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Data definitions for Physical Network Resources

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Abstract
This research note provides data definitions for physical resources of the telecommunication network.

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Preface

The author has been the main contributor to and editor of ITU-T Recommendation M.1401 on Formalization of interconnection designations among operators' networks, developed under Question 2/4.

During this work, Telcordia has often referred to their Common Language and ANSI T1M1 standards. And the Tecordia representative has a contract to harmonise ITU-T and ANSI standards in this field. Therefore, two representatives from Telcordia, Paul Levine and Pascale Pecha, met with the author at Wadahl mountain hotel during January 2004.

After the mentioned meeting, the author developed the current paper on Physical Network Resources - PNR. This paper is based on Telenor thinking over many years, and a commercial software package is based on some of the ideas herein. However, the paper is not defined to be a company standard for Telenor.

Note that current ITU-T Recommendations on the Telecommunication Management Networks do not go into any details on PNR. However, ITU-T Recommendation M.3100, in its new edition, plans to incorporate several of the notions in M.1401.

Based on this, Paul Levine has developed a draft ANSI T1M1 standard that maps from M.1401 and this PNR paper to Common Language.

1 Introduction

Previously, the US ANSI standards and Telcordia Common Language did not provide a graphical or formal definition like the one found in M.1401 and PNR. Therefore, it was hard to understand the correspondences and analyse the differences. This is now believed to be much simpler.

We observe that the US standards are flexible, but informal. Hence, using these standards, two users or organisations may develop very different models of similar networks, and apply different ways to register their networks.

ITU-T M.1401 and PNR are more rigid and formal, and will ensure that the networks are correctly registered and can be formally analysed, eg. for the consequences of failures in the network.

Many US software products are based on ANSI standards or Common Language. Therefore, this paper is an important source to understand differences and correspondences.

Significance for Telenor

This research note provides data definitions that define a formal model for the Physical Network Resources.

The definitions may be used to design software for managing the Physical Network. Also, the definitions provide important help to analyse offered standards and software packages.

Annex A Identification of Physical Network Resources

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Background and Purpose

Telecordia Common Language (CL) is used both for registration of Logical and Physical Network Resources (PNR). However, it has proved difficult to identify the object classes and how they map to ITU-T Recommendations M.3100 and M.1401.

This contribution is provided in order to facilitate a more complete picture of Physical Network Resources, and show how they relate to M.1401. The document is using the same specification technique as in M.1401.

A similar specification is planned for the relevant portions of CL and its mapping to M.1401 and the enclosed representation of PNR.

The current contribution is based on network registration of access networks in Telenor and a proposed harmonisation with registration of the transport network using M.1401 with extensions.

It is uncertain whether it would be appropriate to propose registration of PNR as a subject for standardisation, and in which forum. PNR data are typically exchanged between a network operator and planning, construction and installation companies.

Summary

This document defines designations and additional information intended primarily for human-to-human communication between network operators and their planning, construction and installation companies.

The area of interest is the communication about physical network resources and their interconnections. The objects of communication are cables, radio links, nodes etc. Proposed terms for these are provided by the application schema defined in this document.

This document is developed in order to facilitate computerized registration of the network as well as interoperation between computer systems and their human users. The specification technique of M.1401 is used for this purpose.

This document contains data definitions for designations of physical network resources. The designations are primarily designed to facilitate registration of access networks, but may also apply for registration of transport networks.

Keywords

Data definitions, designations, physical network resources, access network, transport network, terminology.

Introduction

This document defines terminology intended primarily for human-to-human communication between network operators and their planning, construction and installation companies.

This document focuses on human needs for stable and recognizable data formats independently of what media they are communicated over. Therefore, in order to support the human-to-human communication, the formats defined in this document are required to be provided at the corresponding human-to-computer interfaces, as well. Hence, this document defines the presentation formats of data at human-to-computer interfaces, but does not define the data communication formats for interfaces between computer systems, such as at the TMN X interface or non-TMN computer interfaces. However, it must be possible to automatically map the human-to-computer formats to the computer-to-computer formats and vice versa. The details of this mapping are for further study.

The document defines data to be exchanged between two companies. However, this document focuses on information on network resources, and does not define order or transaction identification or additional information on the status or processing of these orders or transactions.

The definition of information is common for the functions it supports. However, the selection of information defined in this document basically supports planning, construction, installation, maintenance and fault handling of physical network resources. Also, this information may have to be accessed to enable provisioning of lines that have physical constraints.

The document aims at defining terminology for technicians and file support personnel at their terminals supporting the network, and serves as design information for developers of operational support systems.

The document defines object classes and references between these, but does not define identifiers or additional attributes to characterize the object classes.

Scope

The area of interest is the communication between companies about network interconnections. The objects of communication are physical network resources and their interconnection points. Correct terms for this are provided by the application schema defined in this document.

This document does not cover sites that do not contain interconnections or equipment. Hence, geographic information, construction of manholes and cable beds, ducts and buildings are not covered.

References

[1] ITU-T Recommendation 1401 (2004), *Formalisation of designations for interconnections among operators' networks*

Definitions

This document is comprised of structured definitions in the context of an application schema graph.

Abbreviations

CL	- Telcordia Common Language
PNR	- Physical Network Resource
TMN	- Telecommunication Management Network

Conventions

This document uses indentations (5 mm) supported with bullets to indicate subordinate data items.

Textual definitions and explanations are provided in paragraphs that are adjusted 5 mm further to the right.

Object class labels are underlined; attribute group and attribute labels are not underlined.

References to other object classes are written in blue, italics and underlined.

Figures use boxes containing object class labels to indicate object classes.

Lines supported with a reversed arrowhead indicate subordinate object class.

Two-way arrows indicate references between object classes.

The formalism used is introduced in Appendix III of Recommendation M.1401.

Blue lines refer to object classes and references already defined in Recommendation M.1401. Black lines depict information that is introduced in this document.

In order to ease the overview, references indicating orientation of the network are indicated in green colour. See Appendix I.

Application schema

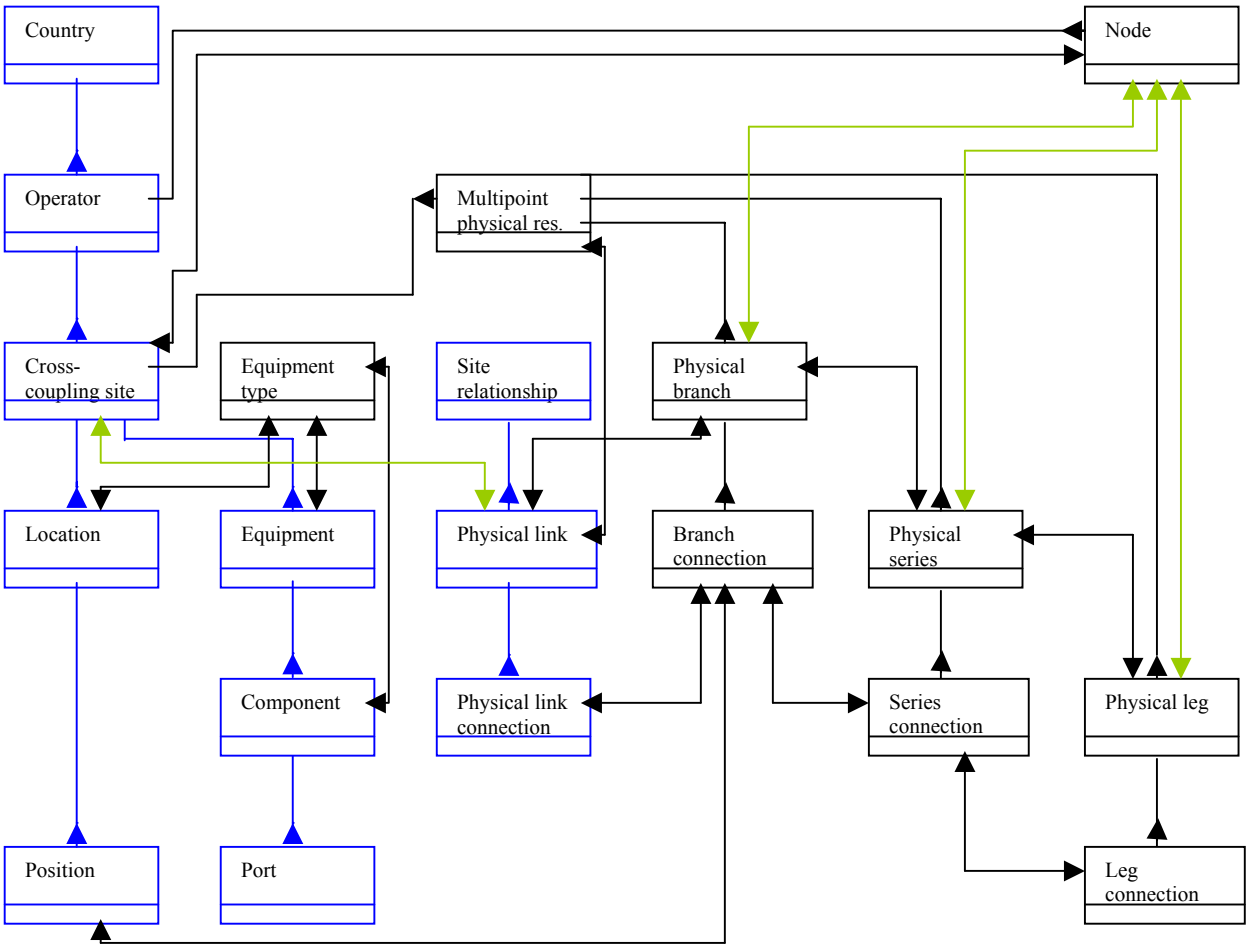

Figure 1 Application schema graph, depicting object classes (boxes), containment (reversed arrowheads) and references (two-way arrows)

Equipment type

A category of equipment instances that may replace each other.

- *Component*

  An Equipment type's subordinate Component is a role of a Component instance belonging to the type

- *Equipment*

  An Equipment type's subordinate Equipment is a role of an Equipment instance belonging to the type.

- *Location*

An Equipment type's subordinate Location is a role of a Location equipment belonging to the type.

Country

- Operator
- - Cross-coupling site
- - - Equipment
- - - - *Equipment type*

An Equipment's subordinate Equipment type is a role of an Equipment type to which the Equipment belongs.

- - - - Component
- - - - - *Equipment type*

A Component's subordinate Equipment type is a role of an Equipment type to which the Component belongs.

- - - Location
- - - - *Equipment type*

A Location's subordinate Equipment type is a role of an Equipment type to which the Location equipment belongs.

- - - - Position
- - - - - *Branch connection*

A Position's subordinate Branch connection is a role of a Branch connection that is terminated at the Position.

- - - Multipoint physical resource

A Multipoint Physical Resource is defined subordinate to some Cross-coupling site. The Cross-coupling site may be a subordinate Physical link's subordinate Inside site, or some Cross-coupling site inside of this again. This way, the operator registering the network is free to choose a Cross-coupling site as a name space for physical resources outside it. See Appendix I.

A Multipoint resource comprises all physical resources that are connected without passing through another Cross-coupling site.

- - - - Physical branch

A Physical branch is a set of Physical series that together connects two branching Nodes. A branching Node connects three or more Cross-coupling sites. See Appendix II.

The Physical branch makes up a graph of Physical series in series and/or in parallel. However, the Physical branch has only two ends, and is terminated in two Nodes. The two Nodes may be pure Nodes, or they may contain Cross-coupling sites. In case a Node is a pure Node, three or more Physical branches will be terminated in this Node, and they connect to three or more Nodes that contain Cross-coupling sites. This explains why these nodes are called branching Nodes.

- - - - - Branch connection

A Branch connection is a series of Series Connections. All Branch connections of a Physical branch terminate in the same two Nodes. Each Branch connection of a Physical branch may have different characteristics.

- *Physical links connection*

  A Branch connection's subordinate Physical link connection is a role of a Physical link connection that is implemented by this Branch connection and maybe other Branch connections in series.

- *Position*

  A Branch connection's subordinate Position is a role of a Position on which this Branch connection is terminated.

- *Series connection*

  A Branch connection's subordinate Series connection is a role of a Series connection that, maybe together with other Series connections in series, implements this Branch connection.

- *Inside node*

  A Physical branch's subordinate Inside node is a role of a Node terminating the Physical branch in the direction away from the customer premises and towards the core of the network.

- *Physical link*

  A Physical branch's subordinate Physical link is a role of a Physical link that is implemented by this Physical branch or other Physical branches in series.

- *Physical series*

  A Physical branch's subordinate Physical series is a role of a Physical series that, maybe together with other Physical series in series or parallel, is implementing the Physical branch.

- *Physical link*

  A Multipoint physical resource's subordinate Physical link is a role of a Physical link that is implemented by this Physical resource.

- Physical series

  A Physical series is a series of Physical legs. See Appendix II.

- Series connection

  A Series connection is a series of Leg connections. A Physical series consists of Series connections in parallel.

  While the Leg connections in series may have compatible characteristics, the Series connections in parallel in a Physical series may have different characteristics.

- *Branch connection*

  A Series connection's subordinate Branch connection is a role of a Branch connection that is implemented by this and maybe other Series connections in series.

- *Leg connection*

  A Series connection's subordinate Leg connection is a role of a Leg connection that, maybe together with other Leg connections in series, implements this Series connection.

- - - - - *Inside node*

  A Physical series' subordinate Inside node is a role of a Node terminating the Physical series in the direction away from the customer premises and towards the core of the network.

- - - - - *Physical branch*

  A Physical series' subordinate Physical branch is a role of a Physical branch that is implemented by this and maybe other Physical series in series or parallel.

- - - - - *Physical leg*

  A Physical series' subordinate Physical leg is a role of a Physical leg that, maybe together with other Physical legs in series, is implementing the Physical series.

- - - - Physical leg

  A Physical leg is the smallest set of parallel connections in the telecommunication network. A Physical leg is terminated in two nodes. See Appendix II.

  The set of parallel connections is delimited by the mantle of a physical cable. One or more connections of the Physical leg are physically cut and maybe terminated in the Node.

  In case of radio connections, the Physical leg is terminated by the antennas in each end.

- - - - - Leg connection

  A Leg connection is made up of one, two or more connectors that may be used together to establish a connection, e.g. a Trail. A Physical leg consists of Leg connections in parallel. Each Leg connection may have different characteristics.

- - - - - - *Series connection*

  A Leg connection's subordinate Series connection is a role of a Series connection that is implemented by this and maybe other Leg connections in series.

- - - - - *Inside node*

  A Physical leg's subordinate Inside node is a role of a Node terminating the Physical leg in the direction away from the customer premises and towards the core of the network.

- - - - - *Physical series*

  A Physical leg's subordinate Physical series is a role of a Physical series that is implemented by this and maybe other Physical legs in series.

- - - *Node*

  A Cross-coupling site's subordinate Node is a role of a Node in which the Cross-coupling site is placed. A Cross-coupling site can be placed in one Node only.

- - - *Outgoing physical link*

  A Cross-coupling site's subordinate Outgoing physical link is a role of a Physical link that is connected to another Cross-coupling site that is considered to be closer in the network to customer premises and further away from the core of the network.

- - Node

  A Node is a site that contains connections between different network resources. In case the connections are provided by construction work only, the Node is called a pure Node.

A pure Node may be a cable junction, may be a repeater station, or may contain a regenerator or other equipment.

A pure Node may connect two or more Physical legs. In case the Physical legs are connecting towards three or more Cross-coupling sites, the pure Node is called a branching Node.

- ▪ ▪ ▪ *Cross-coupling site*

  A Node's subordinate Cross-coupling site is a role of a Cross-coupling site that is placed in this Node. A Node may contain only one Cross-coupling site.

- ▪ ▪ ▪ *Outgoing branch*

  A Node's subordinate Outgoing branch is a role of a Physical branch leading in the direction of customer premises and away from the core of the network.

- ▪ ▪ ▪ *Outgoing leg*

  A Node's subordinate Outgoing leg is a role of a Physical leg leading in the direction of customer premises and away from the core of the network.

- ▪ ▪ ▪ *Outgoing series*

  A Node's subordinate Outgoing series is a role of a Physical series leading in the direction of customer premises and away from the core of the network.

Site relationship

- Physical link
- ▪ *Inside site*

  A Physical link's subordinate Inside site is a role of a Cross-coupling site that is considered to be furthest away from customer premises of the Physical link's two Cross-coupling sites. This Cross-coupling site is considered to be closest to the core of the network of the Physical link's two Cross-coupling sites. Also, the Inside site may point in the direction of a Cross-coupling site containing an Exchange. See Appendix I.

- ▪ *Multipoint resource*

  A Physical link's subordinate Multipoint resource is a role of a Multipoint resource that implements the Physical link.

- ▪ *Physical branch*

  A Physical link's subordinate Physical branch is a role of a Physical branch on whose subordinate Branch connections its Physical link connections are routed. A Physical link may have several Physical branches in series.

- ▪ Physical link connection
- ▪ ▪ *Branch connection*

  A Physical link connection's subordinate Branch connection is a role of a Branch connection that, maybe in a series with other Branch connections, makes up the Physical link connection.

APPENDIX I

Nodes , Multipoint physical resources and orientation of the network

(This appendix does not form an integral part of this document)

I.1 Nodes

Terminations, couplings, and placement of equipment can take place in Nodes only. Some nodes allow the terminations, couplings and equipment to be modified by construction work only. These nodes are called pure Nodes.

If the change is based on a cross-coupling order, e.g. service delivery of a leased line, then the Node will contain one Cross-coupling site that allows for the change.

Note that other sites, like a manhole, bend of a duct etc. are not addressed by this document, and are not considered to be Nodes.

Nodes are identified local to an Operator.

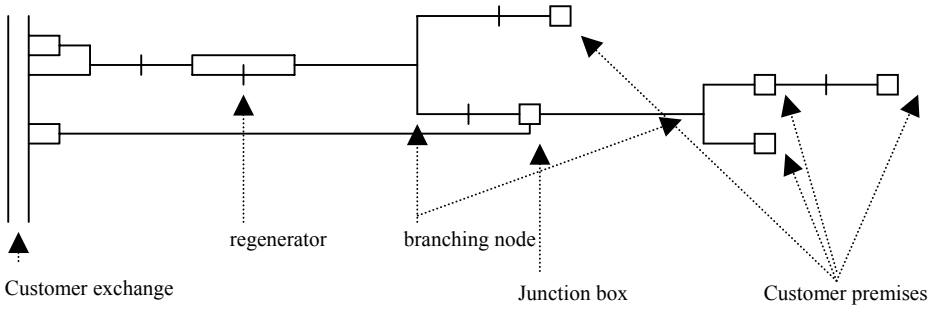

Figure I/1 Schematic graph of an example physical network

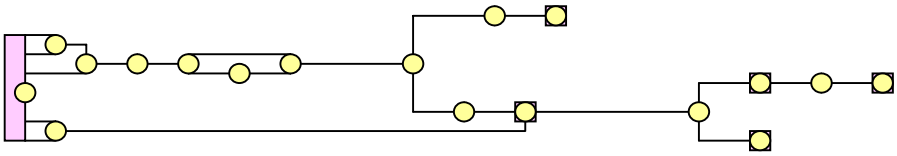

Figure I/2 Nodes (yellow circles) and Cross-coupling sites (red rectangles) of example network

I.2 Multipoint physical resources

A Multipoint physical resource connects two or more Cross-coupling sites.

The Physical links of a Multipoint physical resource cannot pas through a Cross-coupling site; this delimits the reach of the Multipoint physical resource.

If you start at a Physical leg and walk via connected Physical legs, without passing through a Cross-coupling site, you may reach all Physical legs in a Multipoint physical resource; this delimits the width of a Multipoint physical resource.

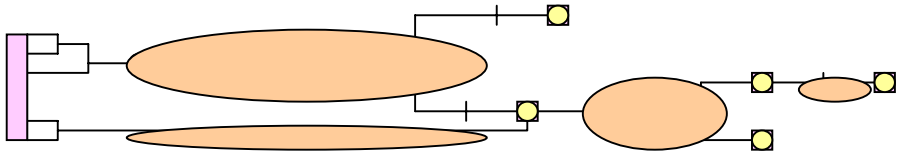

Figure I/3 Multipoint physical resources (ellipses) in the example physical network

The Multipoint physical resources are identified local to a Cross-coupling site that is on the inside of every resource contained in it.

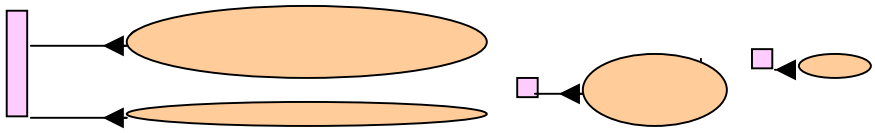

Figure I/4 Example identification of Multipoint physical resources

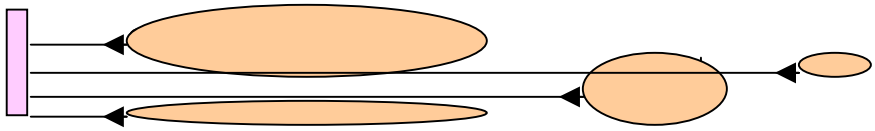

Figure I/5 Another example identification of Multipoint physical resources

Note that Multipoint physical connections are not addressed in this document.

I.3 Orientation of physical links

A Physical link is terminated in two Cross-coupling sites. These Cross-coupling sites are given by the Physical link's superior Site relationship's subordinate A-end and B-end. However, the A-end and B-end are given in alphabetical sequence and may tell nothing about the orientation of the network.

The Physical link's subordinate Inside site is a role of the Cross-coupling site that is closest to the core of the network and furthest away from customer premises. This information may be used for two purposes:

- routing of Trails from customer premises towards the core of the network, e.g. to a customer Exchange.
- identification of Physical links local to the Cross-coupling site, e.g. in the access network

The access network has typically a hierarchical structure, as indicated in Figure I/6. Green lines indicate Inside site. Note that Outside site is not addressed in this document.

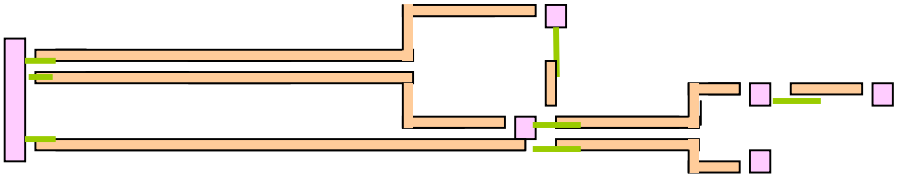

Figure I/6 Orientation of Physical links

Note that in the above Figure, the vertical Physical branch is routed via the branch Node.

If Physical links are identified local to their Inside site, these identifiers will be unique within their Site relationship, as well. This allows Physical links in the access network to be identified both local to the Inside site and local to Site relationship.

Note that the reverse logic does not work: If a Physical link is identified locally to a Site relationship, as required by M.1401, this does not guarantee that the identifier is unique within the scope of the Inside site.

APPENDIX II

Physical resources

(This appendix does not form an integral part of this document)

II.1 Introduction

This Appendix illustrates use of Physical branches, Physical series and Physical legs to represent an example access network. Branch connections, Series connections and Leg connections are not illustrated. These connections may make up Multipoint physical connections. Multipoint physical connections are not addressed in this document.

This Appendix uses the same example as in Appendix I.

II.2 Physical legs

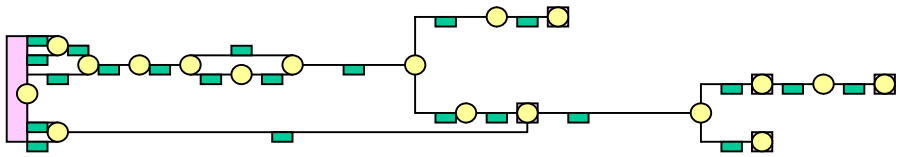

Figure II/1 Physical legs (long green rectangles) of example physical network

II.3 Physical series

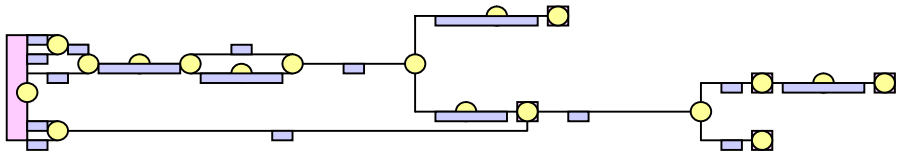

Figure II/2 Physical series (long dark blue rectangles) of example physical network

II.4 Physical branches

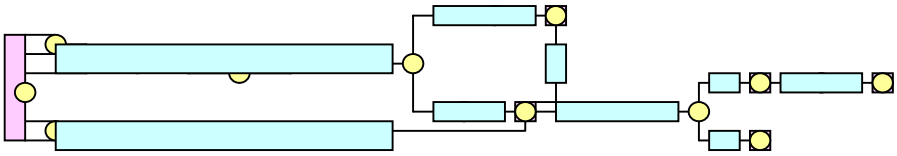

Figure II/3 Physical branch (long light blue rectangles) of example physical network

The next Figure depicts how Physical branches may be identified. Physical series and Physical legs are identified in a similar way.

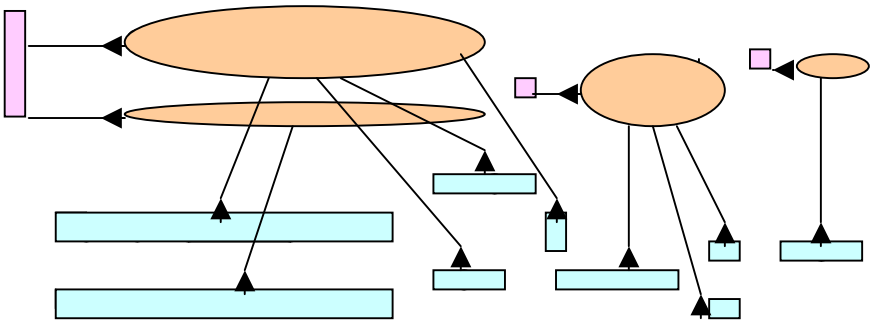

Figure II/4 Example identification of Physical branches

APPENDIX III

Derived data

(This appendix does not form an integral part of this document)

III.1 Derivations

If all Physical legs and their terminations of a network are known, then the Physical series and Physical branches may be derived automatically. Note, however, that their identifiers may not become the same if new data are added in other parts of the network.

Also, references between Physical legs, Physical series, Physical branches and Physical links may be derived depending on what other references exist. Some such derived data are indicated by red colour in the following Figure.

Similarly, the references between Leg connections, Series connections, Branch connections and Physical link connections may be derived depending on what other references exist.

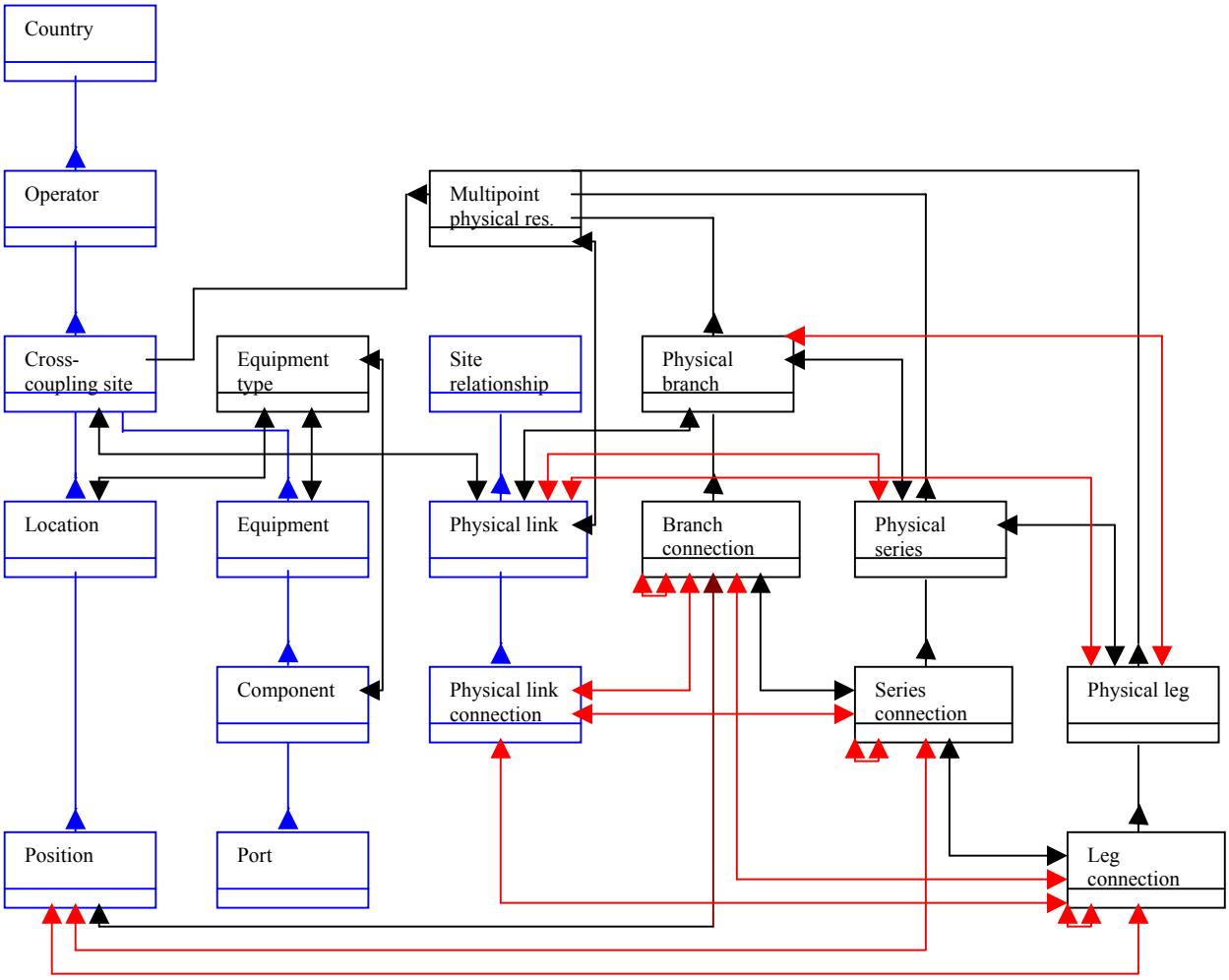

Figure III/1 Example of derived data (red lines)