



The ATM Forum
Technical Committee

**Requirements and Logical
MIB for management of Path
and Connection trace**

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Requirements and Logical MIB

1. Introduction

This document presents requirements and a logical MIB for management of connection and path tracing. It is based on the functionality described in 'PNNI addendum for path and connection trace version 1.0' [1].

The trace functionality described in this document is dependent on a network deploying the PNNI protocol between the network elements as this currently is the only protocol that has been extended with the new trace functionality (see [1]). It is also necessary that the involved network elements have implemented handling of the new information element (trace transit list), the new messages (TRACE CONNECTION, TRACE CONNECTION ACK), and other support functionality needed for the trace activation, trace execution and retrieval of the trace results as described in this document.

Network elements not supporting the path and connection trace functionality may be involved in a trace if a 'pass along indicator' has been set when the trace was ordered. The trace result will in this case not contain any trace data from the 'by-passed' NEs. That is, there will be a 'gap' in the trace result data for the 'by-passed' NEs.

The tracing is initiated by a network management system (NMS) operating towards one of the network elements within the PNNI network. The management system has the possibility to invoke three different types of tracing:

- Test call trace
- Automatic path trace on call set-up
- Connection trace on established connections

The test call trace is a trace to determine the path taken through the network for a certain called party number and traffic class (service category). The automatic path trace is a way to start traces upon call set-ups without any operator intervention. Any call (SVC or SPVC) set-up matching an operator defined trace filter will in this case trigger a trace. Finally, the connection trace is used to find the path for an already established connection.

The result of a performed trace will be presented in a MIB table in the NE where the trace was ordered by the NMS. The trace result will contain information that enables the management system to identify the trace. It will also contain additional information about the traced connection or call set-up such as identities of the nodes (NEs) and ports passed by the traced connection.

Optionally the trace result may contain the VPIs/VCIs and/or Call References (and End Point References) of the traced connection, if this information has been requested by the NMS when ordering the trace. The NMS also has the option to specify if crankback information shall be included in the result at a test call or automatic path trace. The crankback information may give hints about any network faults that results in a non-optimal call routing.

Figure 1 shows an example of a connection trace on an established SPVC connection

As the figure illustrates there are several possibilities when performing a connection trace. The first trace (trace 1) illustrates a trace from the originating end point of the SPVC in Node A towards the terminating end point in Node C. The second trace (trace 2) is performed from Node B where the connection is only visible as an SVC. A precondition for the second trace is that there is some way to find the relevant SVC connection to trace upon in Node B.

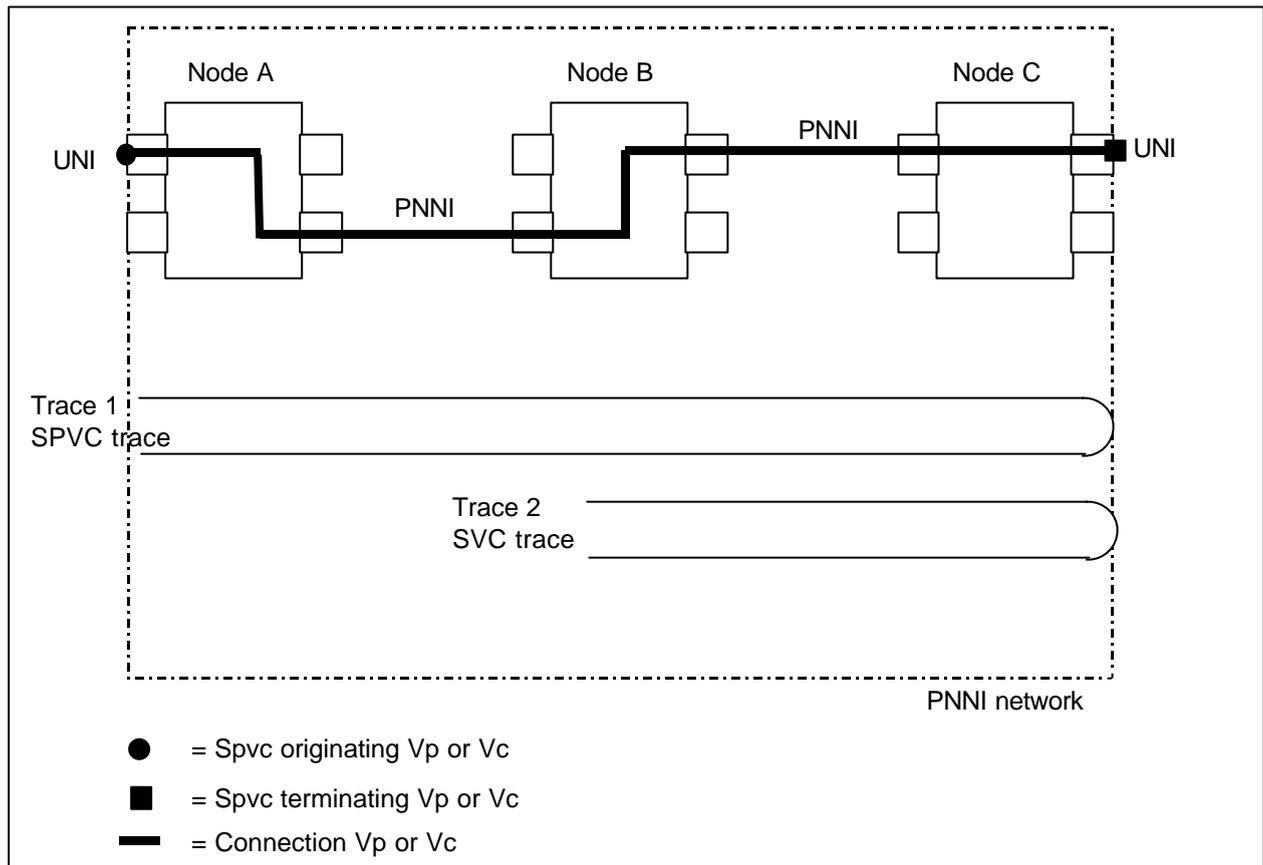


Figure 1 : Examples of connection traces on an SPVC

2. Terminology

Automatic Path Trace	An automatic trace of the path of an SVC or SPVC performed during call establishment by the involved network elements. The trace is performed for connection set-ups that match the automatic path trace filtering criteria.
CO-BI connection	Connection oriented bearer independent. A connection that is signaled through the network but does not have VPI/VCI resources associated with it. That is, a connection existing only in the control plane (signaling) and not in the user plane (data phase).
Connection Trace	Trace of the path for an already established SVC or SPVC. The connection trace is performed by the NMS towards a selected NE for a certain established connection. The result of the trace will be presented through a Trace Result managed entity.
Incoming port	The ATM interface (port) at which a call enters a network element
Incoming VPI/VCI	The VPI/VCI value at the incoming port.
NE	Network element
NMS	Network management system
Outgoing port	The ATM interface (port) through which a call progresses out of the network element.
Outgoing VPI/VCI	The VPI/VCI value at the outgoing port.
PNNI	Private Network Node Interface
SVC	Switched virtual connection.
SPVC	Soft permanent virtual connection. A connection that is permanent in the originating and terminating end points (VPL or VCL) and switched (SVC) in between.
Test call trace	Manual trace of the path taken for a certain called party number and traffic type (service category). The trace is performed by the network management system ordering a test call from the trace starting point (NE) towards a specified 'Called party number'. The test call is typically cleared automatically by the network after a performed trace.

Trace destination node	The node in which the path and connection trace ends and from which the trace information will be returned to the trace source node.
Trace destination port	A port at which a performed trace will terminate. A trace performed towards such as port will only give trace information from the trace starting point to the destination port. A PNNI port could be defined as a trace destination port. The reason for this could be that an adjacent node does not support the trace function.
Trace source node	The node in which a path or connection trace is starts and in which the result of the performed trace will be stored.
Trace transit list	Information element containing the trace information sent through the network at a path or connection trace. The trace transit list will be included in e.g. the SETUP, CONNECT, TRACE CONNECTION, and TRACE CONNECTION ACK messages as described in [1].

3. General trace requirements

This chapter describes the general trace (abbreviated GT) requirements that apply for all three types of tracing: test call trace, automatic path trace and the trace of established connections.

As an NMS may initiate a considerable amount of traces towards a NE it is necessary to have some limitations on the number of traces stored in the NE. It is also desirable to have a limitation on the number of simultaneously ongoing trace requests (e.g. test calls) to avoid excessive network load from the tracing.

- (R)-GT-1 The number of traces stored in a NE must be limited (e.g. through a max. number of traces or a time to live per trace) to save memory space.
- (R)-GT-2 It shall be possible to configure the maximum number of concurrent trace requests towards a NE. With concurrent trace requests is meant the sum of the ongoing (not completed) test calls and the ongoing (not completed) connection traces. An unlimited number of ongoing traces may also be specified.
- (R)-GT-3 It shall be possible to retrieve the number of available trace requests towards a NE. With available trace requests is meant the number of trace request that can be invoked towards the NE before the maximum number of concurrent trace requests is reached.
- (R)-GT-4 Each trace shall be tagged with a time stamp taken when the trace was performed. The time stamp shall be included in the Trace Result managed entity.

As there may be parts of the PNNI network that not support the trace functionality it is desirable to have a means to define certain PNNI ports as 'trace destination' ports, meaning that a performed trace will be terminated at such a port.

- (R)-GT-5 It shall be possible to define a PNNI port as a 'trace destination port'. This means that a trace will not continue beyond this interface. This applies for both incoming and outgoing calls at this port.

Some NEs within the network that not support tracing still have the possibility to forward the trace information if the 'pass along' indication is set when performing a trace. The NMS shall because of this have the possible to define if 'pass along' shall be used or not. The 'pass along' information will be forwarded to involved NEs with the 'pass along request' bit in the 'trace transit list' information element.

- (R)-GT-6 When starting a path or connection trace, it shall be possible to specify if the trace information (trace transit list information element and the new trace messages TRACE CONNECTION and TRACE CONNECTION ACK) shall be passed transparently (pass along) through nodes not supporting path and connection trace or not. This shall also be possible to specify for the automatic path trace.

Information that is presented in the trace result is dependent on the type of trace performed. For example, for a trace on an established connection the essential information is the NEs, interfaces, VPIs

and VCIs passed by the connection whereas for a test call trace other information such as 'called party number' and traffic contract of the test call are as important. In this chapter only the common trace result requirements are listed.

- (R)-GT-7 The result of a connection or path trace shall be stored in the NE for retrieval by the management system.
- (R)-GT-8 The trace result shall for each trace contain relevant information about the trace as specified by the trace transit list in [1]. Examples of trace information contained in the trace transit list is: node identities, port identities, VPIs, VCIs, Call References etc. of the traced connection.
- (O)-GT-9 The trace result should have attributes that make it possible to retrieve the DLCI values for the source and destination interface if these are available.

The possibility to specify that a notification shall be sent as a result of a performed trace will enable the NMS to detect that trace result information is available in the trace result without having to 'poll' (read) the result at regular intervals. This is especially beneficial to the automatic trace function when filters have been defined that result in traces being performed very infrequently.

- (O)-GT-10 If notifications are supported, it shall be possible to define whether a notification shall be sent upon completion of a performed trace or not. This shall be specified when the trace is ordered and shall be configurable for the three different types of traces:
 - test call trace
 - trace of established connections
 - automatic trace upon call setup
- (O)-GT-11 If notifications are supported, it is requested that the notification sent upon completion of a trace shall contain information that makes it possible to identify the particular completed trace.

It shall be possible to specify the maximum length of the TTL (Trace transit list) information element that is acceptable by a NE. If the length is exceeded, the trace will terminate at the NE where the maximum length has been reached. The call set-up may however proceed, but no trace information will be received from the succeeding nodes. If the 'clear call at destination' condition has been specified for the trace, the call will be released if the maximum TTL length is reached.

- (O)-GT-12 It should be possible to define the maximum acceptable length in octets for the trace transit list information element. The length shall be in the range 1076 to 65535. Ranges bigger than the default length 1076 are optional.

The management system shall be able to specify an owner attribute for each configured trace. This attribute will make it possible to distinguish between traces configured from different management entities.

- (R)-GT-13 Each trace shall have an owner attribute that identifies the management entity that configured the trace.

4. Test call trace

This chapter describes the test call (abbreviated TC) requirements that apply specifically for the test call trace. The test call trace is a trace to determine the path taken through the network for a certain called party number and traffic class (service category).

4.1 Test call requirements

- (R)-TC-1 It shall be possible to establish a manual path trace (test call) for a certain 'Called party number' to check the path used for the specified number. The test call shall be performed through the Path Trace managed entity.
- (R)-TC-2 Each manual path trace (test call) shall be assigned a trace identifier. The trace identifier makes it possible to store several trace results for the same called party number or connection.
- (R)-TC-3 A manual path trace (test call) shall be possible to initiate from any network element (that supports tracing) within the PNNI network.
- (R)-TC-4 The trace result shall identify the performed path trace (test call). The path trace could be identified through the called party number and trace identifier.

When performing a trace there are several different trace options that may be selected. Only the selected options will be presented in the trace result.. The possible trace options are:

- Tracing of crank back (Mandatory)
- Tracing of VPI/VCI values (and DLCI if present) (Optional)
- Tracing of 'Call reference' values (Optional)

- (R)-TC-5 It shall be possible to configure if crank back trace shall be performed or not. If crank back trace has been specified the result of any crank backs at call set-up shall be available through the trace result..
- (O)-TC-6 It should be possible to configure if a VPI/VCI trace shall be performed or not. If VPI/VCI trace has been specified the VPIs (and VCIs) used by the traced connection shall be available through the trace result.. The VPI/VCI trace option shall also activate the tracing of DLCI values (if present).
- (O)-TC-7 It should be possible to configure if a 'Call reference' trace shall be performed or not. If a 'Call reference' trace has been specified the 'Call references' used by the traced connection shall be available through the trace result.

There shall be an option to be able to start a test call without the network tearing it down when it reaches the trace destination node. In this case the VPI (and VCI) of the starting point has to be specified. This option will enable the network provider to test the user plane (data transmission) of the test connection before releasing it. It will also enable tests of point-to-multipoint connections by allowing the NMS to first establish a new root-to-leaf connection (leaving it up) and then subsequently add new leaves to it.

- (O)-TC-8 It should be possible to decide when making a test call if the call shall be released immediately or be left 'up'. Specifying the Clear Call at Destination (X-flag) when performing the test call trace does this. If the call is to be left up, it shall be possible to specify the starting point of the test call using the interface identifier, VPI (and VCI). The default shall be to automatically release the call when it reaches the trace destination node.
- (CR)-TC-9 If the option in (O)-TC-8 is not supported the default shall be to automatically release the call when it reaches the trace destination node.

Giving the NMS the possibility to define the traffic contract of a test call enables it to see how connections with different traffic characteristics are routed through the network. In addition to this, it is of value to enable the NMS to specify the type of connection (VP, VC or CO-BI connection) that shall be tested and if the connection shall be of point-to-point or point-to-multipoint type.

- (R)-TC-10 It shall be possible to specify the traffic contracts (traffic descriptors) for the forward and backward direction when performing a manual path trace (test call).
- (R)-TC-11 When doing a manual path trace (test call) it shall be possible to specify if the trace shall be done using a:
-VC connection (mandatory)
-VP connection (optional)
-CO-BI connection (optional)
- (R)-TC-12 It shall be possible to make a test call for a point-to-multipoint connection either by adding a leaf to an already existing point-to-multipoint connection or by establishing a new point-to-multipoint connection.

When performing a test call it shall be optionally possible to specify the 'Calling party number' of the test connection. This may be useful if the involved NEs use some sort of 'Calling party number' screening.

- (O)-TC-13 It should be possible to define the 'Calling party number' of the manual path trace (test call).

The management system shall have the possibility to perform a simplified restart (repetition) of a trace. The restart action is performed on an already existing Path Trace managed entity. A new trace will be performed with the same trace data as was initially specified when the trace was configured.

- (R)-TC-14 An individual test call trace shall be possible to restart. A restart of the trace means that a new trace shall be performed with the same trace data as have been configured in the Path Trace managed entity.

5. Automatic trace on call setup

This chapter describes the automatic trace (abbreviated AT) requirements that apply specifically for the automatic trace. The automatic trace is a way to start traces upon call set-ups without any operator intervention. A trace will in this case triggered by a call set-up matching one or several automatic trace conditions. One or several automatic trace filters define the conditions that determine when an automatic trace will be performed.

5.1 Automatic trace requirements

To do automatic tracing the NMS has to specify a trace filter that gives the criteria for when to start a trace. The filter is defined on a per node (NE) basis. The trace filter is stored in an Automatic Trace Filter managed entity. The NE will initiate an automatic trace whenever a connection setup matches the filtering criteria.

Note: If a filter match occurs for two or more filters within the same NE, one trace result shall be produced for each filter. If however two trace filters have been defined in two different NEs and both filters are matching, only the first matching filter (in the NE where the call setup enters first) will produce a trace result (see also [1]).

(R)-AT-1 It shall be possible to specify one or more 'path trace filters' which decides if automatic path tracing shall be performed or not during set-up of a connection.

The NMS shall have the possibility to control the filtering by turning it on or off for either a whole NE or for an individual trace filter. If the filtering is enabled at the NE level, the individual control of each filter will decide if filtering is to occur or not. If the filtering is disabled at NE level, no filtering (automatic traces) will occur regardless of the individual filter settings.

(R)-AT-2 It shall be possible to turn the automatic filtering on or off for the whole NE. When turned off, the defined path trace filters shall remain but the automatic tracing shall be disabled.

(R)-AT-3 It shall be possible to turn the automatic filtering on or off for a specific path trace filter. When turned off, the defined path trace filter shall remain but the automatic tracing shall be disabled.

It shall be possible to define a set of filtering criteria that decide when an automatic trace shall be performed. The used filtering criteria are:

- Incoming Interface (Mandatory)
- Called Party Number Prefix (Mandatory)
- Outgoing Interface (Optional)
- Calling Party Number Prefix (Optional)
- Connection Kind (Optional)

- Cast Type (p-to-p, p-to-mp) (Optional)
- Service Category (cbr, vbrRt, vbrNrt,ubr ...) (Optional)

(R)-AT-4 It shall be possible to filter calls based on the incoming interface (where the call enters the NE). This means that calls entering the node on the specified incoming interface shall be traced (if all other filter conditions match). It shall be possible to define the incoming interface as a 'don't care' filter criterion.

(R)-AT-5 It shall be possible to filter calls based on the Called Party Number Prefix. That is, calls that have a called party number which first digits match the prefix filter shall be traced (if all other filter conditions match). It shall be possible to define the Called Party Number Prefix as a 'don't care' filter criterion.

(O)-AT-6 It should be possible to filter calls based on the outgoing interface (where the call leaves the NE). This means that calls leaving the node on the specified outgoing interface shall be traced (if all other filter conditions match). It shall be possible to define the outgoing interface as a 'don't care' filter criterion.

(O)-AT-7 It should be possible to filter calls based on the Calling Party Number Prefix. That is, calls that have a calling party number which first digits match the prefix filter shall be traced (if all other filter conditions match). It shall be possible to define the Calling Party Number Prefix as a 'don't care' filter criterion.

The NMS shall optionally have the possibility to decide on which connection kinds to perform automatic tracing. This will for example enable the NMS to specify that automatic traces shall only be performed for SPVC initiators (i.e. SPVCs originating in the NE) or for 'SVC and SPVC not initiators' (SVCs or SPVCs that does not originate in the NE). One or several of the connection kinds may be specified in the filter.

(R)-AT-8 It should be possible to filter calls based on the connection kind, where the connection kind is defined as zero, one or several of:

- SVC and 'SPVC not initiator' (mandatory)
- SPVC initiator (mandatory)
- SVP and 'SPVP not initiator' (optional)
- SPVP initiator (optional)
- CO-BI connection (connection oriented, bearer independent) (optional)

Calls matching any of the defined connection kinds shall be traced (if all other filter conditions match). If none of the alternatives have been selected this filter criteria is of 'don't care' type.

(O)-AT-9 It should be possible to filter calls based on the cast type, where the cast type is defined as zero, one or several of:

- point to point
- point to multipoint

Calls matching any of the defined cast types shall be traced (if all other filter conditions match). If none of the alternatives has been selected this filter criteria is of 'don't care' type.

(O)-AT-10 It should be possible to filter calls based on the service category, where the service category is defined as zero, one or several of:

- cbr
- rt-vbr
- nrt-vbr
- abr
- ubr
- gfr

Calls matching any of the defined service categories shall be traced (if all other filter conditions match). If none of the alternatives has been selected this filter criteria is of 'don't care' type.

(R)-AT-11 Each automatic (during call set-up) path trace shall be assigned a unique trace identifier that shall be presented in the trace result.

(R)-AT-12 The trace result shall apart from the trace identifier contain attributes that make it possible to identify the connection for which an automatic path trace has been made. The filtering criteria that resulted in an automatic path trace shall also be available through the trace result.

When defining a trace filter there are several different trace options that may be selected. Only the selected options will be presented in the trace result. The possible trace options are:

- Tracing of crank back (Mandatory)
- Tracing of VPI/VCI values (and DLCI if present) (Mandatory)
- Tracing of 'Call reference' values (Mandatory)

(R)-AT-13 It shall be possible to configure if crank back trace shall be performed or not. If crank back trace has been specified the result of any crank backs at call set-up shall be available through the trace result.

(R)-AT-14 It should be possible to configure if a VPI/VCI trace shall be performed or not. If VPI/VCI trace has been specified the VPIs (and VCIs) used by the traced connection shall be available through the trace result. The VPI/VCI trace option shall also activate the tracing of DLCI values (if present).

(R)-AT-15 It shall be possible to configure if a 'Call reference' trace shall be performed or not. If a 'Call reference' trace has been specified the 'Call references' used by the traced connection shall be available through the trace result.

The management system shall have the option to specify if an call that is traced shall be left up or if it shall be released automatically when it reaches the trace destination node.

(O)-AT-16 It should be possible to decide when specifying an automatic trace filter if the traced calls shall be released immediately or be left 'up'. Specifying the Clear Call at Destination (X-flag) when defining the trace filter does this. The default shall be to not release the automatically traced call.

(CR)-AT-17 If the option in (O)-AT-16 is not supported, the default shall be to not release the call when it reaches the trace destination node.

For automatic traces there shall be a mechanism that prevents the management system from being overloaded with notifications (if notifications are supported).

(O)-AT-18 It notifications are supported, and if notifications has been specified for an automatic trace filter, there shall be a mechanism that prevents the management system from being overloaded with notifications.

It shall optionally be possible to specify that filtering shall stop after a certain number of traces. This is to enable 'one shot' tracing when a certain filter condition is matched.

(O)-AT-19 It should be possible to specify that automatic tracing shall be stopped after a certain number of matching call setups. The trace result records shall in this case be kept in the database.

6. Trace of established connections

This chapter describes the connection trace (abbreviated CT) requirements that apply specifically for the trace of established connections. The connection trace is a trace made on an already established connection. The trace will be performed by use of the signaling messages TRACE CONNECTION and TRACE CONNECTION ACK that has been specified in [1].

6.1 Connection trace requirements

(R)-CT-1 It shall be possible to trace already established connections through operating on a Connection Trace managed entity. This managed entity shall make it possible to invoke a trace on a specified connection.

It shall be possible to unambiguously point out the connection to trace upon. In the point to point case the interface identifier, the VPI and VCI could be used. In the point to multipoint case, the 'End Point Reference' may be used to distinguish between leaves starting at the same interface, VPI (and VCI). An alternative way to point out the leaves for the starting point of an SPVC when SNMP is used, is given in by the 'Leaf Reference' described in [2].

(R)-CT-2 The identity of the connection on which to trace shall be specified through the port identity, VPI, and VCI at the trace starting point. In case of point-to-multipoint it shall be possible to select which leaf to trace upon. This could be done through the use of the 'End point reference' in addition to the port, VPI and VCI.

Typically a trace will proceed from the trace source interface, through the trace source node, and then progress towards the trace destination node as trace 1 in figure 2 illustrates. If however the NE supports the option that enables the NMS to choose the direction of the trace, there is also another possibility. The trace may then as an alternative go directly out of the trace source node from the trace source interface (as trace 2 in figure 2 illustrates). If the latter optional requirement (O-CT-4) is not supported, the trace shall always be performed according to the (CR)-CT-3 below.

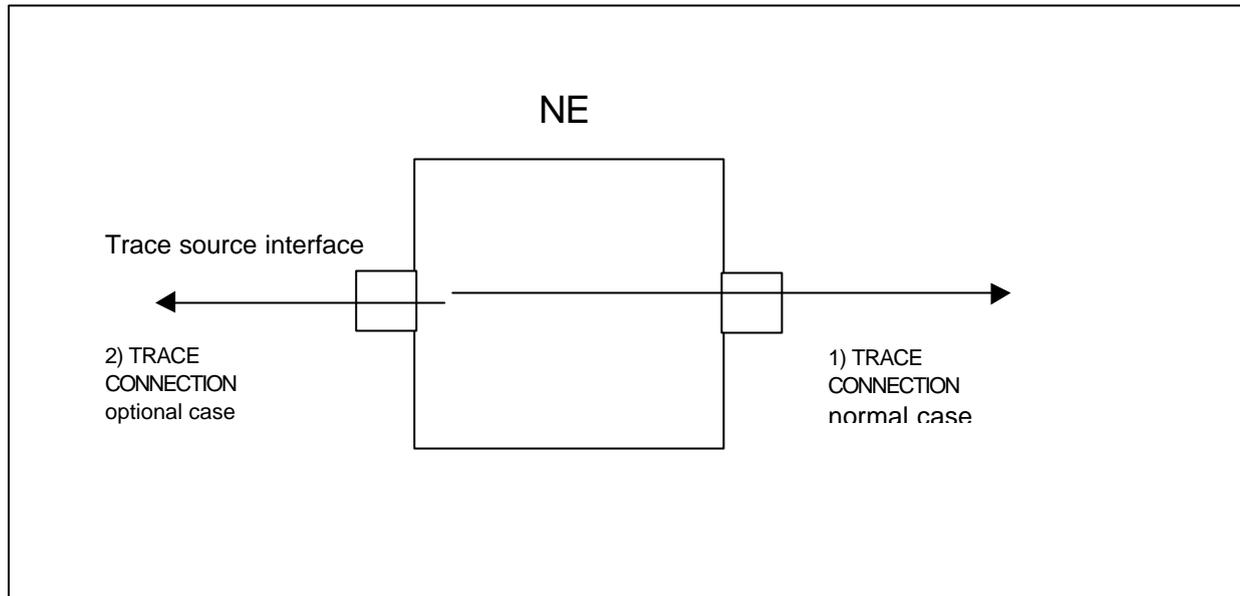


Figure 2: Examples of connection traces in different directions

- (CR)-CT-3 The connection trace shall when activated be performed from the starting point through the start node and towards the remote end of the connection (see figure 2). The starting point for a signalled connection (SVC) trace is any interface through which the SVC is routed. The starting point for a Soft PVC trace could either be the originating or terminating interface of the SPVC or it could be an intermediate interface through which the SPVC is routed.
- (O)-CT-4 It should be possible to specify in which direction a trace on an established connection shall be performed. Either into and through the starting NE or out of the starting NE.
- (R)-CT-5 There shall be a trace identifier that uniquely identifies each connection trace. This identifier shall be presented in the trace result. The trace identifier makes it possible to identify the trace when several trace results have been produced for the same connection.
- (R)-CT-6 The trace result shall apart from the trace identifier contain attributes that identify the connection that is traced upon. The connection could be identified through the port identifier, VPI and VCI of at the trace starting point. In case of point-to-multipoint it shall be possible to find a specific leaf trace. This could be done through the use of the 'End point reference' in addition to the port, VPI and VCI.

When performing a connection trace there are several different trace options that may be selected. Only the selected options will be presented in the trace result. The possible trace options are:

- Tracing of VPI/VCI values (and DLCI if present) (Mandatory)
- Tracing of 'Call reference' values (Mandatory)

- (R)-CT-7 It should be possible to configure if a VPI/VCI trace shall be performed or not. If VPI/VCI trace has been specified the VPIs (and VCIs) used by the traced connection shall be available through the trace result. The VPI/VCI trace option shall also activate the tracing of DLCI values (if present).
- (R)-CT-8 It shall be possible to configure if a 'Call reference' trace shall be performed or not. If a 'Call reference' trace has been specified the 'Call references' used by the traced connection shall be available through the trace result.

It shall be possible to trace a VC and optionally a VP connection. In addition to this it is also desirable to be able to optionally trace CO-BI (Connection oriented bearer independent) and frame relay connections. The CO-BI connections don't have any associated VPI/VCI along the established path.

- (R)-CT-9 It shall be possible to trace an established connection of any of the following types:
- VC connection (mandatory)
 - VP connection (optional)
 - CO-BI connection (optional)
 - Frame relay connection (optional)

The starting point of a trace could either be specified by the interface identifier, VPI and VCI as described in (R)-CT-2 or as interface identifier and call reference according to the requirement (O)-CT-10. The possibility to use the call reference is mandatory if trace of CO-BI connections is supported.

- (O)-CT-10 It should be possible to point out the starting point of a trace by using the call reference as an alternative to the VPI/VCI (see (R)-CT-2). This is mandatory if trace of CO-BI connections is supported.
- (O)-CT-11 When tracing on frame relay connections is supported and a trace upon an existing frame relay connection is performed; it shall be possible to point out the DLCI at the starting point of the trace as an alternative to the VPI and the VCI or the Call reference.

The NMS shall optionally have the possibility to set a timer, when doing a connection trace, that specifies after how long time a connection trace is considered to have failed. The reason for this timer is that the TRACE CONNECTION messages don't have the same timer supervision as the normal messages (e.g. SETUP) that are used at a test call trace or at an automatic path trace.

- (O)-CT-12 When tracing upon an existing connection it shall be possible to define a timer that specifies after how long time a connection trace shall be considered to have failed. Upon expiry of this timer a notification indicating 'end of trace' shall be sent (if notifications have been specified).

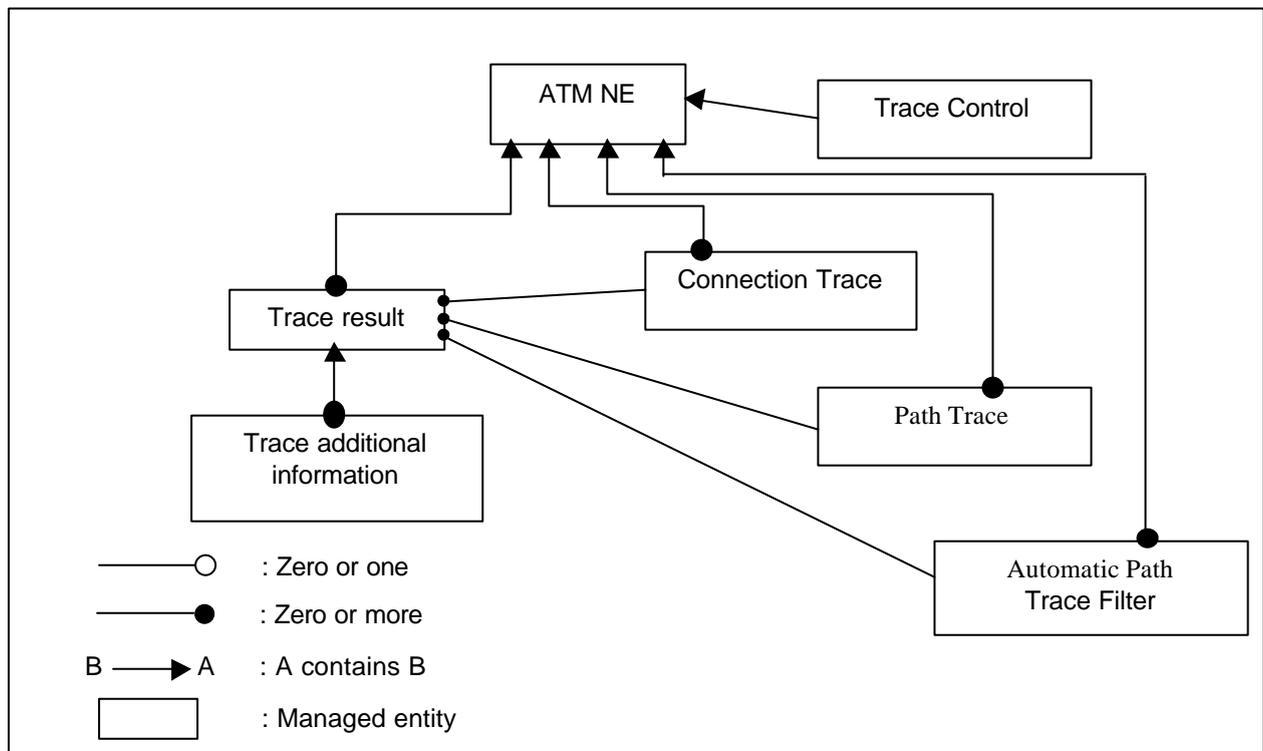
The management system shall have the possibility to perform a simplified restart (repetition) of a trace. The restart action is performed towards an already configured Connection Trace managed entity. A new trace will be performed with the same trace data as was initially specified when the trace was configured.

(R)-CT-13 An individual connection trace shall be possible to restart. A restart of the trace means that a new trace shall be performed with the same trace data as has been earlier configured in the Connection Trace managed entity.

7. Logical MIB

The figure below illustrates the relations between the different managed entities for connection and path tracing. The Trace Control managed entity is used to initiate any of the three different types of traces. The result of each trace will be presented through the Trace Result managed entity. An instance of the Trace Result managed entity will be created for each performed trace. Each Trace Result instance will have a set of Trace Additional Information managed entity instances associated with it. There will be one instance of the Trace Additional Information per NE that is traversed by the trace. This is true also for the first NE. (See figure 4).

Figure 3: Managed entity relationship diagram



7.1 ATM Network Element

This managed entity is defined in the M4 NE View Requirements and Logical MIB [3]. It is used here to establish a containment relation for managed entities associated with the trace operations.

7.1.1 Relationships

The ATM NE managed entity contains one or more instances of the following:

- Trace control
- Path trace
- Connection trace
- Automatic path trace filter
- Trace result
- Trace additional information

7.2 Trace Control

This managed entity is used to initiate connection and path traces. It also contains the global settings associated with path and connection trace.

7.2.1 Attributes

Trace destination port

This attribute which shall be settable per PNNI interface defines if the interface shall be a trace destination point for a connection or path trace or not. The attribute could be used towards nodes that do not support path tracing. Default value for the attribute is false (Read-write)

Automatic path trace control

This attribute, which is valid for the whole NE, specifies if automatic path trace shall be performed or not. If the automatic path trace is turned off, the Automatic Path Trace Filter managed entities will still remain but no automatic tracing will be performed. (Read-write)

Maximum number of trace requests

This attribute specifies the maximum number of concurrent trace requests that may be invoked towards a NE from an NMS. The maximum number of trace requests may be defined as unlimited (Read-only)

Available number of trace request

This attribute specifies the available number (before the maximum number of trace requests is reached) of concurrent trace requests that may be invoked towards a NE from an NMS (Read-only)

Maximum trace transit list size

This attribute specifies the maximum length (in octets) of the 'trace transit list' information element accepted by this NE. The range of this parameter is 1466 to 65535. Default value is 1466. (Read-write)

7.2.2 Actions

Initiate path trace

This action will create an instance of the Path Trace managed entity and start a trace on the indicated called party number. The input data needed for initiating the path trace is:

- Trace owner
- Cast type
- Connection kind
- Source interface
- Traced called party number
- Traced calling party number
- Traffic contract
- Trace crankback
- Trace VPI/VCI
- Trace call reference
- Clear call at destination
- Pass Along Indicator
- Point-to-multipoint New Connection
- Source VPI
- Source VCI
- Age Timeout
- Notification control

For a description of the attributes above see section 7.4.1.

Initiate connection trace

This action will create an instance of the Connection Trace managed entity and start a trace on the indicated connection. The input data needed for initiating the connection trace is:

- Trace owner
- Connection kind
- Source interface
- Source VPI
- Source VCI
- Source DLCI
- Source Call Reference
- Source End Point Reference
- Trace VPI/VCI
- Trace call reference
- Trace direction
- Pass Along Indicator
- Age Timeout
- Trace failure timer

- Notification control

For a description of the attributes above see section 7.5.1.

Initiate automatic path trace filtering

This action will create an instance of the Automatic Path Trace Filter managed entity and begin filtering calls according to the specified filtering criteria. The input data needed for initiating the automatic path trace filter is:

- Trace owner
- Trace crankback
- Trace VPI/VCI
- Trace call reference
- Clear call at destination
- Incoming interface filter
- Outgoing interface filter
- Called party number prefix filter
- Calling party number prefix filter
- Connection kind filter
- Cast type filter
- Service category filter
- Pass Along Indicator
- Age Timeout
- Stop Timeout
- Record Countdown
- Maximum number of records
- Notification control

For a description of the attributes above see section 7.3.1.

7.3 Automatic Path Trace Filter

This managed entity specifies a set of filtering criteria that will, if matched at a connection setup, result in an automatic path trace.

7.3.1 Attributes

Managed entity id

This attribute provides a unique name for the managed entity instance in the NE.

Trace filter on/off

This attribute enables the management system to turn filtering on or off for a particular Automatic Path Trace Filter. If turned off, the filter will still remain but will be inactive (Read-write)

Trace owner

This attribute identifies the entity that configured this filter (Read-write).

Trace crankback

This attribute specifies if crankbacks shall be tested at an automatic trace or not (Read-write).

Trace VPI/VCI

This attribute defines if VPI/VCI (and DLCI) tracing shall be performed at a trace or not (Read-write)

Trace call reference

This attribute defines if call reference (and EPR) tracing shall be performed at a trace or not (Read-write)

Clear call at destination

This attribute specifies if the traced call shall be cleared automatically by the network upon reaching the trace destination node or not (Read-write).

Incoming interface filter

This parameter specifies for which incoming interface automatic tracing shall be performed. If an incoming interface has been specified all calls that enter the NE at this interface will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Outgoing interface filter

This parameter specifies for which outgoing interface automatic tracing shall be performed. If an outgoing interface has been specified all calls that leave the NE at this interface will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Called party number prefix filter

This parameter specifies for which 'called party number' prefix automatic tracing shall be performed. If a 'called party number' prefix has been specified all calls that have 'called party numbers' that match this prefix will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Calling party number prefix filter

This parameter specifies for which 'calling party number' prefix automatic tracing shall be performed. If a 'calling party number' prefix has been specified all calls that have 'calling party numbers' that match this prefix will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Connection kind filter

This parameter specifies for which 'connection kind' automatic tracing shall be performed. If a 'connection kind' filter has been specified all calls that have a 'connection kind' that match this filter will be traced (if the other filter criteria are met). The possible values for the 'connection kind' parameter are listed in section 5.1. The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Cast type filter

This parameter specifies for which 'cast type' (point-to-point or point-to-multipoint) automatic tracing shall be performed. If a 'cast type' filter has been specified all calls that have a 'cast type' that match this filter will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Service category filter

This parameter specifies for which 'service category' (cbr, rt-vbr, nrt-vbr, abr, ubr, gfr) automatic tracing shall be performed. If a 'service category' filter has been specified all calls that have a 'service category' that match this filter will be traced (if the other filter criteria are met). The parameter may be set to 'don't care' meaning that this filter criterion is not used. (Read-write)

Pass Along Indicator

Specifies if the path trace shall be passed transparently through nodes not supporting path tracing or not (Read-write).

Age Timeout

Specifies how long time in seconds this filter will be existing. When the timer expires this managed entity and the corresponding Trace Result and Trace Additional Information managed entities will be deleted. An infinite value for the timer may be specified (Read-write).

Stop Timeout

Specifies how long time in seconds this filter will be active. When the timer expires filtering will be stopped for this managed entity. The Trace Result and Trace Additional Information managed entities will be kept when filtering has stopped. An infinite value for the timer may be specified (Read-write).

Record Countdown

Number of records left to be collected before filtering will be stopped for this entity. This attribute is set at filter creation and counted down by one for each performed trace triggered by this filter. When the counter reaches zero filtering will be stopped. (Read-write)

Maximum number of records

Specifies the maximum number of trace result records that will be stored on the behalf of this filter. When the maximum number of records is reached new trace results will replace the oldest ones. The number of records may be defined as unlimited. (Read-write).

Number of matches

The number of call set-ups that have matched the filtering criteria of this filter since it was created.
(Read-only)

Notification control

This parameter indicates if a notification shall be sent or not for a trace that is performed as a result of this filter. The NE will automatically disable notifications for the filter when a notification has been sent. The NMS thus has to set this parameter to enable again to get a new notification. (Read-write)

7.3.2 Actions

Purge performed traces

This action will delete all the Trace Result managed entities that have been created as a result of this filter.

7.3.3 Notifications

Automatic trace notification

This notification will be sent when a trace has been performed as a result of a call set-up matching a trace filter that has notifications enabled. The notification contains information that enables the NMS to identify the performed trace.

7.3.4 Relationships

Each Automatic Path Trace Filter managed entity will be related to zero, one or several Trace Result managed entities (one result for each automatic trace).

7.4 Path Trace

This managed entity is used to activate a manual path trace (test call). This managed entity is either deleted by the management system or upon expiry of a timer. When a path trace (test call) is made that is requested to stay up, the call will be released when this managed entity is deleted.

7.4.1 Attributes

Managed entity id

This attribute provides a unique name for the managed entity instance in the NE.

Trace owner

This attribute identifies the entity that configured this trace(Read-write).

Cast type

The cast type (point-to-point or point-to-multipoint) of the connection that shall be tested
(Read-write).

Connection kind

The connection kind of the test call: VP connection, VC connection, CO-BI (connection oriented bearer independent) connection or frame relay connection. (Read-write)

Source interface

The interface at which the manual path trace shall start (Read-write).

Traced called party number

This attribute contains the called party number to do a path trace upon (Read-write)

Traced calling party number

This attribute contains the calling party number to do a path trace upon (Read-write)

Traffic contract

The traffic contracts (traffic descriptors) to use for the forward and backward direction when performing the path trace (Read-write).

Trace identifier

This attribute uniquely identifies the performed trace. The identifier will be assigned by the network element when this managed entity is created (Read-only).

Trace crankback

This attribute specifies if crankbacks shall be tested by the test call or not (Read-write).

Trace VPI/VCI

This attribute defines if VPI/VCI (and DLCI) tracing shall be performed at a trace or not (Read-write)

Trace call reference

This attribute defines if call reference (and EPR) tracing shall be performed at a trace or not (Read-write)

Clear call at destination

This attribute specifies if the test call shall be cleared automatically by the network upon reaching the trace destination node or not (Read-write).

Pass Along Indicator

Specifies if the path trace shall be passed transparently through nodes not supporting path tracing or not (Read-write).

Point-to-multipoint New Connection

This attribute specifies if a new connection (root) shall be created for a point-to-multipoint trace. If this attribute is set to false the trace shall be performed upon an existing point-to-multipoint connection (Read-write).

Source VPI

Indicates one of the following:

- ◆ the VPI of an existing point-to-multipoint root at the source interface when a path trace on a new party (leaf) is initiated
- ◆ the VPI to be used at the source interface if a test call is to be left up (when automatic clearing of the call not has been requested)

(Read-write).

Source VCI

Indicates one of the following:

- ◆ the VCI of an existing point-to-multipoint root at the source interface when a path trace on a new party (leaf) is initiated
- ◆ the VCI to be used at the source interface if a test call is to be left up (when automatic clearing of the call not has been requested)

(Read-write).

Age Timeout

Specifies how long time in seconds this managed entity will be existing. Upon expiry of this timer this entity and corresponding Trace Result and Trace Additional Information managed entities will be deleted. An infinite value for the timer may be specified (Read-write).

Notification control

This parameter indicates if a notification shall be sent or not upon completion of the test call (Read-write)

7.4.2 Actions

Restart tracing

Specifies that the tracing shall be restarted. Any old tracing is cleared (released) an a new tracing is performed with the same parameters.

7.4.3 Notifications

Test call notification

This notification will be sent when test call trace has been performed (if the NMS enabled notifications when ordering the test call). The notification contains information that enables the NMS to identify the performed trace.

7.4.4 Relationships

Each Path Trace managed entity will be related to zero, one or several Trace Result managed entities. One Trace Result will be produced for each path trace performed (A new Trace Result will be created when the *Restart tracing* action is executed).

7.5 Connection Trace

This managed entity is used to activate a connection trace. This managed entity is either deleted by the management system or upon expiry of a timer.

7.5.1 Attributes

Managed entity id

This attribute provides a unique name for the managed entity instance in the NE.

Trace owner

This attribute identifies the entity that configured this trace(Read-write).

Connection kind

The connection kind of the connection to trace upon: VC connection, VP connection, CO-BI connection or frame relay connection (Read-write)

Source interface

The identifier of the originating interface from which the connection trace shall start.
(Read-write)

Source VPI

The VPI value (if VPI/VCI trace) at the originating interface from which the connection trace shall start.
(Read-write)

Source VCI

The VCI value (if VPI/VCI trace and a VC connection) at the originating interface from which the connection trace shall start. (Read-write)

Source DLCI

The DLCI value (if VPI/VCI trace and a frame relay connection) at the originating interface from which the connection trace shall start. (Read-write)

Source Call Reference

The 'Call reference' value (if call reference trace) at the originating interface from which the connection trace shall start. If a CO-BI connection is traced this parameter holds the CO-BI call reference (Read-write)

Source End Point Reference

The 'End point reference' value (if call reference trace) at the originating interface from which the connection trace shall start. This may be the leaf reference if an SPVC originating connection is traced.
(Read-write)

Trace identifier

This attribute uniquely identifies the performed trace. The identifier will be assigned by the network element when this managed entity is created (Read-only).

Trace VPI/VCI

This attribute defines if VPI/VCI (and DLCI) tracing shall be performed at a trace or not (Read-write)

Trace call reference

This attribute defines if 'Call reference' (and 'End point reference') tracing shall be performed at a trace or not (Read-write)

Trace direction

This parameter indicates the direction of the connection trace. Into and through the NE from the trace starting point or directly out of the NE at the trace starting point (Read-write)

Pass Along Indicator

Specifies if the connection trace shall be passed transparently through nodes not supporting connection tracing or not (Read-write).

Age Timeout

Specifies how long time in seconds this managed entity will be existing. Upon expiry of this timer this entity and the corresponding Trace Result and Trace Additional Information managed entities will be deleted. An infinite value for the timer may be specified (Read-write).

Trace failure timer

This parameter specifies after how long time in seconds a connection trace shall be considered to have failed if no TRACE CONNECTION ACK has been received. Default value is 30 seconds (Read-write)

Notification control

This parameter indicates if an notification shall be sent or not upon completion of this connection trace (Read-write)

7.5.2 Actions

Restart tracing

Specifies that the tracing shall be restarted. A new tracing is performed with the same parameters.

7.5.3 Notifications

Connection trace notification

This notification will be sent when a trace has been performed as a result of an ordered connection trace (if the NMS enabled notifications when performing the connection trace). The notification contains information that enables the NMS to identify the performed trace.

7.5.4 Relationships

Each Connection Trace managed entity will be related to zero, one or several Trace Result managed entities. One Trace Result will be produced for each connection trace performed (A new Trace Result will be created when the *Restart tracing* action is executed).

Trace status

Trace status according to [1] (trace in progress, trace completed normally, trace incomplete etc.) (Read-only).

Connection kind

The connection kind for which the trace was performed:
SVC or SPVC not initiator, SPVC initiator, SVP or SPVP not initiator, SPVP initiator,
CO-BI connection (connection oriented, bearer independent) (Read-only).

Service Category

The service category of the connection for which the trace was made: cbr, vbr-nrt, vbr-rt, ubr, abr or
gfr (Read-only).

Cast type

The cast type of the connection that was traced upon: point-to-point or point-to-multipoint (Read-only)

Incoming interface

The interface at which the trace started in this NE (Read-only).

Outgoing interface

The interface to which the trace progressed in this NE (Read-only).

Release cause

The release cause that was received at a manual path trace failure. The cause could either be a normal
release cause or a crankback cause (Read-only).

Release diagnostics

The release diagnostics that was received at a manual path trace failure. The diagnostics could either be
a normal release diagnostics or crankback diagnostics (Read-only).

Traced called party number

This attribute contains the called party number for which the trace was performed (if a path trace).
(Read-only)

Traced calling party number

This attribute contains the calling party number for which the trace was performed (if an automatic path
trace). (Read-only)

Source interface

This parameter identifies the interface in the node where the trace started (Read-only).

Destination VPI

This parameter identifies the VPI at the terminating interface in the trace destination node. The parameter is only present if VPI/VCI trace has been selected. (Read-only).

Destination VCI

This parameter identifies the VCI at the terminating interface in the trace destination node. The parameter is only present if VPI/VCI trace has been selected and if a VCC connection is traced (Read-only).

Source DLCI

This parameter identifies the DLCI at the originating interface in the node where the trace started. The attribute is only set if frame relay is used and if VPI/VCI tracing has been selected. (Read-only).

Destination Call Reference

This parameter identifies the Call reference at the terminating interface in the trace destination node. The parameter is only present if call reference trace has been selected. (Read-only).

Destination End Point Reference

This parameter identifies the EPR at the terminating interface in the trace destination node. The parameter is only present if call reference trace has been selected and the connection is of point-to-multipoint type (Read-only).

Destination DLCI

This parameter identifies the DLCI at the terminating interface in the node where the trace terminates. The attribute is only set if frame relay is used and if VPI/VCI tracing has been selected. (Read-only).

Time stamp

Time stamp taken when the trace was performed. (Read-only).

7.6.2 Relationships

Each Trace Result managed entity will be related to one and only one instance of the following managed entities:

- Automatic Path Trace Filter
- Path Trace
- Connection Trace

The trace result will contain one or several of the Trace Additional Information entities. One Trace Additional Information entity will be created for each NE traversed by a trace.

7.7 Trace Additional Information

Instances of this managed entity are created automatically as a result of a performed trace. One instance of this entity is created for each node (NE) involved in a trace, including the first NE (see figure 4). Each Trace Additional Information instance will be related to only one instance of the Trace Result. All instances are stored in the node where the trace was started.

7.7.1 Attributes

Managed entity id

This attribute provides a unique name for the managed entity instance in the NE

Trace identifier

Identifies the performed trace. This was assigned by the NE when the trace was initiated (Read-only).

Additional information sequence index

An integer that identifies this specific instance of the additional information. This attribute will be incremented by one for each node within a trace (Read-only).

Node identifier

The identity of the logical node traversed by the trace (Read-only).

Outgoing port identifier

An identifier of the logical (PNNI) port, at the preceding side of an interface, which was used to progress the call towards the called party. For the trace destination port another identifier may be used if not PNNI (Read-only).

Incoming VPI

The VPI value used at the succeeding side of the interface indicated by the logical port parameter in the Trace Additional Information managed entity preceding this one (unless there are gaps in trace result data). If this Trace Additional Information entity is 'belonging to' the trace source node the parameter indicates the VPI at the source interface. The parameter is only present if VPI/VCI trace has been selected. (Read-only).

Incoming VCI

The VCI value used at the succeeding side of the interface indicated by the logical port parameter in the Trace Additional Information managed entity preceding this one (unless there are gaps in trace result data). If this Trace Additional Information entity is 'belonging to' the trace source node the parameter indicates the VCI at the source interface. The parameter is only present if VPI/VCI trace has been selected and if the connection is of VCC type (Read-only).

Incoming Call Reference

The Call Reference value used at the succeeding side of the interface indicated by the logical port parameter in the Trace Additional Information managed entity preceding this one (unless there are gaps

in trace result data). If this Trace Additional Information entity is 'belonging to' the trace source node the parameter indicates the Call reference at the source interface. The parameter is only present if call reference trace has been selected. (Read-only).

Incoming End Point Reference

The End Point Reference value used at the succeeding side of the interface indicated by the logical port parameter in the Trace Additional Information managed entity preceding this one (unless there are gaps in trace result data). If this Trace Additional Information entity is 'belonging to' the trace source node the parameter indicates the 'End point reference' at the source interface. The parameter is only present if call reference trace has been selected and if the connection is of point-to-multipoint type (Read-only).

Trace refusal indicator

Indicates whether the node identified by the 'Node identifier' refused to participate in the trace. The value of the attribute is 'true' or 'false' (Read-only)

Crankback received at destination

Indicates whether a crankback was received at the node identified by the 'Node identifier', when that node is the trace destination node and the trace destination interface is a non-PNNI interface. The value of the attribute is 'true' or 'false' (Read-only)

Crankback gap

Indicates that the trace was propagated beyond the node identified by the 'Node identifier', but was cranked back, and no trace information was returned by the node initiating crankback. The value of the attribute is 'true' or 'false' (Read-only)

Crankback indicator

Indicates whether crankback information is present after the node identified by the 'Node identifier', but before the next node identified in the 'trace transit list' information element as defined in [1]. The value of the attribute is 'true' or 'false' (Read-only)

Crankback blocked transit type

If the value of the 'Crankback indicator' is true, this attribute will indicate the type of blockage in the case of a blocked call at the node identified by the 'Node identifier'. Valid values of the attribute are 'blocked incoming link', 'blocked node' or 'blocked outgoing link'. The attribute has no defined value if the value of the 'Crankback indicator' attribute is 'false'. (Read-only).

Crankback blocked transit information

If the value of the 'Crankback indicator' is true, this attribute includes the contents of the 'blocked transit trace information' field from the 'trace transit list' information element specified in [1]. The attribute has no defined value if the value of the 'Crankback indicator' attribute is 'false'. (Read-only).

Crankback cause

If the value of the 'Crankback indicator' is true, this attribute will indicate the 'crankback cause' value. The attribute has no defined value if the value of the 'Crankback indicator' attribute is 'false'. (Read-only).

7.7.2 Relationships

Each Trace Additional Information managed entity will be related to one instance of the Trace Result managed entity.

8. References

- [1] af-cs-0141.000, PNNI addendum for Path and Connection Trace Version 1.0
- [2] af-pnni-0066.000, PNNI version 1.0 addendum, Soft PVC MIB
- [3] af-nm-0020.001, M4 Interface Requirements and Logical MIB