

Win in the flat world

Telecom Testing and Convergence

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Abstract

Convergence is a hot topic in the communication industry. The wide spread popularity of IP Multimedia Subsystem (IMS) is a clear indication that independent networks will be integrated into a single IP-based infrastructure referred to as Next Generation Networks (NGN) in the near future. The services, network architectures and traffic pattern in NGN will dramatically differ from the current networks. The heterogeneity and complexity in NGN, including concepts like Fixed Mobile Convergence, will bring a number of challenges to the integration of products in a multi-vendor environment.

The telecom technology is evolving rapidly and convergence is one of the key ingredients to this growth. Standardizing forums are coming up with strategies in design to cater to the changing telecom needs. Testing methods still rely on legendary models which is not suited for converged world. The high degree of complexity accompanying the telecom technology necessitates testing strategies that can create and deploy new service offerings with a higher degree of flexibility and a shorter time-to-market, while staying at the competitive edge in rolling out new, compelling service with improved customer satisfaction.

This paper presents a unique perspective of telecom testing using a lifecycle approach to testing rather than legendary models like V, X and proactive testing models. Using the telecom testing lifecycle, the challenges introduced for testing in the converged world are addressed. Focused testing and test artifact generation based on NGOSS concepts are also outlined.



1. Introduction

As operators begin to add new networks and expand existing networks to support new technologies and products, standardizing bodies are coming up with models, tools and methodologies for design and development in converged space. Testing strategies have not evolved with technology and they still rely on legendary models like V, X and a proactive testing model which is not best suited for the telecom industry. Testing in the telecom domain is much more complicated than other domains in terms of environment, hand offs and technology. With convergence and concepts like multi-service, multi-vendor and heterogeneous networks; testing of interface and components become more difficult and complicated.

Another important factor influencing the requirement for proper telecom testing are the mergers and acquisitions among the key vendors. Ease of integration is critical and requires a holistic view of telecom testing. These requirements trigger the need for new strategies in telecom testing.

This paper presents a Telecom Testing lifecycle in which the different activities of the telecom stake holders are represented as views. The paper gives a holistic view to telecom testing lifecycle using NGOSS lifecycle as its foundation.

The paper is organized as follows. First, the current testing models and the problems they fail to address are briefly outlined. Then, we discuss the proposed telecom testing lifecycle. Each view of the lifecycle is then handled to describe the testing challenges and their resolution. Finally, a lifecycle model is created and an approach to use the same is discussed. The paper also includes a brief discussion on mapping telecom testing to NGOSS concepts.

2. Existing Models for Software Testing

The V Model is the most popular testing model and is based on the waterfall lifecycle model. It has several distinct testing levels and illustrates how each level addresses a different stage of the software lifecycle. The V shows the typical sequence of design and development on the left-hand (downhill) side and the corresponding sequence of test execution activities on the right-hand (uphill) side.

As design models have evolved and the concept of handoffs between levels became popular such as the spiral design model, testing using V model proved less effective in projects that involved frequent build cycles. The X model for testing was then adopted by many, to address some of the concerns raised against the V model.

Proactive testing intertwines development and testing lifecycle, identifying key activities in both with better time management by testing each deliverable and iterative development-test approach.

No test discussion would be complete without the test-planning structure suggested by IEEE standard 829-1998 which involves conceptualizing test plans at different levels, either as individual documents or sections within a larger document.

3. Telecom Testing

Telecom lifecycle is different from the software lifecycle and a testing strategy based on the telecom lifecycle is required to address the issues of converged space. V, X and proactive testing models do not address the challenges of telecom end-to-end business in the converged world as

it is non-standard and lacks a common industry acceptance. Issues in telecom testing are taken up in more detail as challenges under each view of telecom lifecycle.

4. Telecom Testing Lifecycle

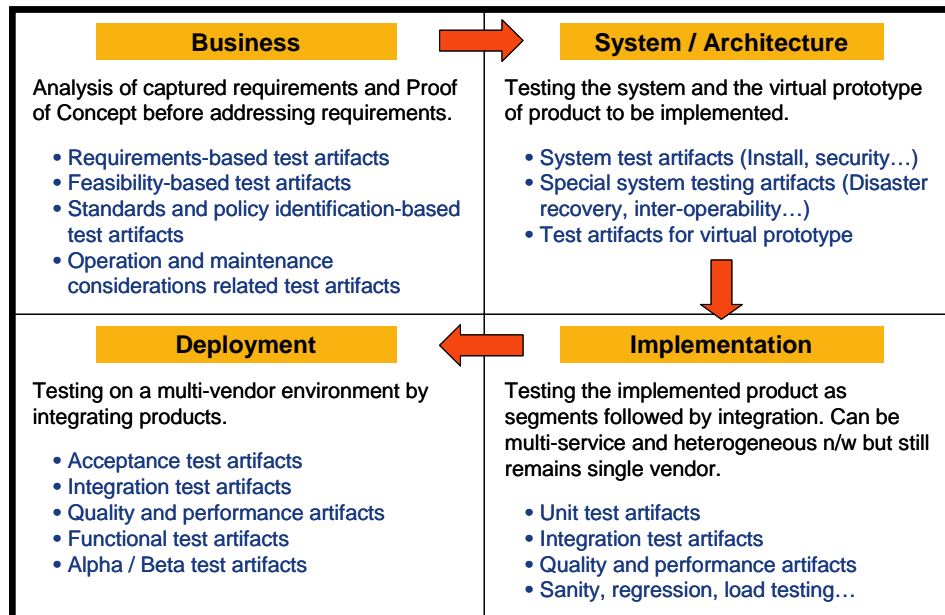


Fig 1: The Four Key View of the Telecom Testing Lifecycle

The telecom testing lifecycle is based on the NGOSS telecom lifecycle defined in GB927. The testing lifecycle consists of four views. The business and deployment view is concerned with the service provider while the System / Architecture and Implementation view correspond to the Service Developer. As shown in figure 1, each view in the telecom testing lifecycle generates a set of artifacts. The artifacts in each view serve as input to the succeeding views.

Any customer request or service development / enhancement can be categorized as a business requirement. The testing lifecycle starts once the business requirement is analyzed. Once a decision is made on developing the requirement, testing then moves to the system / architecture view where the service developer works on defining a technology- neutral method of implementing the requirement. This is followed by the Implementation view where the requirement is implemented. The implementation view in itself would involve certain amount of integration of the component developed in stages. The major view where a telecom-based testing pays off is in the deployment view where multiple implementations are integrated during deployment. In a multi-service, heterogeneous, multi-vendor environment, the test artifacts and their execution results for the other views serve as input to generation of deployment artifacts that result in providing new service offerings with a higher degree of flexibility and a shorter time-to-market with minimal or zero failures during operation.

The test artifacts developed in different views can be test plan, test case or even a test model for the specific telecom scenario. Figure 2 shows the items that make up the test artifacts developed in each view.

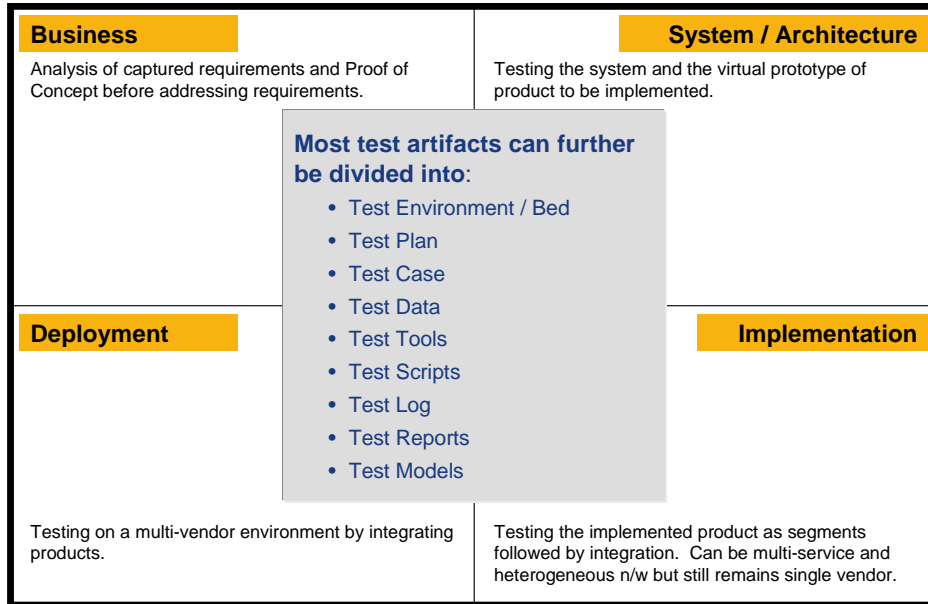


Fig 2: Classification of Test Artifacts

5. Views in the Testing Lifecycle

5.1 Business View

This view handles investigation of the requirements and Proof of Concept before taking up the requirements. The investigation of the requirements starts with elicitation and ends with specification. Based on requirement specification artifacts, a proof of concept (PoC) is developed to assess the feasibility of taking the requirement to service developers based on current infrastructure and products.

5.1.1 Challenges

- 1) Issues at any stage of the requirements investigation leading to product development not meeting actual business requirements. Some examples of the issues that can happen are:
 - a. Requirements handoff to service developers in stages or partially due to pit holes in elicitation, without understanding the impact of providing a detailed set of requirements.
 - b. Requirements creep like continual addition and change of requirements.
 - c. Inability to identify the real business requirements.
- 2) PoC developed by a Service Provider does not meet the actual infrastructure of the Service Developer.
- 3) Lack of analysis of the business view documents or not making the requirements explicit to best cater to a heterogeneous network, multiple service, and multi-vendor environment.
- 4) Not considering the impacts of the operation and maintenance of the developed product that meets the requirement. Operation should consider adding requirements of scalability and re-usability of the service developed as per requirements.

5.1.2 Resolution

- 1) Make requirement based test cases. However, these may not be sufficient as a requirement can be invalid, yet still be testable.

- 2) Define acceptance criteria during the requirement phase. An acceptance criterion does not just come from the defined requirements. Instead, it comes from a testing perspective and can help to identify incorrect requirements.
- 3) At a minimum, the following set of documents are generated in this view:
 - a. Requirement-based test artifacts
 - b. Feasibility-based test artifacts
 - c. Standards and policy (includes contracts) based test artifacts
 - d. Operation and maintenance-based test artifacts

5.2 System/Architecture View

This stage involves testing the system / architecture developed and the prototype based of the same.

5.2.1 Challenges

- 1) Static reviews are not sufficient enough to catch defects in design.
- 2) Analysis of telecom standards for developing the specified business case is not considered.
- 3) Business View testing was incomplete or not properly executed.

5.2.2 Resolution

- 1) Developing technical test plan to have a well organized set of test artifacts for this view.
- 2) Simulation / Virtual prototyping – Building an executable model or prototype of design for simulation. That model is used to verify and test various elements of the entire system design.
- 3) Conducting white board sessions with all stakeholders before beginning the process of formally documenting HLD.
- 4) Involvement of stakeholders from different views during review of final HLD.
- 5) Ensure that system and business requirements are based on telecom standards and implementation outline will help to implement the product without any ambiguity.
- 6) If testing at business view was not properly executed or is incomplete, then re-work on business view or at least prepare a minimum set of artifacts to be captured from business view.

5.3 Implementation View

Implementation of service or parts of the service (can be an NE or even a security application) takes place at this stage. This view is still limited to a single vendor though that vendor may have suppliers and partners who assist with the implementation.

5.3.1 Challenges

- 1) Not enough tools available to test the interfaces between different components
- 2) Third party applications can affect the functioning of the product
- 3) Actual environment in terms of actual traffic is not available
- 4) In legacy systems, there is always some dependency on lower components. Unless lower components are available, you cannot test the higher components independently
- 5) Interoperability issues
- 6) Business View or System View testing was incomplete or not properly executed

5.3.2 Resolution

- 1) The Implementation view should also look into development of tools to test interfaces for functionality as well as compliancy to standards. These tools will also be useful in the deployment view to check for interface compliancy of equipment from multiple vendors as the standards and open interfaces remain the same.
- 2) Third party tools should have well defined interface descriptions as well as the shared information and data model it supports which should be well evaluated when selecting these tools.
- 3) There are many companies who have products that can simulate actual traffic at core network, access as well as number of user nodes. Service developers should also buy / lease these products and effectively test reliability as well as quality offered by the components developed in implementation view.
- 4) Moving to open standards and products that interoperate well with legacy systems and at the same time, work as independent units can go a long way to improving interoperability and interfaces with the legacy systems.
- 5) Perform rework on business view and system view, at a minimum, to the basic set of artifacts, in case these stages were incomplete or improperly executed.

5.4 Deployment View

The actual integration for the live operation of the service / product occurs in this view. This is the multi-vendor environment which is now a critical view in current telecom industry with converged networks and services.

5.4.1 Challenges

- 1) Lack of a standardized telecom testing model covering end-to-end telecom lifecycle
- 2) Immature guiding templates, contracts and models for test progress
- 3) Non-standardized and proprietary language in defining telecom test-related artifacts
- 4) There is no standardization in testing tools to test for compliance of standards and policies
- 5) No testing benchmark exists today that can be used for end-to-end lifecycle validation

5.4.2 Resolution

- 1) Follow the telecom lifecycle approach in testing which uses NGOSS lifecycle as a backbone
- 2) Standard bodies to work on developing templates and contracts for test artifacts
- 3) Testing tools should be defined and developed at the implementation view to check for compliance to standards, policies and interfaces
- 4) Test artifacts and test results from the business, system and implementation views to provide inputs to the deployment view for identifying effective interoperability with other products
- 5) Enough emphasis and standards for testing to be defined along with bodies that validate and certify the approach

6. Advantages of this approach

- Minimum failure during deployment and operation at site
- Reduce CAPEX and OPEX due to late discovery of bugs
- The artifacts generated can be referenced by various telecom stake holders to find solutions to testing challenges

- Testing adds completeness to NGOSS, provides a holistic view and brings a common language for the much awaited telecom testing
- Standards and guidelines for testing in a multi-vendor environment
- Service Provider can make more intelligent and informed decisions while selecting products or partner / supplier / service developer for offering a service to the end customer
- Technical support has more information to respond to customer queries and it is easier to isolate and fix issues. For example, product performance and capability parameters would be well documented for easy reference.

7. Using the lifecycle approach in testing and flow of artifacts

Figure 3 shows telecom lifecycle as a set of concentric layers. This is to show the flow of data and to explain the approach to use the lifecycle model in a practical telecom scenario. The testing is usually done in-house or out sourced to suppliers, partners or IT service / consulting companies. Hence, the involvement of the test team might happen at any view of the telecom lifecycle and in most cases occurs only at the implementation or deployment view.

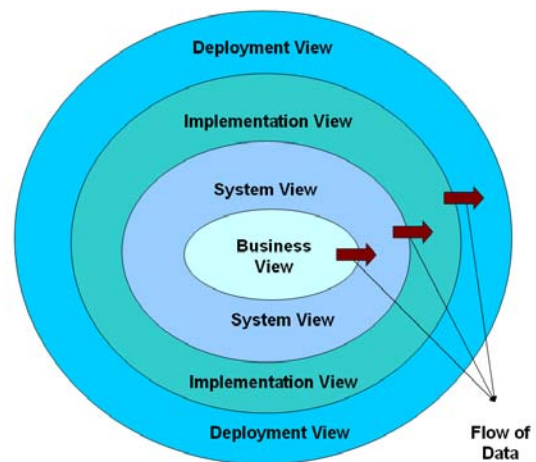


Fig 3: Telecom Lifecycle Model for Testing

The approach primarily involves 4 steps:

- Identifying the view (concentric circle) where testing is to be performed.
- Iterate through the inner views as much possible and prepare at least the minimum artifacts in inner views and execute the test.
- When test activities on the inner views is complete, work on the current view and prepare artifacts, execute test cases and log results.
- Prepare test artifacts and tools which might be useful in the external views and move to external view.

The approach is shown as a flow diagram in figure 4.

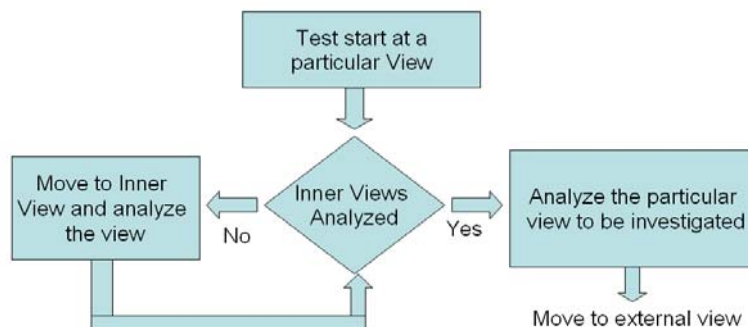


Fig 4: Approach to use the testing lifecycle model

8. Mapping with NGOSS concepts

Test activity maps to NGOSS concepts. It maps to:

- Process map of eTOM (Enhanced Telecom Operations Map)
- Telecom application map (TAM) on testing specific applications
- SID for defining the test artifacts based on shared information and data (SID)
- TMF artifacts for developing test artifacts for specific requirements

A detailed mapping of testing to NGOSS concepts is outside the scope of this paper though an outline is discussed.

8.1 eTOM

A focused approach towards test activity using the eTOM model leads to proper test planning, test artifact creation and delivery of test artifacts. Telcos using the eTOM model could have their test team identify and plan test strategy based on the specific eTOM process they work on.

For example, a test team associated with “Resource Capability and Delivery” can focus on test strategy as explained in figure 5. This figure shows the level 3 processes decomposition of “Resource Capability Delivery” with flags identifying the test activities in each of the decomposed process. According to eTOM release 7.1 GB921-D, “Manage Handover to Resource Operations” ensures that “all operational and performance design requirements have been met by the installed resource infrastructure, and that all tools, test equipment, operational procedures, support groups, and training is in place to allow for successful operation” and “Manage Resource Capability Delivery” manage “the commissioning of the new resource infrastructure by ensuring the availability of test programs and specifications against which to test the new resource infrastructure meets the design requirements”. These two processes in the level 3 decomposition handle the delivery, execution and management of test artifacts while other processes involve creation of test artifacts or would be categorized as a decision-making process.

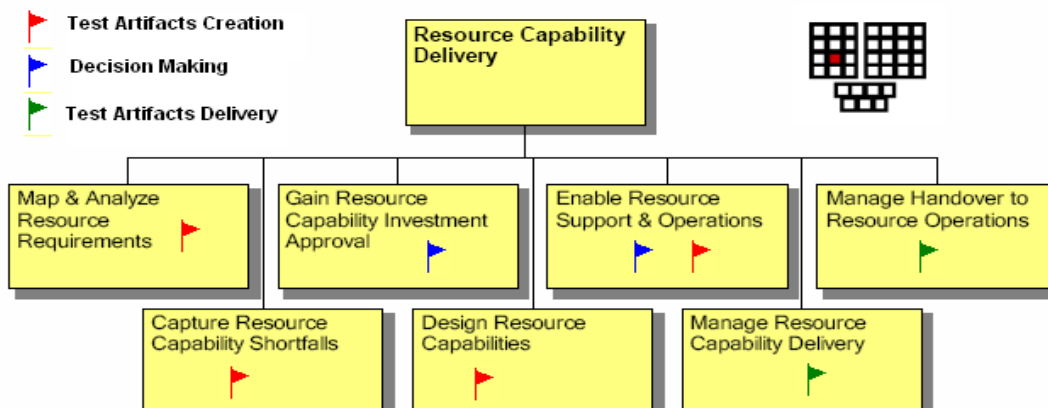


Fig 5: Resource Capability Delivery
(SIP <Strategy, Infrastructure & Product> Process Area)

This way test specific activities can be identified at every process level, providing focused test progress based on eTOM business process map.

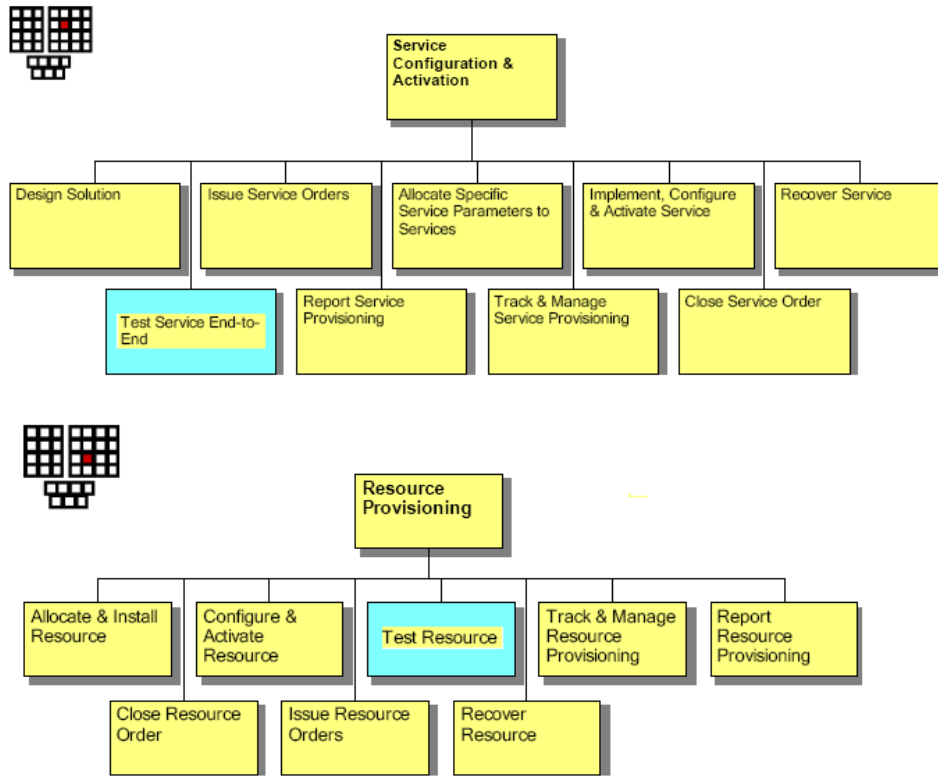


Fig 6: Test Feed from SIP Area Mapping to Level 3 Processes in OFAB (Operations Process Area – Fulfillment, Assurance, Billing & Operations support and readiness)

These test artifacts in the SIP Region forms feed to the real time OFAB Region. Figure 6 shows two explicit test processes that are fed by the test artifacts in SIP.

8.2 TAM

An application is associated with a process or a set of processes. A focused approach to the development of this application can be achieved using Telecom Applications Map.

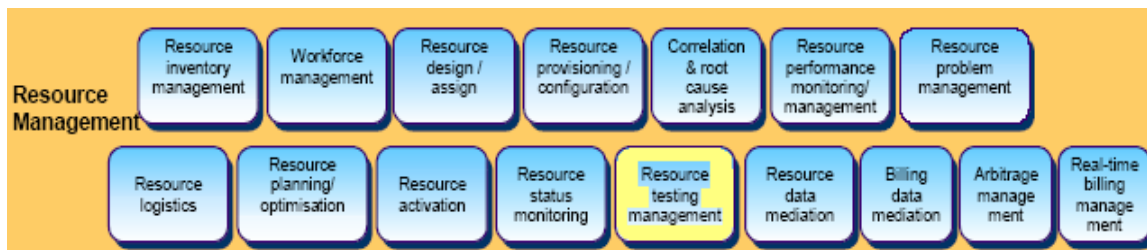


Fig 7: Resource Management and Operations Applications

For example, consider a telecom application development scenario where a test team is working on developing an application for “Resource Testing Management”. TMF TAM document GB929

provides application flow for testing management and lists out the processes the application needs to take care of.

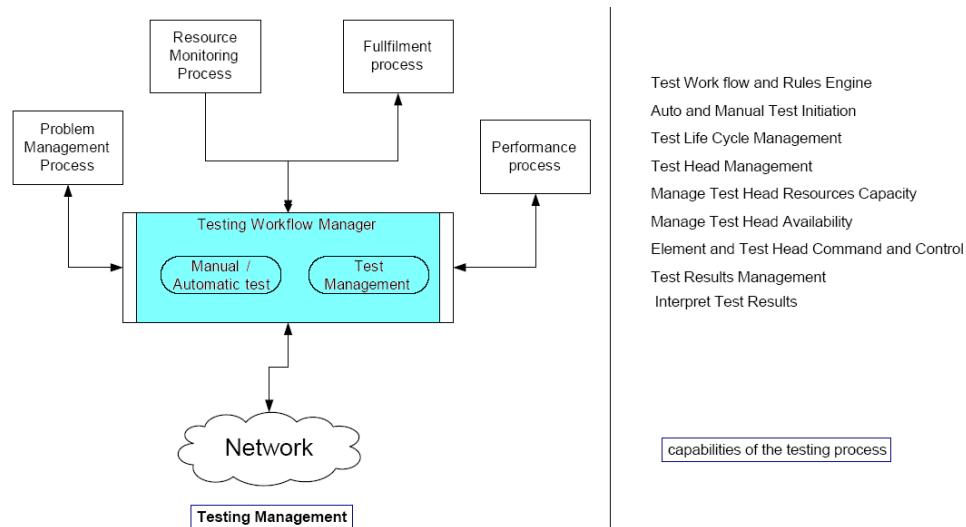


Fig 8: Test Management Application Flow and Test Process Capabilities

TMF is working on preparing TAM process decomposition. Release of this document will help to provide a detailed testing application map and having an effective approach to test application development.

8.3 Use Case

(Lifecycle approach and artifacts based on SID / TNA and other TMF documents)

Consider a services firm involved during the start of implementation for testing a provisioning agent in the EML (Element Management Layer) design requisite is to have the agent as an add-on service that can inter operate with other service / components developed by multiple vendors. The first step from lifecycle perspective is to verify if the test activity in Business and System View was executed properly. If the test activity was not complete, the services firm can start by preparing the minimum required set of artifacts for business and system view and then proceed with test strategy in implementation view. Some of the sample test cases generated for this requirement would include:

- 1) Compliance to TMF814 standard based on CORBA for interaction of provisioning agent on EML with services/applications in NML (Network Management Layer)
- 2) Compliance to port parameters defined in SID GB922 – Addendum 5PR for connection with physical port of the resource to be provisioned
- 3) Compliance of provisioning agent component architecture to NGOSS component definitions specified in TNA (TMF053 document).

The above short example is to illustrate the utilization of SID, TNA and TMF documents in preparing test artifacts and using the testing lifecycle to form a structured approach to telecom testing.

9. Scope of future work

This paper is intended to initiate the thought process of having standards in telecom testing. A focused work group for testing will be required to:

- Jointly work towards identifying the issues in end-to-end testing
- Prioritize and identify the final barriers
- Use NGOSS components to fix the barriers
- Create standards and bench marks

Detailed mapping of testing to NGOSS concepts of eTOM, TAM, SID and TNA and generation of test artifacts based on the same is also part of future work, with this paper serving as a backbone.

10. Conclusion

The high degree of complexity accompanying the telecom technology necessitates testing strategies that can create and deploy new service offerings with a higher degree of flexibility and a shorter time-to-market, while staying at the competitive edge in rolling out new, compelling service with improved customer satisfaction. This requires a holistic view to telecom testing lifecycle which can be achieved using NGOSS lifecycle as the backbone to define the testing lifecycle.

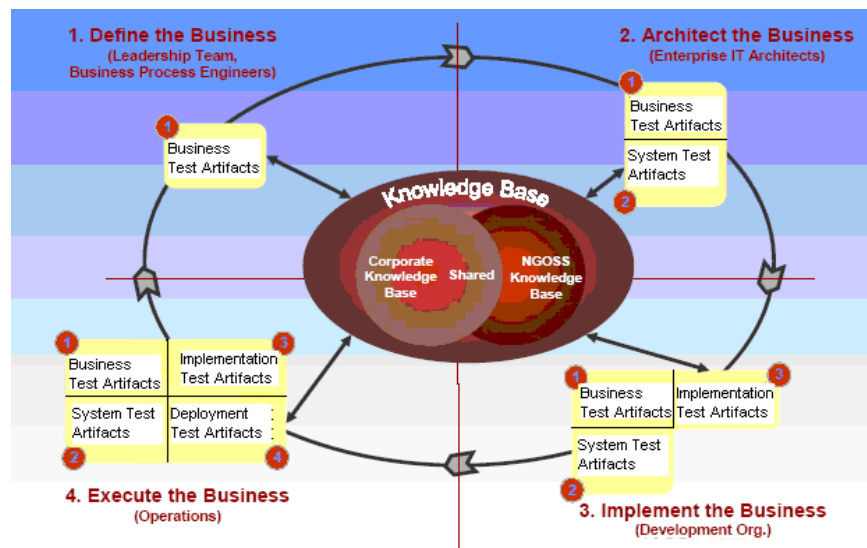


Fig 9: Test Artifact deriving and providing inputs to knowledge base

NGOSS Knowledge Base already has the required artifacts that can be used as a baseline to build test strategies that address challenges in telecom testing. The artifacts prepared by the focus group will add on to the NGOSS knowledge base. These artifacts will help telecom stakeholders at various stages of the telecom lifecycle to perform testing to eliminate issues in a converged space. The paper triggers the thought of having a standards based approach to testing for solving the issues of telecom convergence.

To learn more about how Infosys can help you address your Testing Challenges, please contact us at PE@infosys.com or visit us at <http://www.infosys.com>

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