



Core Information Model (CoreModel)

TR-512.9

OAM

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This Technical Recommendations has been approved by the Project TST, but has not been approved by the ONF board. This Technical Recommendation is an update to a previously released TR specification, but it has been approved under the ONF publishing guidelines for 'Informational' publications that allow Project technical steering teams (TSTs) to authorize publication of Informational documents. The designation of '-info' at the end of the document ID also reflects that the project team (not the ONF board) approved this TR.

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Document History

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1.6	January 2024	Initial version

1 Introduction to the document suite

This document is an addendum to the TR-512 ONF Core Information Model and forms part of the description of the ONF-CIM. For general overview material and references to the other parts refer to [TR-512.1](#).

1.1 References

For a full list of references see [TR-512.1](#).

1.2 Definitions

For a full list of definition see [TR-512.1](#).

1.3 Conventions

See [TR-512.1](#) for an explanation of:

- UML conventions
- Lifecycle Stereotypes
- Diagram symbol set

1.4 Viewing UML diagrams

Some of the UML diagrams are very dense. To view them either zoom (sometimes to 400%), open the associated image file (and zoom appropriately) or open the corresponding UML diagram via Papyrus (for each figure with a UML diagram the UML model diagram name is provided under the figure or within the figure).

1.5 Understanding the figures

Figures showing fragments of the model using standard UML symbols as well as figures illustrating application of the model are provided throughout this document. Many of the application-oriented figures also provide UML class diagrams for the corresponding model fragments (see [TR-512.1](#) for diagram symbol sets). All UML diagrams depict a subset of the relationships between the classes, such as inheritance (i.e. specialization), association relationships (such as aggregation and composition), and conditional features or capabilities. Some UML diagrams also show further details of the individual classes, such as their attributes and the data types used by the attributes.

1.6 Introduction to the OAM model

This document describes a general model of OAM suitable for representation of the capabilities that relate to monitoring the network and for representation of the relationship to the model of the network from the monitoring perspective.

A data dictionary that sets out the details of all classes, data types and attributes is also provided ([TR-512.DD](#)).

2 Operations, Administration and Maintenance (OAM)

This document focuses on OAM. This version provides a relatively high-level overview of OAM and relates to more detailed work on some key aspects of the overall OAM solution in other documents.

2.1 Background

For a network to operate successfully and to deliver on the agreed contracts (intents) it is necessary to have appropriate closed loop control.

Whilst control can be manual, the focus in this work is automation¹ in the context of the Management-Control Continuum as discussed in [TR-512.8](#). Automated closed loop control can be summarized in terms of five distinct capabilities (stages) [IEEE SYSOPT]:

- Sense: Detect changes in properties of the system.
- Discern: Measure, analyse and evaluate those properties and project the insights into the terminology of the intent
- Infer: Determine whether the intent is being met by the system and if not direct assessment of necessary action
- Decide: Assess and evaluate possible actions to recover the intent and decide on the specific action in conjunction with the Infer capability
- Act: Coordinate the required actions to maintain the intent

The whole control cycle, "closing the loop" to ensure successful ongoing realization of intent (assurance, maintenance), is discussed in [TR-512.8](#). From the perspective of this ONF model, OAM² covers measurement, i.e., elements of Sense and Discern.

Solution capabilities are designed to measure to:

- Validate integrity
- Identify and alert of problems in terms of the realization of intents
- Generate trigger for problem resolution and recovery of support of the intent

On this basis, OAM can be considered in this model as the representation of the:

- Sensors/detectors
- Process of activation of measurements
- Sensor/measurement data
- Process of reporting of sensor/measurement data
- Process of analysis of outputs from those sensors/measurements (to provide a view of impact in terms of intent)
- Analysis results
- Process of reporting of analysis results

¹ Some longer-term control loops will continue to be manual in nature for some time due to the complex analysis and lack of suitably sophisticated tooling.

² The term OAM has many inconsistent formal and informal definitions in the industry. A specific narrow definition is used in this document. Administration is discussed in [TR-512.A.15](#).

The reporting of sensor data, measurement data and analysis results is considered in terms of streaming as discussed in [TR-512.8](#).

Details of the specific process of analysis are outside the scope of this modeling activity. A generalized task is described in [TR-512.8](#) which can be used as a framework to describe each of the processes required (including those listed above).

This document focusses on the representation of:

- Sensors
- Sensor/measurement data
- Analysis results

It is important to recognize that a sensor may be sophisticated and may perform a complex analysis and that some sensors will also be assessed for the correct operation such that the sensor operational characteristics are measured, i.e., there are sensors on the sensor. As a consequence, the problem is, as usual, somewhat recursive/fractal.

Measurements taken will be considered at various levels of abstraction and in terms of timeframes, scopes and spans:

- Whole network scope
- Single equipment scope
- Long term assessment
- Short term assessment (to trigger recovery)
- Etc.

The determination of specific measurements for specific purposes and the processing of those measurements is outside the scope of this document. Measured signal characteristics could include those that relate to signal quality (shape etc.) such as:

- Delay
- Errors
- Repeats
- Etc.

The measurement may assess the integrity of the:

- Bit stream
- Frame structure
- Source identifier
- Etc.

Taking and assessing a measurement uses resources and hence has a cost. This must be exceeded by the value of the measurement to the analysis and successful maintenance of intent etc. for it to be worthwhile taking the measurement.

Often, vital measurements are taken regularly over very short periods. This leads to vast volumes of data and a requirement for the transfer of information on the measurement to be efficient and reliable.

Setting up and activating measurements in any particular context is outside the scope of this document.

Measurements of signals take place when processing the structure or content of a signal.

A measurement may be non-intrusive in that it does not disrupt the ongoing flow of the signal or the ongoing functionality related to the processing of the information. Some measurements are made on specific data added to the flow to enable measurement, other measurements are made on the natural flow itself.

Considering the models in TR-512, signal processing takes place primarily in the LTP. Assessment of the essence of the information carried by a signal takes place in the PC and also in specialist functional entities such as the CC.

3 The Model

This section discusses how the existing model can be used to represent the structures of OAM discussed in the previous section.

3.1 Traditional models

Models of detectors that measure some aspects of a signal have tended to split into two different forms. Those that consider the detector as:

1. An integral part of the traffic termination function (e.g., an SDH frame error counter)
2. Part of a dedicated detector function (e.g., an Ethernet MEP) separate from the traffic termination function

Clearly, regardless of the position of the detector in the model it is necessary to terminate the whole signal or part of that signal so as to measure some aspect of it.

Some measurements:

- a. Are on the fundamental signal of transmission (e.g., frame alignment error counter)
- b. Are of some additional aspect of the signal designed to enable assessment of signal integrity (e.g., error measurement, which require some additional coding to enable error detection)
- c. Require dedicated additional signals (e.g., SDH Trail Trace which requires an additional framed structure).

Where the detectors are considered as an integral part (1) above, measurements of type (c) above require a complex "termination in termination" structure.

3.2 Core OAM modeling

3.2.1 Termination aspect

As has been discussed in [TR-512.7](#), an LP in an LTP can:

- Be of arbitrary complexity including deep nesting of termination functions
- Encapsulate some subset of a full LP
 - Just a CP
 - Just a TCP
 - Just the adapter
 - Some other subset

A sequence of LTPs with subset LPs can be chained and connected in various ways. This versatile variable encapsulate of the LTP model allows the LTP to support both forms of detector modeling ((1) and (2) above).

A detector can be encapsulated in the LP that represents the processing of the primary signal (service/traffic/etc.) or it can be encapsulated in an LP that solely represents the termination of the measurable property where that LP is part of an LTP that is connected to the LTP that includes the LP that represents the processing of the primary signal.

Hence OAM sensors are modelled using the existing LTP class. Arrangements of LTPs can represent sensors for:

- Network Connection Monitoring (NCM) [ITU-T G.805] – basic monitoring of normal terminations
- Intermediate non-intrusive monitoring [ITU-T G.805] – taking a copy/portion of the signal and terminating it to assess its characteristics
- Tandem Connection Monitoring (TCM) [ITU-T G.805]
- Maintenance signal monitoring (using MEPs and MIPs) [ITU-T G.8013]
- Deep inspection – A generalized form of deep packet inspection (see [ITU-T Y.2771] and associated documents)

Specific OAM mechanisms can be represented using the generalized task model as set out in [TR-512.8](#) and can be reported using the streaming approach also set out in [TR-512.8](#). The task model and reporting method can be used to represent measurements that are:

- Ongoing
- Periodic
- Occasional (snapshot)
- ...

In general, the arrangements of the LP content of each LTP is represented via specifications as described in [TR-512.7](#).

[TR-512.2](#) provides a description of non-intrusive monitoring showing multiple terminations in a single LTP. A figure from [TR-512.2](#) has been adapted to apply to a simple monitoring case below.

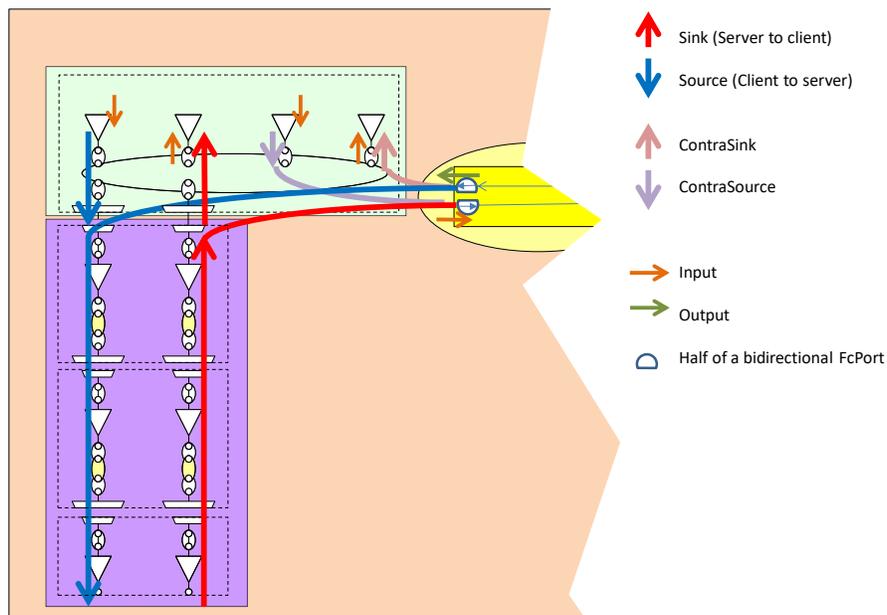


Figure 3-1 Showing monitors and signal sources

In the figure the sink terminations (triangles) in the green LTP terminate and measure a copy of the received signal. These terminations have a role related to monitoring as explained in their specification.

In the green LTP there are also source terminations. These terminations only inject a component of the signal related to monitoring (maintenance signaling data). When active, this data is sent to the adapter (the trapezoid under the termination) for it to substitute that data for the corresponding data passing from the connection.

For example, consider a MIP measurement. The output from the FC (green arrow) passes both to the contra-sink of the green LTP and to the purple LTP. In the contra-sink only processes the MIP signaling data.

There can be multiple MIP functions, in which case there would be multiple termination functions inside the green LTP, each uniquely identified within the LTP.

In the example described above the monitoring capability and the traffic capability are encapsulated in the same LTP (i.e., are "An integral part of the traffic termination function." as discussed in section 3.1 Traditional models on page 9).

It is also possible to separate out the monitoring capabilities from the normal traffic termination (to become "Part of a dedicated detector function." (again, as discussed in section 3.1 Traditional models on page 9)). The following figure show an example of separation of monitoring and traffic termination.

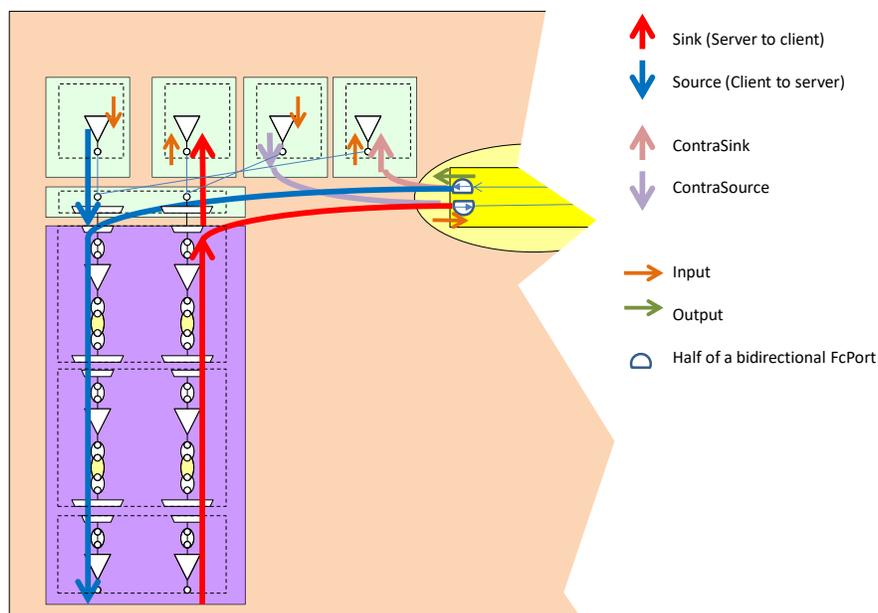


Figure 3-2 Separate monitors and signal sources

The measurements can be taken on functions that are always exposed and part of the general model or on functions that are only occasionally exposed under certain analysis scenarios (spotlight).

Key considerations when modeling the terminations related to measurement are:

- Signal granularity
- Measurement domain demarcation

3.2.2 Flow aspect

When considering TCM and MEP/MIP solutions, there are flows of signaling between the monitoring termination. These flows can be represented using FCs where an FC defines the measurement span.

Further explanation will be provided in a future release of this document.

3.3 Measurement of multiple flows

Some measurements will be performed on multiple flows in aggregate. To model this requires separate LTPs (for monitoring) connected to the traffic LTPs via FCs.

Further explanation will be provided in a future release of this document.

3.4 OAM and measurement lifecycle

As noted earlier, the underpinning structure of the model in this area is covered by [TR-512.8](#). This underpinning structure includes modeling of tasks and profiles.

The specific measurement tasks will deal with coordination of:

- Configuration of detectors
- Activation of detectors
- Collection of results
- Deactivation of the detectors
- Etc.

The measurement process will include:

- Event detection
- Counting
- Thresholding
- Further counting of threshold crossings
- Etc.

The reporting process may include mechanisms such as:

- Same value suppression
- Expected trend suppression

Reporting of information may include:

- Streaming³ of measurements

³ Details of streaming are provided in [TR-512.8](#).

- Streaming of alerts of significant changes

The processing of measurement data will include:

- Long term storage
- Analysis
- Interpretation
- Expression of problems, impacts, resolutions
- Etc.

All of the above will be detailed in a future version of this document.

4 Further considerations

Determination of what to measure is outside the scope of the Core Model and is dependent on network technology and application of that technology.

In a running solution it is the responsibility of ControlConstructs to define and coordinate measurement as defined by ControlTasks ([TR-512.8](#)).

Measurement duration and scheduling can be defined using the temporal model as defined in [TR-512.18](#).

Storage can build on the model of Compute ([TR-512.15](#)) and the Log Record model defined in streaming (in [TR-512.8](#)). Further work is required in this area.

5 Future considerations

5.1 Maintenance signal flow

Further explain the use of the FC to represent maintenance signal flow.

5.2 Measurement of multiple flows

Further explain the representation of measurement of multiple flows using LTP and FC.

5.3 OAM and measurement lifecycle

Expand on explanation of OAM lifecycle.

5.4 Storage considerations

Develop usage of the compute model and the log record model to deal with bins etc.

5.5 Various process output forms

Develop models to support generalized representation of threshold crossing etc.

5.6 Measurement strategies

Various measurement strategies need to be explored, for example:

- Single-ended passive
- Dual-ended, one-way within frame
- Dual-ended, one-way separate packets
- Dual-ended, two-way, round trip

These are not expected to have any significant impact on the modeling approach.

5.7 OAM examples

Develop a .A.x document to cover various usages of the model described in this document.

End of document