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DATA ITEM DESCRIPTION

1. TITLE	2. Identification Number
REQUIREMENTS TRACEABILITY REPORT IN SYSTEM DESIGN (RTR-SD)	PPI-005696-3 17 August 2017

3. DESCRIPTION

The Requirements Traceability Report in System Design (RTR-SD) provides information on requirements flow-down from one physical level of problem definition to requirements on elements of solution, one physical level below the problem level.

For example, the RTR-SD may depict traceability from a set of capability system requirements to sets of requirements on end-use technology items, support elements and other solution elements implementing that capability.

In product development, the RTR-SD may depict traceability from a set of requirements defined in a product development specification to sets of requirements on subsystems comprising solution elements for the product. Solution elements may be hardware or software.

In subsystem development, the RTR-SD may depict traceability from a set of requirements on the subsystem to sets of requirements on lower-level subsystems comprising solution elements for the parent subsystem. Solution elements may be hardware or software.

Traceability is bi-directional between requirements at adjacent physical levels having a problem-solution relationship, each linkage being between a pair of requirements.

Although requirements traceability is always between requirements at adjacent physical levels, the RTR-SD may be extended to incorporate requirements traceability from Physical Level 1 to Physical Level 2 to Physical Level 3, etc.

4. PURPOSE

The RTR-SD provides a means of confirming that all system requirements have been actioned, to see where they have been actioned, or if they haven't been actioned, to see why not. In the reverse direction, the RTR-SD helps ensure that are no orphan requirements (requirements without parents) - that all child requirements can be traced back to satisfaction of one or more parent system requirements.

5. PREPARATION GUIDELINES

5.1 General Instructions

a. **Automated techniques.** Use of automated techniques is encouraged. The term "document" in this DID means a collection of data regardless of its medium.

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6. SOURCE

5. PREPARATION GUIDELINES (continued)

b. **Alternative presentation styles.** Diagrams, tables, matrices, and other presentation styles are suitable substitutes for text when data required by this DID can be made more readable using these styles.

c. **Title page or identifier.** When data are supplied in the form of a paper document or word processing file, the document should include a title page containing, as applicable: document number; volume number; version/revision indicator; security markings or other restrictions on the handling of the document; date of issue, document title; name, abbreviation, and any other identifier for the system, subsystem, or item to which the document applies; contract number if applicable; CDRL item number if applicable; organization for which the document has been prepared and name and address of the preparing organization. For data supplied in an alternative form, this information should be included on external and internal labels or by equivalent identification methods.

d. **Table of contents.** When data are supplied in the form of a paper document or word processing file, the document should contain a table of contents providing the number, title, and page number of each titled paragraph, figure, table and annex. For data supplied in an alternative form, this information should consist of an internal or external table of contents containing pointers to, or instructions for, accessing, each paragraph, figure, table and annex or their equivalents.

e. **Page numbering/labeling.** When data are supplied in the form of a paper document or word processing file, each page should contain a unique page number and display the document number, including version, volume, and date of issue, as applicable. For data supplied in an alternative form, files, screens, or other entities should be assigned names or numbers in such a way that desired data can be indexed and accessed.

f. **Response to tailoring instructions.** When data are supplied in the form of a paper document, paragraphs that have been tailored out of the DID should result in the corresponding paragraph number and title in the document, followed by “Not applicable” or alternatively, paragraph numbering may be varied to allow for the missing paragraph. For data supplied in an alternative form, the “Not applicable” representation may be incorporated in the table of contents or equivalent.

g. **Multiple paragraphs and subparagraphs.** Any section, paragraph, or subparagraph in this DID may be written as multiple paragraphs or subparagraphs to enhance readability.

h. **Standard data descriptions.** If a data description required by this DID has been published in a standard data element dictionary, reference to an entry in that dictionary is preferred over inclusion in the data item itself.

i. **Declarative style.** Where a non-declarative guidance style is used in this DID (“should”) but a declarative style (“shall”) is required by the user of the DID, the DID should be tailored accordingly.

j. **Substitution of existing documents.** Other existing documents may be substituted for all or part of the data item if they contain the required data and are invoked in the data item as a part of the data item.

5.2 Acronyms

Acronyms used in this document shall be interpreted as follows:

DID Data Item Description

RA Requirements Analysis

RTR Requirements Traceability Report

RTR-RA Requirements Traceability Report in Requirements Analysis

RTR-SD Requirements Traceability Report in System Design

SD System Design

5.3 Abbreviations

Abbreviations used in this document shall be interpreted as follows:

CapSyRS Capability System Requirements Specification

I/S Infrastructure

Info Information

REQID Requirement Identifier

SI International System of Units

SyRS System Requirements Specification

5.4 Foreword

Requirements traceability in design is of considerable importance in ensuring that the solution fully addresses the specified requirements and goals, no more and no less. Ultimately, this form of requirements traceability helps ensure that all significant acquisition or development activity is responsive to the needs of the enterprise.

5.5 Content Requirements

Content requirements begin on the page 5. The numbers shown designate the paragraph numbers to be used in the document. Each such number is understood to have the prefix "5.5" within this DID. For example, the paragraph numbered 1.1 is understood to be paragraph 5.5.1.1 within this DID.

TABLE OF CONTENTS

1. INTRODUCTION AND SCOPE

1.1 Document Overview and Use

This DID provides requirements for the minimum content of a requirements database for the system design and development application, including capability development application, and requirements for the minimum content of a Requirements Traceability Report in System Development (RTR-SD). This DID contrasts with DID PPI-005695: "Requirements Traceability Report in Requirements Analysis (RTR-RA)" which deals with the requirements analysis application of requirements traceability.

The RTR-RA report format is not specified, as the origin of such a report may be from a requirements management tool that provides tool-specific report formats only.

This DID also lists other potential requirements traceability (in design) reports.

2. APPLICABLE AND OTHER REFERENCED DOCUMENTS

2.1 Applicable Documents

There are no applicable documents.

2.2 Other Referenced Documents

PPI-005695: *"Requirements Traceability Report in Requirements Analysis (RTR-RA)".*

3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

The following definitions shall apply in the interpretation of requirements in this document:

a) **Capability System** means, in the context of this document, the system comprising the interacting set of relevant technology, people, process and other elements that satisfies, or is intended to satisfy, on a whole-of-life basis, the needs of one or more humans or organizations of humans by means of satisfaction of requirements specified in a Capability System Requirements Specification (CapSyRS).

b) **May** expresses permissive guidance.

c) **Non-Requirement** means an entity designated by the originator as a requirement (originating requirement), but classified by somebody with the authority to do so as an entity not recognized as, nor to be acted upon as, a requirement.

d) **Requirement**, in the context of this document, means a characteristic that the item that is the subject of the requirement is required to possess.

e) **Shall** expresses a requirement.

f) **Should** expresses a target or goal to be pursued, but not necessarily achieved.

g) **Verification Requirement**, in the context of this document, means a requirement specifying the quality of evidence that a verification activity is to provide, the evidence being as to whether or not the system requirement to which the verification requirement corresponds has been satisfied.

h) **Will** expresses a declaration of intent by a party, usually the sponsoring or acquiring organization. "Will" does not express a requirement. "Will" may also be used in cases where the simple future tense is needed, for example, "The operating system will be supplied by the client".

3.2 Acronyms

This section should list alphabetically each acronym used in the document, together with the acronym's expanded meaning.

3.3 Abbreviations

This section should list alphabetically each abbreviation used in the document, together with the abbreviation's expanded meaning, except that abbreviations within the International System of Units (SI) should not be listed.

4. BACKGROUND TO REQUIREMENTS TRACEABILITY

4.1 Description

The RTR-SD provides information on requirements flow-down from one physical level of problem definition to requirements on elements of solution at the next physical level down from the problem level, for example, a set of capability system requirements to sets of requirements on technology items, support elements and other elements implementing that capability.

In product development, the RTR-SD may depict traceability from a set of requirements defined in a product development specification (that can be regarded as the top physical level, Physical Level 1) to sets of requirements on subsystems comprising solution elements for the product (that can be regarded as Physical Level 2). Solution elements may be hardware or software.

In subsystem development, the RTR-SD may depict traceability from a set of requirements on the subsystem to sets of requirements on lower-level subsystems comprising solution elements for the parent subsystem. Solution elements may be hardware or software.

Traceability is bi-directional between requirements at adjacent physical levels having a problem-solution relationship.

The RTR-SD may be extended to incorporate requirements traceability from Level 1 to Level 2 to Level 3, etc.

These concepts and their relationships to requirements traceability in Requirements Analysis are illustrated in Figure 4.1-1, using an enterprise as an example.

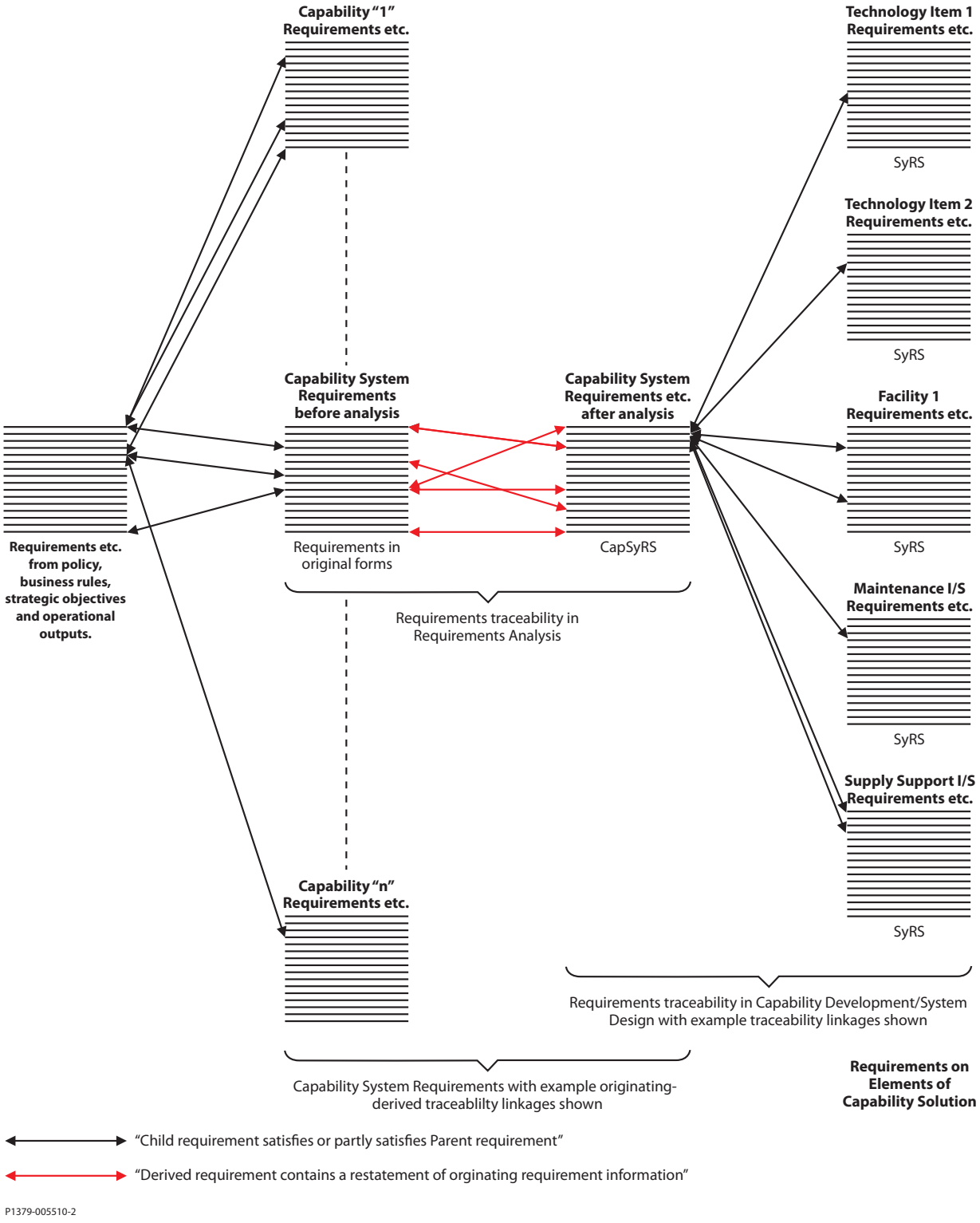

Figure 4.1-1 The Concepts of Requirements Traceability in Requirements Analysis and in Capability Development/System Design – Example

4.2 Purpose of Requirements Traceability Report in SD

The RTR-SD provides primarily a means to confirm that all system requirements have been actioned, or if they haven't, why not. In the reverse direction, the report helps ensure that there are no orphan requirements - that all child requirements can be traced back to satisfaction of one or more parent requirements, and ultimately, to the needs of the enterprise.

The RTR-SD has many other purposes, including:

a) facilitation of review of design of proposed solution at a detailed level (detailed design review), to identify errors and omissions;

b) efficient conduct of analysis of the potential span of impact of a proposed system requirement change;

c) reduction in the amount of work needed to respond to changing system requirements;

d) where a technology item forms a part of more than one system, reduction in the likelihood of change initiated for one use inadvertently rendering the technology item unable to satisfy another use;

e) reduction in the amount of work needed to correct latent design defects in system solutions;

f) reduction in the amount of work needed to deal with technology item obsolescence;

g) increased potential for economies through the creation of visible, reusable requirements sets;

h) monitoring and communication of verification status; and

i) linkage to verification traceability, through verification requirements, verification procedures, verification events carried out on verification articles, verification results, and verification records.

These are substantial benefits!

4.3 Applicability

The RTR-SD applies to requirements ("shall" statements) and goals ("should" statements), as well as to non-requirements. The RTR-SD does not apply to permissive guidance – "may" statements, and declarations of intent or futurity – "will" statements.

4.4 System (Capability, Software, Technology Item) Requirements Attributes in a Database

4.4.1 Minimum Requirements and Goals Attributes for SD Requirements Traceability

In order for a requirement to be uniquely identifiable and therefore traceable, it is to have the following minimum attributes in a requirements database:

a) REQID - The requirement identifier (REQID) **uniquely** identifies the specific requirement within a set of requirements. This number could be project-specific or programme-specific, and may have been generated automatically by a requirements management tool in use. The REQID may incorporate identification of the item that is the subject of the requirement.

b) Subject - This is the item that is the subject of the requirement (the Actor). Every requirement must have an Actor, unless it is in a library of reusable requirements.

c) Requirement Statement - This is the expression of the requirement in some suitable language, and may include additional information by reference.

d) Ownership - This is the identification of the organization and/or person who, with appropriate authority, created or has a right to change the requirement. A requirement must have at least one owner, and may have more than one owner.

e) Importance - One of Critical, Very Important, Important, Desirable, Preferred, or similar scale of importance.

f) Status:

   i) For requirement: “Incomplete Requirement” (work-in-progress), “Un-baselined Requirement”, “Baselined Requirement”, “Superseded Requirement”, or “Non-Requirement”. “Non-Requirement” should be used only for parent requirements.

   ii) For goal: “Incomplete Goal” (work-in-progress), Un-baselined Goal, “Baselined Goal”, “Superseded Goal”, or “Non-Goal”. “Non-Goal” should be used only for parent goals.

g) Rationale - This attribute field must be present, however, it should be populated selectively. The rationale for the requirement in system solution decisions can be one of the most important attributes. For child requirements, Rationale provides the solution thinking that created the requirement. It may be the only source of corporate memory when requirements changes take place at a later stage in a project. The Rationale record ensures that the original insight and thought process are understood before changes are made.

h) Included Note - The text (if any) of any note that is to accompany the requirement in its database form and its form in a requirements specification document.

i) Comments - This attribute is used for ad-hoc comments and notes (if any) not intended to be reproduced with the requirement in a requirements specification.

j) Corresponding Verification Requirement (if any) - For a requirement, this attribute identifies and links to the corresponding verification requirement relating to system verification (not design verification). For a goal, this attribute identifies and links to the corresponding verification requirement relating to determination as to whether, or to what degree, the goal has been satisfied.

k) Verification Status - One of Not Used/Planned/Passed/Failed/Passed After Re-verification/Not Applicable.

Not Used means that the requirement database is not being used to record verification status. It does not necessarily mean that the satisfaction of the requirement will not be verified. Planned means that verification is planned but has not yet been conducted or completed. Not Applicable means that there is no intent to conduct verification of satisfaction of the requirement.

Not Applicable means that there is no intent to conduct verification of satisfaction of this requirement.

Where “requirement” is referred to in this paragraph without any corresponding reference to goal, the reference applies to both requirements and goals.

4.4.2 Optional Requirements Attributes for Requirements Traceability in SD

a) Version - For larger developments for more critical systems, each requirement identified by its REQID may itself be versioned, allowing the evolution of a child requirement through system development to be traced. In this case, earlier versions will have the status “Superseded Requirement”. Alternatively, a requirement that is the subject of a change may be superseded and replaced by a new requirement.

b) Name - The name of the requirement is a short descriptive name that can be used to refer to the requirement in addition to its REQID.

c) Source Reference - A reference or link into system development (solution decision-making) records.

d) Type - The type of requirement can be *one* of the following:

   i) State/Mode - states the required states and/or modes of the item, or the required transition between one state and another state, one mode and another mode, mode in one state to mode in another state. May state the response required as a direct consequence of a transition having occurred. A “state” is a condition of something. A “mode” is functionality related to a significant aspect of use, usually a group of functionality.

   ii) Functional - states what the item is to *do*. Functional alone is, at least technically, incomplete.

iii) Performance - for a given function, states *how well* that function is to be performed by the item, that is, performance is an attribute of function. Performance alone is incomplete.

iv) Functional and Performance.

v) External Interface - states the required characteristics at a localized point, or region, of connection of the item to the outside world (e.g., location of interface, geometry of connection, inputs and outputs by name and specification, allocation of signals to pins, etc.).

vi) Environmental - limits the effect that the external enveloping environment (natural or induced) is to have on the item, and the effect that the item is to have on the external enveloping environment.

vii) Resource - limits the usage or consumption by the item of an *externally* provided resource, or requires the use of an *externally* provided resource.

viii) Physical - states a required *physical characteristic* (property of matter) of the item as a whole (e.g., mass, dimension, volume).

ix) Other Quality - states any other required quality of the item that is not one of the above defined types, nor is it a design requirement.

x) Design - directs the design (internals of the item), by inclusion (build it internally this way), or exclusion (don't build it internally this way). Any requirement on a subsystem, component, part, material, etc. in a requirement set for a parent system is, by definition, a Design Requirement.

xi) Compound - a requirement statement that expresses more than one requirement in the one expression, e.g. sentence.

Note: The same types apply also to goals (also termed design goals, targets, objectives).

Where "requirement" is referred to in this paragraph without any corresponding reference to "goal", the reference applies to both requirements and goals.

4.5 Verification Requirements Attributes for Requirements Traceability in SD

4.5.1 Minimum Verification Requirements Attributes for Requirements Traceability in SD

a) REQID - The verification requirements identifier (REQID) **uniquely** identifies the specific verification requirement within a set of verification requirements. This number could be project-specific or programme-specific, and may have been generated automatically by a requirements management tool.

b) Verification Requirement Statement - This is the expression of the verification requirement, which is a statement on the qualities of the evidence required that a system requirement has been satisfied: the characteristics required of any verification solution. A Verification Requirement Statement may comprise or include a statement defining a directed verification method (one of Analogy, Analysis, Analysis incorporating Test data, Certification, Demonstration, Examination/Inspection; and Test), but verification requirements are not (or should not be) just a list of verification methods.

4.5.2 Optional Verification Requirements Attributes for Requirements Traceability in SD

a) Name - The name of the verification requirement is a short descriptive name that can be used in addition to the REQID to refer to the verification requirement. Such a name will often reflect the subject matter of the system or software (etc.) requirement to which the verification requirement relates. An alternative is to use the Name attribute (if used) of the corresponding system or software (etc.) requirement.

4.6 Requirements Traceability Factors to Consider for Requirements Traceability in SD

Requirements traceability in SD has to provide the evidence of parent-child associations between a set of requirements on a system and a set of solution-specific requirements on solution elements, created by design of the system and subsequently communicated in requirements specifications or requirements databases. Due to the number and complexity of these relationships, requirements traceability for SD is typically implemented with computer-based requirements management tools.

There is also a further temporal aspect to requirements traceability, viz. that the requirements themselves and the traceability between requirements change over time, necessitating a formal change control process with respect to baselined requirements and associated requirements traceability information.

5. REQUIREMENTS FOR A REQUIREMENTS TRACEABILITY REPORT IN SYSTEM DESIGN

A RTR-SD should contain the following minimum information with respect to requirements of status: "Baselined Requirement" and "Un-baselined Requirement":

a) The system of which the parent requirements are requirements

b) For each parent requirement, the requirement REQID

c) For each parent requirement, Class "Parent"

d) For each child requirement, the requirement REQID

e) For each child requirement, Class "Child"

f) For each child requirement, the system solution element (technology item, support item, etc.) of which the requirement is a requirement

g) For each parent requirement, the requirement text, or a link to the requirement text

h) For each child requirement, the requirement text, or a link to the requirement text

i) For each parent requirement, the one or more child requirements derived by design

j) For each child requirement, the one or more parent requirements

k) For each requirement, the baselining status of the requirement (i.e. Baselined or Un-baselined)

l) For each requirement, its Verification Status - one of Planned/Passed/Failed/Passed After Re-verification/Not Applicable.

For each parent Non-Requirement:

a) the "requirement" REQID

b) the "requirement" text, or a link to the "requirement" text

c) the reason for classification as a Non-Requirement

d) the identity of the person or persons authorizing the classification "Non-Requirement".

Note that, by definition, parent non-requirements cannot have children.

A RTR-SD may contain the following additional information with respect to requirements of status: "Baselined Requirement" and "Un-baselined Requirement", depending on need:

a) for each child requirement, the one or more verification requirements that state(s) the quality of evidence that is required to adequately verifies its satisfaction by the system element.

b) for each requirement, that has been baselined, the date and time of creation of, or of any previous change to the requirement, whichever is the later.

6. OTHER POTENTIAL REPORTS

Other reports may be generated flexibly or be included in the RTR-SD, especially:

a) list of child requirements each with corresponding verification status.

b) list of child requirements each with identity and text of corresponding verification requirements.

c) list of child requirements, each with corresponding Rationale.

d) Up-Down trace, showing for a given child requirement on a given solution element, the parent(s), and for each parent, the corresponding children, and for each of these children, the system solution element of which the child requirement is a requirement.

Although requirements traceability in design is always between requirements at adjacent physical levels, the RTR-SD may be extended to incorporate requirements traceability from Physical Level 1 to Physical Level 2 to Physical Level 3, etc. But traceability must never jump physical levels.