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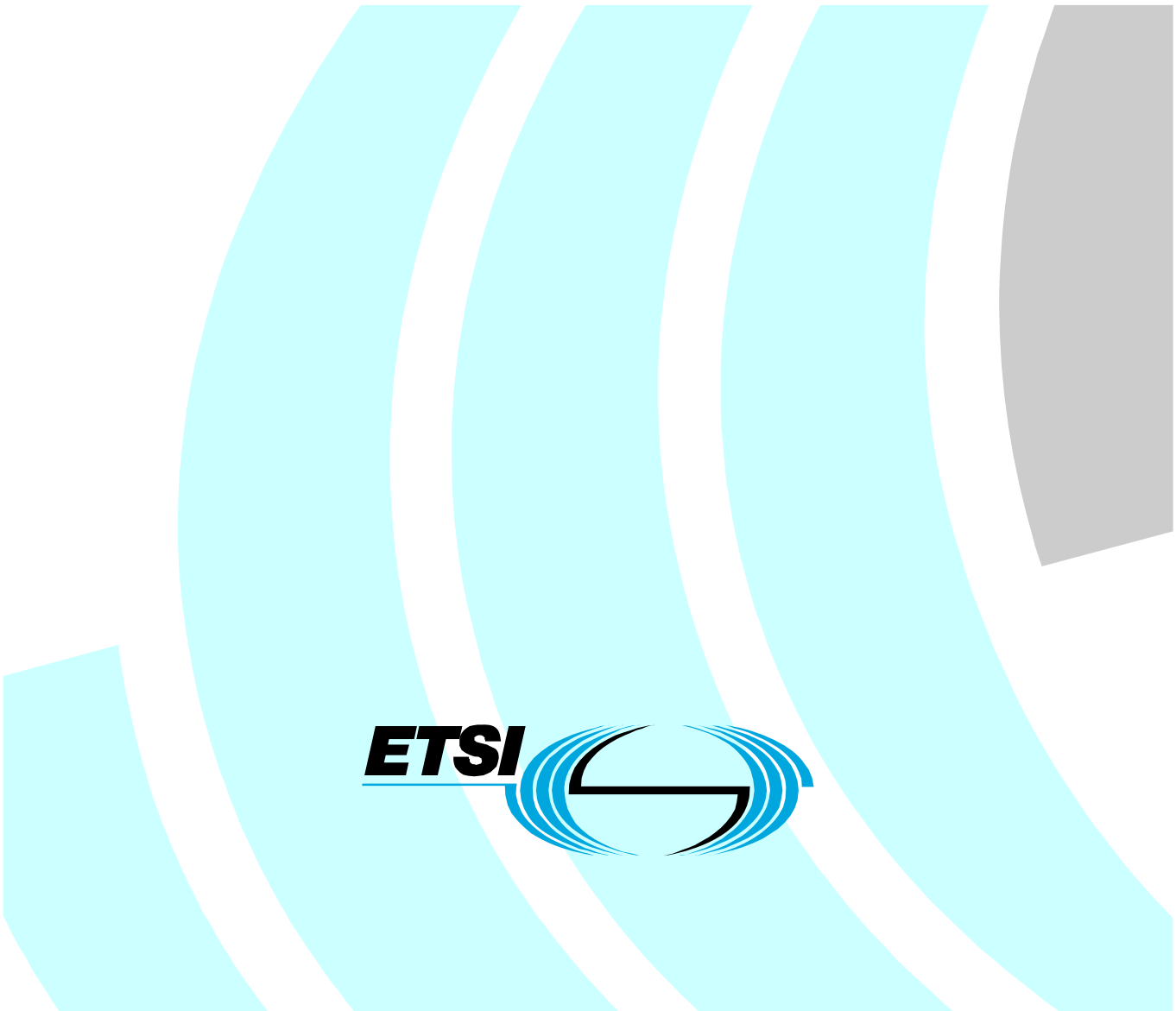
Technical Specification

Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Methods and protocols; Part 1: Method and proforma for Threat, Risk, Vulnerability Analysis



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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN).

The present document is part 1 of a multi-part deliverable covering methods and protocols for security standardization, as identified below:

Part1: "Method and proforma for Threat, Risk, Vulnerability Analysis";

Part 2: "Protocol Framework Definition; Security Counter Measures".

Introduction

The present document is one of a set of documents that addresses standardization of security protocols and mechanisms within the context of the *e*Europe 2005 programme. The suite of documents is composed as follows:

- ETSI EG 202 387 [i.1]: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method for application of Common Criteria to ETSI deliverables".
- ETSI ES 202 383 [1]: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method and proforma for defining Security Targets".
- ETSI ES 202 382 [2]: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method and proforma for defining Protection Profiles".
- **ETSI TS 102 165-1: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Methods and protocols; Method and proforma for Threat, Risk, Vulnerability Analysis" (the present document).**
- ETSI TS 102 165-2 [4]: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Protocol Framework Definition; Security Counter Measures".
- ETSI TS 102 556 [i.5]: "Telecommunication and Internet converged Services and Protocols for Advanced Networking (TISPAN); Protection Profile".
- ETSI EG 202 549 [i.6]: "Telecommunication and Internet converged Services and Protocols for Advanced Networking (TISPAN); Design Guide; Application of security countermeasures to service capabilities".

These documents are developed based on the objectives of the *e*Europe programme and are also developed to ensure they comply with the overall objectives of the European regulatory framework as defined in the following documents:

- Directive 2002/19/EC [14] of the European Parliament and of the council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive).

- Directive 2002/20/EC [15] of the European Parliament and of the council of 7 March 2002 on the authorization of electronic communications networks and services (Authorization Directive).
- Directive 2002/21/EC [16] of the European Parliament and of the council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive).
- Directive 2002/22/EC [17] of the European Parliament and of the council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive).
- Directive 2002/58/EC [18] of the European Parliament and of the council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications).

In particular the present document forms part of the standardization initiative for the Next Generation Network (NGN) platform to be used in *e*Europe and upon which the trust and viability of the *e*-enabled community will, to a very large part, depend on.

The *e*Europe 2005 action plan has been drawn up to focus on "*the widespread availability and use of broadband networks throughout the Union … and the security of networks and information, eGovernment, eHealth and eBusiness*" requiring a supporting infrastructure, which is truly pan-European. To quote COM(2002)263 [i.8]: "*By 2005 Europe should have … a secure information infrastructure*".

1 Scope

The present document defines a method for use by ETSI standards developers in undertaking an analysis of the threats, risks and vulnerabilities of a telecommunications system.

The method builds from the Common Criteria for security assurance and evaluation defined in ISO/IEC 15408 [9] and specifically targets the means to build a Threat Vulnerability and Risk Analysis (TVRA) to allow its reference by an ETSI specification developed using the guidelines given in EG 202 387 [i.1] and ES 202 382 [2]. The TVRA forms part of the documentation set for the Target Of Evaluation as specified in ES 202 382 [2] with its intended audience being a developer of standards based Protection Profiles.

The Unified Modelling Language (UML) is used to model relationships within systems for analysis within the TVRA as a semi-formal tool with verification and simulation capabilities deployed during development.

NOTE: This is in accordance with the goals of the *e*Europe project under objective Good practices (COM(2002) 263 page 18) [i.8].

The present document provides a database definition for TVRA and provides, in annexes, the application of the TVRA method to a number of NGN subsystems or components. The database definition is appended to the present document as a text file containing Structured Query Language (SQL) database definition commands.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 202 383: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method and proforma for defining Security Targets".

[2] ETSI ES 202 382: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method and proforma for defining Protection Profiles".

[3] Void.

[4] ETSI TS 102 165-2 (2006) "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Methods and protocols; Part 2: Protocol Framework Definition; Security Counter Measures".

[5] ETSI TS 187 001: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN SECurity (SEC); Requirements".

[6] ISO/IEC 15408-1: "Information technology - Security techniques - Evaluation criteria for IT security - Part 1: Introduction and general model".

[7] ISO/IEC 15408-2: "Information technology - Security techniques - Evaluation criteria for IT security - Part 2: Security functional requirements".

[8] ISO/IEC 15408-3: "Information technology - Security techniques - Evaluation criteria for IT security - Part 3: Security assurance requirements".

[9] ISO/IEC 15408: "Information technology - Security techniques - Evaluation criteria for IT security".

NOTE: When referring to all parts of ISO/IEC 15408 the reference above is used.

[10] CCMB-2005-07-004: "Common Methodology for Information Technology Security Evaluation; Evaluation methodology; July 2005; Version 3.0 Revision 2".

[11] CCMB-2005-07-001: "Common Criteria for Information Technology Security Evaluation Part 1: Introduction and general model June 2005 Version 3.0 Revision 2".

[12] AS/NZS 4360: "Standards Australian, Risk Management".

[13] ISO/IEC 18028:2005: Information technology -- Security techniques -- IT network security", parts 4 and 5".

NOTE: ISO/IEC 18028 is a multipart publication and the reference above is used to refer to the series.

[14] Directive 2002/19/EC of the European Parliament and of the council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive).

[15] Directive 2002/20/EC of the European Parliament and of the council of 7 March 2002 on the authorization of electronic communications networks and services (Authorization Directive).

[16] Directive 2002/21/EC of the European Parliament and of the council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive).

[17] Directive 2002/22/EC of the European Parliament and of the council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive).

[18] Directive 2002/58/EC of the European Parliament and of the council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications).

[19] ISO/IEC 27002:2005: Information technology -- Security techniques -- Code of practice for information security management".

[20] ISO/IEC 27001:2005: "Information Technology - Security Techniques - Information Security Management Systems - Requirements".

[21] ptc/ 04-10-02: "Object Management Group. UML 2.0 Superstructure Specification", edition, 2004.

[22] IETF RFC 3761: "The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EG 202 387: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Security Design Guide; Method for application of Common Criteria to ETSI deliverables".

[i.2] ETSI TR 187 011: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Security; Application of ISO-15408-2 requirements to ETSI standards - guide, method and application with examples".

[i.3] ETSI TR 187 002: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); TISPAN NGN Security (NGN-SEC); Threat, Vulnerability and Risk Analysis".

[i.4] ETSI TR 102 055: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); ENUM scenarios for user and infrastructure ENUM".

[i.5] ETSI TS 102 556: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Protection Profile".

[i.6] ETSI EG 202 549: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Design Guide; Application of security countermeasures to service capabilities".

[i.7] ETSI TS 102 051: "ENUM Administration in Europe".

[i.8] COM(2002)263: "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the regions".

NOTE: Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2002:0263:FIN:EN:PDF.

[i.9] ETSI ETR 332 (1996): "Security Techniques Advisory Group (STAG); Security requirements capture".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in EG 202 387 [i.1], ISO/IEC 17799 [19], ISO/IEC 18028 [13] and the following apply:

asset: anything that has value to the organization, its business operations and its continuity

authentication: ensuring that the identity of a subject or resource is the one claimed

availability: property of being accessible and usable on demand by an authorized entity ISO/IEC 18028 [13]

confidentiality: ensuring that information is accessible only to those authorized to have access

impact: result of an information security incident, caused by a threat, which affects assets

integrity: safeguarding the accuracy and completeness of information and processing methods

mitigation: limitation of the negative consequences of a particular event

nonce: arbitrary number that is generated for security purposes (such as an initialization vector) that is used only one time in any security session

NOTE: Although random and pseudo-random numbers theoretically produce unique numbers, there is the possibility that the same number can be generated more than once.

non-repudiation: ability to prove an action or event has taken place, so that this event or action cannot be repudiated later

residual Risk: risk remaining after risk treatment

risk: potential that a given threat will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organization

threat: potential cause of an incident that may result in harm to a system or organization

NOTE 1: A threat consists of an asset, a threat agent and an adverse action of that threat agent on that asset (clause 6.2 of Common Criteria part 1 [11]).

NOTE 2: A **threat** is enacted by a **threat agent**, and may lead to an **unwanted incident** breaking certain pre-defined security objectives.

threat agent: entity that can adversely act on an asset

unwanted incident: incident such as loss of confidentiality, integrity and/or availability

NOTE: See AS/NZS 4360 [12].

user: person or process using the system in order to gain access to some system resident or system accessible service

vulnerability: weakness of an asset or group of assets that can be exploited by one or more threats

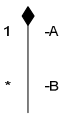
NOTE: A **vulnerability**, consistent with the definition given in ISO/IEC 18028 [13], is modelled as the combination of a **weakness** that can be exploited by one or more **threats**.

3.2 Symbols

For the purposes of the present document, the symbols given in OMG UML2 [21] and the following apply:

Generalization/Specialization: UML concept showing relationship between entities A and B where the two entities exhibit the property that A (top of arrow) is the general case whereas B is the specific case

EXAMPLE: A countermeasure is a specialized asset.



Composition: UML concept showing relationship between entities A and B where A "is composed of" B

EXAMPLE: Vulnerability "is composed of" a threat and a weakness.

Dependency: UML concept showing relationship between entities A and B where B is dependent upon A

EXAMPLE: Security requirements "depend on" security objectives.

Aggregation: UML concept showing relationship between entities A and B where A "is an aggregate of" B

EXAMPLE: System "is an aggregate of" assets.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ANSI	American National Standards Institute
CC	Common Criteria
CIAAA	Confidentiality, Integrity, Availability, Authenticity and Accountability
CPU	Core Processor Unit
DDDS	Dynamic Delegation Discovery System
DDoS	Distributed Denial of Service
DNS	Domaine Name Service
DNSSEC	DNS SECurity
DoS	Denial of Service

EAL Evaluation Assurance Level
ERD Entity Relationship Diagram

FAU Functional class Audit

NOTE: From ISO/IEC 15408-2 [11]

FCO Functional class Communication

NOTE: From ISO/IEC 15408-2 [11].

FCS Functional class Cryptographic Support

NOTE: From ISO/IEC 15408-2 [11].

FDP Functional class user Data Protection

NOTE: From ISO/IEC 15408-2 [11].

FIA Functional class Identification and Authentication

NOTE: From ISO/IEC 15408-2 [11].

FMT Functional class Security Management

NOTE: From ISO/IEC 15408-2 [11].

FPR Functional class Privacy

NOTE: From ISO/IEC 15408-2 [11].

FPT Functional class Protection of the TSF

NOTE: From ISO/IEC 15408-2 [11].

FRU Functional class Resource Utilisation

NOTE: From ISO/IEC 15408-2[11].

FTA Functional class TOE Access

NOTE: From ISO/IEC 15408-2 [11].

FTP Functional class Trusted Path/Channels

NOTE: From ISO/IEC 15408-2 [11].

ICMP Internet Control Message Protocol
IMSI International Mobile Subscriber Identity
IN Intelligent Network
IP Internet Protocol
IPsec IP security
IT Information Technology
NAPTR Naming Authority PoinTeR
NAT Network Address Translation
NGN Next Generation Network
PP Protection Profile
RRSet Resource Record Set
RRSIG Resource Record SIGnature
RTP Realtime Transport Protocol
SIP Session Initiation Protocol
SQL Structured Query Language
SSH Secure SHell
ST Security Targets
TCP Transport Control Protocol
TIMSI Temporary IMSI
TISPAN Telecommunications and Internet converged Services and Protocols for Advanced Networking

TOE	Target Of Evaluation
TTP	Trusted Third Party
TVRA	Threat Vulnerability and Risk Analysis
UDP	User Datagram Protocol
UML	Unified Modelling Language
URI	Uniform Resource Identifiers

4 Introduction

4.1 Role of TVRA

It is recognized that without an understanding of the system, the threats to the system and a systematic countermeasure cost-benefit analysis that appropriate selection of countermeasures cannot be made. Within ETSI a Threat Vulnerability and Risk Analysis (TVRA) is used to identify risk to the system based upon the product of the likelihood of an attack, and the impact that such an attack will have on the system. The TVRA is primarily used within the standards domain to give justification for the development of standards based security solutions. In addition the TVRA may be used as the source of parts of a Protection Profile (PP), see ES 202 382 [2]. Large parts of the descriptive text of a PP will be derived from the TVRA: Security objectives; Security requirements; Rationale.

The method described in the present document provides a means of documenting the rationale for designing security countermeasures in a system by application of a systematic method, and by using part of the method to visualize the relationship of objectives, requirements, system design and system vulnerabilities.

The depth of the TVRA changes as the system design becomes more detailed. A TVRA working from the system objectives will identify at a very coarse level the required security functionality to ensure that the objectives can be met without damage to the system. The structure of activities in development of a TVRA is shown in figure 1. The process is shown as recursive wherein in any change to any aspect of the system or its environment requires the process to restarted.

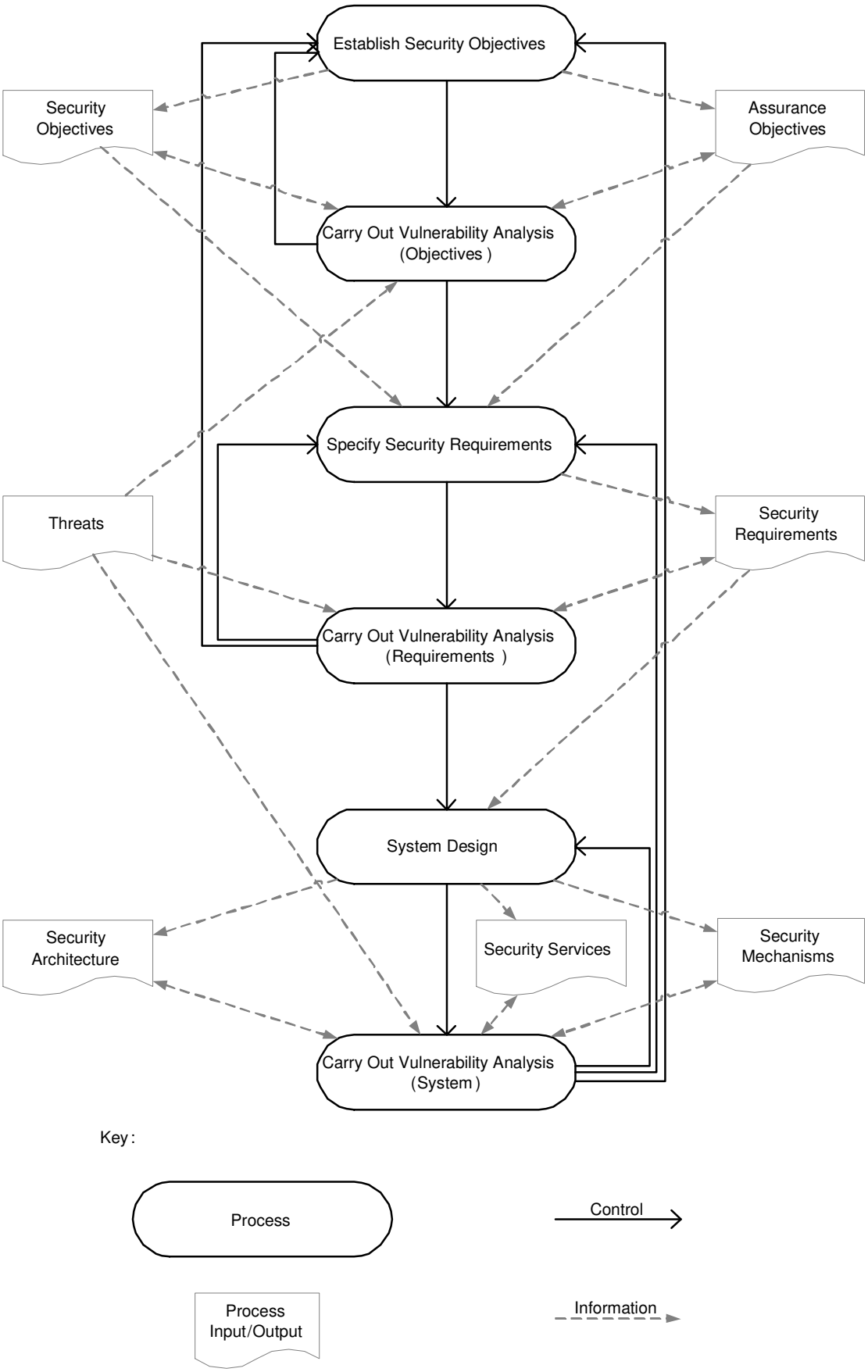


Figure 1: Structure of security analysis and development in standards documents

The purpose of the TVRA is to determine how open to attack the system, or components of the system are. A measure of openness of the system to attack is "attack potential" which combines factors of expertise, availability and resources to give a metric for attack evaluation and this is explored further in clause 6.6.

An alternative view of the nature of TVRA is given in figure 2 showing that any change either internal (say by application of countermeasures) or external to the system requires that the TVRA process is redone.

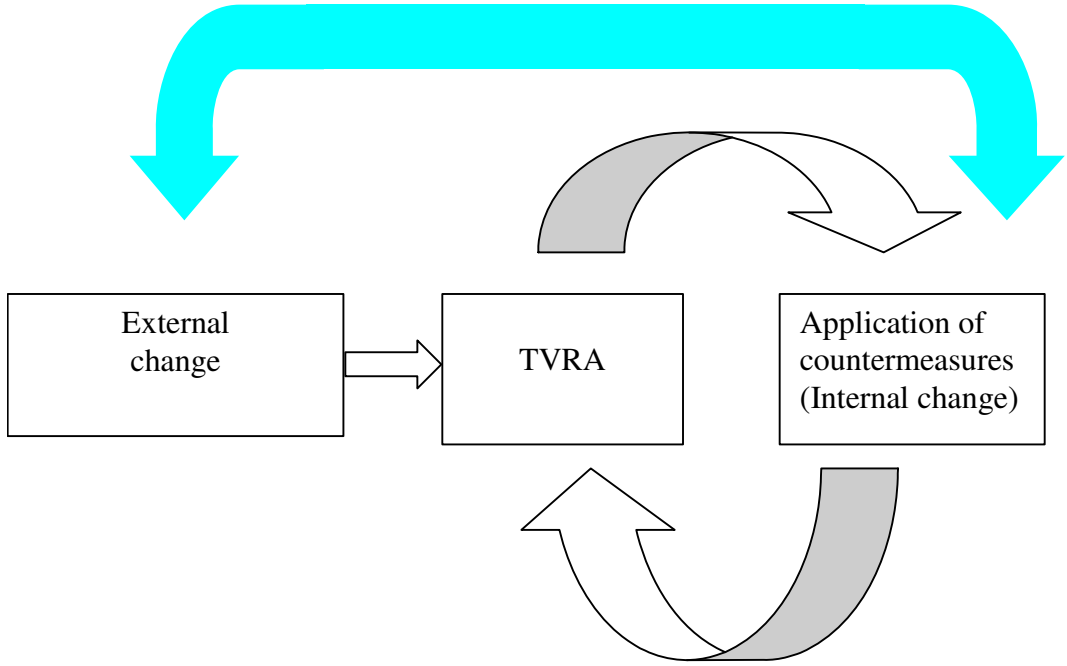


Figure 2: Cyclical nature of TVRA

4.2 Generic TVRA relationships

One of the keys to a successful TVRA, and also of a successful system design, is the ability to show the relationship of objectives and requirements to the system design. Figure 3 shows the dependencies between system objectives, system requirements and system design highlighting the interplay of security objectives and requirements.

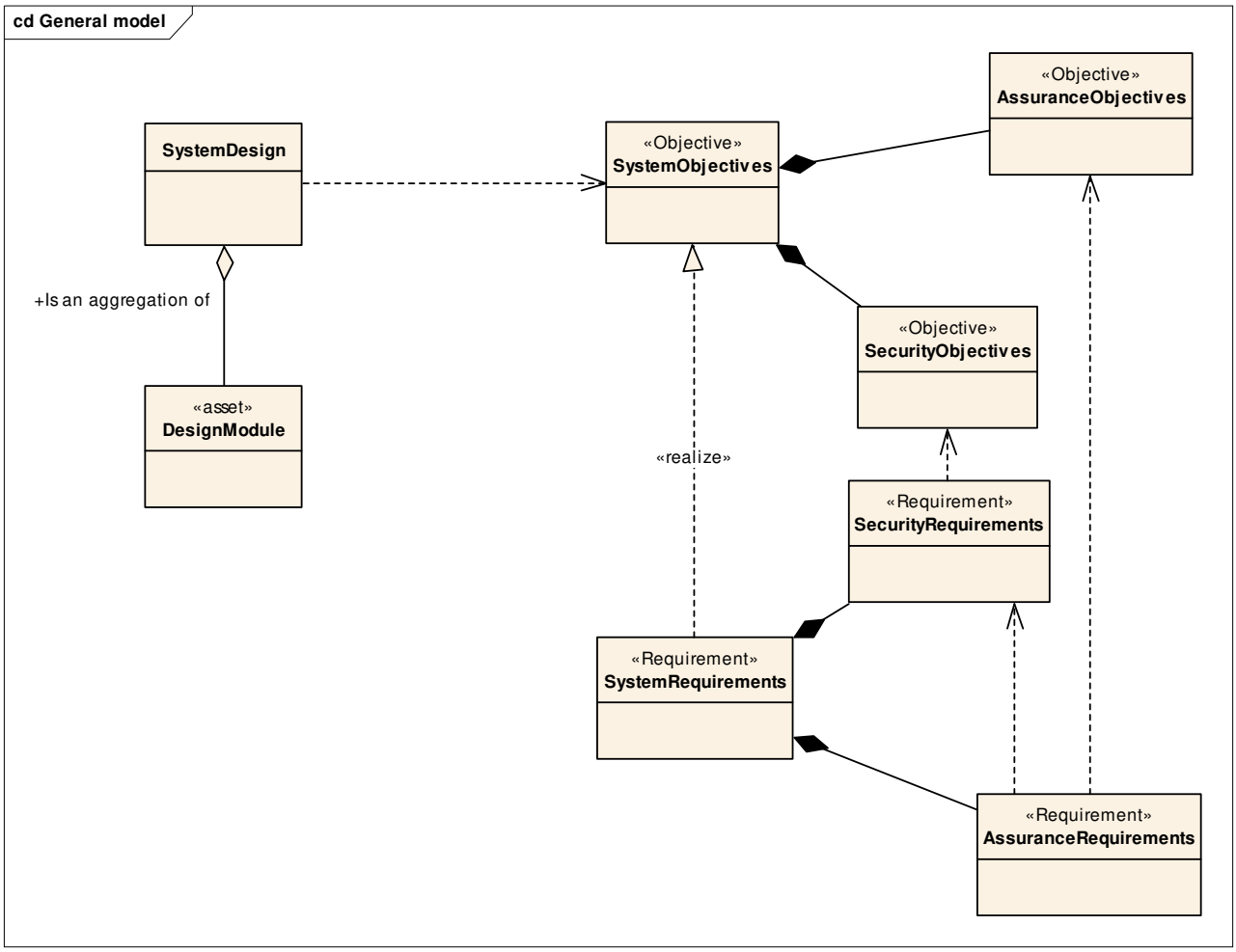


Figure 3: Relationship between system design, objectives and requirements

For most systems and in particular for the Next Generation Network (NGN) the development of system requirements goes far beyond just security and one concern for TVRA is to ensure that the system design is itself robust and therefore has fully documented requirements across all its aspects.

A TVRA requires that both the system being examined (with its catalogued objectives and requirements) and the assets of the system and how it fits to its environment are clearly identified. In the context of TVRA the key relationship is that between a vulnerability and an asset and this is a weighted relationship with the weighting being defined as the risk to the asset due to the associated vulnerability. A pictorial view of the asset-threat-weakness-vulnerability-countermeasure relationship to system design is given in figure 4.

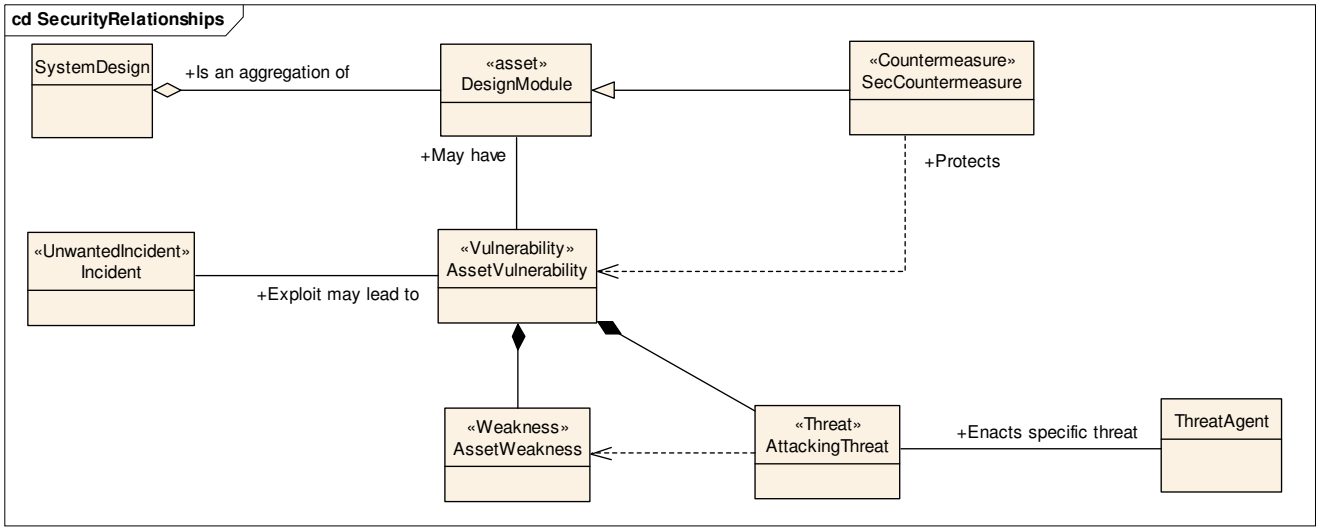


Figure 4: Generic security TVRA model

One of the purposes of security design is to minimize the probability of any instance of the class "unwanted incident" being instantiated. It should be noted that whilst some countermeasures may themselves become system assets, and as such have their own vulnerabilities, many instances of countermeasures will be considered as policies, system guidelines and, if captured early enough, system redesign.

The data types pertaining to the model in figure 4 are given in figure 5. Essentially threats can be classified as one of 4 types:

- Interception
- Manipulation
- Denial of service
- Repudiation of sending
- Repudiation of receiving

Similarly security objectives can be classified as one of 5 types (commonly referred to as "CIAAA" types):

- Confidentiality
- Integrity
- Availability
- Authenticity
- Accountability

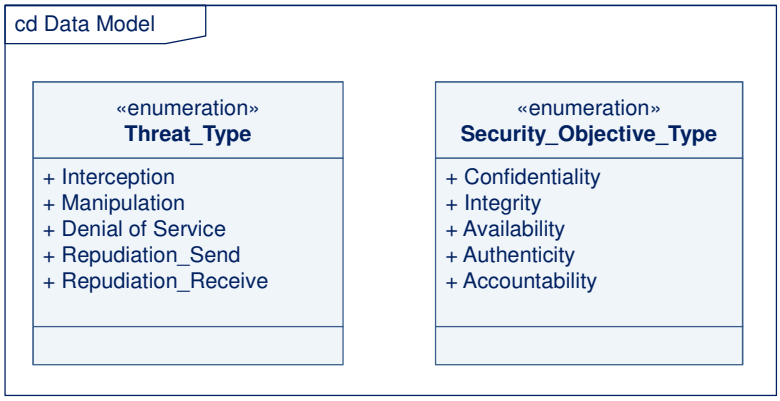


Figure 5: Data types pertaining to security relationship model

4.3 Countermeasure strategies

The goal of security design is to ensure a low likelihood of an unwanted incident arising. As the likelihood of an unwanted incident is dependent upon the presence of weakness in an asset and also the presence of both threats and threat agents that exploit the weakness it is the purpose of security systems to remove, or mask, the weaknesses of an asset. An essential non-technical component of security strategies is the management of the system and its human components. The non-technical measures are outlined in ISO/IEC 27001 [20] and in ISO/IEC 27002 [19].

The following strategies are considered within the present document:

- Asset redesign.
- Asset hardening.

4.3.1 Asset redesign

The assumption made prior to analysis is that all assets have weaknesses and the job of the analyst is to identify those weaknesses. Where weaknesses are found and have a large number of associated threats and threat agents there may be a possibility to redesign the asset in such a way as to remove the inherent weaknesses. The viability of this strategy will depend on a number of factors including the maturity of the asset design and the relative cost of redesign versus the cost of weakness masking through asset hardening.

4.3.2 Asset hardening

An asset may have some weaknesses that cannot be removed but which may be masked or made inaccessible by the addition of additional features or capabilities to the vulnerable asset or other assets in the system such that the combination of assets in the system presents a lower likelihood of attack, and hence a lower risk to the system.

4.4 Relationship with Common Criteria evaluation

The primary purpose of an ETSI TVRA is to support and rationalize security standardization, and to support and rationalize system design decisions, where the overall objective of the standard is to minimize risk of exploitation and attack of a compliant system when deployed. In order to consider this fully the TVRA method described in the present document addresses the impact of an attack on the system whereas ISO/IEC 15408 [9] primarily addresses the resistance to attack of the system. In this view the TVRA method compliments ISO/IEC 15408 [9]. A particular objective of the TVRA method is to prepare the justifications for security decisions and that may as a result be referenced in a PP for the security feature.

The structure of the assurance class for vulnerability analysis described in ISO/IEC 15408 [9] is slightly different from the structure recommended for a TVRA in the present document, however the two approaches are considered complimentary.

Within a final common criteria evaluation [9] the vulnerability analysis assurance family assumes that the system design is complete whereas the purpose of the vulnerability analysis exercise in ETSI is to be able to identify vulnerabilities that require the provision of countermeasures, and then to assess the vulnerabilities that exist in the system with the countermeasures applied. The final documented TVRA may be used in the context of common criteria evaluation [9] to satisfy those aspects of evaluation found in sections (a), (b) and (c) of a protection profile (see ES 202 382 [2], clauses 5.1.2 through to 5.1.7).

Figure 6 (taken from EG 202 387 [i.1]) shows a simplified view of the relationships between the components of Common Criteria Protection Profiles (PP), Security Targets (ST) and Targets Of Evaluation (TOE)). The standardization process fits primarily in the "Consumer side" of the figure.

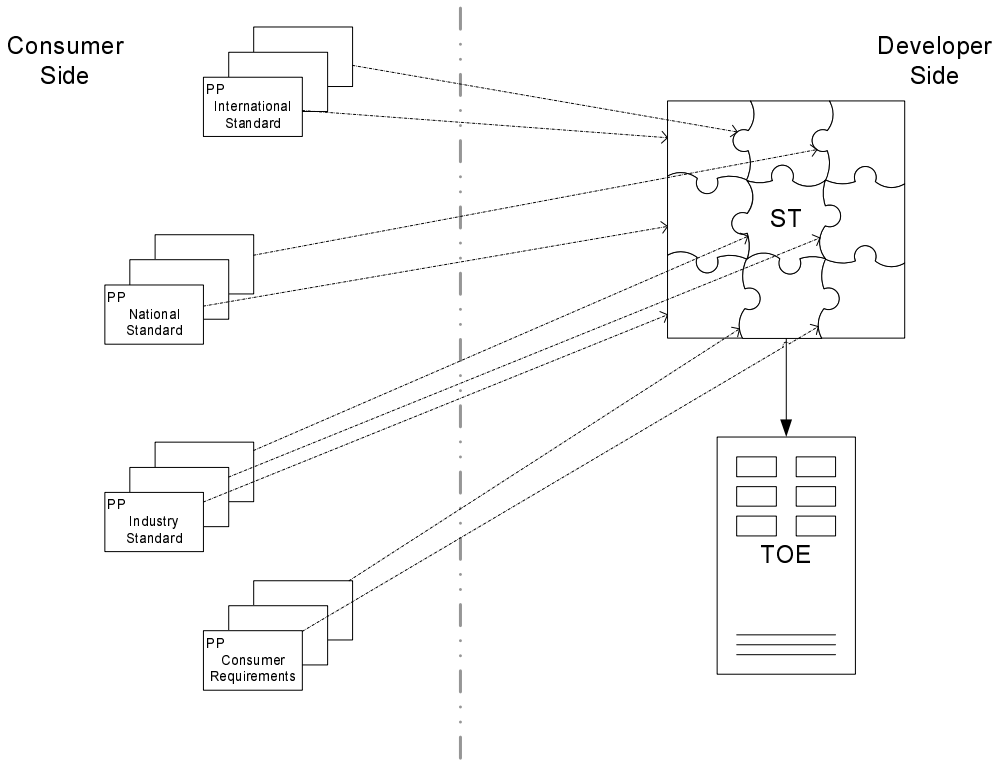


Figure 6: Relationship between PPs, STs and TOEs

5 TVRA method

5.1 Overview

The TVRA method involves a systematic identification of the unwanted incidents to be prevented in the system, and for the system itself, identifying the assets it is composed of and their associated weaknesses, the threats and the threat agents that will attack the system, before determining the risk to the system by modelling the likelihood and impact of attacks on the system's vulnerabilities.

The TVRA method derives from the model shown in figure 4. The TVRA models a system consisting of assets. An asset may be physical, human or logical. **Assets** in the model may have **Weaknesses** that may be attacked by **Threats**. A **Threat** is enacted by a **Threat Agent**, and may lead to an **Unwanted Incident** breaking certain pre-defined security objectives. A **Vulnerability**, consistent with the definition given in ISO/IEC 18028 [13], is modelled as the combination of a **Weakness** that can be exploited by one or more **Threats**. When applied, **Countermeasures** protect against **Threats** to **Vulnerabilities** and reduce the **Risk**.

The TVRA method process consists of the following steps:

1) Identification of the Target of Evaluation (TOE) resulting in a high level description of the main assets of the TOE and the TOE environment and a specification of the goal, purpose and scope of the TVRA.

2) Identification of the objectives resulting in a high level statement of the security aims and issues to be resolved.

3) Identification of the functional security requirements, derived from the objectives from step 2.

4) Inventory of the assets as refinements of the high level asset descriptions from step 1 and additional assets as a result of steps 2 and 3.

5) Identification and classification of the vulnerabilities in the system, the threats that can exploit them, and the unwanted incidents that may result.

6) Quantifying the occurrence likelihood and impact of the threats.

7) Establishment of the risks.

8) Identification of countermeasures framework (conceptual) resulting in a list of alternative security services and capabilities needed to reduce the risk.

9) Countermeasure cost-benefit analysis (including security requirements cost-benefit analysis depending on the scope and purpose of the TVRA) to identify the best fit security services and capabilities amongst alternatives from step 8.

10) Specification of detailed requirements for the security services and capabilities from step 9.

Each step in the method has guidance attached to lead the analyst. In particular for steps 6 and 9, which involves detailed calculations of the likelihood and impact values and cost and benefit of alternative countermeasures, the use of repeatable metrics is essential to the repeatability of the analysis over time. The metrics used in step 5 are developed from the guidance given in ETR 332 [i.9] and ISO/IEC 15408 [9]. One characteristic of the method is to include an evaluation of whether an attack exploiting a vulnerability can be automated thereby offering an additional metric to be used in assessing risk. The product of occurrence likelihood and impact values from step 5 gives a measure of the risk to the asset. A countermeasure will reduce the likelihood of the threat being successful and/or reduces its impact. Step 8 identifies alternative countermeasures to protect the system and its assets against threats. The costs and benefits of each countermeasure are evaluated in Step 9 in order to identify those that are the most effective at removing threats at an acceptable cost.

The application of countermeasures adds assets to the system and may create new vulnerabilities, indicating that the TVRA will need to be undertaken again, and the method should be repeated until all the risks have been reduced to an acceptable level. Furthermore, by allowing the analysis to be rerun when attack likelihood changes, the risk to the system may be re-evaluated as knowledge of new or revised attacks becomes available.

It is recommended to use a database to store the system elements (assets), threats, threat agents, weaknesses, vulnerabilities and countermeasures such that the analysis can be repeated whenever the design or the environment changes.

NOTE 1: The database is to be compiled by the analyst/designer. A sample database structure is provided in annex E.

NOTE 2: The database structure provided in Annex E is referred to as the eTVRA and is intended as a interactive tool to support the TVRA method.

The method systematically addresses those aspects of telecommunications systems covered by standardization and quantifies their assets, vulnerabilities and threats. The primary focus of the TVRA is on the assets of a system and is required to ensure that they can perform their primary function when subjected to malicious attack. The output of the TVRA is a quantified measure of the risks to the assets and a set of detailed security requirements that will minimize that risk.

For the purposes of analysis all assets are considered to have weaknesses.

The TVRA method identifies the assets of a system, the weaknesses of each asset and the potential threats associated with these weaknesses. Publishing the details of a particular weakness is likely to increase the risk to the system, particularly where a means of exploiting the weakness is also published unless countermeasures are implemented promptly.

NOTE 3: The term threat agent is used in the present document to refer to a specific means to enact a threat in order to exploit a weakness.

It should be noted that in some cases the determination of a countermeasure to a particular threat will not automatically lead to its deployment. Step 9 of the TVRA method provides an analysis of the costs and benefits of each countermeasure.

5.1.1 Target of Evaluation description

ISO/IEC 15408-1 [6] requires that a brief but clear description of the Target of Evaluation (TOE) is given in order to make the security aspects of the TOE clear. A similar approach is adopted in the TVRA method and the scope of the TVRA should be considered in the same way that a TOE is considered in ISO/IEC 15408-1 [6] and in the PP proforma defined in ES 202 382 [2]. It is recognized that an attack on any asset may affect not only the asset but also the system in which the asset exists (the environment).

5.1.1.1 Security environment

The security environment describes the security aspects of the environment in which the asset is intended to be used. It shall include:

- security assumptions:
  - the intended use of the implementation;
  - the physical, user and connection aspects of the environment in which an implementation will operate.
- assets:
  - the assets with which the asset under analysis will interact with;
  - the nature of the asset's interaction with other assets.
- threats and threat agents:
  - all threats against which specific protection is required within either the implementation of a standard or its expected environment;
  - the threat agents that will be used to enact the identified threats.
- organizational security policies:
  - any security policies or rules with which an implementation of a standard must comply.

The description of the security environment shall be tabulated following the format illustrated in the example.

EXAMPLE:

A Security Environment		
a.1 Assumptions		
TVRA-id	**Summary text**	**Citation**
a.1.1	ENUM is used to resolve a given telephone number (E.164 identity) to a known IP address	RFC 3761 [22] TS 102 051 [i.7] TR 102 055 [i.4]
a.1.2	ENUM runs over DNS	
..	..	..
a.2 Assets		
a.2.1	DNS records in Leaf server	
a.2.2	NAPTR record in Leaf server	
..	..	..
a.3 Threats		
a.3.1	Confidentiality	
a.3.2		
..	..	..
a.4 Threat agents		
a.4.2	overload of communication	
a.4.3		
..	..	..
a.5 Security policies (OPTIONAL)		
a.5.1		
a.5.2		

5.1.1.2 Security objectives

A TVRA shall contain a definition of the security objectives of both the asset and its environment [6]. These objectives are expected to cover the assumptions, threats and policies described in the asset security environment (see clause 5.1.1.1). They should be expressed in broad terms rather than in detail and should be segregated into two distinct groups, thus:

- security objectives for the asset:
  - it should be clear which aspects of the identified threats and policies are addressed by each objective;
  - if the base security standard specifies a protocol, it is likely that the asset security objectives will be specified in the Stage 1 (or equivalent) specification.
- security objectives for the environment:
  - it should be clear which aspects of the identified threats and policies are expected to be addressed by the environment because they are not covered (either wholly or in part) by the asset security objectives;
  - communications standards rarely specify requirements for the environment so it is unlikely that the security objectives for the environment will be stated explicitly in the base security standard or any associated document.

EXAMPLE:

B Security Objectives		
b.1 Security objectives for the asset		
b.1.1	The asset should ensure that only registered users may access the system	
b.1.2		
..	..	..
b.2 Security objectives for the environment		

5.1.1.3 Security requirements

5.1.1.3.1 The relationship between security objectives and security requirements

The distinction between security objectives and security requirements is an important one to make. An objective is the expression of what a security system should be able to do in very broad terms whereas a requirement is a more detailed specification of how an objective is achieved. As an example, the following statement is a security objective for an asset.

EXAMPLE 1: The asset should ensure that only registered users may access the system.

One of the security requirements associated with this objective could be:

EXAMPLE 2: A user shall be successfully identified and authenticated to the asset by means of a user name and password before all other interactions between the asset and that user.

NOTE: It would not be unusual for a single objective to be realized by the implementation of more than one requirement nor for a single requirement to partially implement more than one objective.

5.1.1.3.2 Security requirements statements

Security requirements should be identified for both the asset and, where applicable, its environment [6]. The asset security requirements should be classified into the following groups:

- asset security functional requirements:
  - an identification of each of the security-related functional requirements specified in the base security standard and an indication of where in the standard the detailed requirement can be found;
  - where possible, an indication of which of the functional components defined in ISO/IEC 15408-2 [7] the requirement represents.
- asset security assurance requirements:
  - an indication of the Evaluation Assurance Level (EAL) [8] that an implementation of the base security standard could be expected to meet. As there are likely to be many implementations in a number of different application areas, the EAL requirement could be expressed as a range (e.g. EAL3 - EAL5);
  - where possible, an identification of any specific assurance components from ISO/IEC 15408-3 [8] which will apply to an implementation;
  - where necessary, a specification of any essential assurance requirements which are not included in ISO/IEC 15408-3 [8].

The specification of security requirements for the environment is optional and should only be included in the analysis if security objectives for the environment are identified earlier in the analysis (see clause 5.1.1.2). If requirements for the environment are included, they should be presented in the same way as functional requirements for the asset.

EXAMPLE:

C Security Requirements			
c.1 asset security requirements			
c.1.1 asset security functional requirements			
c.1.1.1	NGN R1 IMS authentication shall support early deployment scenarios (with support for legacy equipments).	FIA_UAU.3	TS 187 001 [5] clause 4.2, ISO/IEC 15408-2 [7] clause 11.4.2
c.1.1.1	In non-early deployment scenarios, IMS authentication shall be independent from access authentication.	FIA_UAU.3	TS 187 001 [5] clause 4.2, ISO/IEC 15408-2 [7] clause 11.4.2
..	..	..	..
c.1.2 asset security assurance requirements			
c.1.2.1			
..	..		..
c.2 Environment security requirements (OPTIONAL)			
c.2.1			

5.1.1.3.2.1 Interaction with ISO/IEC 15408

In the preceding clause it is recommended that where possible assurance and functional components from ISO/IEC 15408-2 [7] and ISO/IEC 15408-3 [8] should be identified. The guidance to the application of Common Criteria in ETSI deliverables, EG 202 387 [i.1], should be used as source material in this case. A summary of the relevant content of EG 202 387 [i.1] follows.

ISO/IEC 15408-2 [7] identifies a set of functional components which cover the major elements of any security product or process and these are defined in the following classes (ISO/IEC 15408-2 [7] component name in brackets):

- Security audit (FAU).
- Communication (FCO).
- Cryptographic support (FCS).
- User data protection (FDP).
- Identification and authentication (FIA).
- Security management (FMT).
- Privacy (FPR).
- Protection of the Target of Evaluation Security Functions (FPT).
- Resource utilization (FRU).
- Target of Evaluation access (FTA).
- Trusted path/channels (FTP).

The components can be used in the development of requirements at both an abstract level and at the detail development level.

The developer needs to be aware of the functional components and to report their use.

EXAMPLE: A countermeasure to prevent masquerade may require that the identity is presented and validated, then authenticated, prior to system access. To implement this countermeasure will require a design that includes components "User identification before action" and "User authentication before action" (FIA_UID.2 and FIA_UAU.2 respectively in ISO/IEC-15408-2 [7]).

Table 1: Evaluation service level summary as specified in ISO/IEC 15408-3 [8]

Assurance Class	Assurance Family	Assurance Component by Evaluation Assurance Level (EAL)						
		EAL1	EAL2	EAL3	EAL4	EAL5	EAL6	EAL7
Development	Security architecture (ADV_ARC)		1	1	1	1	1	1
	Functional specification (ADV_FSP)	1	2	3	4	5	5	6
	Implementation representation (ADV_IMP)				1	1	2	2
	TSF internals (ADV_INT)					2	3	3
	Security policy modelling (ADV_SPM)						1	1
	TOE design (ADV_TDS)		1	2	3	4	5	6
Guidance documents	Operational user guidance (AGD_OPE)	1	1	1	1	1	1	1
	Preparative procedures (AGD_PRE	1	1	1	1	1	1	1
Life-cycle support	CM capabilities (ALC_CMC)	1	2	3	4	4	5	5
	CM scope (ALC_CMS)	1	2	3	4	5	5	5
	Delivery (ALC_DEL)		1	1	1	1	1	1
	Development security (ALC_DVS)			1	1	1	2	2
	Flaw remediation (ALC_FLR)							
	Life-cycle definition (ALC_LCD)			1	1	1	1	2
	Tools and techniques (ALC_TAT)				1	2	3	3
Security Target evaluation	Conformance claims (ASE_CCL)	1	1	1	1	1	1	1
	Extended components definition (ASE_ECD)	1	1	1	1	1	1	1
	ST introduction (ASE_INT)	1	1	1	1	1	1	1
	Security objectives (ASE_OBJ)	1	2	2	2	2	2	2
	Security requirements (ASE_REQ)	1	2	2	2	2	2	2
	Security problem definition (ASE_SPD)		1	1	1	1	1	1
	TOE summary specification (ASE_TSS)	1	1	1	1	1	1	1
Tests	Coverage (ATE_COV)		1	2	2	2	3	3
	Depth (ATE_DPT)			1	1	3	3	4
	Functional tests (ATE_FUN)		1	1	1	1	2	2
	Independent testing (ATE_IND)	1	2	2	2	2	2	3
Vulnerability assessment	Vulnerability analysis (AVA_VAN)	1	2	2	3	4	5	5

TR 187 011 [i.2] provides guidelines and method on how to apply ISO/IEC 15408-2 [7] requirements to ETSI standards. TR 187 002 [i.3] provides examples of security functional requirements.

5.1.2 Threats and threat agents

Threats to a telecommunications system are fairly restricted and fall into a small set of easily identified operations. The means to enact these threats are conversely many and varied and it is the "agent of threat" that will take most time to identify and that is the source of the risk to the system.

Threats in telecommunications belong to one of the following groups (showing subclasses of each threat) as outlined in clause 4.2 and shown in a tree in figure 7:

- Interception
  - Eavesdropping:
    - A breach of confidentiality by unauthorized monitoring of communication.
- Manipulation
  - Masquerade ("spoofing"):
    - The pretence of an entity to be a different entity. This may be a basis for other threats like unauthorized access or forgery.
  - Loss or corruption of information:
    - The integrity of data (transferred) is compromised by unauthorized deletion, insertion, modification, reordering, replay or delay.

- Unauthorized access:
  - An entity accesses data in violation to the security policy in force.
- Forgery:
  - An entity fabricates information and claims that such information was received from another entity or sent to another entity.

- Repudiation
  - An entity involved in a communication exchange subsequently denies the fact.
- Denial of service
  - An entity fails to perform its function or prevents other entities from performing their functions.

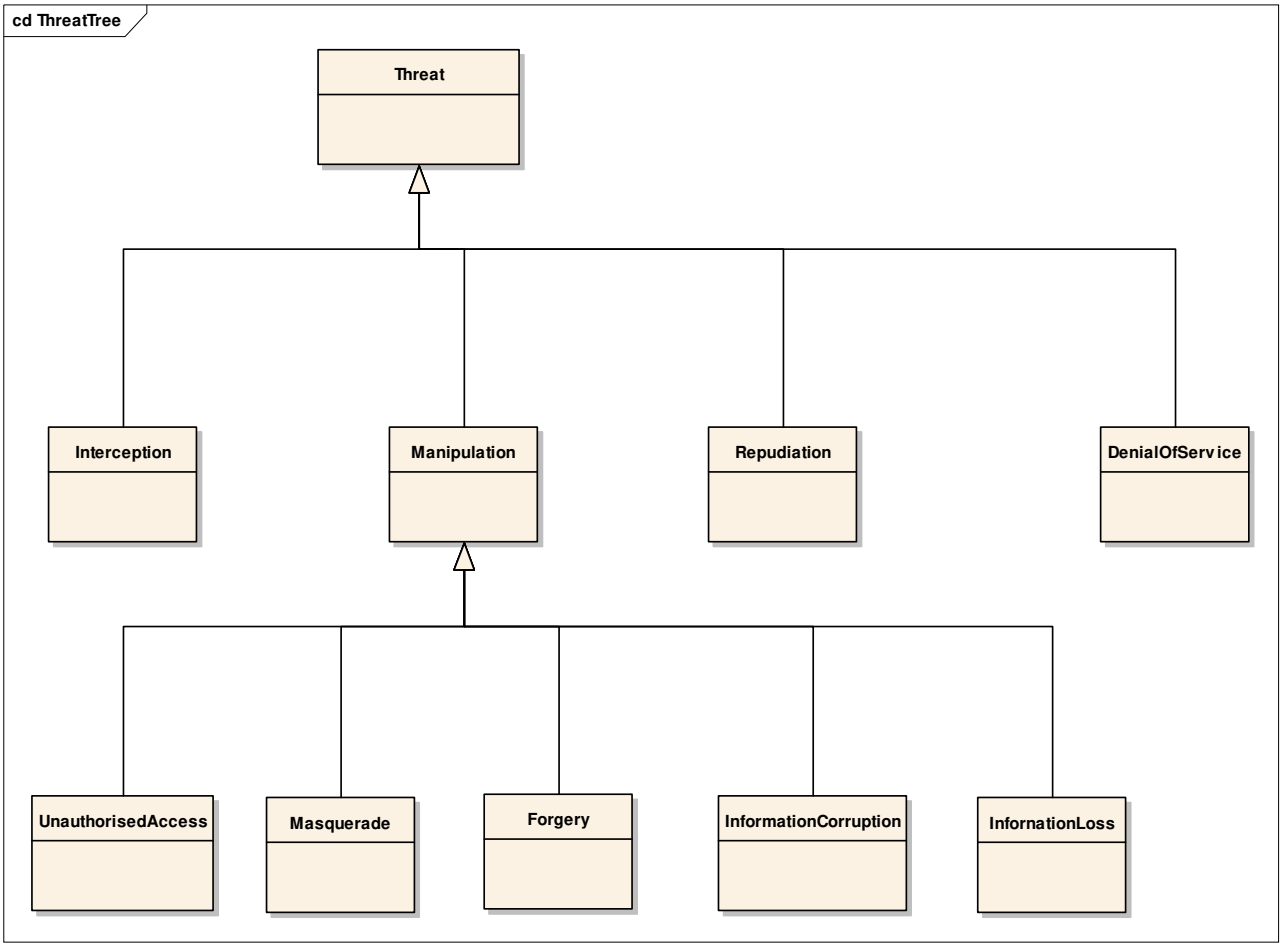


Figure 7: Threat tree

Table 1A shows how the principle CIAAA security objective classifications are vulnerable to specific types of threat.

Table 1A: Threats to security objective types

Threat	Objective type				
	Confidentiality	Integrity	Availability	Authenticity	Accountability
Interception (eavesdropping)	X				
Unauthorized access	X	X		X	X
Masquerade	X	X		X	X
Forgery		X	X	X	X
Loss or corruption of information		X	X		
Repudiation		X		X	X
Denial of service			X		

5.2 Actors and roles

For the purpose of security standardization, only technical security countermeasures are considered, which means that relevant actors to consider are *users*. A user is defined as a person or process using the system in order to gain access to some system resident or system accessible service. Users can further be categorized dependent on whether they belong to the organization running the services (internal users) or whether they access the services as external users.

Each time a user accesses a service, the user will take on a role. In some cases there will be a one-to-one relationship between a user and a role, i.e. the user will always stay in the same role. In other cases there will be a one-to-many relationship between a specific user and the possible roles the user can play. This latter case is the normal telecommunications and ICT case in which the same user may act as a call initiator, call receiver, registrant, etc.

The following gives a high level classification of the most common roles:

- network operators (*private or public*);
- service providers (Bearer Service Providers or Value Added Service Providers);
- service subscribers/service customers;
- service end users;
- equipment/software vendors.

Some security measures may require actors to enforce the role of a Trusted Third Party (TTP). An important security issue is how these actors should be allowed to interact with each other in the context of the NGN.

5.3 Rationale

ISO/IEC 15408-1 [6] requires that a PP should provide a rationale, for both the security objectives and the security requirements. It should explain in detail how the security objectives and the security requirements address the threats identified in the asset security environment. The purpose of the TVRA is to provide this rationale and it may, therefore, be referred to in the PP as the source of the rationale. The association of objectives, requirement, threats and assets within a TVRA provides the rationale for the selection of the security architecture and the countermeasures.

6 Method process

6.1 Overview

The method systematically identifies the assets and then for each asset establishes the weaknesses this asset may have, assesses how practical it is to attack this weakness and assesses the resulting risk.

For each step in this method a number of metrics are defined to assist the user of the method.

6.2 Step 1: Identification of Target Of Evaluation (TOE)

A successful TVRA depends on a clear definition of the scope, purpose and goal of the analysis. It is also recommended to produce a comprehensive description of the Target Of Evaluation (TOE) and its environment. A TOE should be considered to represent a "system under standardization". At this early stage it is essential that the boundary between the system (the target of standardization) and its environment is defined. Without this definition, it is likely that at least some of the security objectives (step 2) specified will be impossible to meet. There are no strict rules on how to determine what is in the system and what is in its environment but, as a guide, in communication systems it is likely that the boundary will pass through interfaces rather than entities and that human users will exist within the environment rather than the system. It is also likely that the system will comprise a number of easily identifiable assets which may be decomposed into multiple assets themselves at a later stage in the development process. The TOE description should include a high level description of the main assets of the TOE and its environment. The simple example in figure 8 shows graphically the boundary between a system and its environment.

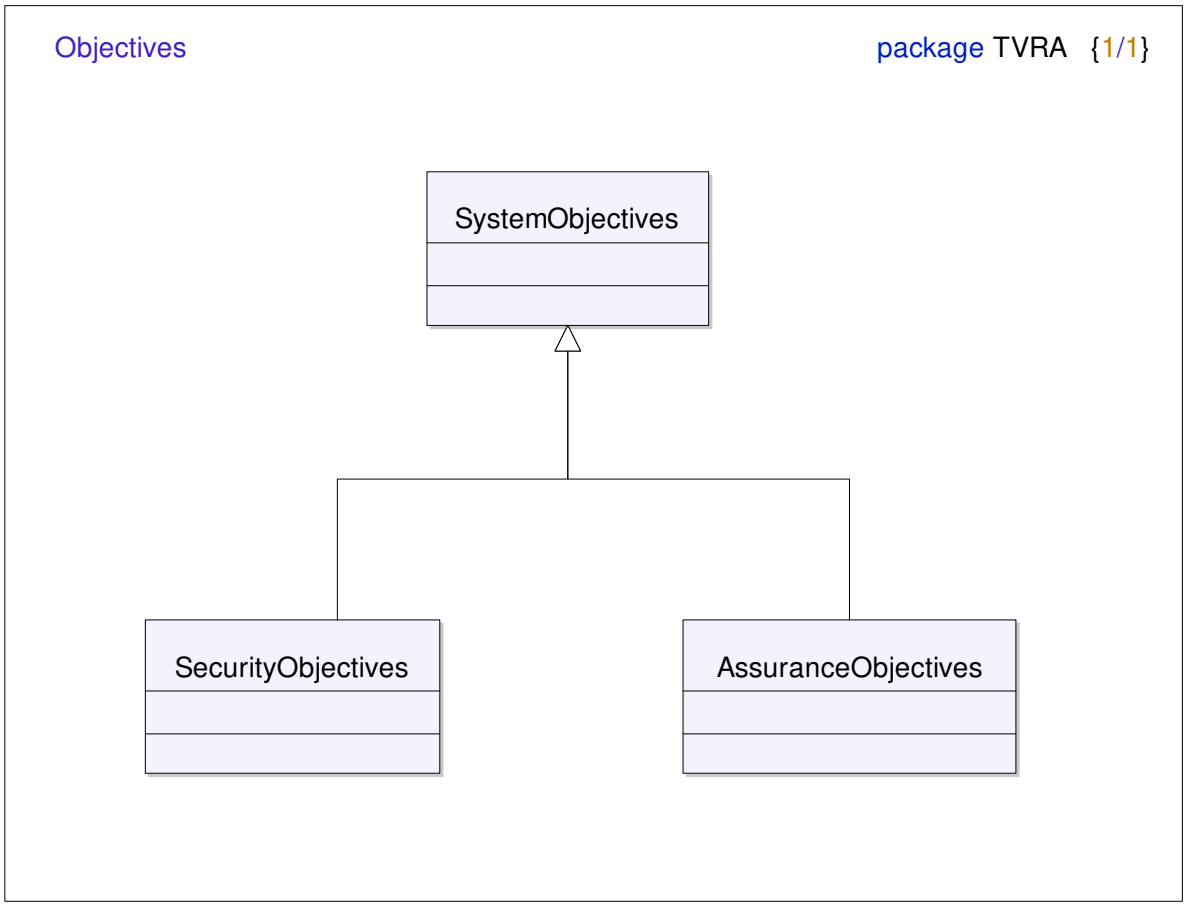


Figure 8: Example of a security system with its environment

The scope defines the boundary of the analysis and may be used to support the identification of the TOE and the TOE environment. It is essential to the analysis that the scope description is specific and unambiguous and that it clearly identifies the assets of both TOE and TOE environment.

The purpose and goal of the analysis is to help to direct the TVRA activities and may be used to verify the quality of the analysis output.

The use of UML use case diagrams, class diagrams, deployment diagrams, object diagrams and behavioural diagrams to model the TOE and the TOE environment may later be used to identify the assets and may assist in other analysis activities. If such methods are used the diagrams should be part of the TOE description and analysis documentation.

The abstraction level required of the TOE and TOE environment depends on the purpose of the analysis and the information available. The TOE description may include an outline and details of the architecture, relevant applications, reference points, information flows and possible attack interfaces. Attack interfaces are specific assets (such as reference points) in the TOE environment or the interfaces between the TOE and the TOE environment that an threat agent may use to launch an attack against one or more weaknesses in the assets. Attack interfaces may also be procedural (exploiting a weakness in a security procedure).

ISO/IEC 15408-1 [6] provides guidelines on producing TOE and TOE environment descriptions. TR 187 002 [i.3] provides examples of TOE descriptions.

6.3 Step 2: Identification of objectives

Security objectives identify the broad aims of a standard or system in terms of the protection to be given to users and information within the framework of the CIAAA attributes. Without such objectives it is difficult to develop a coherent set of security requirements and, therefore, complete a meaningful TVRA exercise. Security objectives should be specific to the target system and clearly specify the CIAAA attributes affected. TR 187 011 [i.2] provides guidelines on how to write security objectives and TR 187 002 [i.3] provides examples of security objectives. The following gives a demonstration of security objectives identification and specification for the CIAAA attribute availability.

Within the context of standardization there are a number of objectives for security that are intended to ensure availability of the network and customer confidence. These objectives break down to the following technical security issues for most telecommunications services:

- charging fraud;
- protection of privacy; and
- ensuring availability of the offered services.

The goals for telecommunications services should therefore aim to reduce these risks by reducing the ability to mount attacks that prevent the achievement of these objectives.

The following technical objectives for telecommunications services security hold:

- Prevention of masquerade:
  - being able to determine that a user claiming to be Alice is always Alice, Bob is always Bob, and Bob cannot pretend to be Alice;
  - applies to both masquerade of the user and of the system or service.
- Ensure availability of the telecommunications services:
  - the service must be accessible and usable on demand by an authorized entity.

NOTE: In general, a user expects to be able to place a call, and complete the call without being cut off in the middle.

- Maintain privacy of communication:
  - where the parties to a call communicate across public networks mechanisms should exist to prevent eavesdropping;
  - the only delivery points for communication have to be the legitimate parties to the call.

6.4 Step 3: Identification of functional security requirements

The system requirements are dependent on the system objectives identified in step 1 and have two specialisms shown in figure 8a identifying security and assurance requirement specialisms.

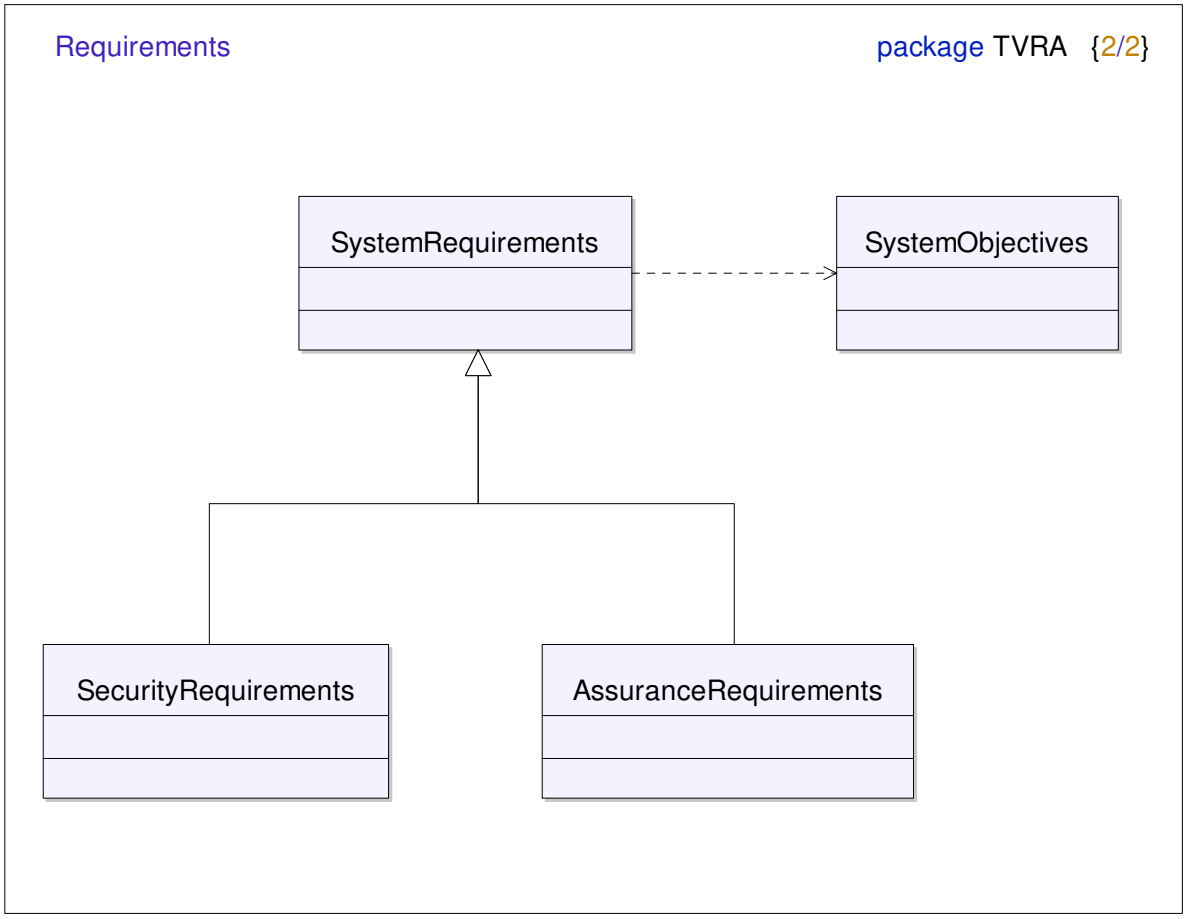


Figure 8a: Dependency relationship between requirements and objectives

When building systems the use of ISO/IEC 15408-2 [7] functional capabilities offer a means to unambiguously state requirements. Annex F of the present document reviews the functional capabilities and how they fit to use in telecommunications.

TR 187 011 [i.2] provides guidelines and method on how to apply ISO/IEC 15408-2 [7] requirements to ETSI standards. TR 187 002 [i.3] provides examples of security functional requirements.

6.5 Step 4: Systematic inventory of the assets

It is important to document the nature of any asset of the system and the complexity of the technology used in the construction of the asset and any information relating to the technology used in the asset that is available in the public domain. Between them these three aspects determine in large part the level of understanding of the asset.

The life expectancy of the asset is used in consideration of the time taken to develop and run an attack (develop a threat agent for a specific attack type). This may be affected by aspects such as the frequency with which a key or password is updated, and the duration in which the asset is expected to be in operational use.

NOTE: If an asset is protected by a key or password and the attack is based on key or password guessing then the frequency of key or password update may be a countermeasure.

Three kinds of **assets** are defined:

- physical assets:
  - equipment.

- human assets; and
- logical assets:
  - the information stored in and handled by the physical assets.

An asset is at **risk** when a weakness exists and a **viable threat** is present. The seriousness of the **vulnerability** depends on the **value** of the **asset** and the **likelihood** of the **weakness** to be exploited by the threat.

Systematic inventory of the assets requires a thorough evaluation of the system at hand. A first round of this evaluation should be performed by addressing typical scenarios appropriate to the system under discussion.

- Take a typical scenario.
- Analyze the physical assets by following the scenario.
- Analyze the human assets involved in the scenario.
- Analyze which logical assets exist in each of the physical assets.
- Analyze which logical assets are handled by the human assets.
- Consider other scenarios which may highlight different assets and repeat the process until no further assets are found.

When the system under discussion has multiple aspects, repeat this process for all aspects of the system until no more assets are found.

The use of UML use case diagrams, class diagrams and object diagrams may assist in the analysis of the system to identify the assets. If such methods are used the diagrams should be used in the analysis documentation.

The eTVRA database may be used to store the assets and the database definition (see annex E) contains a number of tables to store the definition of the asset and its relationship to other assets and to the system it is a member of.

In order to catalogue an asset the following attributes and relationships have to be identified:

- The system in which the asset resides.

NOTE 1: An asset may exist in more than one system and a system may contain many assets (a many to many relationship).

- The asset parent-child-sibling relationships if any exist.

NOTE 2: An asset may be a parent to one or more other assets and such relationships have to be captured. Similarly an asset may be a peer (sibling) to another asset and such relationships have to be captured.

It is the impact on the system from a successful attack on a specific asset that is particularly important when analysing a TOE. Table 2 identifies the three levels of impact used to evaluate assets in Step 4 of the TVRA process.

Table 2: Asset impact

Impact	Explanation	Value
Low	The concerned party is not harmed very strongly; the possible damage is low.	1
Medium	The threat addresses the interests of providers/subscribers and cannot be neglected.	2
High	A basis of business is threatened and severe damage might occur in this context.	3

6.6 Step 5: Systematic identification of vulnerabilities

In order to identify potential vulnerabilities in a TOE and its environment it is first necessary to determine where its weaknesses exist, what, if any, viable threats could exploit those weaknesses and what harm could be caused by an attack on each weakness. It is only a weakness for which such a threat exists that can be considered to be a vulnerability within the system.

6.6.1 Identification of weakness

A weakness within a system offers a potential point of attack for a threat agent. However, viable attacks will not necessarily be possible at all weaknesses. It is only those where an attack could realistically be mounted that can be considered to be vulnerabilities.

6.6.2 Identification of a vulnerability

Possible attack interfaces need to be identified and all possible attacks need to be elaborated. This is in addition to those already identified in step 1 and involves a further analysis of such.

6.6.3 Identification of attack method (threat agent)

A *threat agent* is an entity that can adversely act on assets [6]. It possesses specific behaviour to exploit one or more vulnerabilities within an asset.

The likelihood that a threat agent is able to mount a successful attack is determined by a number of factors that are defined and described in detail in the remainder of this clause.

6.6.3.1 Assessment of the practicality

An evaluator must determine the attack potential associated with each of the vulnerabilities identified and must consider the effect of the vulnerability becoming publicly known. That is, an attacker would not have to repeat the analysis to identify the vulnerability, but would only have to perform the exploitation. In some instances knowledge of the vulnerability would not immediately facilitate exploitation because considerable further analysis would be required to permit the development of an attack method.

In direct attacks against probabilistic or permutational mechanisms, the issue of exploitation will normally be the most important, since potential vulnerabilities in these mechanisms will often be self evident, however this may not always be the case. With cryptographic mechanisms, for example, knowledge of subtle potential vulnerabilities may considerably affect the effectiveness of a brute force attack. Knowledge that users of a system tend to choose first names as passwords will have a similar effect. For vulnerability testing above AVA_VAN.1 (see ISO/IEC 15408-3 [8] and EG 202 387 [i.1] for further consideration of the Common Criteria Vulnerability Analysis Assurance class), the initial identification of potential vulnerabilities will become a much more important consideration, since the existence of difficult to uncover potential vulnerabilities may be promulgated, often rendering exploitation trivial.

The factors defined here are derived from those defined in clause B.4 of the Common Criteria Evaluation methodology [10] using the **weighted summation method** to calculate the overall attack potential.

The following factors shall be evaluated during analysis to determine the weight of the attack potential required to exploit a vulnerability:

- System knowledge
- Time.
- Expertise.
- Opportunity.
- Equipment.

6.6.3.1.1 Knowledge factor

The knowledge factor is derived from that defined in clause B.4 of the Common Criteria Evaluation methodology [10] using the weighted summation method to calculate the overall attack potential.

Knowledge of the asset refers to specific expertise in relation to the asset. This is distinct from generic expertise, but not unrelated to it. Identified levels are as follows:

- **Public** information concerning the asset (e.g. as gained from the Internet).
- **Restricted** information concerning the asset (e.g. knowledge that is controlled within the developer organization and shared with other organizations under a non-disclosure agreement).
- **Sensitive** information about the asset (e.g. knowledge that is shared between discreet teams within the developer organization, access to which is constrained only to members of the specified teams).
- **Critical** information about the asset (e.g. knowledge that is known by only a few individuals, access to which is very tightly controlled on a strict need to know basis and individual undertaking).

The knowledge of the asset may graduate according to design abstraction, although this can only be done on an asset by asset basis. Some asset designs may be public source (or heavily based on public source) and therefore even the design representation would be classified as public or at most restricted, while the implementation representation for other assets is very closely controlled as it would give an attacker information that would aid an attack and is therefore considered to be sensitive or even critical.

Care should be taken here to ensure the highest level of knowledge of the asset required during identification, development and running of the potential vulnerability is identified.

6.6.3.1.2 Time factor

The role of time in evaluating the likelihood of an attack requires evaluation of the total amount of time taken by an attacker to identify that a particular, potential, weakness may exist, then to develop an attack method (threat agent) and to sustain effort required to mount the attack. When considering this factor, the worst case scenario should be used to estimate the amount of time required.

EXAMPLE: The time taken to identify a potential vulnerability may be the time taken to locate the potential vulnerability from information that is publicly available or may be the time required to analyse the design information to identify a potential vulnerability.

In addition to this time taken for identification, consideration of the time required to develop an attack method (which may also be publicly available) and to successfully mount the attack on the asset to exploit the vulnerability must be included in this factor.

The following definitions apply (values escalate):

- within minutes
  - an attack can be identified or exploited in less than an hour;
- within hours
  - an attack can succeed in less than a day;
- within days
  - an attack can succeed in less than a week;
- within weeks
  - an attack can succeed in less than a month;
- within months
  - a successful attack requires in excess of a month.

6.6.3.1.3 Expertise factor

Specialist expertise refers to the level of generic knowledge of the underlying principles, product type or attack methods (e.g. Internet protocols, Unix operating systems, buffer overflows). The levels of expertise to be applied within this factor are defined as below:

- **Laymen** are not knowledgeable compared to experts or proficient persons, with no particular expertise.
- **Proficient** persons are knowledgeable in that they are familiar with the security behaviour of the product or system type.
- **Experts** are familiar with the underlying algorithms, protocols, hardware, structures, security behaviour, principles and concepts of security employed, techniques and tools for the definition of new attacks, cryptography, classical attacks for the product type, attack methods, etc. implemented in the product or system type.

When describing the expertise required, the total number of experts required must be included; the number of people for each type of expertise required and access to the expertise (dissemination) must be considered when describing the expertise required. Therefore, if expertise in both techniques for types of attack applicable to the asset and underlying algorithms and protocols is required, then the highest level of Specialist Expertise characterization should be assumed.

6.6.3.1.4 Opportunity factor

Opportunity is also an important consideration, and has a relationship to the Elapsed Time factor. Identification or exploitation of a vulnerability may require considerable amounts of access to an asset that may increase the likelihood of detection. Some attack methods may require considerable effort off-line, and only brief access to the asset to exploit. Access may also need to be continuous, or over a number of sessions.

For some assets the Window of opportunity may equate to the number of samples of the asset that the attacker can obtain. This is particularly relevant where attempts to penetrate the asset and undermine the TSP may result in the destruction of the asset preventing use of that asset sample for further testing, e.g. hardware devices. Often in these cases distribution of the asset is controlled and so the attacker must apply effort to obtain further samples of the asset.

For the purposes of this discussion unnecessary/unlimited access means that the attack does not need any kind of opportunity to be realized; easy means that access is required for less than a day or that the number of asset samples required to perform the attack is less than ten; moderate means that access is required for less than a month or that the number of asset samples required to perform the attack is less than fifty; difficult means that access is required for at least a month or that the number of asset samples required to perform the attack is less than one hundred; none means that the opportunity window is not sufficient to perform the attack (the length for which the asset to be exploited is available or is sensitive is less than the opportunity length needed to perform the attack -for example, if the asset key is changed each week and the attack needs two weeks).

Consideration of this factor may result in a determining that it is not possible to complete the exploit, due to requirements for time availability that are greater than the opportunity time.

6.6.3.1.5 Equipment factor

IT hardware/software or other equipment refers to the equipment required to identify or exploit a vulnerability:

- **Standard** equipment is readily available to the attacker, either for the identification of a vulnerability or for an attack. This equipment may be a part of the asset itself (e.g. a debugger in an operating system), or can be readily obtained (e.g. Internet downloads, protocol analyser or simple attack scripts).
- **Specialized** equipment is not readily available to the attacker, but could be acquired without undue effort. This could include purchase of moderate amounts of equipment (e.g. power analysis tools, use of hundreds of PCs linked across the Internet would fall into this category), or development of more extensive attack scripts or programs.
- **Bespoke** equipment is not readily available to the public as it may need to be specially produced (e.g. very sophisticated software), or because the equipment is so specialized that its distribution is controlled, possibly even restricted. Alternatively, the equipment may be very expensive.

Specialist expertise and knowledge of the asset are concerned with the information required for persons to be able to attack an asset. There is an implicit relationship between an attacker's expertise (where the attacker may be one or more persons with complementary areas of knowledge) and the ability to effectively make use of equipment in an attack. The weaker the attacker's expertise, the lower the potential to use equipment (IT hardware/software or other equipment). Likewise, the greater the expertise, the greater the potential for equipment to be used in the attack. Although implicit, this relationship between expertise and the use of equipment does not always apply, for instance, when environmental measures prevent an expert attacker's use of equipment, or when, through the efforts of others, attack tools requiring little expertise to be effectively used are created and freely distributed (e.g. via the Internet).

6.6.3.1.6 Intensity factor

The intensity of an attack may be a factor in determining risk to the system or asset under attack. Table 3 identifies three possible levels of attack intensity and assigns values to each for use in the subsequent threat analysis.

Table 3: Attack intensity levels

Attack intensity	Value
Single instance of attack	0
Moderate level of multiple instances	1
Heavy level of multiple instances	2

The intensity of an attack may be modified by use of:

- distributed threat agents (many sources of attack);
- reducing the time interval between attacks; or
- by combining these two.

In the simplest case a threat agent is assumed to operate at one place for one instance of an attack in any one time period (where even if the attack is repeated the interval between attacks is greater than the asset recovery time such that the attacks can be considered as discrete). For many attacks where manual processes need to be executed at a particular location (such as intercepting a physical line) this is an adequate point of view. In many practical implementations or deployments, including those considered in standards development, consideration only of the discrete attack may be insufficient for risk analysis. Assets are often automated and accessible via networks, and as threat agents are also assets, then so may the attacks be automated and network accessible.

6.7 Step 6: Calculation of the likelihood of the attack and its impact

Each of the attack factors are summed (i.e. Time + Expertise + Knowledge + Opportunity + Equipment) to give an overall attack potential rating as shown in table 4. The attack potential value is then mapped to a vulnerability rating (Table 6) from which the Occurrence likelihood is determined using table 6. The computation template to support step 6 is given in annex H.

Table 4: Attack potential

Factor	Range	Value
Time (1 point per week)	≤1 day	0
	≤ 1 week	1
	≤ 1 month	4
	≤ 3 months	13
	≤ 6 months	26
	> 6 months	See note 1
Expertise	Layman	0
	Proficient	2
	Expert	5
Knowledge	Public	0
	Restricted	1
	Sensitive	4
	Critical	10
Opportunity	Unnecessary / unlimited access	0
	Easy	1
	Moderate	4
	Difficult	12
	None	See note 2
Equipment	Standard	0
	Specialized	3
	Bespoke	7
NOTE 1: Attack potential is beyond high. NOTE 2: Attack path is not exploitable.		

Table 5: Vulnerability rating

Attack potential values	Resistant to attacker with attack potential of:
0 to 2	No rating
3 to 6	Basic
7 to 14	Moderate
15 to 26	High
> 26	Beyond high

The method for threat analysis defined in ETR 332 [i.9] combines the likelihood with the impact of the attack in determining if a countermeasure should be applied. The form of countermeasures can include redesign of the element at risk in the system to remove the vulnerability that is to be attacked, and application of a defensive system component that masks the vulnerability.

Table 6: Mapping of vulnerability rating to likelihood of attack

Vulnerability rating	Likelihood
Beyond high	Unlikely
High	
Moderate	Possible
Basic	Likely
No rating	
NOTE: Motivation is not considered explicitly in the vulnerability rating.	

6.8 Step 7: Establishment of the risks

For each of the assets in the system under study one can identify their vulnerabilities and corresponding threats and weaknesses. For each vulnerability the likelihood should be computed as described in the clause above. For each asset the risk associated with each vulnerability should be computed. The computation template to support step 7 is given in annex H.

6.8.1 Impact of intensity

The overall impact on a system of a particular threat can vary with the intensity with which the attack is mounted. The resulting impact, shown in Table 7, is determined by summing the asset impact value (from Table 2) and the attack intensity value (from Table 3).

Table 7: Result on overall Impact of varying attack intensity

Asset Impact	Attack Intensity	Resulting Impact
1	0	1
1	1	2
1	2	3
2	0	2
2	1	3
2	2	3 (note)
3	0	3
3	1	3 (note)
3	2	3 (note)
NOTE: The Asset Impact Is assigned a value in the range of 1 to 3. Consequently, any Resulting Impact value calculated to be greater than 3 is given the value of 3.		

6.8.2 Classification of risk

6.8.2.1 Overview

Risk is defined in ETSI standards as the product of the likelihood of an attack and the impact of the attack on the system.

The likelihood of a threat occurring may be estimated with values from 1 to 3 as explained in Table 8 (Occurrence likelihood).

Table 8: Occurrence likelihood

Value	Likelihood of occurrence	Explanation
1	Unlikely	According to up-to-date knowledge, a possible attacker needs to solve strong technical difficulties to state the threat or the motivation for an attacker is very low.
2	Possible	The technical requirements necessary to state this threat are not high and could be solved without significant effort; furthermore, there is a reasonable motivation for an attacker to perform the threat.
3	Likely	There are no sufficient mechanisms installed to counteract this threat and the motivation for an attacker is quite high.

The impact of a threat is also estimated with values from 1 to 3 as explained in Table 2.

The product of occurrence likelihood and impact value as defined in clause 6.6 gives the risk which serves as a measurement for the risk that the concerned asset is compromised. The result is classified into three categories as shown in Table 9.

Table 9: Risk

Value	Risk	Explanation
1, 2	Minor	No essential assets are concerned, or the attack is unlikely. Threats causing minor risks have no primary need for counter measures.
3, 4	Major	Threats on relevant assets are likely to occur although their impact is unlikely to be fatal. Major risks should be handled seriously and should be minimized by the appropriate use of countermeasures.
6, 9	Critical	The primary interests of the providers and/or subscribers are threatened and the effort required from a potential attacker's to implement the threat(s) is not high. Critical risks should be minimized with highest priority.
NOTE: Because risk is calculated as the product of likelihood and impact the values 5, 7 and 8 cannot occur.		

6.9 Step 8: Security countermeasure identification

Security Countermeasures are assets that are added to the system to reduce the weighted risk to the system. The purpose of countermeasures is to reduce either the likelihood of an attack or to the impact attack. Security countermeasures are modelled in the TVRA as instances of assets and whilst primarily logical may also be human or physical.

There might be several alternative countermeasures and these should first be identified, then evaluated and compared to identify the costs and benefits of each so that an informed decision can be made of which countermeasures to select.

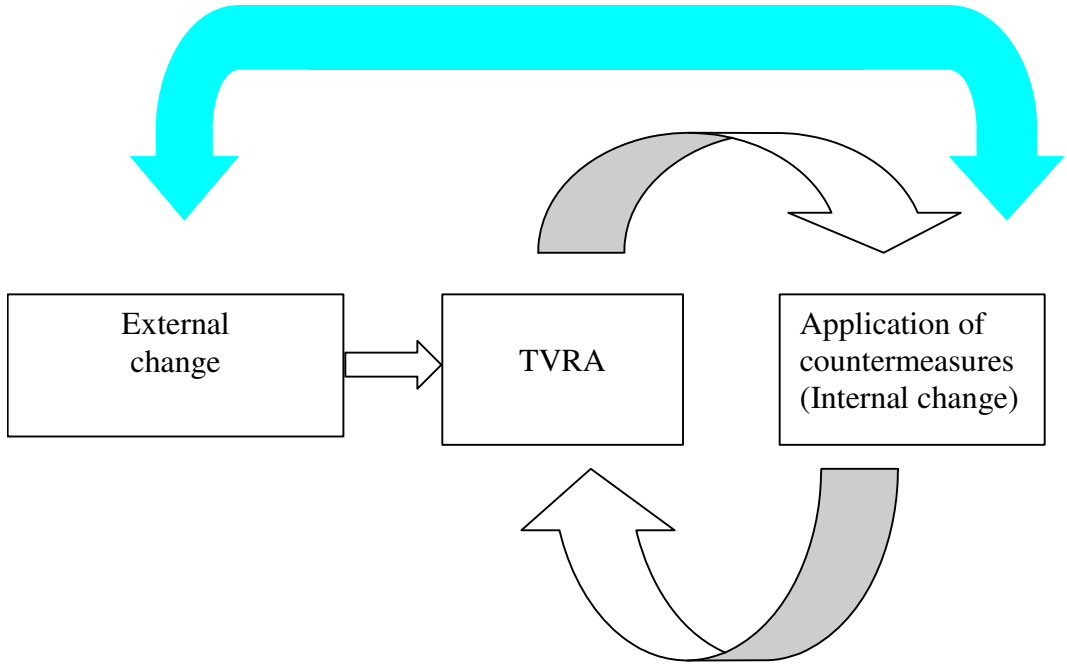


Figure 9: Cyclical nature of TVRA

Figure 9 shows that countermeasures are added as internal changes to the system and require that the TVRA process is repeated. This should continue either until no further countermeasures are applied (indicating stability in the system).

NOTE 1: Some countermeasures may be inferred by inspection of the security requirements.

6.9.1 Countermeasures in the system

Where a countermeasure has been defined as is implemented as a logical asset it will require to be deployed in a corresponding physical assets (e.g. a firewall rule requires a firewall). The countermeasures and their supporting physical assets will bring their own vulnerabilities.

6.9.2 Composite countermeasures applied to the system

More than one countermeasures may be applied against a single threat agent, or to protect a single asset. In such case the residual risk is only identified by re-performing the TVRA.

6.9.3 Impact of countermeasures applied to the system

The impact of countermeasures on the overall risks analysis takes a similar approach as the automated threat agents. In this case the least likely of the two values is taken for each of the likelihood parameters. The impact of the countermeasures on the impact is similarly calculated by taking the least impact. This calculation is applied after the impact of automated threat agents.

6.10 Step 9: Countermeasure Cost-benefit analysis

More than one countermeasure may be effective in reducing particular risks or the overall risks. The TVRA method specifies a countermeasure cost-benefit analysis for this purpose. The goal of the analysis is to identify the most cost-effective countermeasure of the alternatives. The main benefit of any countermeasure is the added security and attack protection introduced. Other benefits may be increased market acceptance and improved regulatory compliance. Costs are not merely economical aspects, but affect standardization, implementation and operation. The countermeasure cost-benefit template and tool is given in annex I.

6.10.1 Standards design

Introducing countermeasures to a standard under development or an existing standard (published) may impose changes affecting the time schedule and resulting in additional effort and cost. The level to which a countermeasure affects the standard design is measured according to the scale in Table 9a.

Table 9a: Standards design evaluation

Scale	Description	Assigned value
No Impact	No effect on the time schedule and resources needed of standards under development or no changes needed on existing and published standards.	0
Low Impact	No significant time delay or additional resource demand for standards under development or changes needed on existing and published standards.	1
Medium Impact	Significant time delay and additional resource demand for standards under development and significant changes needed on existing and published standards.	4
Major Impact	Unacceptable time delay and additional resource demand for standards under development and unacceptable changes needed on existing and published standards.	9

6.10.2 Implementation

Adding countermeasures to standards may affect its adoption and implementation in the targeted user community. This is an important aspect of standards adoption and crucial for countermeasure cost-benefit analysis. The level to which a countermeasure affects implementation of the standard is measured according to the scale in Table 10.

Table 10: Implementation evaluation

Scale	Description	Assigned value
No Impact	No effect on standards adoption in the targeted user community.	0
Low Impact	No significant effect on standards adoption in the targeted user community.	1
Medium Impact	Significant effect on standards adoption in the targeted user community.	4
Major Impact	Unacceptable effect on standards adoption in the targeted user community.	9

6.10.3 Operation

Countermeasures may impact the ongoing operation of standardized products or systems once they have been deployed into an operational environment. The level to which a countermeasure affects the operation of standardized products is measured according to the scale in Table 11.

Table 11: Operation evaluation

Scale	Description	Assigned value
No Impact	No effect on operation of realized standards design and targeted operational environment.	0
Low Impact	No significant effect on operation of realized standards design or targeted operational environment.	1
Medium Impact	Significant effect on operation of realized standards design and targeted operational environment.	4
Major Impact	Unacceptable effect on operation of realized standards design and targeted operational environment.	9

6.10.4 Regulatory impact

Regulatory impacts concern the influence that the countermeasure may have on ensuring regulatory compliance. Regulatory impact is evaluated according to the scale in Table 11a.

Table 11a: Regulatory impact evaluation

Scale	Description	Assigned value
Severe Negative Impact	Unacceptable effect on regulatory compliance requirements.	-9
Negative Impact	Significant negative effect on regulatory compliance requirements.	-4
No Impact	No effect on regulatory compliance requirements.	0
Positive Impact	Significant positive effect on regulatory compliance requirements.	4
Severe Positive Impact	Very favourable effect on regulatory compliance requirements.	9

6.10.5 Market acceptance

Adoption of a standard into industrial products and its acceptance by the targeted user community determine the success of a standard. Therefore, countermeasures with negative predicted effect on market acceptance should be carefully analyzed. The level to which a countermeasure affects market acceptance of the standard is measured according to the scale in Table 12.

Table 12: Market acceptance evaluation

Scale	Description	Assigned value
Severe Negative Impact	Unacceptable effect on market acceptance.	-9
Negative Impact	Significant negative effect on market acceptance.	-4
No Impact	No effect on market acceptance.	0
Positive Impact	Significant positive effect on market acceptance.	4
Severe Positive Impact	Very favourable effect on market acceptance.	9

6.11 Step 10: Specification of detailed requirements

Security requirements should be identified for both the asset and, where applicable, its environment. Detailed requirements are refined from the functional security requirements from step 3 and the security services and capabilities of the countermeasures and security requirements identified in step 8 and analyzed in step 9. Guidelines for the specification of detailed requirements are given in TR 187 011 [i.2].

Annex A (normative): TVRA proforma

Notwithstanding the provisions of the copyright clause related to the text of the present document, ETSI grants that users of the present document may freely reproduce the TVRA definition proforma in this annex so that it can be used for its intended purposes and may further publish the completed TVRA definition.

A Security Environment			
a.1 Assumptions			
a.1.1	*Text of assumption*		*Citation for full text*
a.1.2			
a.2 Assets			
a.2.1	*Short text describing asset*		*Citation for full text*
a.2.2			
a.3 Threat agents			
a.3.1	*Short text describing threat agent*		*Citation for full text*
a.3.2			
a.4 Threats			
a.4.1	*Short text describing threat*		*Citation for full text*
a.4.2			
a.5 Security policies (OPTIONAL)			
a.5.1	*Short text describing security policy*		*Citation for full text*
a.5.2			
B Security Objectives			
b.1 Security objectives for the asset			
b.1.1	*Short text describing objective for the asset*		*Citation for full text*
b.1.2			
b.2 Security objectives for the environment			
b.2.1	*Short text describing objective for the requirement*		*Citation for full text*
b.2.2			
C IT Security Requirements			
c.1 asset security requirements			
c.1.1 asset security functional requirements			
c.1.1.1	*Short text describing security functional requirement*	*ISO15408 [9] class*	*Citation for full text*
c.1.1.2			
c.1.2 asset security assurance requirements			
c.1.2.1	*Short text describing security assurance requirement*	*ISO15408 [9] class*	*Citation for full text*
c.1.2.2			
c.2 Environment security requirements (OPTIONAL)			
c.2.1	*Short text describing security environment requirement*	*ISO15408 [9] class*	*Citation for full text*
c.2.2			
D Application notes (OPTIONAL)			
E Rationale			
The eTVRA should define the full rational, if this is true only a citation (reference) to the full text is required			

Annex B (informative): The role of motivation

A full critique of the role of motivation in attacking a system when viewed in the context of Common Criteria evaluation can be found in clause B.4.1.1 of the Common Criteria Evaluation methodology [10]. In the present document motivation is addressed in broadly similar terms as a factor in determining attack potential.

Motivation can be used to describe aspects both of the attacker, and of the system (assets) he is attacking. The following key criteria may be considered when evaluating motivation:

- The likelihood of an attack:
  - If a threat is highly motivated an attack can be considered imminent, with a corollary of.
  - If a threat is unmotivated no attack can be anticipated.
- The value of the asset, monetarily or otherwise, to either the attacker or the asset holder:
  - An asset of very high value is likely to motivate an attack, with a corollary of.
  - An asset of little value is unlikely to motivate an attack.
- The expertise and resources with which an attacker is willing to effect an attack:
  - A highly motivated attacker is likely to acquire sufficient expertise and resources to defeat the measures protecting an asset, with a corollary of.
  - An attacker with significant expertise and resources is not willing to effect an attack using them if the attacker's motivation is low.

In each case there is no probabilistic means of determining the role of motivation in mounting an attack. However in assessing threat potential it is essential to consider motivation in order to minimize the effect of motivation on the attacker.

Annex C:
Void

Annex D (informative): Denial of service attacks

A "denial-of-service" attack is characterized by an explicit attempt by attackers to prevent legitimate users of a service from using that service. Examples include:

- attempts to "flood" a network, thereby preventing legitimate network traffic;
- attempts to disrupt connections between two machines, thereby preventing access to a service;
- attempts to prevent a particular individual from accessing a service;
- attempts to disrupt service to a specific system or person.

Not all service outages, even those that result from malicious activity, are necessarily denial-of-service attacks. Other types of attack may include a denial of service as a component, but the denial of service may be part of a larger attack.

Illegitimate use of resources may also result in denial of service.

Denial-of-service attacks come in a variety of forms and aim at a variety of services. There are three basic aims of the attacker:

- To cause consumption of scarce, limited, or non-renewable resources.
- To lead to destruction or alteration of configuration information.
- To cause physical destruction or alteration of network components.

D.1 DDoS Attacks viable on the NGN

D.1.1 Land

In Land attacks, the attacker sends the victim a TCP SYN packet that contains the same IP address as the source and destination addresses. Such a packet completely locks the victim's system.

D.1.2 SYN Flood

A SYN flood attack occurs during the three-way handshake that marks the onset of a TCP connection. In the three-way handshake, a client requests a new connection by sending a TCP SYN packet to a server. After that, the server sends a SYN/ACK packet back to the client and places the connection request in a queue. Finally, the client acknowledges the SYN/ACK packet. If an attack occurs, however, the attacker sends an abundance of TCP SYN packets to the victim, obliging it both to open a lot of TCP connections and to respond to them. Then the attacker does not execute the third step of the three-way handshake that follows, rendering the victim unable to accept any new incoming connections, because its queue is full of half-open TCP connections.

D.1.3 Ping of Death

In Ping of Death attacks, the attacker creates a packet that contains more than 65 536 bytes, which is the limit that the IP protocol defines. This packet can cause different kinds of damage to the machine that receives it, such as crashing and rebooting.

D.1.4 Process Table

This attack exploits the feature of some network services to generate a new process each time a new TCP/IP connection is set up. The attacker tries to make as many uncompleted connections to the victim as possible in order to force the victim's system to generate an abundance of processes. Hence, because the number of processes that are running on the system cannot be boundlessly large, the attack renders the victim unable to serve any other request.

D.1.5 Smurf Attack

In a "smurf" attack, the victim is flooded with *Internet Control Message Protocol* (ICMP) "echo-reply" packets. The attacker sends numerous ICMP "echo-request" packets to the broadcast address of many subnets. These packets contain the victim's address as the source IP address. Every machine that belongs to any of these subnets responds by sending ICMP "echo-reply" packets to the victim. Smurf attacks are very dangerous, because they are strongly distributed attacks.

D.1.6 SSH Process Table

Like the Process Table attack, this attack makes hundreds of connections to the victim with the *Secure Shell* (SSH) Protocol without completing the login process. In this way, the daemon contacted by the SSH on the victim's system is obliged to start so many SSH processes that it is exhausted.

D.1.7 TCP Reset

In TCP Reset attacks, the network is monitored for "tcpconnection" requests to the victim. As soon as such a request is found, the malevolent attacker sends a spoofed TCP RESET packet to the victim and obliges it to terminate the TCP connection.

D.1.8 Teardrop

While a packet is travelling from the source machine to the destination machine, it may be broken up into smaller fragments, through the process of fragmentation. A Teardrop attack creates a stream of IP fragments with their offset field overloaded. The destination host that tries to reassemble these malformed fragments eventually crashes or reboots.

D.1.9 UDP Storm

In a User Datagram Protocol (UDP) connection, a character generation ("chargen") service generates a series of characters each time it receives a UDP packet, while an echo service echoes any character it receives. Exploiting these two services, the attacker sends a packet with the source spoofed to be that of the victim to another machine. Then, the echo service of the former machine echoes the data of that packet back to the victim's machine and the victim's machine, in turn, responds in the same way. Hence, a constant stream of useless load is created that burdens the network.

D.2 DDoS characteristics

Distributed Denial of Service (DDoS) attacks extend conventional Denial of Service (DoS) attacks by the additional characteristic of being distributed attacks (i.e. the attack is from many points at once). For a DDoS attack the multiplicity of the attack relationship in figure D.1 is 1 too many (1 victim, many attackers), whereas in most conventional attacks the multiplicity is 1 to 1.

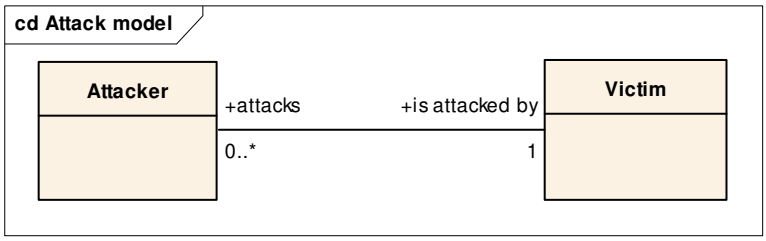


Figure D.1: Attack model (static state)

There are two primary assets of a system that are victimised in DDoS attacks:

- Bandwidth.
- Processing resources (CPU cycles).

Bandwidth is consumed by flooding the network with useless packets. Attacks against processing resource may be achieved by generating several thousands of useless processes on the victim's system sufficient to fully occupy memory and process tables.

D.3 Defence against DDoS

From the beginning, all legitimate users have tried to respond against these threats. University communities and software corporations have proposed several methods against the DDoS threat. Despite the efforts, the solution remains a dream. The attackers manage to discover other weaknesses of the protocols and, what is worse, they exploit the defence mechanisms in order to develop attacks. They discover methods to overcome these mechanisms or they exploit them to generate false alarms and to cause catastrophic consequences.

Many experts have tried to classify the DDoS defence mechanisms in order to clarify them. This classification gives users an overall view of the situation and helps defence-mechanism developers cooperate against the threat. The basic discrimination is between preventive and reactive defence mechanisms.

D.3.1 Preventive Mechanisms

The preventive mechanisms try to eliminate the possibility of DDoS attacks altogether or to enable potential victims to endure the attack without denying services to legitimate clients. With regard to attack prevention, countermeasures can be taken on either victims or on zombies. In both cases the system configuration is modified to eliminate the possibility of accepting a DDoS attack or participating in a DDoS attack.

Filtering of input and output traffic may be possible and may offer simple rules, for example, the source IP address of output traffic should belong to the sub-network, whereas the source IP address of input traffic should not.

D.3.2 Reactive Mechanisms

Reactive mechanisms try to detect the attack and respond to it immediately and by doing so restrict the impact of the attack on the victim.

RISK: Characterizing a legitimate connection as an attack.

D.3.2.1 Signature detection mechanisms

Signature-based methods search for patterns (signatures) in observed network traffic that match known attack signatures from a database. The advantage of these methods is that they can easily and reliably detect known attacks, but they cannot recognize new attacks. Moreover, the signature database must always be kept up-to-date in order to retain the reliability of the system.

D.3.2.2 Anomaly detection mechanisms

Anomaly-based methods compare the parameters of the observed network traffic with normal traffic. Hence it is possible for new attacks to be detected. However, in order to prevent a false alarm, the model of "normal traffic" must always be kept updated and the threshold of categorizing an anomaly must be properly adjusted.

D.3.3 Difficulties of defence

Development of detection and defending tools is unlikely to every prove 100 % effective and some of the more common problems include:

- DDoS attacks flood victims with packets. The rate of change of network activity that leads to an attack may be greater than the speed at which countermeasures can be brought into play.
- Any attempt of filtering the incoming flow may mean that legitimate traffic will be rejected.
- Filtering may rob processor time and more advanced filtering rules take more of the resource.
- Attack packets usually have spoofed IP addresses so tracing the real attacker rather than a masqueraded victim may be difficult.

Annex E (informative): TVRA database structure

E.1 Database structure

The database Entity Relationship Diagram (ERD) shown in figure E.1 has been extracted from the database used in development. For readability the lookup tables have been omitted.

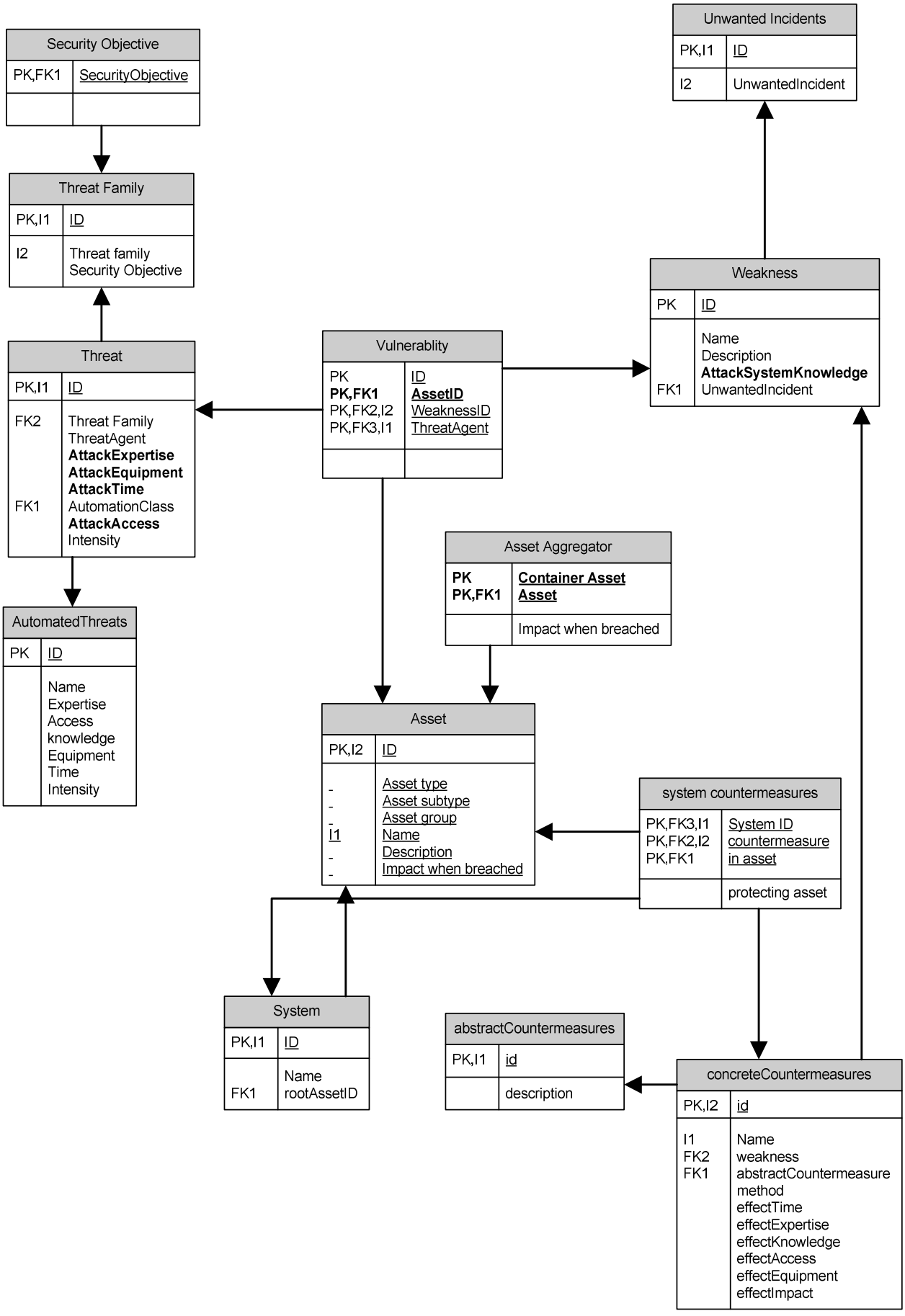


Figure E.1: Database structure extracted from MS-Access™ TVRA test database

E.2 SQL code for TVRA database

The following SQL code is offered without claims for completeness but to allow readers of the present document to incorporate them into an existing database environment. The code follows the ANSI-SQL language syntax wherever possible and has been tested using the open source mySQL database without optimization.

NOTE: For use in mySQL databases the database engine has to be set to InnoDB in order to allow foreign key relationships to work.

E.2.1 Lookup tables

Lookup tables are used throughout the database to store data that is either intransient, or which may be referenced in more than one of the core tables. This covers the criteria for weighting a risk as defined in clauses 5 and 6 of the present document, the use of Common Criteria Functional and Assurance classes as defined in ISO/IEC 15408 [9] and referred to in clause 5 of the present document, and citations used to record the source material used in analysis.

NOTE: Lookup tables are used to resolve many-to-one relationships identified in the UML models in the core of the present document.

```
CREATE TABLE Citation_LU (
  CitationId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (CitationId),
  Publisher Text(50) NOT NULL,
  DocumentName Text(255),
  Notes Text(255)
) ENGINE = InnoDB
;
```

```
CREATE TABLE RequirementType_LU (
  RequirementTypeId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (RequirementTypeId),
  RquirementType Text(25) NOT NULL,
  RequirementTypeDescription Text(127)
)
;
```

```
CREATE TABLE CC_Components_LU (
    ComponentId INT NOT NULL AUTO_INCREMENT,
    PRIMARY KEY (ComponentId),
    Citation INT,
    INDEX (Citation),
    FOREIGN KEY (Citation) REFERENCES Citation_LU (CitationId),
    CC_ComponentShortName Text(7) NOT NULL,
    CC_ComponentLevel INT NOT NULL,
    CC_ComponentLongName Text(80) NOT NULL
)
;
```

```
CREATE TABLE Likelihood_LU (
    LikelihoodId INT NOT NULL,
  PRIMARY KEY (LikelihoodId),
    Likelihood Text(50),
    Description Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE AssetValue_LU (
    AssetImpact INT NOT NULL,
  PRIMARY KEY (AssetImpact),
    AssetImpactShortText Text(50) NOT NULL,
    AssetImpactLongDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE AttackEquipment_LU (
    AttackEquipment INT NOT NULL,
  PRIMARY KEY (AttackEquipment),
    Equipment Text(50) NOT NULL,
    AttackEquipmentLongDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE AttackExpertise_LU (
    AttackExpertise INT NOT NULL,
  PRIMARY KEY (AttackExpertise),
    Expertise Text(50) NOT NULL,
    AttackExpertiseLongDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE AttackKnowledge_LU (
    AttackKnowledge INT NOT NULL,
  PRIMARY KEY (AttackKnowledge),
    Knowledge Text(50) NOT NULL,
  AttackKnowledgeLongDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE AttackOpportunity_LU (
    AttackOpportunity INT NOT NULL,
  PRIMARY KEY (AttackOpportunity),
    OpportunityText Text(50) NOT NULL,
  OpportunityLongDesrciption Text(1024)
) ENGINE = InnoDB
;
```

E.2.2 Core tables

Core tables are those that contain the main body of the analysis. This covers the assets, threats, threat agents, weaknesses, vulnerabilities and unwanted-incidents. The tables make use of many foreign key relationships that ensure that terms stored in the database are restricted to those values found in the lookup tables using only the index of the lookup tables. As such a *SELECT * FROM <<table-name>>* query may return non-user readable output.

```
CREATE TABLE Asset_T (
    AssetId INT NOT NULL AUTO_INCREMENT,
  AssetName Text(50) NOT NULL,
  AssetDescription Text(1024),
  CitationId INT,
  AssetImpactWeight INT,
  PRIMARY KEY (AssetId),
  INDEX (AssetImpactWeight),
  FOREIGN KEY (AssetImpactWeight) REFERENCES AssetValue_LU (AssetImpact),
  INDEX (CitationId),
  FOREIGN KEY (CitationId) REFERENCES Citation_LU (CitationId)
) ENGINE = InnoDB
;
```

```
CREATE TABLE System_T (
    SystemId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (SystemID),
  SystemName Text(50) NOT NULL,
    SystemDescription Text(1024),
  CitationId INT,
  INDEX (CitationId),
  FOREIGN KEY (CitationId) REFERENCES Citation_LU (CitationId)
) ENGINE = InnoDB
;
```

```
CREATE TABLE ThreatAgent_T (
    ThreatAgentId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (ThreatAgentId),
    TA_name Text(50) NOT NULL,
    TA_description Text(1024) NOT NULL,
    AttackTimeValue INT,
    AttackExpertise INT,
  AttackKnowledge INT,
  AttackOpportunity INT,
  AttackEquipment INT,
  INDEX (AttackExpertise),
  FOREIGN KEY (AttackExpertise) REFERENCES AttackExpertise_LU (AttackExpertise),
  INDEX (AttackKnowledge),
  FOREIGN KEY (AttackKnowledge) REFERENCES AttackKnowledge_LU (AttackKnowledge),
  INDEX (AttackOpportunity),
  FOREIGN KEY (AttackOpportunity) REFERENCES AttackOpportunity_LU (AttackOpportunity),
  INDEX (AttackEquipment),
  FOREIGN KEY (AttackEquipment) REFERENCES AttackEquipment_LU (AttackEquipment)
) ENGINE = InnoDB
;
```

```
CREATE TABLE Threat_T (
    ThreatId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (ThreatId),
  ThreatName Text(50),
    ThreatDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE UnwantedIncident_T (
    UnwantedIncidentId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (UnwantedIncidentId),
  Name Text(50),
    Description Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE Weakness_T (
    WeaknessId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (WeaknessId),
    WeaknessName Text(50),
    WeaknessDescription Text(1024)
) ENGINE = InnoDB
;
```

```
CREATE TABLE Objective_T (
    ObjectiveId INT NOT NULL AUTO_INCREMENT,
    Objective Text(255) NOT NULL,
    Citation INT,
    INDEX (Citation),
    FOREIGN KEY (Citation) REFERENCES Citation_LU (CitationId),
  PRIMARY KEY (ObjectiveId)
)
;
```

```
CREATE TABLE Requirement_T (
    RequirementId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (RequirementId),
    Requirement Text(255) NOT NULL,
  Citation INT,
    RequirementType INT NOT NULL,
    CCReference INT,
    INDEX (CCReference),
    FOREIGN KEY (CCReference) REFERENCES CC_Components_LU (ComponentID),
    INDEX (RequirementType),
    FOREIGN KEY (RequirementType) REFERENCES RequirementType_LU (RequirementTypeId),
    INDEX (Citation),
    FOREIGN KEY (Citation) REFERENCES Citation_LU (CitationId)
)
;
```

E.2.3 Linking tables

Linking tables are used throughout the database to store data that combines two or more tables. For example an asset may appear in many systems, an objective may be tied to an asset.

NOTE: Linking tables are used to resolve many-to-many relationships identified in the UML models in the core of the present document.

```
CREATE TABLE AssetObjective_LT (
  ObjectiveId INT,
  AssetId INT,
  INDEX (ObjectiveId),
  INDEX (AssetId),
  FOREIGN KEY (ObjectiveId) REFERENCES Objective_T (ObjectiveId),
  FOREIGN KEY (AssetId) REFERENCES Asset_T (AssetId)
)
;
```

```
CREATE TABLE SystemObjective_LT (
  ObjectiveId INT,
  SystemId INT,
  INDEX (ObjectiveId),
  INDEX (SystemId),
  FOREIGN KEY (ObjectiveId) REFERENCES Objective_T (ObjectiveId),
  FOREIGN KEY (SystemId) REFERENCES System_T (SystemId)
)
;
```

```
CREATE TABLE ProblemsToAvoid_LT (
    UnwantedIncidentId INT,
  SystemId INT,
  ObjectiveId INT,
  INDEX (UnwantedIncidentId),
  INDEX (SystemId),
  INDEX (ObjectiveId),
  FOREIGN KEY (ObjectiveId) REFERENCES Objective_T (ObjectiveId),
  FOREIGN KEY (SystemId) REFERENCES System_T (SystemId),
  FOREIGN KEY (UnwantedIncidentId) REFERENCES UnwantedIncident_T (UnwantedIncidentId)
) ENGINE = InnoDB
;
```

```
CREATE TABLE RiskAssesment_LT (
    VulnerabilityId INT NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (VulnerabilityId),
    AssetId INT,
    WeaknessId INT,
    ThreatAgentId INT,
  Likelihood INT,
    RiskAssesmentDate DateTime,
  INDEX (AssetId),
  INDEX (WeaknessId),
  INDEX (ThreatAgentId),
  INDEX (Likelihood),
  FOREIGN KEY (AssetId) REFERENCES Asset_T (AssetId),
  FOREIGN KEY (WeaknessId) REFERENCES Weakness_T (WeaknessId),
  FOREIGN KEY (ThreatAgentId) REFERENCES ThreatAgent_T (ThreatAgentId),
  FOREIGN KEY (Likelihood) REFERENCES Likelihood_LU (LikelihoodId)
)
ENGINE = InnoDB
;
```

```
CREATE TABLE SystemComponents_LT (
    SystemId INT,
    AssetId INT,
  INDEX (SystemId),
  FOREIGN KEY (SystemId) REFERENCES System_T (SystemId),
  INDEX (AssetId),
  FOREIGN KEY (AssetId) REFERENCES Asset_T (AssetId)
) ENGINE = InnoDB
;
CREATE TABLE ThreatEnabler_LT (
    ThreatAgentId INT,
  ThreatId INT,
  INDEX (ThreatAgentId),
  INDEX (ThreatId),
  FOREIGN KEY (ThreatAgentId) REFERENCES ThreatAgent_T (ThreatAgentId),
  FOREIGN KEY (ThreatId) REFERENCES Threat_T (ThreatId)
) ENGINE = InnoDB
;
```

E.2.4 Sample queries (used to complete input to eTVRA proforma)

Not yet tested.

Annex F (informative): Use of ISO/IEC 15408-2 security functional classes in security requirements statements

F.1 Overview

When preparing the security requirements the model given in ISO/IEC 15408-2 [7] is highly recommended as it provides a clear statement of the requirement and uses a common language that can be applied to any ICT security scenario.

Each class of functions in ISO/IEC 15408-2 [7] is defined such that they can be combined to provide complex composite requirements. TR 187 011 [i.2] provides guidelines and method on how to apply ISO/IEC 15408-2 [7] requirements to ETSI standards, and TR 187 002 [i.3] provides examples of security functional requirements.

NOTE: The tables shown in this annex were derived from Edition 2 of ISO/IEC 15408-2 [7]. Edition 3 of ISO/IEC 15408-2 [7] introduced some significant changes which are not reflected here but will be incorporated in a future release of the present document.

Table F.1 summarizes the classes and their class members.

Table F.1: ISO/IEC 15408-2 [7] classes and families

Class	Class members	
FAU Security audit	FAU_ARP	Security audit automatic response
	FAU_GEN	Security audit data generation
	FAU_SAA	Security audit analysis
	FAU_SAR	Security audit review
	FAU_SEL	Security audit event selection
	FAU_STG	Security audit event storage
FCO Communication	FCO_NRO	Non-repudiation of origin
	FCO_NRR	Non-repudiation of receipt
FCS Cryptographic support	FCS_CKM	Cryptographic key management
	FCS_COP	Cryptographic operation
FDP User Data Protection	FDP_ACC	Access control policy
	FDP_ACF	Access control functions
	FDP_DAU	Data authentication
	FDP_ETC	Export to outside TSF control
	FDP_IFC	Information flow control policy
	FDP_IFF	Information flow control functions
	FDP_ITC	Import from outside TSF control
	FDP_ITT	Internal TOE transfer
	FDP_RIP	Residual information protection
	FDP_ROL	Rollback
	FDP_SDI	Stored data integrity
	FDP_UCT	Inter-TSF user data confidentiality transfer protection
	FDP_UIT	Inter-TSF user data integrity transfer protection
FIA Identification and authentication	FIA_AFL	Authentication failures
	FIA_ATD	User attribute definition
	FIA_SOS	Specification of secrets
	FIA_UAU	User authentication
	FIA_UID	User identification
	FIA_USB	User-subject binding
FMT Security management	FMT_MOF	Management of functions in TSF
	FMT_MSA	Management of security attributes
	FMT_MTD	Management of TSF data
	FMT_REV	Revocation
	FMT_SAE	Security attribute expiration
	FMT_SMR	Security management roles
FPR Privacy	FPR_ANO	Anonymity
	FPR_PSE	Pseudonymity
	FPR_UNL	Unlinkability
	FPR_UNO	Unobservability
FPT Protection of the TSF	FPT_AMT	Underlying abstract machine test
	FPT_FLS	Fail secure
	FPT_ITA	Availability of exported TSF data
	FPT_ITC	Confidentiality of exported TSF data
	FPT_ITI	Integrity of exported TSF data
	FPT_ITT	Internal TOE TSF data transfer
	FPT_PHP	TSF physical protection
	FPT_RCV	Trusted recovery Protection of the TSF
	FPT_RPL	Replay detection
	FPT_RVM	Reference mediation
	FPT_SEP	Domain separation
	FPT_SSP	State synchrony protocol
	FPT_STM	Time stamps
	FPT_TDC	Inter-TSF TSF data consistency
	FPT_TRC	Internal TOE TSF data replication consistency
	FPT_TST	TSF self test
FRU Resource Utilization	FRU_FLT	Fault tolerance
	FRU_PRS	Priority of service
	FRU_RSA	Resource allocation

Class	Class members	
FTA TOE Access	FTA_LSA	Limitation on scope of selectable attributes
	FTA_MCS	Limitation on multiple concurrent sessions
	FTA_SSL	Session locking
	FTA_TAB	TOE access banners
	FTA_TAH	TOE access history
	FTA_TSE	TOE session establishment
FTP Trusted path/channels	FTP_ITC	Inter-TSF trusted channel
	FTP_TRP	Trusted path

The use and application of the security requirements class members in defining deployable security capabilities is considered in greater depth in TS 102 165-2 [4].

F.2 Review of functional capabilities

NOTE: When writing requirements using the statements in the tables that follow the designer has to explicitly identify the "assignment" and "selection" criteria for each chosen statement. This may lead to many variants of a single functional requirement.

F.2.1 Authentication and identification

The functional capabilities in the authentication and identification class address the requirements to establish and verify a claimed user identity.

Table F.2: ISO/IEC 15408-2 [7] functional capabilities (Authentication and Identification class)

Shortname	Definition	Form of assignment in NGN
FIA_AFL.1.1	The TSF shall detect when [**assignment:** number] unsuccessful authentication attempts occur related to [**assignment:** list of authentication events].	Integer number of allowed failures
FIA_AFL.1.2	When the defined number of unsuccessful authentication attempts has been met or surpassed, the TSF shall [**assignment:** list of actions].	Barring further attempts (e.g. barring a SIM after 3 failed PIN entry attempts)
FIA_ATD.1.1	The TSF shall maintain the following list of security attributes belonging to individual users: [**assignment:** list of security attributes].	Application dependent
FIA_SOS.1.1	The TSF shall provide a mechanism to verify that secrets meet [**assignment:** a defined quality metric].	Not normally done
FIA_SOS.2.1	The TSF shall provide a mechanism to generate secrets that meet [**assignment:** a defined quality metric].	Not normally done
FIA_SOS.2.2	The TSF shall be able to enforce the use of TSF generated secrets for [**assignment:** list of TSF functions].	Not normally done
FIA_UAU.1.1	The TSF shall allow [**assignment:** list of TSF mediated actions] on behalf of the user to be performed before the user is authenticated.	Making emergency calls; Location update processing
FIA_UAU.1.2	The TSF shall require each user to be successfully authenticated before allowing any other TSF-mediated actions on behalf of that user.	Any actions not restricted by FIA_UAU.1.1 and within the access allowance of the NGN user
FIA_UAU.2.1	The TSF shall require each user to be successfully authenticated before allowing any other TSF-mediated actions on behalf of that user.	As per FIA_UAU.1.2
FIA_UAU.3.1	The TSF shall [**selection:** detect, prevent] use of authentication data that has been forged by any user of the TSF.	Detect and prevent
FIA_UAU.3.2	The TSF shall [**selection:** detect, prevent] use of authentication data that has been copied from any other user of the TSF.	Detect and prevent
FIA_UAU.4.1	The TSF shall prevent reuse of authentication data related to [**assignment:** identified authentication mechanism(s)].	This has to be applied to specific NGN mechanisms
FIA_UAU.5.1	The TSF shall provide [**assignment:** list of multiple authentication mechanisms] to support user authentication.	
FIA_UAU.5.2	The TSF shall authenticate any user's claimed identity according to the [**assignment:** rules describing how the multiple authentication mechanisms provide authentication].	Needs an identity management method
FIA_UAU.6.1	The TSF shall re-authenticate the user under the conditions [**assignment:** list of conditions under which re-authentication is required].	Time; Change of location
FIA_UAU.7.1	The TSF shall provide only [**assignment:** list of feedback] to the user while the authentication is in progress.	Information messages relating to the authentication
FIA_UID.1.1	The TSF shall allow [**assignment:** list of TSF-mediated actions] on behalf of the user to be performed before the user is identified.	Making of emergency calls
FIA_UID.1.2	The TSF shall require each user to be successfully identified before allowing any other TSF-mediated actions on behalf of that user.	Any NGN service not excluded by FIA_UID.1.1
FIA_UID.2.1	The TSF shall require each user to identify itself before allowing any other TSFmediated actions on behalf of that user.	As per FIA_UID.2.1
FIA_USB.1.1	The TSF shall associate the appropriate user security attributes with subjects acting on behalf of that user.	Applies to user-agents in the NGN

F.2.2 Communication class (non-repudiation)

The functional capabilities in the communication class address those requirements dealing with repudiation (and non-repudiation) of a communication).

Table F.3: ISO/IEC 15408-2 [7] functional capabilities (Communication class (non-repudiation))

Shortname	Definition	Form of assignment in NGN
FCO_NRO.1.1	The TSF shall be able to generate evidence of origin for transmitted [**assignment:** list of information types] at the request of the [**selection:** originator, recipient, [assignment: list of third parties]].	Billable events and messages
FCO_NRO.1.2	The TSF shall be able to relate the [**assignment:** list of attributes] of the originator of the information, and the [**assignment:** list of information fields] of the information to which the evidence applies.	FFS
FCO_NRO.1.3	The TSF shall provide a capability to verify the evidence of origin of information to [**selection:** originator, recipient, [**assignment:** list of third parties]] given [**assignment:** limitations on the evidence of origin].	Originator and recipient
FCO_NRO.2.1	The TSF shall enforce the generation of evidence of origin for transmitted [**assignment:** list of information types] at all times.	Not generally done in communications scenarios but may apply for e-commerce scenarios
FCO_NRO.2.2	The TSF shall be able to relate the [**assignment:** list of attributes] of the originator of the information, and the [**assignment:** list of information fields] of the information to which the evidence applies.	FFS
FCO_NRO.2.3	The TSF shall provide a capability to verify the evidence of origin of information to [**selection:** originator, recipient, [**assignment:** list of third parties]] given [**assignment:** limitations on the evidence of origin].	FFS
FCO_NRR.1.1	The TSF shall be able to generate evidence of receipt for received [**assignment:** list of information types] at the request of the [**selection:** originator, recipient, [**assignment:** list of third parties]].	FFS
FCO_NRR.1.2	The TSF shall be able to relate the [**assignment:** list of attributes] of the recipient of the information, and the [**assignment:** list of information fields] of the information to which the evidence applies.	Not generally done in communications scenarios but may apply for e-commerce scenarios
FCO_NRR.1.3	The TSF shall provide a capability to verify the evidence of receipt of information to [**selection:** originator, recipient, [**assignment:** list of third parties]] given [**assignment:** limitations on the evidence of receipt].	Not generally done in communications scenarios but may apply for e-commerce scenarios
FCO_NRR.2.1	The TSF shall enforce the generation of evidence of receipt for received [**assignment:** list of information types].	Not generally done in communications scenarios but may apply for e-commerce scenarios
FCO_NRR.2.2	The TSF shall be able to relate the [**assignment:** list of attributes] of the recipient of the information, and the [**assignment:** list of information fields] of the information to which the evidence applies.	FFS
FCO_NRR.2.3	The TSF shall provide a capability to verify the evidence of receipt of information to [**selection:** originator, recipient, [**assignment:** list of third parties]] given [**assignment:** limitations on the evidence of receipt].	Not generally done in communications scenarios but may apply for e-commerce scenarios

F.2.3 User data protection class

The functional capabilities in the user data protection class address those requirements dealing protection of data and cover information policy, and transfer as well as the actual mechanics of protection.

Table F.4: ISO/IEC 15408-2 [7] functional capabilities (User data protection class)

Shortname	Definition	Form of assignment in NGN
FDP_ACC.1.1	The TSF shall enforce the [**assignment:** access control SFP] on [**assignment:** list of subjects, objects, and operations among subjects and objects covered by the SFP].	At gateways using policy or firewall rules
FDP_ACC.2.1	The TSF shall enforce the [**assignment:** access control SFP] on [**assignment:** list of subjects and objects] and all operations among subjects and objects covered by the SFP.	At gateways using policy or firewall rules
FDP_ACC.2.2	The TSF shall ensure that all operations between any subject in the TSC and any object within the TSC are covered by an access control SFP.	Management policy
FDP_ACF.1.1	The TSF shall enforce the [**assignment:** access control SFP] to objects based on [**assignment:** security attributes, named groups of security attributes].	At gateways using policy or firewall rules
FDP_ACF.1.2	The TSF shall enforce the following rules to determine if an operation among controlled subjects and controlled objects is allowed: [**assignment:** rules governing access among controlled subjects and controlled objects using controlled operations on controlled objects].	At gateways using policy or firewall rules
FDP_ACF.1.3	The TSF shall explicitly authorize access of subjects to objects based on the following additional rules: [**assignment:** rules, based on security attributes, that explicitly authorize access of subjects to objects].	
FDP_ACF.1.4	The TSF shall explicitly deny access of subjects to objects based on the [**assignment:** rules, based on security attributes, that explicitly deny access of subjects to objects].	
FDP_DAU.1.1	The TSF shall provide a capability to generate evidence that can be used as a guarantee of the validity of [**assignment:** list of objects or information types].	
FDP_DAU.1.2	The TSF shall provide [**assignment:** list of subjects] with the ability to verify evidence of the validity of the indicated information.	
FDP_DAU.2.1	The TSF shall provide a capability to generate evidence that can be used as a guarantee of the validity of [**assignment:** list of objects or information types].	
FDP_DAU.2.2	The TSF shall provide [**assignment:** list of subjects] with the ability to verify evidence of the validity of the indicated information and the identity of the user that generated the evidence.	
FDP_ETC.1.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] when exporting user data, controlled under the SFP(s), outside of the TSC.	
FDP_ETC.1.2	The TSF shall export the user data without the user data's associated security attributes.	
FDP_ETC.2.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] when exporting user data, controlled under the SFP(s), outside of the TSC.	
FDP_ETC.2.2	The TSF shall export the user data with the user data's associated security attributes.	
FDP_ETC.2.3	The TSF shall ensure that the security attributes, when exported outside the TSC, are unambiguously associated with the exported user data.	
FDP_ETC.2.4	The TSF shall enforce the following rules when user data is exported from the TSC: [**assignment:** additional exportation control rules].	
FDP_IFC.1.1	The TSF shall enforce the [**assignment:** information flow control SFP] on [**assignment:** list of subjects, information, and operations that cause controlled information to flow to and from controlled subjects covered by the SFP].	
FDP_IFC.2.1	The TSF shall enforce the [**assignment:** information flow control SFP] on [**assignment:** list of subjects and information] and all operations that cause that information to flow to and from subjects covered by the SFP.	
FDP_IFC.2.2	The TSF shall ensure that all operations that cause any information in the TSC to flow to and from any subject in the TSC are covered by an information flow control SFP.	
FDP_IFF.1.1	The TSF shall enforce the [**assignment:** information flow control SFP] based on the following types of subject and information security attributes: [**assignment:** the minimum number and type of security attributes].	

Shortname	Definition	Form of assignment in NGN
FDP_IFF.1.2	The TSF shall permit an information flow between a controlled subject and controlled information via a controlled operation if the following rules hold: [**assignment:** for each operation, the security attribute-based relationship that must hold between subject and information security attributes].	
FDP_IFF.1.3	The TSF shall enforce the [**assignment:** additional information flow control SFP rules].	
FDP_IFF.1.4	The TSF shall provide the following [**assignment:** list of additional SFP capabilities].	
FDP_IFF.1.5	The TSF shall explicitly authorize an information flow based on the following rules: [**assignment:** rules, based on security attributes, that explicitly authorize information flows].	
FDP_IFF.1.6	The TSF shall explicitly deny an information flow based on the following rules: [**assignment:** rules, based on security attributes, that explicitly deny information flows].	
FDP_IFF.2.1	The TSF shall enforce the [**assignment:** information flow control SFP] based on the following types of subject and information security attributes: [**assignment:** the minimum number and type of security attributes].	
FDP_IFF.2.2	The TSF shall permit an information flow between a controlled subject and controlled information via a controlled operation if the following rules, based on the ordering relationships between security attributes hold: [**assignment:** for each operation, the security attribute-based relationship that must hold between subject and information security attributes].	
FDP_IFF.2.3	The TSF shall enforce the [**assignment:** additional information flow control SFP rules].	
FDP_IFF.2.4	The TSF shall provide the following [**assignment:** list of additional SFP capabilities].	
FDP_IFF.2.5	The TSF shall explicitly authorize an information flow based on the following rules: [**assignment:** rules, based on security attributes, that explicitly authorize information flows].	
FDP_IFF.2.6	The TSF shall explicitly deny an information flow based on the following rules: [**assignment:** rules, based on security attributes, that explicitly deny information flows].	
FDP_IFF.2.7	The TSF shall enforce the following relationships for any two valid information flow control security attributes: a) There exists an ordering function that, given two valid security attributes, determines if the security attributes are equal, if one security attribute is greater than the other, or if the security attributes are incomparable; and b) There exists a 'least upper bound' in the set of security attributes, such that, given any two valid security attributes, there is a valid security attribute that is greater than or equal to the two valid security attributes; and c) There exists a 'greatest lower bound' in the set of security attributes, such that, given any two valid security attributes, there is a valid security attribute that is not greater than the two valid security attributes.	
FDP_IFF.3.1	The TSF shall enforce the [**assignment:** information flow control SFP] to limit the capacity of [**assignment:** types of illicit information flows] to a [**assignment:** maximum capacity].	
FDP_IFF.4.1	The TSF shall enforce the [**assignment:** information flow control SFP] to limit the capacity of [**assignment:** types of illicit information flows] to a [**assignment:** maximum capacity].	
FDP_IFF.4.2	The TSF shall prevent [**assignment:** types of illicit information flows].	
FDP_IFF.5.1	The TSF shall ensure that no illicit information flows exist to circumvent [**assignment:** name of information flow control SFP].	
FDP_IFF.6.1	The TSF shall enforce the [**assignment:** information flow control SFP] to monitor [**assignment:** types of illicit information flows] when it exceeds the [**assignment:** maximum capacity].	
FDP_ITC.1.1	The TSF shall enforce the [**assignment:** access control SFP and/or information flow control SFP] when importing user data, controlled under the SFP, from outside of the TSC.	
FDP_ITC.1.2	The TSF shall ignore any security attributes associated with the user data when imported from outside the TSC.	

Shortname	Definition	Form of assignment in NGN
FDP_ITC.1.3	The TSF shall enforce the following rules when importing user data controlled under the SFP from outside the TSC: [**assignment:** additional importation control rules].	
FDP_ITC.2.1	The TSF shall enforce the [**assignment:** access control SFP and/or information flow control SFP] when importing user data, controlled under the SFP, from outside of the TSC.	
FDP_ITC.2.2	The TSF shall use the security attributes associated with the imported user data.	
FDP_ITC.2.3	The TSF shall ensure that the protocol used provides for the unambiguous association between the security attributes and the user data received.	
FDP_ITC.2.4	The TSF shall ensure that interpretation of the security attributes of the imported user data is as intended by the source of the user data.	
FDP_ITC.2.5	The TSF shall enforce the following rules when importing user data controlled under the SFP from outside the TSC: [**assignment:** additional importation control rules].	
FDP_ITT.1.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to prevent the [**selection:** disclosure, modification, loss of use] of user data when it is transmitted between physically-separated parts of the TOE.	
FDP_ITT.2.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to prevent the [**selection:** disclosure, modification, loss of use] of user data when it is transmitted between physically-separated parts of the TOE.	
FDP_ITT.2.2	The TSF shall separate data controlled by the SFP(s) when transmitted between physically-separated parts of the TOE, based on the values of the following: [**assignment:** security attributes that require separation].	
FDP_ITT.3.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to monitor user data transmitted between physically-separated parts of the TOE for the following errors: [**assignment:** integrity errors].	
FDP_ITT.3.2	Upon detection of a data integrity error, the TSF shall [**assignment:** specify the action to be taken upon integrity error].	
FDP_ITT.4.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to monitor user data transmitted between physically-separated parts of the TOE for the following errors: [**assignment:** integrity errors], based on the following attributes: [**assignment:** security attributes that require separate transmission channels].	
FDP_ITT.4.2	Upon detection of a data integrity error, the TSF shall [**assignment:** specify the action to be taken upon integrity error].	
FDP_RIP.1.1	The TSF shall ensure that any previous information content of a resource is made unavailable upon the [**selection:** allocation of the resource to, deallocation of the resource from] the following objects: [**assignment:** list of objects].	
FDP_RIP.2.1	The TSF shall ensure that any previous information content of a resource is made unavailable upon the [**selection:** allocation of the resource to, deallocation of the resource from] all objects.	
FDP_ROL.1.1	The TSF shall enforce [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to permit the rollback of the [**assignment:** list of operations] on the [**assignment:** list of objects].	
FDP_ROL.1.2	The TSF shall permit operations to be rolled back within the [**assignment:** boundary limit to which rollback may be performed].	
FDP_ROL.2.1	The TSF shall enforce [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to permit the rollback of all the operations on the [**assignment:** list of objects].	
FDP_ROL.2.2	The TSF shall permit operations to be rolled back within the [**assignment:** boundary limit to which rollback may be performed].	
FDP_SDI.1.1	The TSF shall monitor user data stored within the TSC for [**assignment:** integrity errors] on all objects, based on the following attributes: [**assignment:** user data attributes].	
FDP_SDI.2.1	The TSF shall monitor user data stored within the TSC for [**assignment:** integrity errors] on all objects, based on the following attributes: [**assignment:** user data attributes].	
FDP_SDI.2.2	Upon detection of a data integrity error, the TSF shall [**assignment:**	

Shortname	Definition	Form of assignment in NGN
	action to be taken].	
FDP_UCT.1.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to be able to [**selection:** transmit, receive] objects in a manner protected from unauthorized disclosure.	
FDP_UIT.1.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to be able to [**selection:** transmit, receive] user data in a manner protected from [**selection:** modification, deletion, insertion, replay] errors.	
FDP_UIT.1.2	The TSF shall be able to determine on receipt of user data, whether [**selection:** modification, deletion, insertion, replay] has occurred.	
FDP_UIT.2.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to be able to recover from [**assignment:** list of recoverable errors] with the help of the source trusted IT product.	
FDP_UIT.3.1	The TSF shall enforce the [**assignment:** access control SFP(s) and/or information flow control SFP(s)] to be able to recover from [**assignment:** list of recoverable errors] without any help from the source trusted IT product.	

F.2.4 Privacy class

The functional capabilities in the privacy class address those requirements dealing with provision of privacy including those required to suppress user identity, provision of anonymity (including linking and unlinking to a real identity).

Table F.5: ISO/IEC 15408-2 [7] functional capabilities (Privacy class)

Shortname	Definition	Form of assignment in NGN
FPR_ANO.1.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine the real user name bound to [**assignment:** list of subjects and/or operations and/or objects].	
FPR_ANO.2.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine the real user name bound to [**assignment:** list of subjects and/or operations and/or objects].	
FPR_ANO.2.2	The TSF shall provide [**assignment:** list of services] to [**assignment:** list of subjects] without soliciting any reference to the real user name.	
FPR_PSE.1.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine the real user name bound to [**assignment:** list of subjects and/or operations and/or objects].	
FPR_PSE.1.2	The TSF shall be able to provide [**assignment:** number of aliases] aliases of the real user name to [**assignment:** list of subjects].	
FPR_PSE.1.3	The TSF shall [**selection**, choose one of: determine an alias for a user, accept the alias from the user] and verify that it conforms to the [**assignment:** alias metric].	
FPR_PSE.2.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine the real user name bound to [**assignment:** list of subjects and/or operations and/or objects].	
FPR_PSE.2.2	The TSF shall be able to provide [**assignment:** number of aliases] aliases of the real user name to [**assignment:** list of subjects].	
FPR_PSE.2.3	The TSF shall [**selection**, choose one of: determine an alias for a user, accept the alias from the user] and verify that it conforms to the [**assignment:** alias metric].	
FPR_PSE.2.4	The TSF shall provide [**selection:** an authorized user,[**assignment:** list of trusted subjects]] a capability to determine the user identity based on the provided alias only under the following [**assignment:** list of conditions].	
FPR_PSE.3.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine the real user name bound to [**assignment:** list of subjects and/or operations and/or objects].	
FPR_PSE.3.2	The TSF shall be able to provide [**assignment:** number of aliases] aliases of the real user name to [**assignment:** list of subjects].	
FPR_PSE.3.3	The TSF shall [**selection**, choose one of: determine an alias for a user, accept the alias from the user] and verify that it conforms to the [**assignment:** alias metric].	
FPR_PSE.3.4	The TSF shall provide an alias to the real user name which shall be identical to an alias provided previously under the following [**assignment:** list of conditions] otherwise the alias provided shall be unrelated to previously provided aliases.	
FPR_UNL.1.1	The TSF shall ensure that [**assignment:** set of users and/or subjects] are unable to determine whether [**assignment:** list of operations][**selection:** were caused by the same user, are related as follows[**assignment:** list of relations]].	
FPR_UNO.1.1	The TSF shall ensure that [**assignment:** list of users and/or subjects] are unable to observe the operation [**assignment:** list of operations] on [**assignment:** list of objects] by [**assignment:** list of protected users and/or subjects].	
FPR_UNO.2.1	The TSF shall ensure that [**assignment:** list of users and/or subjects] are unable to observe the operation [**assignment:** list of operations] on [**assignment:** list of objects] by [**assignment:** list of protected users and/or subjects].	
FPR_UNO.2.2	The TSF shall allocate the [**assignment:** unobservability related information] among different parts of the TOE such that the following conditions hold during the lifetime of the information: [**assignment:** list of conditions].	
FPR_UNO.3.1	The TSF shall provide [**assignment:** list of services] to [**assignment:** list of subjects] without soliciting any reference to [**assignment:** privacy related information].	
FPR_UNO.4.1	The TSF shall provide [**assignment:** set of authorized users] with the capability to observe the usage of [**assignment:** list of resources and/or services].	May apply for lawful interception and management roles.

F.2.5 Resource utilization class

The functional capabilities in the resource utilization class address those requirements dealing with system reliability and availability.

Table F.6: ISO/IEC 15408-2 [7] functional capabilities (Resource utilization class)

Shortname	Definition	Form of assignment in NGN
FRU_FLT.1.1	The TSF shall ensure the operation of [**assignment:** list of TOE capabilities] when the following failures occur: [**assignment:** list of type of failures].	
FRU_FLT.2.1	The TSF shall ensure the operation of all the TOE's capabilities when the following failures occur: [**assignment:** list of type of failures].	
FRU_PRS.1.1	The TSF shall assign a priority to each subject in the TSF.	
FRU_PRS.1.2	The TSF shall ensure that each access to [**assignment:** controlled resources] shall be mediated on the basis of the subjects assigned priority.	
FRU_PRS.2.1	The TSF shall assign a priority to each subject in the TSF.	
FRU_PRS.2.2	The TSF shall ensure that each access to all shareable resources shall be mediated on the basis of the subjects assigned priority.	
FRU_RSA.1.1	The TSF shall enforce maximum quotas of the following resources: [**assignment:** controlled resources] that [**selection:** individual user, defined group of users, subjects] can use [**selection:** simultaneously, over a specified period of time].	
FRU_RSA.2.1	The TSF shall enforce maximum quotas of the following resources [**assignment:** controlled resources] that [**selection:** individual user, defined group of users] can use [**selection:** simultaneously, over a specified period of time].	
FRU_RSA.2.2	The TSF shall ensure the provision of minimum quantity of each [**assignment:** controlled resource] that is available for [**selection:** an individual user, defined group of users, subjects] to use [**selection:** simultaneously, over a specified period of time].	

F.2.6 Trusted path/channel class

The functional capabilities in the trusted path/channel class address those requirements dealing with the communication path between users and the TSF, and for a trusted communication channel between the TSF and other trusted IT products. Trusted paths and channels have the following general characteristics:

- The communications path is constructed using internal and external communications channels that isolate an identified subset of TSF data and commands from the remainder of the TSF and user data.
- Use of the communications path may be initiated by the user and/or the TSF.
- The communications path is capable of providing assurance that the user is communicating with the correct TSF, and that the TSF is communicating with the correct user.

Table F.7: ISO/IEC 15408-2 [7] functional capabilities (Trusted path/channel class)

Shortname	Definition	Form of assignment in NGN
FTP_ITC.1.1	The TSF shall provide a communication channel between itself and a remote trusted IT product that is logically distinct from other communication channels and provides assured identification of its end points and protection of the channel data from modification or disclosure.	
FTP_ITC.1.2	The TSF shall permit [**selection:** the TSF, the remote trusted IT product] to initiate communication via the trusted channel.	
FTP_ITC.1.3	The TSF shall initiate communication via the trusted channel for [**assignment:** list of functions for which a trusted channel is required].	
FTP_TRP.1.1	The TSF shall provide a communication path between itself and [**selection:** remote, local] users that is logically distinct from other communication paths and provides assured identification of its end points and protection of the communicated data from modification or disclosure.	
FTP_TRP.1.2	The TSF shall permit [**selection:** the TSF, local users, remote users] to initiate communication via the trusted path.	
FTP_TRP.1.3	The TSF shall require the use of the trusted path for [**selection:** initial user authentication, [**assignment:** other services for which trusted path is required]].	

F.2.7 Security management class

The functional capabilities in the security management class address those requirements dealing with the establishment, maintenance and deletion of security functions and data.

Table F.8: ISO/IEC 15408-2 [7] functional capabilities (Security management class)

Shortname	Definition	Form of assignment in NGN
FMT_MOF.1.1	The TSF shall restrict the ability to [**selection:** determine the behaviour of, disable, enable, modify the behaviour of] the functions [**assignment:** list of functions] to [**assignment:** the authorized identified roles].	
FMT_MSA.1.1	The TSF shall enforce the [**assignment:** access control SFP, information flow control SFP] to restrict the ability to [**selection:** change_default, query, modify, delete,[**assignment:** other operations]] the security attributes [**assignment:** list of security attributes] to [**assignment:** the authorized identified roles].	
FMT_MSA.2.1	The TSF shall ensure that only secure values are accepted for security attributes.	
FMT_MSA.3.1	The TSF shall enforce the [**assignment:** access control SFP, information flow control SFP] to provide [**selection**, choose one of: restrictive, permissive,[**assignment:** other property]] default values for security attributes that are used to enforce the SFP.	
FMT_MSA.3.2	The TSF shall allow the [**assignment:** the authorized identified roles] to specify alternative initial values to override the default values when an object or information is created.	
FMT_MTD.1.1	The TSF shall restrict the ability to [**selection:** change_default, query, modify, delete, clear,[**assignment:** other operations]] the [**assignment:** list of TSF data] to [**assignment:** the authorized identified roles].	
FMT_MTD.2.1	The TSF shall restrict the specification of the limits for [**assignment:** list of TSF data] to [**assignment:** the authorized identified roles].	
FMT_MTD.2.2	The TSF shall take the following actions, if the TSF data are at, or exceed, the indicated limits: [**assignment:** actions to be taken].	
FMT_MTD.3.1	The TSF shall ensure that only secure values are accepted for TSF data.	
FMT_REV.1.1	The TSF shall restrict the ability to revoke security attributes associated with the [**selection:** users, subjects, objects,[**assignment:** other additional resources]] within the TSC to [**assignment:** the authorized identified roles].	
FMT_REV.1.2	The TSF shall enforce the rules [**assignment:** specification of revocation rules].	
FMT_SAE.1.1	The TSF shall restrict the capability to specify an expiration time for [**assignment:** list of security attributes for which expiration is to be supported] to [**assignment:** the authorized identified roles].	
FMT_SAE.1.2	For each of these security attributes, the TSF shall be able to [**assignment:** list of actions to be taken for each security attribute] after the expiration time for the indicated security attribute has passed.	
FMT_SMF.1.1	The TSF shall be capable of performing the following security management functions: [**assignment:** list of security management functions to be provided by the TSF].	
FMT_SMR.1.1	The TSF shall maintain the roles [**assignment:** the authorized identified roles].	
FMT_SMR.1.2	The TSF shall be able to associate users with roles.	
FMT_SMR.2.1	The TSF shall maintain the roles: [**assignment:** authorized identified roles].	
FMT_SMR.2.2	The TSF shall be able to associate users with roles.	
FMT_SMR.2.3	The TSF shall ensure that the conditions [**assignment:** conditions for the different roles] are satisfied.	
FMT_SMR.3.1	The TSF shall require an explicit request to assume the following roles: [**assignment:** the roles].	

F.2.8 Protection of the TSF class

The functional capabilities in the TSF protection class address those requirements dealing with the integrity and management of the mechanisms that provide the TSF.

Table F.9: ISO/IEC 15408-2 [7] functional capabilities (Protection of the TSF class)

Shortname	Definition	Form of assignment in NGN
FPT_AMT.1.1	The TSF shall run a suite of tests [**selection:** during initial start-up, periodically during normal operation, at the request of an authorized user,[**assignment:** other conditions]] to demonstrate the correct operation of the security assumptions provided by the abstract machine that underlies the TSF.	
FPT_FLS.1.1	The TSF shall preserve a secure state when the following types of failures occur: [**assignment:** list of types of failures in the TSF].	
FPT_ITA.1.1	The TSF shall ensure the availability of [**assignment:** list of types of TSF data] provided to a remote trusted IT product within [**assignment:** a defined availability metric] given the following conditions [**assignment:** conditions to ensure availability].	
FPT_ITC.1.1	The TSF shall protect all TSF data transmitted from the TSF to a remote trusted IT product from unauthorized disclosure during transmission.	
FPT_ITI.1.1	The TSF shall provide the capability to detect modification of all TSF data during transmission between the TSF and a remote trusted IT product within the following metric: [**assignment:** a defined modification metric].	
FPT_ITI.1.2	The TSF shall provide the capability to verify the integrity of all TSF data transmitted between the TSF and a remote trusted IT product and perform [**assignment:** action to be taken] if modifications are detected.	
FPT_ITI.2.1	The TSF shall provide the capability to detect modification of all TSF data during transmission between the TSF and a remote trusted IT product within the following metric: [**assignment:** a defined modification metric].	
FPT_ITI.2.2	The TSF shall provide the capability to verify the integrity of all TSF data transmitted between the TSF and a remote trusted IT product and perform [**assignment:** action to be taken] if modifications are detected.	
FPT_ITI.2.3	The TSF shall provide the capability to correct [**assignment:** type of modification] of all TSF data transmitted between the TSF and a remote trusted IT product.	
FPT_ITT.1.1	The TSF shall protect TSF data from [**selection:** disclosure, modification] when it is transmitted between separate parts of the TOE.	
FPT_ITT.2.1	The TSF shall protect TSF data from [**selection:** disclosure, modification] when it is transmitted between separate parts of the TOE.	
FPT_ITT.2.2	The TSF shall separate user data from TSF data when such data is transmitted between separate parts of the TOE.	
FPT_ITT.3.1	The TSF shall be able to detect [**selection:** modification of data, substitution of data, re-ordering of data, deletion of data,,[**assignment:** other integrity errors]] for TSF data transmitted between separate parts of the TOE.	
FPT_ITT.3.2	Upon detection of a data integrity error, the TSF shall take the following actions: [**assignment:** specify the action to be taken].	
FPT_PHP.1.1	The TSF shall provide unambiguous detection of physical tampering that might compromise the TSF.	
FPT_PHP.1.2	The TSF shall provide the capability to determine whether physical tampering with the TSF's devices or TSF's elements has occurred.	
FPT_PHP.2.1	The TSF shall provide unambiguous detection of physical tampering that might compromise the TSF.	
FPT_PHP.2.2	The TSF shall provide the capability to determine whether physical tampering with the TSF's devices or TSF's elements has occurred.	
FPT_PHP.3.1	The TSF shall resist [**assignment:** physical tampering scenarios] to the [**assignment:** list of TSF devices/elements] by responding automatically such that the TSP is not violated.	
FPT_RCV.1.1	After [**assignment:** list of failures/service discontinuities] the TSF shall enter a maintenance mode where the ability to return to a secure state is provided.	
FPT_RCV.2.1	When automated recovery from [**assignment:** list of failures/service discontinuities] is not possible, the TSF shall enter a maintenance mode where the ability to return to a secure state is provided.	
FPT_RCV.2.2	For [**assignment:** list of failures/service discontinuities], the TSF shall ensure the return of the TOE to a secure state using automated procedures.	
FPT_RCV.3.1	When automated recovery from [**assignment:** list of failures/service discontinuities] is not possible, the TSF shall enter a maintenance mode where the ability to return to a secure state is provided.	
FPT_RCV.3.2	For [**assignment:** list of failures/service discontinuities], the TSF shall ensure the return of the TOE to a secure state using automated procedures.	
FPT_RCV.3.3	The functions provided by the TSF to recover from failure or service discontinuity shall ensure that the secure initial state is restored without exceeding [**assignment:** quantification] for loss of TSF data or objects within the TSC.	

Shortname	Definition	Form of assignment in NGN
FPT_RCV.3.4	The TSF shall provide the capability to determine the objects that were or were not capable of being recovered.	
FPT_RCV.4.1	The TSF shall ensure that [**assignment:** list of SFs and failure scenarios] have the property that the SF either completes successfully, or for the indicated failure scenarios, recovers to a consistent and secure state.	
FPT_RPL.1.1	The TSF shall detect replay for the following entities: [**assignment:** list of identified entities].	
FPT_RPL.1.2	The TSF shall perform [**assignment:** list of specific actions] when replay is detected.	
FPT_RVM.1.1	The TSF shall ensure that TSP enforcement functions are invoked and succeed before each function within the TSC is allowed to proceed.	
FPT_SEP.1.1	The TSF shall maintain a security domain for its own execution that protects it from interference and tampering by untrusted subjects.	
FPT_SEP.1.2	The TSF shall enforce separation between the security domains of subjects in the TSC.	
FPT_SEP.2.1	The unisolated portion of the TSF shall maintain a security domain for its own execution that protects it from interference and tampering by untrusted subjects.	
FPT_SEP.2.2	The TSF shall enforce separation between the security domains of subjects in the TSC.	
FPT_SEP.2.3	The TSF shall maintain the part of the TSF related to [**assignment:** list of access control and/or information flow control SFPs] in a security domain for their own execution that protects them from interference and tampering by the remainder of the TSF and by subjects untrusted with respect to those SFPs.	
FPT_SEP.3.1	The unisolated portion of the TSF shall maintain a security domain for its own execution that protects it from interference and tampering by untrusted subjects.	
FPT_SEP.3.2	The TSF shall enforce separation between the security domains of subjects in the TSC.	
FPT_SEP.3.3	The TSF shall maintain the part of the TSF that enforces the access control and/or information flow control SFPs in a security domain for its own execution that protects them from interference and tampering by the remainder of the TSF and by subjects untrusted with respect to the TSP,	
FPT_SSP.2.1	The TSF shall acknowledge, when requested by another part of the TSF, the receipt of an unmodified TSF data transmission.	
FPT_SSP.2.2	The TSF shall ensure that the relevant parts of the TSF know the correct status of transmitted data among its different parts, using acknowledgements.	
FPT_STM.1.1	The TSF shall be able to provide reliable time stamps for its own use.	
FPT_TDC.1.1	The TSF shall provide the capability to consistently interpret [**assignment:** list of TSF data types] when shared between the TSF and another trusted IT product.	
FPT_TDC.1.2	The TSF shall use [**assignment:** list of interpretation rules to be applied by the TSF] when interpreting the TSF data from another trusted IT product.	
FPT_TRC.1.1	The TSF shall ensure that TSF data is consistent when replicated between parts of the TOE.	
FPT_TRC.1.2	When parts of the TOE containing replicated TSF data are disconnected, the TSF shall ensure the consistency of the replicated TSF data upon reconnection before processing any requests for [**assignment:** list of SFs dependent on TSF data replication consistency].	
FPT_TST.1.1	The TSF shall run a suite of self tests [**selection:** during initial start-up, periodically during normal operation, at the request of the authorized user, at the conditions[**assignment:** conditions under which self test should occur]] to demonstrate the correct operation of the TSF. operation of [**selection:** [**assignment:** parts of TSF], the TSF].	
FPT_TST.1.2	The TSF shall provide authorized users with the capability to verify the integrity of [**selection:** [**assignment:** parts of TSF], TSF data].	
FPT_TST.1.3	The TSF shall provide authorized users with the capability to verify the integrity of stored TSF executable code.	

F.2.9 Cryptographic support class

The functional capabilities in the cryptographic support class address those requirements dealing with the use of cryptographic material.

NOTE: ETSI standards will, in general, not make specific requirements in this class.

Table F.10: ISO/IEC 15408-2 [7] functional capabilities (cryptographic support class)

Shortname	Definition	Form of assignment in NGN
FCS_CKM.1.1	The TSF shall generate cryptographic keys in accordance with a specified cryptographic key generation algorithm [**assignment:** cryptographic key generation algorithm] and specified cryptographic key sizes [**assignment:** cryptographic key sizes] that meet the following: [**assignment:** list of standards].	
FCS_CKM.2.1	The TSF shall distribute cryptographic keys in accordance with a specified cryptographic key distribution method [**assignment:** cryptographic key distribution method] that meets the following: [**assignment:** list of standards].	
FCS_CKM.3.1	The TSF shall perform [**assignment:** type of cryptographic key access] in accordance with a specified cryptographic key access method [**assignment:** cryptographic key access method] that meets the following: [**assignment:** list of standards].	
FCS_CKM.4.1	The TSF shall destroy cryptographic keys in accordance with a specified cryptographic key destruction method [**assignment:** cryptographic key destruction method] that meets the following: [**assignment:** list of standards].	
FCS_COP.1.1	The TSF shall perform [**assignment:** list of cryptographic operations] in accordance with a specified cryptographic algorithm [**assignment:** cryptographic algorithm] and cryptographic key sizes [**assignment:** cryptographic key sizes] that meet the following: [**assignment:** list of standards].	

F.2.10 Security audit class

The functional capabilities in the security audit class address those requirements dealing with recognizing, recording, storing, and analysing information related to security relevant activities.

Table F.11: ISO/IEC 15408-2 [7] Functional capabilities (security audit class)

Shortname	Definition	Form of assignment in NGN
FAU_ARP.1.1	The TSF shall take [**assignment:** list of the least disruptive actions] upon detection of a potential security violation.	
FAU_GEN.1.1	The TSF shall be able to generate an audit record of the following auditable events: a) Start-up and shutdown of the audit functions; b) All auditable events for the [**selection**, choose one of**:** minimum, basic, detailed, not specified] level of audit; and c) [**assignment:** other specifically defined auditable events].	
FAU_GEN.1.2	The TSF shall record within each audit record at least the following information: a) Date and time of the event, type of event, subject identity, and the outcome (success or failure) of the event; and b) For each audit event type, based on the auditable event definitions of the functional components included in the PP/ST, [**assignment:** other audit relevant information].	
FAU_GEN.2.1	The TSF shall be able to associate each auditable event with the identity of the user that caused the event.	
FAU_SAA.1.1	The TSF shall be able to apply a set of rules in monitoring the audited events and based upon these rules indicate a potential violation of the TSP.	
FAU_SAA.1.2	The TSF shall enforce the following rules for monitoring audited events: a) Accumulation or combination of [**assignment:** subset of defined auditable events] known to indicate a potential security violation; b) [**assignment:** any other rules].	
FAU_SAA.2.1	The TSF shall be able to maintain profiles of system usage, where an individual profile represents the historical patterns of usage performed by the member(s) of [**assignment:** the profile target group].	
FAU_SAA.2.2	The TSF shall be able to maintain a suspicion rating associated with each user whose activity is recorded in a profile, where the suspicion rating represents the degree to which the user's current activity is found inconsistent with the established patterns of usage represented in the profile.	
FAU_SAA.2.3	The TSF shall be able to indicate an imminent violation of the TSP when a user's suspicion rating exceeds the following threshold conditions [**assignment:** conditions under which anomalous activity is reported by the TSF].	

Shortname	Definition	Form of assignment in NGN
FAU_SAA.3.1	The TSF shall be able to maintain an internal representation of the following signature events [**assignment:** a subset of system events] that may indicate a violation of the TSP.	
FAU_SAA.3.2	The TSF shall be able to compare the signature events against the record of system activity discernible from an examination of [**assignment:** the information to be used to determine system activity].	
FAU_SAA.3.3	The TSF shall be able to indicate an imminent violation of the TSP when a system event is found to match a signature event that indicates a potential violation of the TSP.	
FAU_SAA.4.1	The TSF shall be able to maintain an internal representation of the following event sequences of known intrusion scenarios [**assignment:** list of sequences of system events whose occurrence are representative of known penetration scenarios] and the following signature events [**assignment:** a subset of system events] that may indicate a potential violation of the TSP.	
FAU_SAA.4.2	The TSF shall be able to compare the signature events and event sequences against the record of system activity discernible from an examination of [**assignment:** the information to be used to determine system activity].	
FAU_SAA.4.3	The TSF shall be able to indicate an imminent violation of the TSP when system activity is found to match a signature event or event sequence that indicates a potential violation of the TSP.	
FAU_SAR.1.1	The TSF shall provide [**assignment:** authorized users] with the capability to read [**assignment:** list of audit information] from the audit records.	
FAU_SAR.1.2	The TSF shall provide the audit records in a manner suitable for the user to interpret the information.	
FAU_SAR.2.1	The TSF shall prohibit all users read access to the audit records, except those users that have been granted explicit read-access.	
FAU_SAR.3.1	The TSF shall provide the ability to perform [**selection:** searches, sorting, ordering] of audit data based on [**assignment:** criteria with logical relations].	
FAU_SEL.1.1	The TSF shall be able to include or exclude auditable events from the set of audited events based on the following attributes: a) [**selection:** object identity, user identity, subject identity, host identity, event type] b) [**assignment:** list of additional attributes that audit selectivity is based upon].	
FAU_STG.1.1	The TSF shall protect the stored audit records from unauthorized deletion.	
FAU_STG.1.2	The TSF shall be able to [**selection:** choose one of: prevent, detect] unauthorized modifications to the stored audit records in the audit trail.	
FAU_STG.2.1	The TSF shall protect the stored audit records from unauthorized deletion.	
FAU_STG.2.2	The TSF shall be able to [**selection:** choose one of: prevent, detect] unauthorized modifications to the stored audit records in the audit trail.	
FAU_STG.2.3	The TSF shall ensure that [**assignment:** metric for saving audit records] audit records will be maintained when the following conditions occur: [**selection:** audit storage exhaustion, failure, attack] .	
FAU_STG.3.1	The TSF shall [**assignment:** actions to be taken in case of possible audit storage failure] if the audit trail exceeds [**assignment:** pre-defined limit].	
FAU_STG.4.1	The TSF shall [**selection:** choose one of: 'ignore auditable events', 'prevent auditable events, except those taken by the authorized user with special rights', 'overwrite the oldest stored audit records'] and [**assignment:** other actions to be taken in case of audit storage failure] if the audit trail is full.	

F.2.11 TOE Access class

The functional capabilities in the TOE Access class address those requirements dealing with the establishment of a user session.

NOTE: In ETSI network standards it is unusual to specify requirements as mandates on the user interface.

Table F.12: ISO/IEC 15408-2 [7] functional capabilities (TOE Access class)

Shortname	Definition	Form of assignment in NGN
FTA_LSA.1.1	The TSF shall restrict the scope of the session security attributes [**assignment:** session security attributes], based on [**assignment:** attributes].	
FTA_MCS.1.1	The TSF shall restrict the maximum number of concurrent sessions that belong to the same user.	
FTA_MCS.1.2	The TSF shall enforce, by default, a limit of [**assignment:** default number] sessions per user.	
FTA_MCS.2.1	The TSF shall restrict the maximum number of concurrent sessions that belong to the same user according to the rules [**assignment:** rules for the number of maximum concurrent sessions].	
FTA_MCS.2.2	The TSF shall enforce, by default, a limit of [**assignment:** default number] sessions per user.	
FTA_SSL.1.1	The TSF shall lock an interactive session after [**assignment:** time interval of user inactivity] by: a) clearing or overwriting display devices, making the current contents unreadable; b) disabling any activity of the user's data access/display devices other than unlocking the session.	
FTA_SSL.1.2	The TSF shall require the following events to occur prior to unlocking the session: [**assignment:** events to occur].	
FTA_SSL.2.1	The TSF shall allow user-initiated locking of the user's own interactive session, by: a) clearing or overwriting display devices, making the current contents unreadable; b) disabling any activity of the user's data access/display devices other than unlocking the session.	
FTA_SSL.2.2	The TSF shall require the following events to occur prior to unlocking the session: [**assignment:** events to occur].	
FTA_SSL.3.1	The TSF shall terminate an interactive session after a [**assignment:** time interval of user inactivity].	
FTA_TAB.1.1	Before establishing a user session, the TSF shall display an advisory warning message regarding unauthorized use of the TOE.	
FTA_TAH.1.1	Upon successful session establishment, the TSF shall display the [**selection:** date, time, method, location] of the last successful session establishment to the user.	
FTA_TAH.1.2	Upon successful session establishment, the TSF shall display the [**selection:** date, time, method, location] of the last unsuccessful attempt to session establishment and the number of unsuccessful attempts since the last successful session establishment.	
FTA_TAH.1.3	The TSF shall not erase the access history information from the user interface without giving the user an opportunity to review the information.	
FTA_TSE.1.1	The TSF shall be able to deny session establishment based on [**assignment:** attributes].	

Annex G (normative): TVRA Risk Calculation Template and Tool

The evaluation and calculation of the factors that affect the risks posed by particular threat groups (as defined in Steps 4, 5, 6 and 7 of the TVRA method) have been consolidated into a MS Excel spreadsheet available as TS102165_1_Risks.xls an electronic attachment in ts_102165v040203p0.zip which accompanies to the present document. An example entry in this spreadsheet is shown in Table G.1.

Table G.1: Example row entry in the TVRA risk calculation spreadsheet

Threat Group	Attack					Impact	Risk
	Factor	Range	Value	Potential	Likelihood		
DoS Denial of access to incoming messages	Time	<= 1 week	1	Moderate	Possible	High	**Critical**
	Expertise	Proficient	2				
	Knowledge	Restricted	1				
	Opportunity	Easy	1				
	Equipment	Specialized	3				
	Asset Impact	High	3				
	Intensity	Single instance	0				

Each of the values in the "Range" column can be selected from drop-down lists which limit the entry to legitimate values only as shown in Table G.2.

Table G.2: Entering data into the risk calculation spreadsheet

Threat Group	Attack					Impact	Risk
	Factor	Range	Value	Potential	Likelihood		
DoS Denial of access to incoming messages	Time	<= 1 week	1	Moderate	Possible	High	**Critical**
	Expertise		2				
	Knowledge		1				
	Opportunity		1				
	Equipment		3				
	Asset Impac		3				
	Intensity		0				

Annex H (normative): TVRA Countermeasure Cost-Benefit Analysis Template and Tool

The calculations described in Step 8 of the TVRA method for analysing the costs and benefits of specific countermeasure solutions have been consolidated into a MS Excel spreadsheet that is available in TS102165_1_CoBa.xls. as an electronic attachment in ts_102165v040203p0.zip which accompanies to the present document to the present document. An example entry in this spreadsheet is shown in Table H.1

Each of the values in the "Cost/Value" column and the "Regulatory Impact" and "Market Acceptance" can be selected from drop-down lists which limit the entry to legitimate values only as shown in Table H.2. The "Original Count" column in the "Benefits" section of the sheet should show number of critical, major and minor risks related to the countermeasure calculated before its implementation. The "Revised Count" column shows the appropriate numbers of risks calculated after the countermeasure has been implemented.

Table H.1: Example row entry in the Countermeasures Cost-Benefit Analysis table

Countermeasure	Cost		Benefit			Result
	Category	Value	Risk Level	Original Count	Revised Count	
Reduce frequency of repeated messages	Standards design	Low Impact	Minor	0	0	14
	Implementation	No Impact	Major	0	3	
	Operation	No Impact	Critical	3	0	
	Regulatory Impact			No Impact		
	Market Acceptance			No Impact		

Table H.2: Entering data into the cost/benefit calculation spreadsheet

Countermeasure	Cost		Benefit			Result
	Category	Value	Risk Level	Original Count	Revised Count	
Reduce frequency of repeated messages	Standards design	Low Impact	Minor	0	0	14
	Implementation	Low Impact	ajor	0	3	
	Operation		itical	3	0	
	Regulatory Impact			No Impact		
	Market Acceptance			No Impact		

No Impact
Low Impact
Medium Impact
Major Impact

Annex I (informative): Bibliography

I.1 UML

The following sources may give the reader a deeper understanding of the use and application of UML and of UML2 in particular.

[UML2-Style] "The elements of UML™ 2.0 style", Scott W. Ambler, Cambridge University Press, 2005. ISBN 0-521-61678-6.

[UML2-Doldi] "UML 2 illustrated: Developing real-time & communications systems", Laurent Doldi, TMSO 2003. ISBN 2-9516600-1-4.

[UML2-OReilly] "UML 2.0 in a nutshell", Dan Pilone with Neil Pitman, O'Reilly. ISBN 0-596-00795-7.

I.2 Others

- ETSI ES 282 004: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture; Network Attachment Sub-System (NASS)".
- IETF RFC 2535: "Domain Name System Security Extensions".
- IETF RFC 3403: "Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System (DNS) Database".
- IETF RFC 2915: "The Naming Authority Pointer (NAPTR) DNS Resource Record".
- Draft-ietf-dnsext-dnssec-protocol-06 (2004): "Protocol Modifications for the DNS Security Extensions".
- Draft-ietf-dnsext-dnssec-records-08 (2004): "Resource Records for DNS Security Extensions".
- Draft-ietf-dnsext-dnssec-intro-11 (2004): "DNS Security Introduction and Requirements".
- ETSI TR 102 420: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Review of activity on security".

Annex J (informative): Change history

Date	WG Doc.	CR	Rev	CAT	Title / Comment	Current Version	New Version
19-10-2010	TISPAN07(10)0139R1	1	-	F/D	TS 102 165-1 CR to introduce requirements and countermeasure cost-benefit analysis and to make minor editorial changes to clause 4.	4.2.1	4.2.2
19-10-2010	TISPAN07(10)0140R2	2	-	B	TS 102 165-1 CR to revise title of eTVRA method to TVRA method and to add three new steps to the TVRA method based on experience from TVRA exercises in TISPAN and ITS and to make minor editorial changes to clause 5.	4.2.1	4.2.2
19-10-2010	TISPAN07(10)0141R1	3	-	B	TS 102 165-1 CR to add three new steps to the TVRA method based on experience from TVRA exercises in TISPAN and ITS and to make minor editorial changes to clause 6.	4.2.1	4.2.2
2-12-2010	TISPAN07(10)0164	4	-	D	Removal of ENUM analysis.	4.2.2	4.2.3

History

Document history		
V4.1.1	February 2003	Publication
V4.2.1	December 2006	Publication
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