed by the eTIR international system. If any inconsistency is detected in the sequence of the messages or with the records of the eTIR database, additional errors may be returned and, in this case, the first error found is immediately returned. At this stage, errors can belong to the second and third families of errors (2XX – Workflow and 3XX – Functional);
4. Finally, a last layer of validation is performed at the eTIR database level, where its set of integrity constraints can reject the recording of the values of the message when they do not match the constraints. In theory, this last safety net should never be catching any issues as they should have been detected and returned by the previous validation layers. If such a rejection occurs, an error from the fourth family will be raised (4XX – Internal) and the eTIR stakeholder who receives such error should contact the eTIR service desk as soon as possible to report it.

89. It is strongly recommended to all eTIR stakeholders to follow the same layered approach in order to validate the eTIR messages they receive from the eTIR international system. In case the eTIR stakeholders detect at least one error in a response message returned by the eTIR international system, they should contact the eTIR service desk immediately to report this problem (as it is not possible to respond to a response message).

5. Error management

90. As described above, when the eTIR international system receives and processes a message, it performs a series of validations on the message and issues a response to the system which has sent this message. If anything goes wrong during these validation and processing steps, a list of errors is returned in the response message. The minimal requirement is to report the first error detected. All other detected errors should be reported, if possible. Each of these errors are presented as an Error code with a list of Pointers that can be used to point to a specific XML element of the request message using the XPath syntax[23].

91. The list of error codes (code list 99) is specific to eTIR and it allows IT teams to better understand errors, especially while implementing the interconnection of their information systems to the eTIR international system. This should result in an overall faster

[21] ECE/TRANS/WP.30/GE.1/2021/34

[22] Families of errors are defined in the next section

[23] See www.w3schools.com/xml/xpath_syntax.asp

implementation, and in more accurate processing of the errors from the system sending messages to the eTIR international system. Furthermore, a detailed error code system also greatly simplifies the communication between the eTIR stakeholders and the eTIR service desk, in case of an incident, to identify and resolve the underlying problem.

92. The list of error codes is based on the best practices from the IT industry. Like the list of HTTP status codes, all error codes have three digits, and the first digit of the status code defines the type of error:

- **1XX – Validation**: validation of the message and its fields;
- **2XX – Workflow**: workflow related problems;
- **3XX – Functional**: other functional problems;
- **4XX – Internal**: eTIR international system internal problems;
- **5XX – Customs**: errors raised by customs authorities.

93. Each type of error has a default error code which indicates, at least, the type of the error if the system cannot send a more explicit error. The figure below shows how a single error is returned in XML.

Figure VII
Single error returned: missing field

```
<ns4:Error>
   <ns4:ValidationCode>101</ns4:ValidationCode>
   <ns4:Pointer>
      <ns4:SequenceNumeric>1</ns4:SequenceNumeric>
      <ns4:Location>/InterGov/ObligationGuarantee/ReferenceID</ns4:Location>
   </ns4:Pointer>
</ns4:Error>
```

94. In the above example, the ValidationCode XML element is set to the error code and the Location XML element inside the Pointer XML element points towards the problematic element of the request message using the XPath syntax. When multiple errors with the same error code are returned, they should be aggregated in a single Error XML element, with a list of Pointer XML elements, as shown in this second XML example in the figure below.

Figure VIII
Two errors returned of the same type

```
<ns4:Error>
   <ns4:ValidationCode>101</ns4:ValidationCode>
   <ns4:Pointer>
      <ns4:SequenceNumeric>1</ns4:SequenceNumeric>
      <ns4:Location>/InterGov/ObligationGuarantee/ReferenceID</ns4:Location>
   </ns4:Pointer>
   <ns4:Pointer>
      <ns4:SequenceNumeric>2</ns4:SequenceNumeric>
      <ns4:Location>/InterGov/ObligationGuarantee/Surety/ID</ns4:Location>
   </ns4:Pointer>
</ns4:Error>
```

95. If there is more than one type of error, more than one Error XML element is used.

96. eTIR stakeholders who interconnect their information systems with the eTIR international system need to properly handle the errors returned in response messages. When implementing the various pairs of eTIR messages, IT experts will find it convenient

to refer to the second table of annex VI.G of this document[24] to see which error codes could be raised. As new error codes may be added during a version of the specifications (in a new update cycle), it is also important to have a generic mechanism to catch all other errors. In all cases, errors should also be logged.

97. As all errors are critical and mean a failure to process the message, the appropriate follow-up actions should be performed based on the information returned by the error. Immediate action should be taken either by the users of information system to correct the information so that the request message can be re-sent, or the IT service desk of the eTIR stakeholder should be involved to correct the issue. If the problem cannot be corrected and the request message is important for the execution of the TIR transport (as most of messages sent by customs authorities), the eTIR stakeholder may decide to start using the relevant fallback procedure (as described in the functional specifications) if the issues cannot be corrected in a short timeframe.

98. When the information systems of the eTIR stakeholders receive messages from the eTIR international system, they should validate them and use the same error codes to return potential errors in the response message. The list of all error codes is reproduced in the first table of annex VI.G of this document[25] and its latest version, including additional up-to-date information, is available on the eTIR web site.[26]

[24] See Table 12 of document ECE/TRANS/WP.30/GE.1/2021/32

[25] See Table 11 of document ECE/TRANS/WP.30/GE.1/2021/32

[26] See etir.org/error-codes