The ATM Forum

Technical Committee

Introduction to ATM Forum Test Specifications, Version 2.0

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1. Introduction

ATM is an information transfer mechanism capable of supporting a variety of existing and future services both in public and private networking environments. One of the key success factors for deployment of any technology is standardization and ensuring interoperability among various implementations.

1.1 Purpose and Scope

This document provides a general overview of testing methodologies (conformance, performance and interoperability) and their relationship to each other. This document should be used as an updated starting point for testing ATM systems and services [11].

The original version of this document, dated December 1994 is for historical reference only. The reader is encouraged to use this updated version.

1.2 Structure of Document

This document is structured as follows:

- Section 1: Constitutes the Introduction. It describes the purpose, scope and structure of this document and introduces basic terms and abbreviations.
- Section 2: Is an overview of the methods of ATM product verification that are available to the Developer and Regulatory personnel.
- Section 3: Supplies information concerning the ICS and IXIT Proforma(s).
- Sections 4, 5 and 6: Define conformance, performance and interoperability testing.
- Section 7: Provides examples of the relationships between the three types of testing.

1.3 References

[1] ATM User-Network Interface Specification, Version 3.1, ATM Forum, September 1994

[2] ISO/IEC 9646-1: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 1: General concepts. (Also available as ITU-T Recommendation X.290 (1995))

[3] ISO/IEC 9646-2: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 2: Abstract test suite specification. (Also available as ITU-T Recommendation X.291 (1995))

[4] ISO/IEC 9646-3: 1998, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 3: The Tree and Tabular Combined Notation (TTCN). (Also available as ITU-T Recommendation X.292 (1998))

[5] ISO/IEC 9646-4: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 4: Test Realization. (Also available as ITU-T Recommendation X.293 (1995))

[6] ISO/IEC 9646-5: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 5: Requirements on test laboratories and clients for the conformance assessment process. (Also available as ITU-T Recommendation X.294 (1995))

[7] ISO/IEC 9646-6: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 6: Protocol profile testing specification. (Also available as ITU-T Recommendation X.295 (1995))

[8] ISO/IEC 9646-7: 1994, Information technology - Open Systems Interconnection -- Conformance testing methodology and framework - Part 7: Implementation Conformance Statement. (Also available as ITU-T Recommendation X.296 (1995))

[9] af-test-tm-0131.000: October, 2000. The ATM Forum, Performance Testing Specification

[10] af-test-0137.000: March, 2000. The ATM Forum, Implementation Conformance Statement (ICS) Proforma Style Guide

[11] af-test-0022.000: December, 1994. The ATM Forum, Introduction to ATM Forum Test Specifications

[12] af-nm-test-0080.000: May, 1997. The ATM Forum, Remote Monitoring MIB Extensions for ATM Networks

[13] af-test-nm-0094.000: February, 1998. The ATM Forum, ATM Test Access Function (ATAF) Version 1.0

1.4 Terminology

The following definitions are used in this document. Where appropriate, the terms are taken from ISO/IEC 9646-1 [2], X.290 of ITU-T series of Recommendations.

1.4.1 Basic Terms

1. **ATM System**: An ATM terminal equipment, an ATM network node or an ATM network.
2. **Client**: The organization that submits a system or implementation for testing.
3. **Conformance**: A property of an implementation to adhere to a specification.
4. **Executable Test Case**: A realization of an abstract test case when the execution environment is taken into account.
5. **Executable Test Suite**: A test suite composed of executable test cases.
6. **ICS**: (**Implementation Conformance Statement**) A statement made by the supplier of a system implementation, stating the capabilities and options, which have been implemented and those that have been omitted.
7. **ICS Proforma**: A document in the form of a questionnaire designed by the test suite specifier (*e.g.*, The ATM Forum) which when completed becomes the ICS.
8. **Implementation Under Test (IUT)**: The part of the system that is to be tested. This can be a physical layer implementation, a protocol, function, *etc*.
9. **Interoperability**: The ability of two or more systems or implementations to function together.

10. **IXIT**: (**Implementation eXtra Information for Testing**) A statement made by a supplier or implementer of an IUT which contains or references all of the information (in addition to that given in the ICS) related to the IUT and its testing environment, which will enable the test laboratory to run an appropriate test suite against the IUT. See Section 3.2 for details.
11. **IXIT Proforma**: A document in the form of a questionnaire provided by the test laboratory, which when completed prior to testing becomes an IXIT.
12. **Means of Testing**: The combination of equipment and procedures that can perform the selection, parameterization and preparation for executing test cases.
13. **Performance**: The behavior of a system related to time and system resources, under different traffic and load conditions.
14. **System Under Test (SUT)**: The system in which the IUT resides.
15. **Test Campaign**: The process of executing the Executable Test Suite for a particular SUT or IUT and producing a Conformance, Performance or Interoperability Log.
16. **Test Case**: A series of test steps needed to put a system or part of it into a given state to observe and describe its behavior.
17. **Test Event**: An indivisible unit of test specification (*e.g.*, sending or receiving a single PDU).
18. **Test Group**: A named set of related test cases.
19. **Test Laboratory**: An organization that carries out testing for conformance, performance and/or interoperability.
20. **Test Purpose**: A detailed description of a specific SUT or IUT area to be verified.
21. **Test Result**: The verdict obtained after executing a test case. One of the following must be used: pass, fail or inconclusive.
22. **Test Specification**: A detailed description of test case(s), their parameter(s) and result(s).
23. **Test Step**: A named subdivision of a test case, constructed from test events and/or test steps.
24. **Test Suite**: A set of individual test cases assembled in a sequence.

1.4.2 Conformance Testing Terms

1. **Abstract Test Case**: A complete and independent specification of the action required to achieve a specific test purpose, defined at the level of abstraction of a particular Abstract Test Method, starting at a stable testing state and ending in a stable testing state.
2. **Abstract Test Method**: The description of how an IUT is to be tested, given at an appropriate level of abstraction to make the description independent of any particular realization of a Means of Testing, but with enough detail to enable tests to be specified for this test method.
3. **Abstract Test Suite (ATS)**: A test suite composed of abstract test cases.
4. **Conforming Implementation**: An implementation, which satisfies both the static and dynamic conformance requirements, consistent with the capabilities stated in the ICS (PICS).

5. **Conformance Log**: A human-readable record of information produced as a result of a test campaign, which is sufficient to record the observed test outcomes and verify the assignment of test results (including test verdicts).
6. **Conformance Test Operation**: The process of conducting conformance testing of an implementation.
7. **Conformance Test Report**: A document produced at the end of a conformance assessment process, giving the details of the testing carried out using a particular ATS. It lists all of the abstract test cases and identifies those for which corresponding executable test cases were run, together with the verdicts assigned.
8. **Conformance Testing**: Testing the extent to which an IUT conforms to a specification.
9. **Dynamic Conformance Requirement**: A requirement that specifies what observable behavior is permitted by the relevant specification(s).
10. **Dynamic Conformance Testing**: Testing the extent to which an IUT conforms to dynamic conformance requirements.
11. **PICS (Protocol Implementation Conformance Statement)**: An ICS for an implementation or system claimed to conform to a given protocol specification.
12. **PICS Proforma**: A document in the form of a questionnaire designed by the protocol or test suite specifier *(e.g.*, The ATM Forum) which when completed becomes the PICS.
13. **PIXIT (Protocol Implementation eXtra Information for Testing)**: An IXIT related to testing for conformance to a given protocol specification.
14. **PIXIT Proforma**: A document in the form of a questionnaire provided by the test laboratory, which when completed prior to testing becomes a PIXIT.
15. **Protocol Conformance Test Report (PCTR)**: A document produced at the end of the conformance assessment process reporting the conformance of the protocol to the set of base specifications for which conformance testing was carried out.
16. **Static Conformance Requirement**: A requirement that specifies the limitations on the combinations of implemented capabilities permitted in a real open system, which is claimed to conform to the relevant specification(s).
17. **Static Conformance Result**: Is a statement to record the finding(s) or observation(s) from carrying out a Static Conformance Review on a SUT.
18. **Static Conformance Review**: (also, known as static conformance testing): A review of the extent to which the static conformance requirements are claimed to be supported by the IUT, by comparing the answers in the ICS(s) with the static conformance requirements expressed in the relevant specification(s).
19. **System Conformance Statement (SCS)**: A document summarizing which OSI or ITU-T Recommendations, International Standards or Profiles are implemented and to which ones conformance is claimed.
20. **System Conformance Test Report (SCTR)**: A document produced at the end of the conformance assessment process, giving an overall summary of the conformance of the implementation or system to the set of base or profile specifications for which conformance testing was carried out.
21. **Static Conformance Testing**: Testing the extent to which an IUT conforms to static conformance requirements.

1.4.3 Performance Testing Terms

1. **Network Performance (NP)**: The ability of a network to provide the functions related to communications between users.
2. **Performance Criteria (also Parameters)**: A set of performance values to verify the performance of a SUT to obtain a result.
3. **Performance Log**: A record of information produced as a result of a test campaign, which is sufficient to record the observed performance test outcomes and verify the assignment of the test results (including test verdicts).
4. **Performance Test Operation**: The process of conducting performance testing of an implementation or system.
5. **Performance Test Suite**: A complete set of performance test cases, possibly combined into nested test groups.
6. **Performance Testing**: Performance testing consists of measuring the Quality of Service (QoS) or Network Performance (NP) parameters, which are traffic dependent. For more details see [9].
7. **Quality of Service (QoS)**: The quality of Service is defined by a set of parameters such as “cell transfer delay”, “cell loss ratio”, “frame latency”, and “frame loss ratio”.
8. **System Test Report**: A document produced at the end of the assessment process, giving an overall report of the testing of a SUT or IUT.

1.4.4 Interoperability Testing Terms

1. **Dynamic Interoperability**: IUTs are dynamically interoperable, if they function together and produce the desired behavior.
2. **Dynamic Interoperability Review**: Dynamic interoperability testing need only be performed on those capabilities for which the IUTs are statically interoperable.
3. **Interoperability Log**: A record of information produced as a result of a test campaign, which is sufficient to record the observed interoperability test outcomes and verify the assignment of the test results (including test verdicts).
4. **Interoperability Test Operation**: The process of conducting interoperability testing of two or more implementations that appear (as claimed in the ICS) to follow a common standard.
5. **Interoperability Test Suite**: A complete set of interoperability test cases, possibly combined into nested test groups.
6. **Interoperability Testing**: Testing the degree of interoperability between two or more systems based on shared functions.
7. **Static Interoperability**: IUTs are statically interoperable if they implement a common and compatible set of features, functions and options. Compatible means that there are no conflicting requirements, which will prevent them from achieving interoperability.
8. **Static Interoperability Review (also known as Static Interoperability Testing)**: A review of the extent to which different IUTs are claimed to be compatible, achieved using a side-by-side comparison

of ICS and/or IXIT from different IUTs. It is performed in order to understand the shared capabilities and limitations on the combinations of implemented capabilities.

9. **Static Interoperability Result**: Is a statement to record the finding(s) or observation(s) from carrying out a Static Interoperability Review.
10. **System Test Report**: A document produced at the end of the assessment process, giving an overall report of the testing of a SUT or IUT.

1.5 Abbreviations

ATM	Asynchronous Transfer Mode
ATS	Abstract Test Suite
CDV	Cell Delay Variation
CLR	Cell Loss Ratio
CTD	Cell Transfer Delay
ILMI	Integrated Local Management Interface
ICS	Implementation Conformance Statement
IOP	InterOPerability
ISO	International Organization for Standardization
IUT	Implementation Under Test
IXIT	Implementation eXtra Information for Testing
MoT	Means Of Testing
NP	Network Performance
NPC	Network Parameter Control
PCTR	Protocol Conformance Test Report
PDU	Protocol Data Unit
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PVC	Permanent Virtual Connection
QoS	Quality of Service
SCS	System Conformance Statement
SCTR	System Conformance Test Report
SUT	System Under Test
SVC	Switched Virtual Connection
TTCN	Tree and Tabular Combined Notation
UPC	Usage Parameter Control
UNI	User-Network Interface

2. Overview of Testing

To ensure that different ATM products will be able to communicate with each other, it must be determined whether the products meet the specifications and whether they can interoperate without problems. Furthermore, the products should be able to perform under various traffic and load conditions. There are three types of testing: conformance, performance and interoperability. Together these types of testing are used to provide users with a level of confidence that the products meet their requirements. Each of these types of testing can be quite extensive and costly. They can be performed independently and one is not necessarily a prerequisite to the other two. In addition, success or failure of one kind of testing is not a prerequisite to the others or indicative of the results of the others. The combination of all three types of testing will provide the highest degree of confidence.

Although independent, these tests usually share common proformas and procedures. Prior to any kind of testing, whether conformance, performance, or interoperability, ICS and IXIT Proformas are used to obtain information from the supplier or the implementer. See [10] for information on how proformas are prepared. These questionnaires request information on what features and functions have been supported and what values or ranges of values are permissible. This information will be used to determine which tests are necessary and what modifications, if any, are needed and in some cases, which tests can be omitted.

Other test specifications have been developed by the Testing Working Group of The ATM Forum. These include af-nm-test-0080.000 [12] “Remote Monitoring MIB Extension for ATM Networks” and af-test-nm-0094.000 [13] “ATM Test Access Function (ATAF) Version 1.0”. The list of all Testing Working Group specifications is available at: http://www.atmforum.com.

3. Proformas

3.1 ICS

To evaluate any implementation it is necessary to have a statement of the capabilities and options, which have been implemented. The ICS (Implementation Conformance Statement) is that statement which is obtained via the use of a "proforma". An ICS Proforma is a document in the form of a questionnaire developed by the creator of the specification or, in the absence of this, by the test suite developer, which when completed becomes the ICS. Answers to the questionnaire should be provided, either by simply indicating a restricted choice (such as Yes or No), or by entering a value or a set or range of values.

The ICS for each IUT helps the test laboratory to compose an appropriate abstract test suite to be executed, and to explain the results obtained. The ICS can also be used to evaluate the static conformance of an IUT or the static interoperability of two IUTs. In the latter case, an ICS for each IUT would have to be obtained. A supplier may also provide additional information, categorized as exceptional or supplementary information. This additional information should be provided as items labeled X.<i> for exceptional information, or S.<i> for supplementary information, where <i> is any unambiguous identification for the item. The exceptional and supplementary information is not mandatory and the ICS may be considered complete without this information.

ICS Proformas are also the basis for developing conformance, performance and interoperability test suites. There is no standardized format for the questions in a proforma [10]. Each question should pertain to at least one of the requirements, mandatory or optional, in the specification. Subsequent conformance, performance and interoperability test suites highlight each of these requirements. Note however that there may not be a one-to-one correspondence for each ICS question and a test case. It is possible to have individual test cases that address multiple requirements and likewise multiple test cases that address single requirements.

3.2 IXIT

To test an implementation, the test laboratory requires information relating to the IUT and its testing environment, in addition to that provided by the ICS. Although according to ISO/IEC 9646-1 [2], the production of an IXIT is the primary responsibility of a test laboratory, a complete proforma is developed in three stages.

1. The test suite specifier (*e.g.*, The ATM Forum) produces a "partial IXIT Proforma" to accompany the Abstract Test Suite.

2. The test releaser augments the "partial IXIT Proforma", an "augmented partial IXIT Proforma", for the Means of Testing.

3. Test laboratory adds its own questions and information to produce the complete IXIT Proforma for a test service.

The terms "partial IXIT Proforma" and "augmented partial IXIT Proforma" are only used within ISO/IEC 9646 [2-8] to distinguish the different stages of development. The ATM Forum Testing WG produces the first stage of an IXIT (the "partial IXIT Proforma") that is included with its abstract test suite. The other

stages are outside of the scope of the Testing WG. The supplier submitting the implementation for testing will provide this IXIT. The IXIT may contain the following:

1. Information needed by the testing laboratory to be able to run an appropriate test suite on the specific system.

2. Information already mentioned in the ICS and which needs to be made more precise.

3. Information to help determine which supported capabilities are testable and which are not testable.

4. Other administrative matters (*e.g.*, the IUT identifier, reference to the related ICS).

4. Conformance Testing

ATM conformance testing consists of testing the extent to which an IUT conforms to a specification defined by the ATM Forum or any standardization body. A conformance testing framework and methodology is proposed in [2]. Conformance testing is generally extensive as it consists of testing an IUT against every feature and function defined in the specification (*e.g.*, signalling, ILMI). A conformance test suite targets a specific layer. A product can meet conformance at one layer but not at another.

Conformance testing can also be used whenever an interoperability problem arises between different pieces of equipment, to further explain the nature of the problem.

Conformance testing is performed by a tester that is connected to the IUT. A generic test configuration is shown in Figure 4.1.

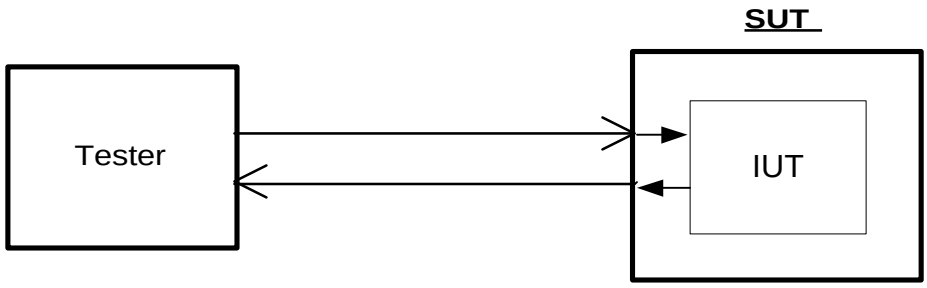

Figure 4.1: Generic Test Configuration for Conformance Testing

4.1 Conformance Assessment Process Outline

The conformance assessment process is given in ISO/IEC 9646-1 [2]. It can be summarized in the flowchart shown in Figure 4.2. A test laboratory receives the ICS, IXIT, SCS, ATS and MoT for the IUT and uses them to select a number of conformance test cases. Before dynamic conformance testing (Test Campaigns), static conformance review is performed. Conformance tests cases are executed and results are analyzed to produce a final test report. A Conformance Log is also produced and used as input in the final test report. The results in the final test report are used to create the SCTR and PCTR.

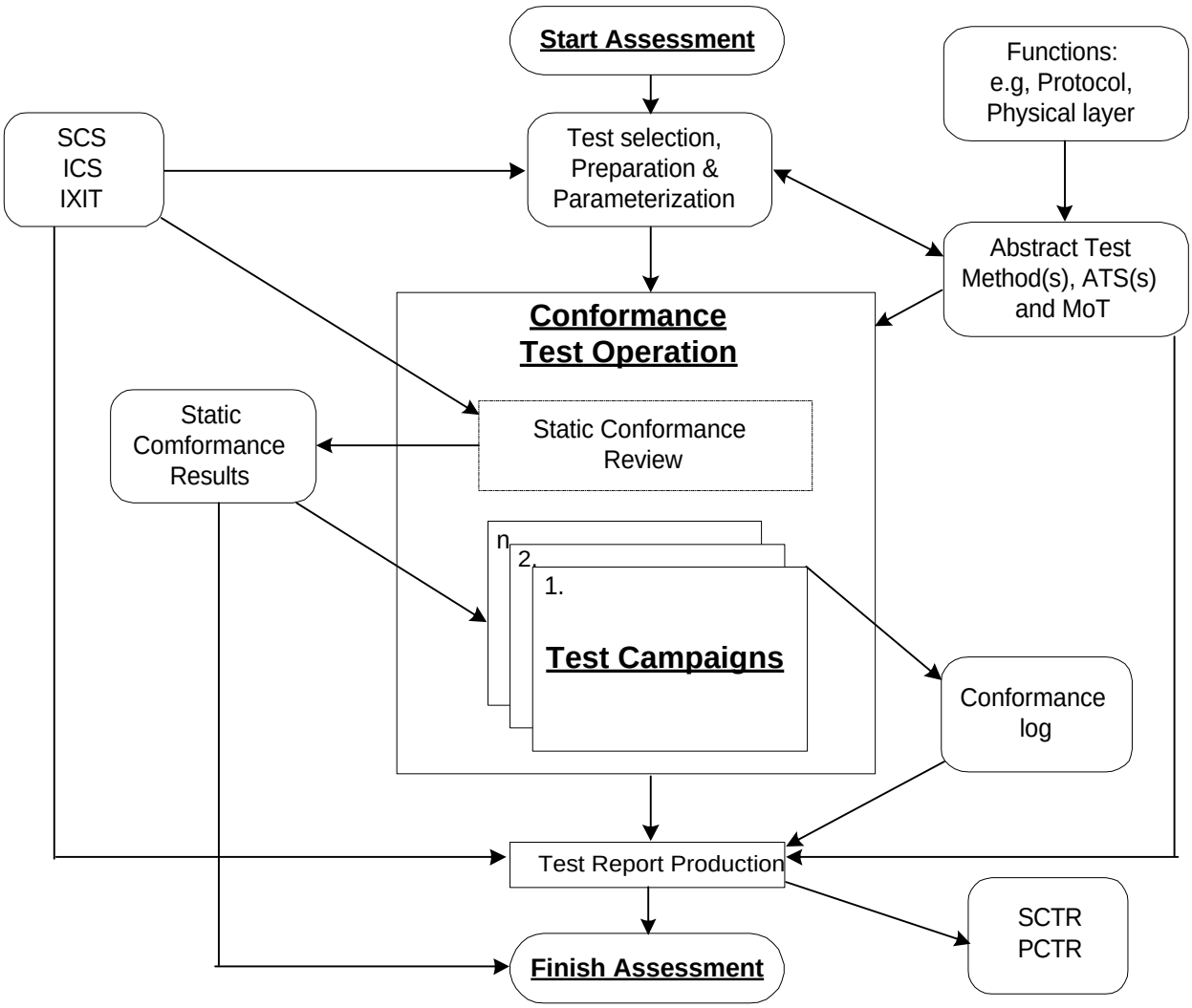

Figure 4.2: Conformance Assessment Process Model

4.2 Conformance ATS Status Reporting

The ATM Forum Abstract Test Suites that are coded in TTCN are also provided as machine processable files (.mp). To assure the user that these .mp files are structurally correct and free of syntax errors, the following statement will be included with the graphical representation of each .mp file:

> The machine processable (.mp) file of each conformance abstract test suite is required to be syntax checked using a commercial tool before it can be considered ready for straw vote. It will be recorded as part of the ATS by the following statement:
>
> Which commercial syntax checking tool was used:_____
>
> Syntax checking tool version:_____
>
> The TTCN of this abstract test suite passed the syntax checking process for version _____ (version #) dated _____(date) of the .MP file according to the TTCN specification in ISO 9646 Part 3 version _____ (version #) dated _____ (date).

In addition, as information to users of the test suites, additional status information may be reported (but is not required) as available:

Status of Test Suite	Date	Comments
Test suite executed against an implementation (simulated or real implementation)		(indicate whether tested against a simulated or a real implementation)
Revisions		(List of revisions and date or refer to an Annex of the ATS)

It is preferred, but not required, that the test suites are capable of execution before approval.

5. Performance Testing

Performance testing evaluates an implementation under different traffic and load conditions to see how well it performs. Performance testing consists of measuring QoS or NP parameters that are traffic dependent under well-known traffic conditions (load and profile). The purpose of performance testing is to give a common method for making performance measurements. The ATM Forum does not perform benchmark testing which is the evaluation of a SUT against predefined performance goal(s) or threshold(s).

Performance parameters of an implementation are function related. For each function, three types of performance criteria can be measured, when it is attempted:

Speed	is the performance criterion that describes the time interval that is used to perform the function or the rate at which the function is performed. (The function may or may not be performed with the desired accuracy.) Example for access speed: Call Establishment Latency. (Call Establishment Time).
Accuracy	is the performance criterion that describes the degree of correctness with which the function is performed. (The function may or may not be performed with the desired speed.) Example for access accuracy: Connection set-up error ratio (*e.g.*, got the wrong number).
Dependability	is the performance criterion that describes the degree of certainty (or surety) with which the function is performed regardless of speed or accuracy, but within a given observation interval. Example for access dependability: Connection stable for 24 hours.

A performance test suite specifies functions of the SUT and the performance parameters with respect to the performance criteria to be measured.

Performance testing falls into two categories of testing:

1. Measurements under Normal Load Conditions: “Normal Load Conditions” means, for example, traffic compliant to the traffic contract and not exceeding system resources. Both in-service and out-of-service measurements are desirable. Common performance measurements include ATM layer QoS parameters (cell transfer delay (CTD), cell delay variation (CDV), cell loss ratio (CLR), *etc*.), throughput, and signalling statistics (call establishment latency, call release latency, call setup rate, *etc*.).

2. Measurements under Overload Conditions: “Overload Conditions” means, for example, traffic in excess of the traffic contract or system resources. SUT congestion control and overload defense mechanisms are tested here.

In general, performance testing involves two functions: traffic generation and traffic analysis. A generic test configuration is shown in Figure 5.1. The Generator generates different patterns of traffic while the Analyzer measures such performance parameters as: cell loss ratio, cell transfer delay and cell delay

variation. In addition, performance testing at the signalling level requires test equipment that can originate calls and equipment that can terminate calls. All of the above functions can be built into a single piece of test equipment.

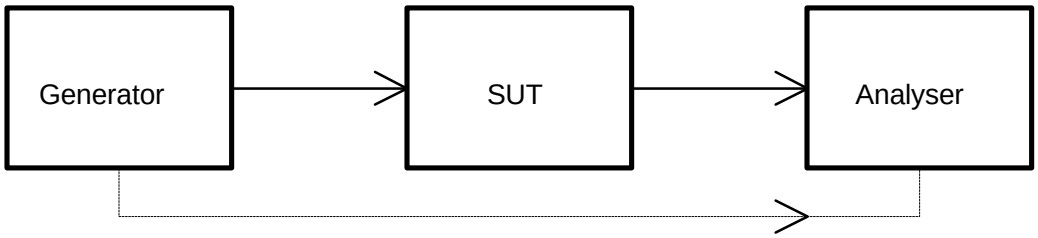

Figure 5.1: Generic Test Configuration for Performance Testing

5.1 Performance Assessment Process Outline

The flowchart shown in Figure 5.2 summarizes the performance assessment process. Using both a performance test suite and MoT, and applying ICS and IXIT information, performance test cases are selected for execution. Performance tests (test campaigns) are executed and results are analyzed to produce a final report. A Performance Log is also produced and used as input in the final test report. The results in the final test report are used to create a STR.

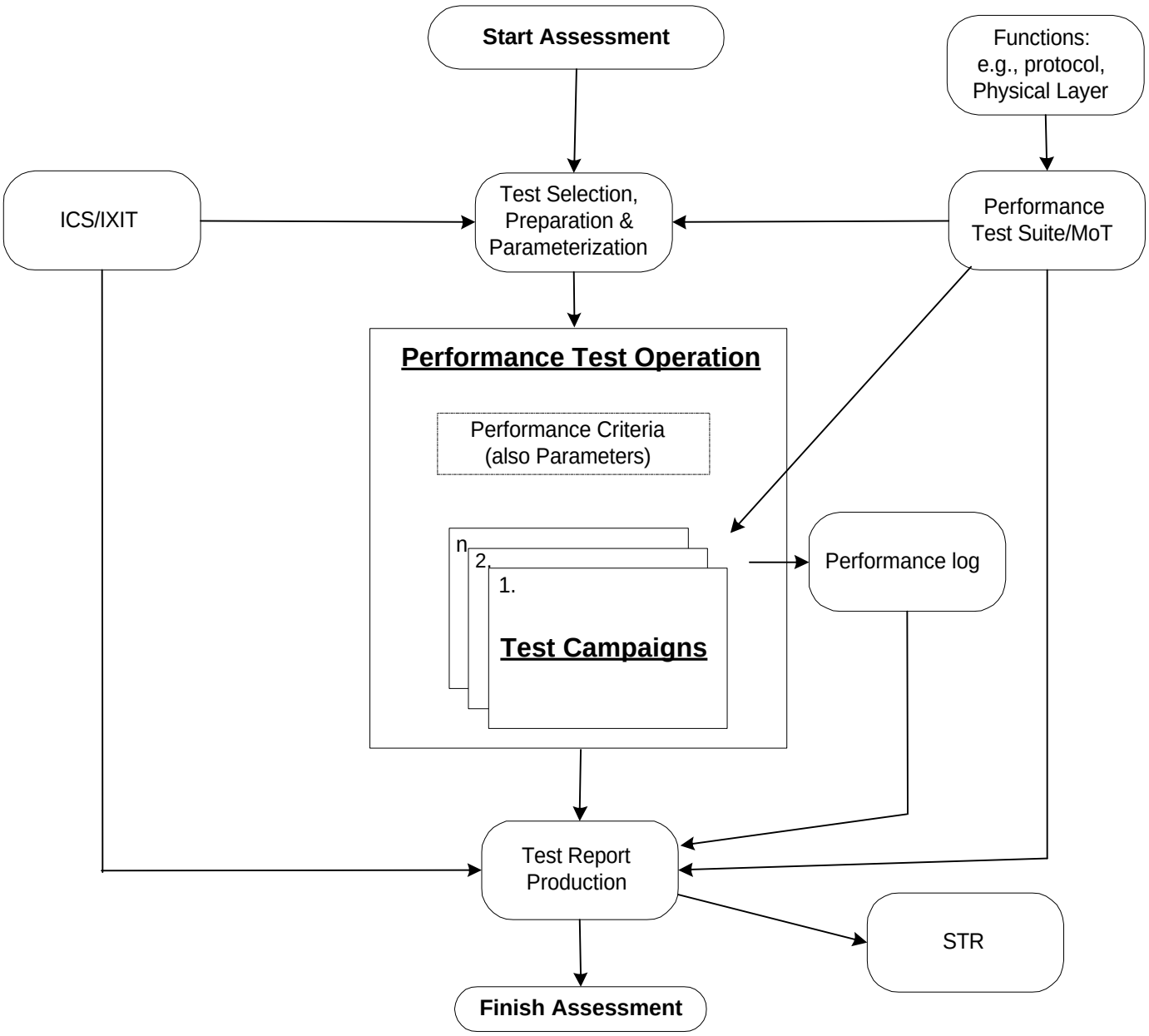

Figure 5.2: Performance Assessment Process Model

6. Interoperability Testing

The problem of interoperability arises when different suppliers' implementations need to be interconnected and users need to have a certain confidence level that the implementations can inter-operate. The purpose of interoperability testing is to confirm the degree of interoperability.

As an example, an IUT may claim to conform to the ATM Forum UNI Specification [1] if the following features/functions are implemented:

- All of the mandatory ones;
- None or some of the optional ones;
- Other not specified features/functions.

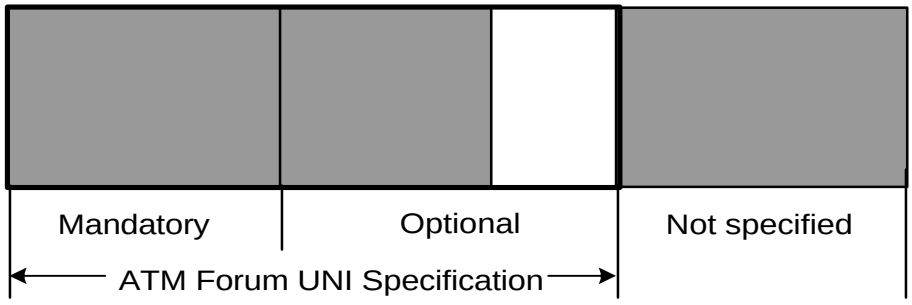

Figure 6.1: Features/Functions Implemented in IUT

For two IUTs to interoperate, two situations can be observed which can impact their ability to do so:

a) The two IUTs implement the same mandatory features/functions, but differ with regard to their optional and not specified ones (see Figure 6.2). In this case, their ability to interoperate depends on these optional and/or not specified features.

b) The two IUTs implement different mandatory features/functions. This situation may occur during the evolvement of standards. In this case, if there is a sufficient overlap, the two IUTs may be able to interoperate (see Figure 6.3).

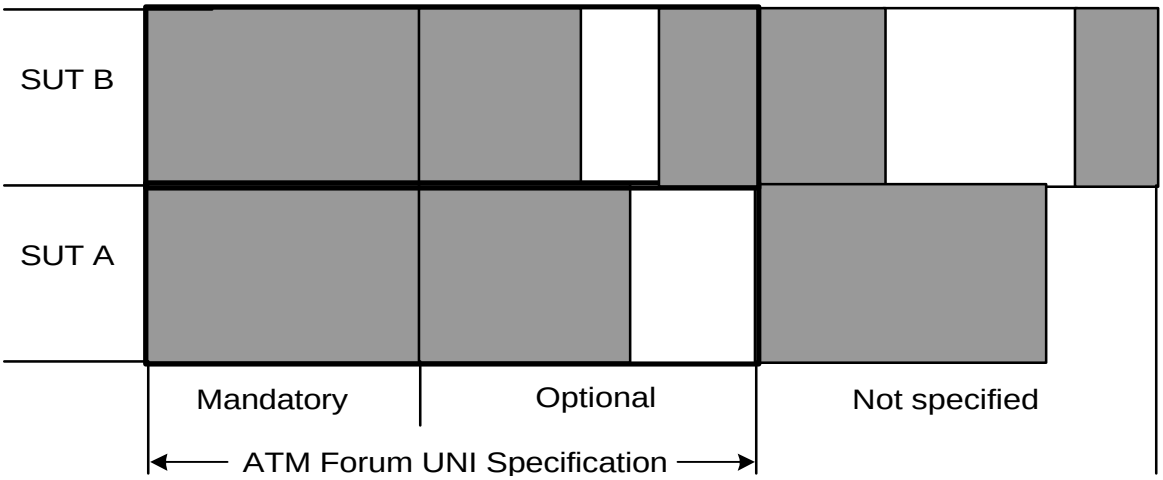

Figure 6.2: Two IUTs with the Same Mandatory Features/Functions Implemented

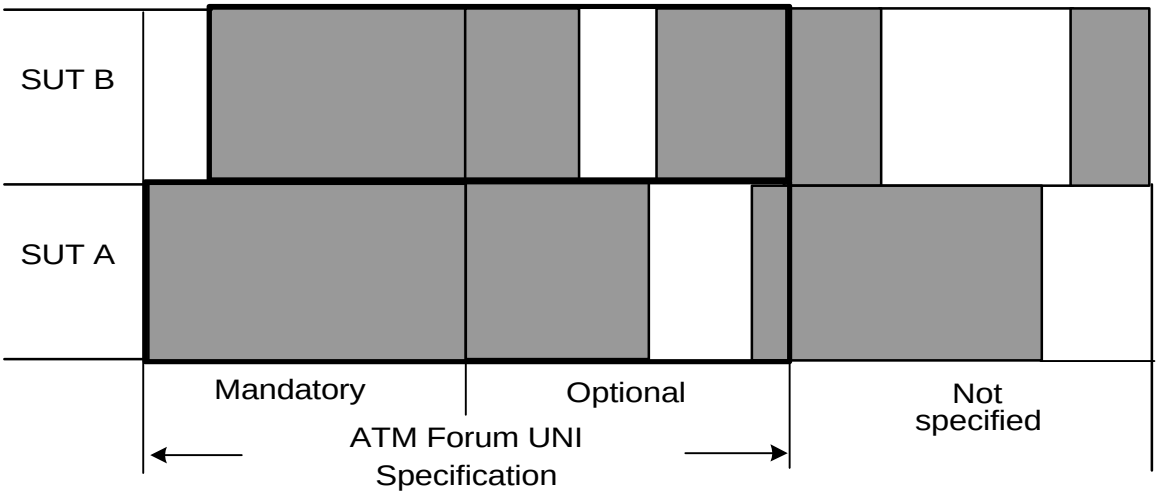

Figure 6.3: Two IUTs with Different Mandatory Features/Functions Implemented

While every attempt is made to avoid ambiguities, specifications may contain ambiguities that are likely to be subjected to different interpretations and thus incompatible implementations. Examples of such ambiguities include supporting optional procedures and parameters, and supporting different ranges of parameter and timer values. While these areas may be addressed during conformance testing, it may be necessary to highlight them in an interoperability test.

It is possible for different implementations not to meet the standard specifications but still to interoperate. These deviations from the standards need to be identified before interoperability testing begins. It may be necessary to generate additional test cases to test these not specified features and/or functions. These additional test cases are beyond the scope of the test specifications published by The ATM Forum.

Therefore, interoperability testing is used to measure the condition under which two or more systems with separate and different implementations will inter-operate and produce the expected behavior. Interoperability testing can be bound to specific layers within the stack. It involves testing both the capabilities and the behavior of an implementation in an interconnected environment and checking whether an implementation can communicate with another implementation of the same.

In the case where the IUT is ATM terminal equipment, the IUT must inter-operate and should be tested to inter-operate with (see Figure 6.4):

1) The ATM network;
2) One or more peer ATM implementations across the ATM network;
3) Hardware or software that performs a higher-layer function over ATM.

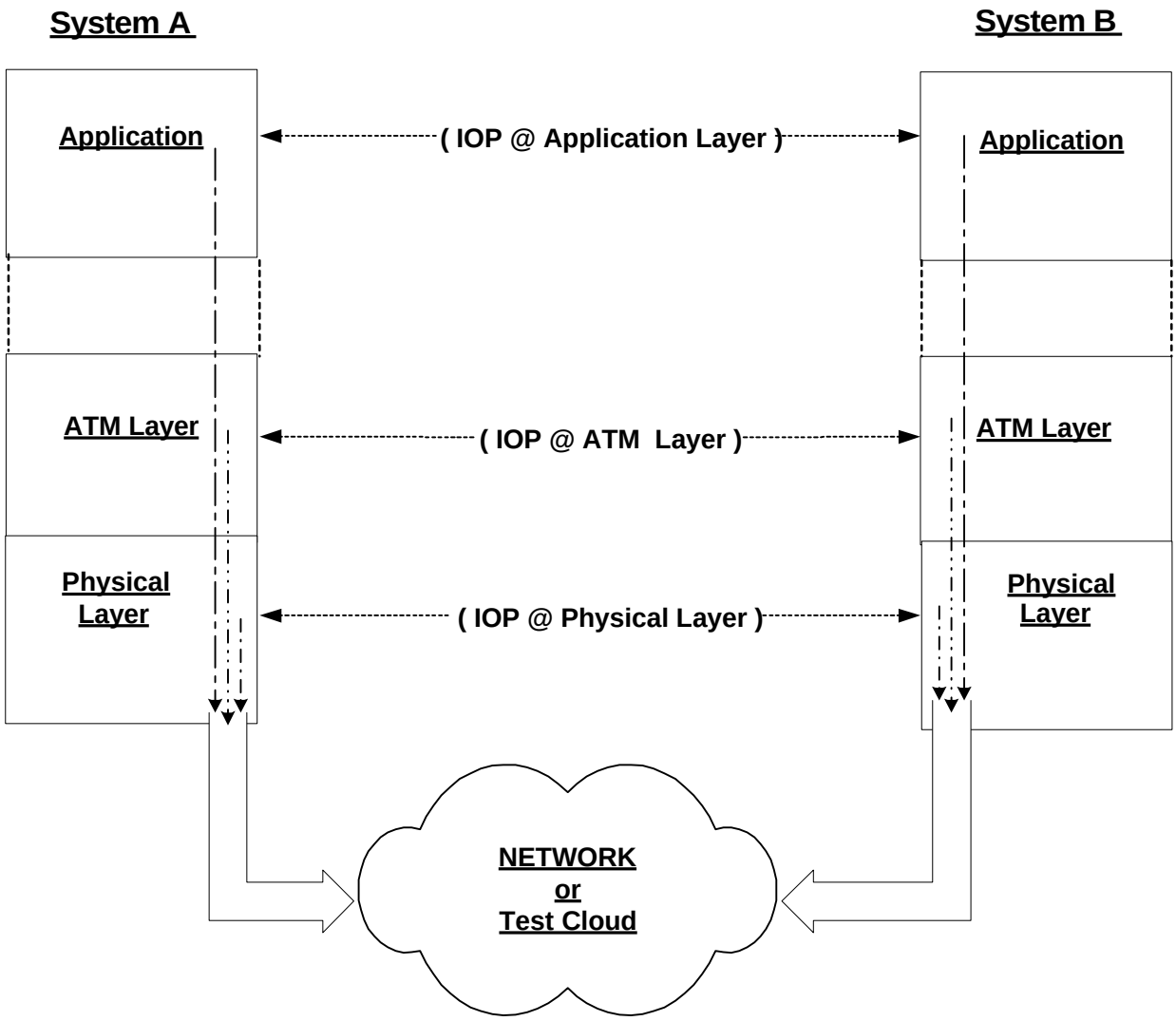

Figure 6.4: Three Types of Interoperability

The figure shows interoperability for several layers. There is a need to test for each layer. The interoperability at one layer does not imply for any other layer.

Interoperability testing should include at the minimum:

1. Static Interoperability Review/Testing

2. Dynamic Interoperability Testing.

For purposes of interoperability, Static Interoperability Testing is the combination of the current definition of static conformance testing and a side-by-side comparison of the ICS for each IUT for certain items,

which is of value. An example, from the PICS Proforma for UNI 3.1 Signalling (Network Side) [af-test-csra-0118.000] follows:

	PICS Questions		Compare PICS Answers	
Item	Does the implementation …	Status	IUT A	IUT B
MC 9.1	support for class X ATM Transport Service?	O.2	Yes ✓ No__	Yes__ No ✓
MC 9.2	support for class A ATM Transport Service?	O.2	Yes ✓ No__	Yes ✓ No__
MC 9.3	support for class C ATM Transport Service?	O.2	Yes__ No ✓	Yes ✓ No__
MC 13	support point-to-multipoint procedures?	O	Yes ✓ No__	Yes ✓ No__

O.2 = mandatory to support at least one service.

For static conformance, both IUTs can claim conformance to MC 9 and MC 13 in the specification - they have met the criteria in the Status of each of these items or group of items (*i.e.*, they each support at least one of the O.2 services).

However, it is obvious from the *side-by-side comparison* that there will not be interoperability of IUT A and IUT B for the particular services that are not supported by both IUTs. There is, therefore, no "*static interoperability*" of these two IUTs for Class X or Class C services (MC 9.1 and MC 9.3). There would also be no need to perform dynamic tests for MC 9.1 and 9.3 to show that they are incompatible, but there continues to be the need to test for MC 13 for the *dynamic capabilities*.

Further, a lack of static interoperability for optional capabilities does not mean that there is not basic interoperability in other areas, though, and tests for the dynamic capabilities would need to be performed to assess the degree of basic interoperability of the two IUTs.

Even though the goal of interoperability testing is to ensure that different implementations can inter-operate, it should be borne in mind that the complexity of ATM and related layer makes exhaustive testing impractical on both technical and economical grounds; therefore different tests should be designed to provide different levels of confidence that products will inter-operate. Each test may require a unique configuration, however the generic configurations shown in Figure 6.5 can be used.

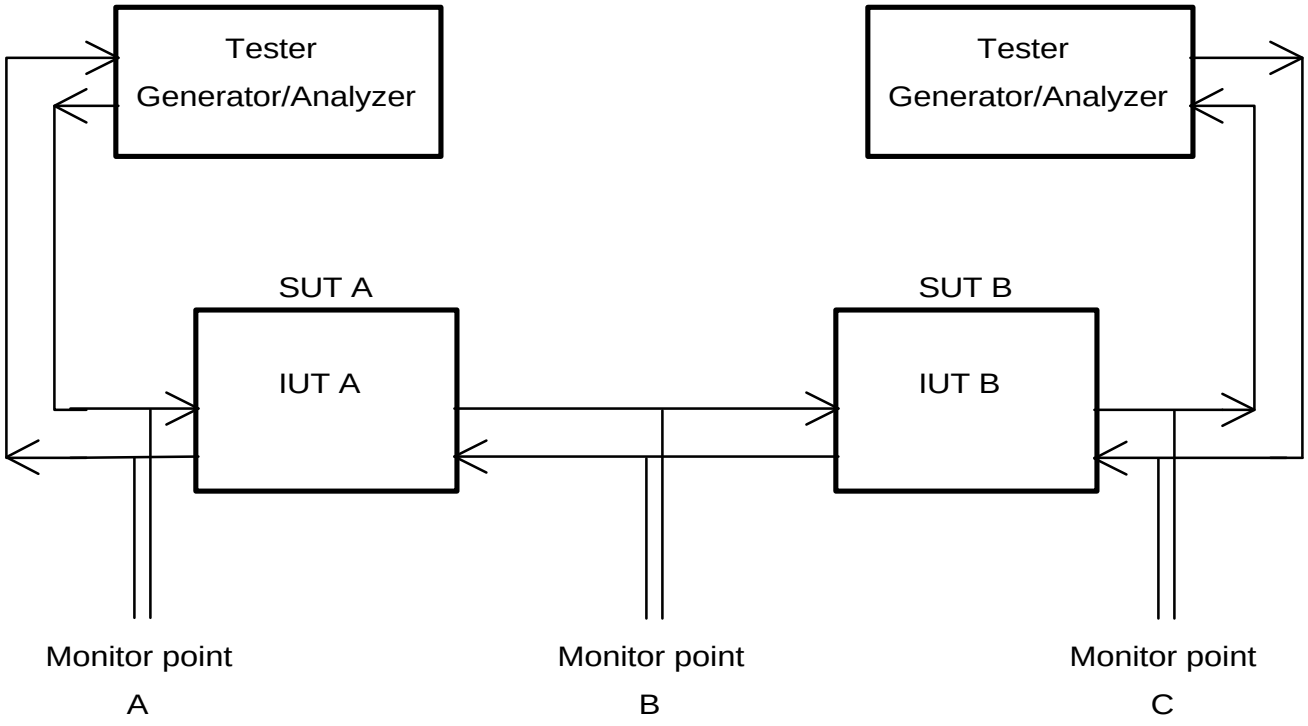

Figure 6.5: Generic Testing Configuration for Interoperability Testing

6.1 Interoperability Assessment Process Outline

The interoperability assessment process can be summarized in the flowchart shown in Figure 6.6. The test laboratory receives ICS, IXIT, Interoperability Test Suite and MoT for IUTs of both suppliers' equipment and uses them to select a number of interoperability test cases. Before dynamic interoperability testing, a static interoperability review is performed based on the Interoperability Test Suite and the ICS. Interoperability test cases are executed and results are analyzed and a detailed final test report is prepared. An Interoperability Log is also produced and used as input in the final test report. The results in the final test report are used to create a STR.

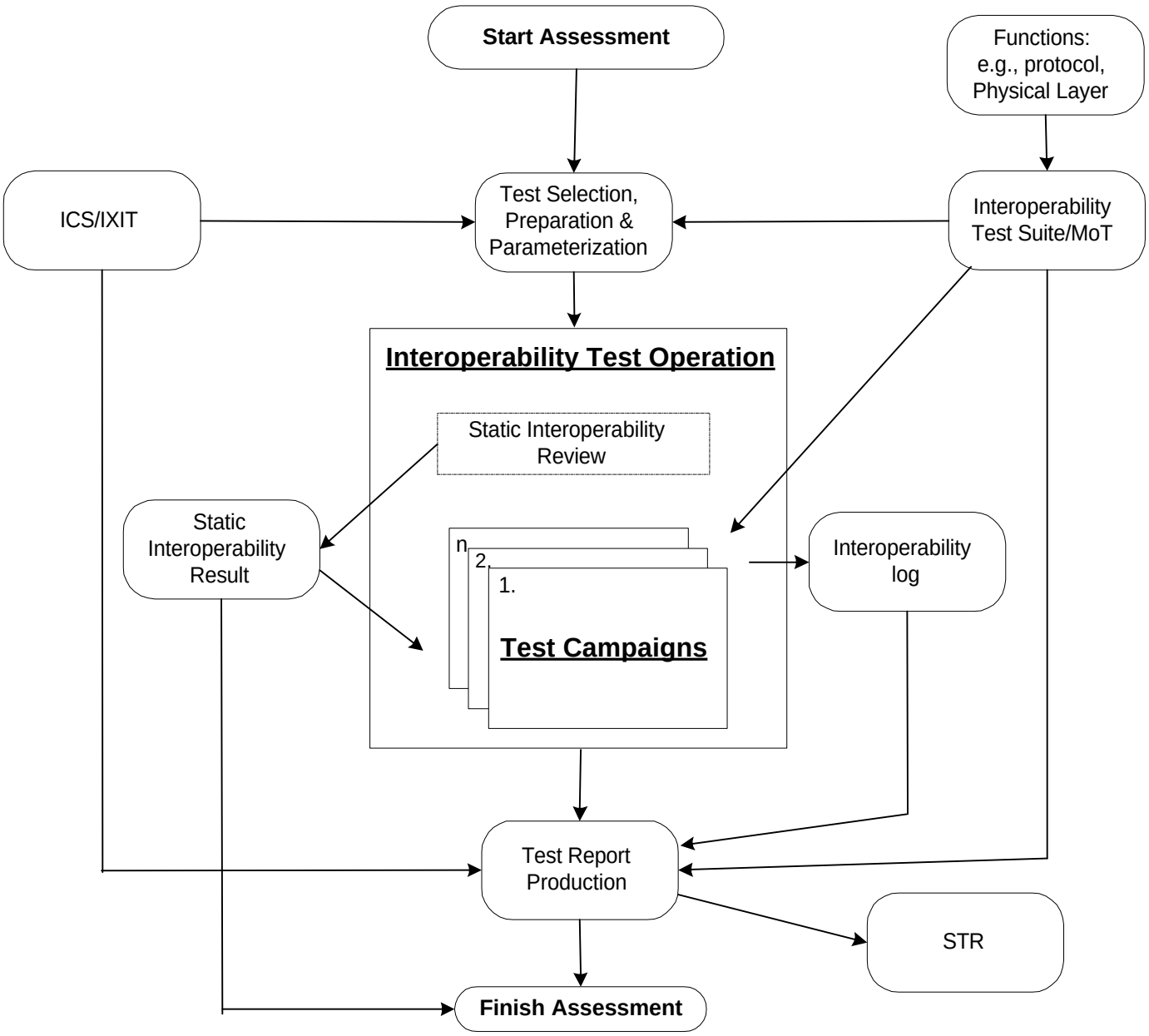

Figure 6.6: Interoperability Assessment Process Outline

7. Relationship between Testing Methodologies

The previous sections described three types of testing: conformance, performance and interoperability. They share some common proformas (ICS and IXIT) and procedures that provide information needed for testing. Nevertheless, the three types of testing are distinct and nearly independent from each other. Examples of their relationships are:

Interoperability testing does not include assessment of the performance, robustness, or reliability of an implementation. The determination of these properties is left to performance testing. However, performance testing of two IUTs together is required for interoperability. In this case, the IUTs together form a SUT for performance testing.

Interoperability testing may not measure the conformance of an implementation relative to the standards since two implementations can be non-standard but still interoperate.

Interoperability testing does not test each mandatory feature defined in a standard against the implementation of the tested IUT; this is left for conformance testing.

Performance testing provides a confidence level of how well a SUT performs under certain load and traffic conditions, regardless of whether or not the SUT conforms to a specification.

The combination of all three types of testing provides the highest degree of confidence.