White Paper

NTAF IN PRACTICE

How NTAF can help manage the complexity of the test lab by providing interoperability and integration in heterogeneous network test environments.

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Network Test Automation Forum

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Contents

ABSTRACT 1
INTRODUCTION 2
CHALLENGES OF HETEROGENOUS TEST LAB ENVIRONMENTS 3
The complexity of the test lab 3
Diverse Assets 3
Trying to make it work together 3
The Key to the Puzzle 5
ARRIVING AT A SOLUTION 6
Why NTAF 6
Customized vs. Standardized Solution 6
How is NTAF Different? 7
A conceptual look under the hood 7
What can it do? 8
How It Goes Together 9
Achieving an NTAF-Enabled lab 9
Making the First Steps 9
Levels of NTAF Support 10
Integrating Varying Levels of NTAF Support 11
SUMMARY 13

ABSTRACT

Automation and interoperability are key to managing the growing complexity of network equipment manufacturers'(NEM) and service providers'(SP) test labs. The Network Test Automation Forum, or NTAF, ratified its first two specifications in June 2011 with the goal to promote the interoperability of commercial test tools and test lab infrastructure in the data communications and telecommunications space. This white paper articulates how those specifications apply to real world situations. We will examine the case of a fictitious service provider facing typical challenges in incorporating heterogeneous test tools and infrastructure components in its test lab. We will demonstrate how the test lab can solve these challenges by using the NTAF specifications and illustrate the decision process for doing so.

INTRODUCTION

We will use as an example the case of fictitious High Plains Networks as a collective image of a typical mid-size service provider, set in the near future when NTAF adoption will have begun to take hold in the network test automation industry. By setting the example of High Plains in the future, we aim to place the reader's thinking into a context with a broad availability of NTAF implementations and to articulate the problems discussed here and their solutions within that context.

High Plains is trying to stay competitive in the face of demand for new services and increased competition. The complexity of the technology environment and the need to accelerate the time to market are placing significant demands on the productivity of its test and validation lab.

Since the inception of NTAF, many of the test equipment vendors and test lab equipment manufacturers that High Plains uses have brought to market a number of NTAF-enabled offerings. High Plains learns that NTAF will allow products from different vendors with differing degrees of NTAF support to be incorporated in the lab. For High Plains, this makes NTAF a key enabler of productivity through simplified integration and interoperability. After a careful analysis High Plains chooses NTAF as the path to realizing systemic synergies in its test lab.

In charting its vision for the test lab, High Plains finds that it may require a flexible approach for securing an NTAF-enabled lab, shaped by its power to influence the market and by the level of NTAF support provided by its vendors. Understanding the market dynamics around the evolving NTAF ecosystem will help High Plains create a successful strategy for achieving a highly efficient test lab.

Before we show how High Plains can create a strategy for meeting its interoperability and integration goals in the test lab through the application of NTAF, we will examine the challenges faced by High Plains, which are typical of the challenges faced by service providers today.

CHALLENGES OF HETEROGENOUS TEST LAB ENVIRONMENTS

The complexity of the test lab

In today's world, High Plains faces the convergence of telecommunication technologies and network architectures. Additionally, customer demand for new services and a number of economic factors drive the need for efficiency in the High Plains test lab. The company has made significant investments in expanding and modernizing its system integration test lab where it determines the quality of its network's performance and user experience. Its strategy is to achieve synergies and efficiencies in the test lab to reduce validation time and accelerate service-to-market time.

Diverse Assets

High Plains is deploying several major classes of infrastructure and test equipment, typical of large test labs, such as: power management equipment, physical layer switches, traffic generators and analyzers, resource scheduling software, and test automation and scheduling software.

High Plains' lab sources each type of equipment and software from a different vendor. In addition, the lab prefers to source traffic generator and analyzer equipment from two competing vendors for their Layer 2-3 test needs and two other competing vendors for their Layer 4-7 testing. High Plains uses total cost of ownership, return on investment, and ease of use as some of the most important factors in selecting a vendor. Since many vendors now implement the NTAF specification, the test lab architects increasingly tend to include NTAF support in their vendor selection criteria.

High Plains hopes that by getting the most out of the test lab it will be able to qualify new equipment images and deploy new services and equipment in the shortest amount of time to keep its customers happy. High Plains realizes that, in order achieve this goal; it needs to put these diverse and complex assets to work together in the most efficient way. Thus interoperability becomes a key element to its success.

Trying to make it work together

Building an efficient test lab is not a simple task. The lab technicians have worked long hours to rack and set up the equipment and to validate the physical configuration of the test beds. The system testers have labored over different test tools to build test configuration to implement the test plan. The test scripters have attempted to automate various aspects of the many processes that make the lab tick, such as reserving and scheduling the test beds, performing DUT image updates, provisioning DUT configuration, configuring lab equipment, and executing tests.

Each of these processes involves a different type of equipment. Each type of equipment -- and sometimes the new and the old version of the same equipment -- comes with its own API that has its own set of unique challenges: it supports its own set of capabilities; it understands only its own set of commands and it can only be interacted with through

maybe only a single programming language. When any of these characteristics are changed, the changes are not published and existing integrations are at risk of breaking.

The high-level functional requirements for integration within High Plains' test lab would thus look like the following:

1. Automate and orchestrate control over a number of disparate test tools which can be interleaved within a test
2. Work with the test bed reservation software which controls the Layer 1 switches
3. Execute automated image updates across the lab
4. Control the power management system and the air conditioning system
5. Integrate with the enterprise test management and reporting system
6. Provide extensive logging and debug capabilities
7. Have thin client accessibility (through the web)

Each of these various tools and systems comes from a different vendor, or in some cases may even be developed in-house. In a test lab of certain scale, such as the lab High Plains is building, the environment is characterized by an inevitable heterogeneity of its components in terms of their API command set, their API programming language implementation, their management communication protocols, and their feature set. Taming such heterogeneity can be enabled by an effective interoperability solution. The diagram below summarizes the components that may be required to interoperate or be automated in a typical test lab such as High Plains'.

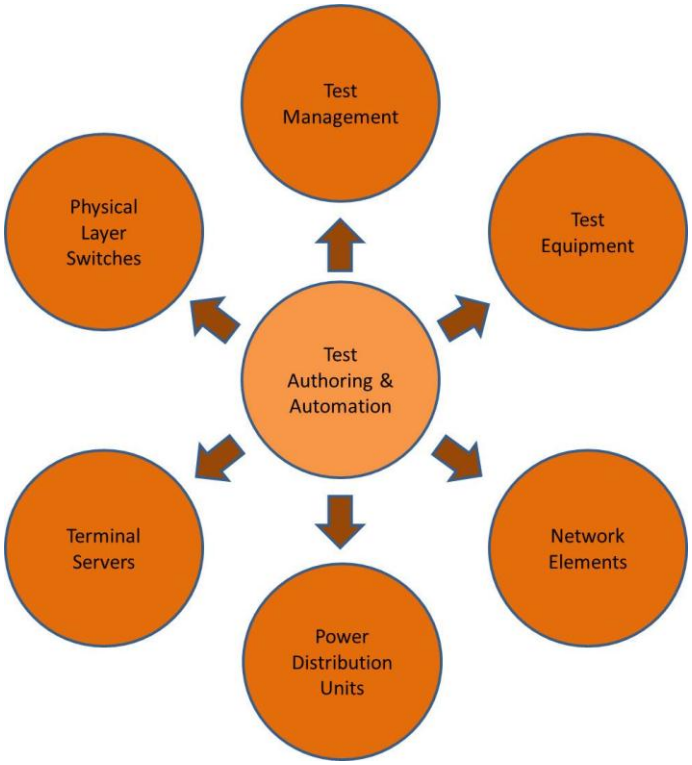

Figure 1: A typical test lab environment

It quickly becomes clear that the effort and resources required to maintain, operate and provide a measure of integration in this complex and dynamic environment can be very substantial.

The Key to the Puzzle

As we just discussed, assembling the lab so that all of the various components can interoperate efficiently is a sensible goal but it is not a trivial task. It is clear that without some way to orchestrate all lab elements to work together and to make discovery, setup and execution more efficient, High Plains will not be optimally utilizing the heavy investment that it has made into the lab. Instead of focusing on validation of new products and services, it will find itself spending time and resources just managing the ever-changing lab environment.

Digging deeper into the implementation details reveals big interoperability gaps between the various types of equipment and within the types of equipment as well. High Plains recognizes that, at its core, this is an interoperability problem and understands that it needs to look for an interoperability solution.

ARRIVING AT A SOLUTION

Why NTAF

Customized vs. Standardized Solution

Traditionally, interoperability or integration gaps of any kind have been addressed by customized solutions. Customized solutions usually solve the problem for some length of time, until a disruptive change comes along which requires the customized solution to be reinvented and re-implemented, or patched in a way that quickly results in deteriorating performance that impacts productivity. This is one of the major risks of customized solutions. By its very nature, a customized solution has a narrow scope as its purpose is to solve a specific problem. This makes such a solution difficult to extend and unable to handle continuous change such as that which characterizes a large service validation lab.

Another significant challenge is that no one professional services vendor or in-house development team has the domain expertise or the scale to cover all types of lab equipment. As scale and diversity of the lab environment grows, no matter how ambitious in scope and implementation a customized solution is facing steep odds.

High Plains realizes that, in contrast, a standardized solution, such as that offered by NTAF, would resolve a number of these challenges. First, as an open specification defined by participating industry entities, NTAF provides extensibility as a matter of fundamental design. Second, the number of adopting vendors is growing as they realize that being NTAF-enabled allows them to focus development resources on functional differentiators rather than on interoperability. This means that as NTAF becomes a standard feature on a growing pool of test lab elements, setting the lab up for an expanding scope of interoperability becomes simpler, more affordable, and sustainable. Additionally, a standardized method of accessing a tool means that any surrounding implementations, whether off-the-shelf or custom, can be easily reused, shared, and replicated across other implementations. Finally, a growing pool of expertise makes possible an evolution towards a higher quality of implementation.

To arrive at a decision on whether to use a customized or a standard-based interoperability solution, High Plains performs a detailed cost-benefit and ROI analysis, which can be elaborated on as a separate subject. In the end the service provider decides to take the standardized solution path. High Plains is aware that the market is in an evolving state: many vendors provide products with off-the-shelf support for NTAF, while many still don't. However High Plains is confident that NTAF can provide the established technology that will close the interoperability gaps in its lab far more successfully and cheaply than a completely customized solution. This means that High Plains embarks on a business needs and strategy assessment for providing the necessary level of NTAF support in its lab.

Before discussing how High Plains can formulate a strategy for securing an NTAF-enabled lab environment, let's provide a brief overview of the NTAF specification in

order to reveal some of the technical understanding that High Plains possessed which helped it make a confident choice of NTAF as the enabling technology for interoperability.

How is NTAF Different?

NTAF is a specification for interoperability in the test lab. The idea of interoperability does not originate with NTAF. Previous attempts to provide standardized interoperability have been made, however they were largely driven by the relatively narrow scope of test equipment vendors' needs. Unlike those, the NTAF specification is based on the interoperability needs of the consumers of test solutions. This means that NTAF addresses potentially a much larger variety of equipment and tools, enabling interoperability at all levels in the lab.

NTAF derives another great advantage from focusing on the correct problem to solve. Its philosophy is rooted in the recognition that the scope and complexity of interoperability needs in the test lab make it virtually impossible to standardize what is interoperable. Instead, NTAF takes the approach of specifying how the test lab tools and equipment will interoperate; leaving it up to the individual vendors to decide what will interoperate. It provides the vendors with a specification framework to allow for the definition and distribution of interoperability information across the lab.

Finally, NTAF is based on a well-established open technology platform (eXtensible Messaging and Presence Protocol or XMPP), which by its very nature promotes interoperability. High Plains is aware that it can choose from amongst several high-quality implementations of the platform which as we see later will play a role in solving one of the mission-critical elements of enabling NTAF across its lab.

A conceptual look under the hood

The open technology platform on which NTAF is based is the Extensible Messaging and Presence Protocol (XMPP), which specifies how entities could discover one another across a network. The NTAF specification builds on XMPP to define its two specifications, whose technical purpose is to specify how tools, regardless of their nature, can discover one another, and how they can communicate with one another in order to exchange information about their capabilities or how they can be controlled.

Specification TS-001 - Tool Registration, Discovery and Activation defines how the mechanisms of tool discovery, registration and activation work. *Specification TS-002 - Tool Automation Harness* defines the mechanisms to allow tools to declare their capabilities and make them available for use to other tools. A tool automation harness is any service provided by the tools in this manner.

The NTAF reference model includes a network of tools, served by one or multiple NTAF servers, connected to a network under test. Each tool, as an NTAF entity, receives requests and produces responses and event notifications.

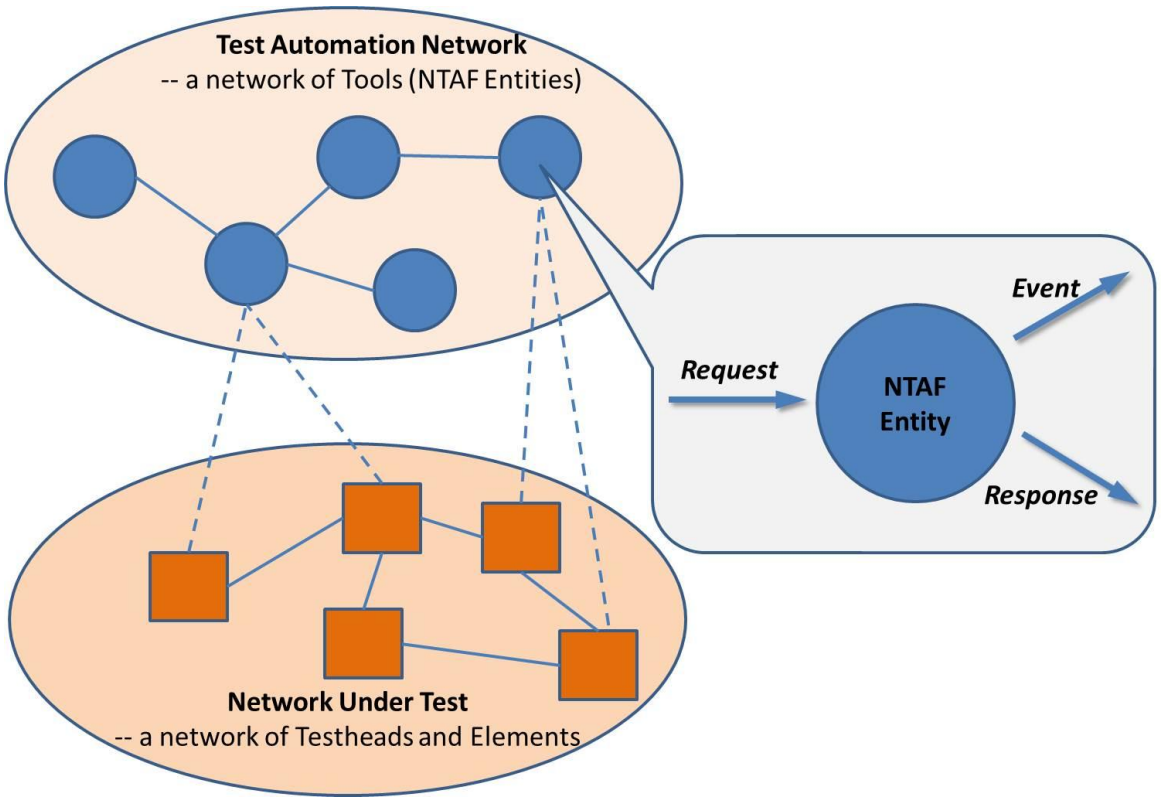

Figure 2: The NTAF Reference Model

Tools participate in the communication (which is based on XML) via client sessions channeled through an NTAF server. The server facilitates the tools' discovery and registration. Tools can be requestors or providers, depending on whether they control or provide control to other tools.

What can it do?

A more concrete dimension of NTAF's technical capabilities is evident when some of the specification capabilities begin to emerge in the lab environment: tools can publish capabilities to other tools; tools can publish changes to their capabilities (including APIs); commercial tools can now interoperate with proprietary in-house tools; remote Web-based implementations that do not require VPN access are now possible over the secure HTTP-based connection; tools are now able to drive other tools – so a resource scheduler can be used to launch scripts, or scripts can be used to launch resource scheduler. The possibilities are virtually unlimited.

High Plains understands the value of unleashing this potential for interoperability. Furthermore, in its assessment of the NTAF offerings in the market, it puts a special emphasis on understanding how to enable its own in-house tools to the NTAF specification. High Plains has a legacy home-grown test execution framework that still performs well and is virtually free. High Plains requires leveraging this framework into its lab solution. This will allow it to better interoperate with its test management system

and its test bed reservation system. We will discuss more on this later, but now we will provide a quick look into how the NTAF framework will come together once the tools and equipment across the lab are NTAF-capable.

How It Goes Together

The NTAF architecture consists of at least one NTAF server and multiple NTAF-capable clients.

The clients utilize XMPP over a TCP session to access a server, subject to an authentication and addressing scheme. Within a session, the client entities can register themselves, discover and activate other entities, as well as perform actions as defined by the registered automation harnesses.

If a tool is to provide a service, its implementer is responsible for the definition of the corresponding harness, as mandated by the specification.

The server is responsible for managing sessions and for routing XML streams between other entities. One of the advantages of NTAF is that its implementation can leverage any specification-compliant off-the-shelf XMPP server of client. Examples of high quality, cross-platform, open-source server software are Apache Vysper, Prosody, and OpenFire, among many others. Examples of quality open-source client implementations that can be adapted are Oyo, OneTeam and Psi, among many others.

One major strength of NTAF lies in its adaptability and flexibility. Since it does not dictate that all tools in the lab have to implement an NTAF client as there is no functional dependency on a comprehensive solution, it allows the implementer the flexibility to deploy it in an evolutionary manner that adds value incrementally and allows for a judicious use of resources.

This flexibility is very important to High Plains as it contemplates its strategy for enabling its lab for interoperability in a sustainable way.

Achieving an NTAF-Enabled lab

Making the First Steps

Once the decision to go with a standardized solution is made, High Plains maps out the high-level plan to make it into reality. The phases and some of the more important steps of the process are outlined next.

High Plains will begin by obtain the NTAF specification and educating stakeholders on the technology. In this initiation phase the stakeholders are identified and a project plan is created.

Next, High Plains will design the solution and identify where NTAF will be used. Since NTAF allows evolutionary change, the implementation can take an incremental

approach once the design is complete. This is reflected in the implementation diagram below, where a continuous evolution cycle loops together the last two phases of the process.

In order for the implementation to succeed, it is most important to identify mission-critical entities. Those most likely will be entities that do not support NTAF for one reason or another. We will discuss those in the next section where High Plains will determine which approach to take in order to secure NTAF support for all of the interoperable entities in the solution.

The implementation phase as well as the test and validation phase are outside the scope of this writing, and are the subject of a separate discussion. The diagram below summarizes the steps discussed above, mapping the key tasks against the project's lifetime cycle phases.

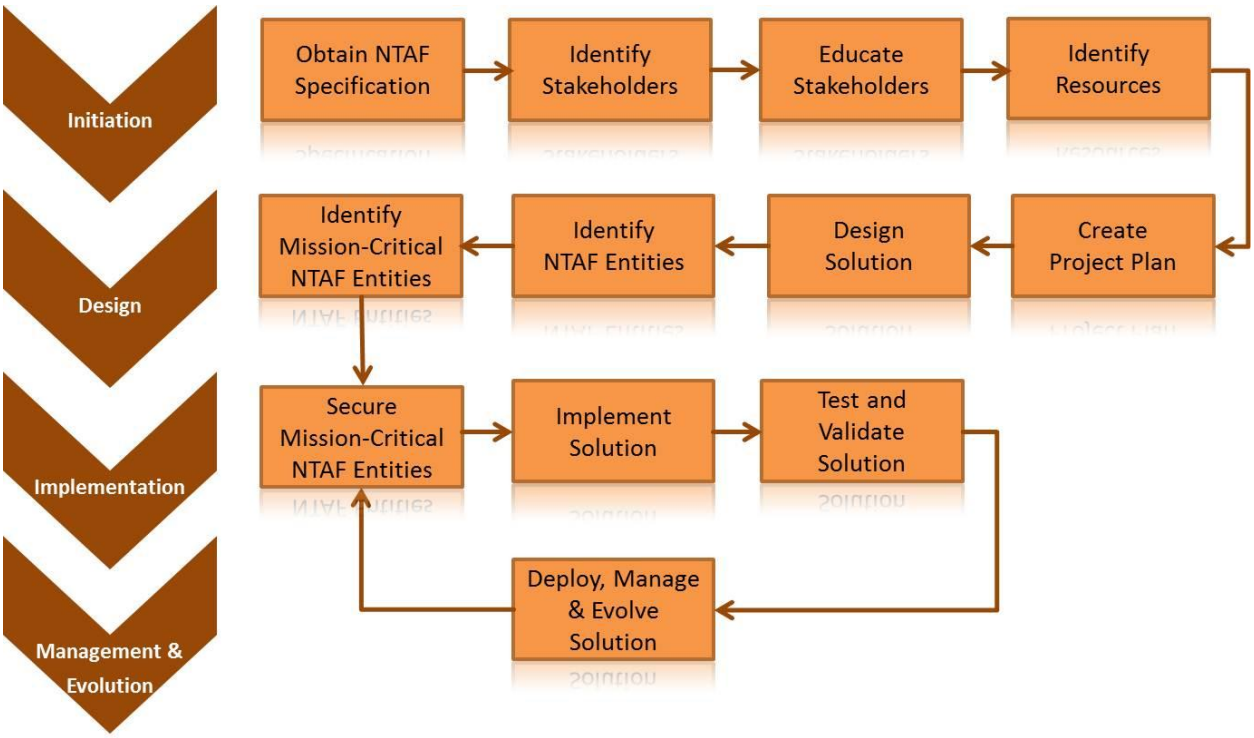

Figure 3: Key steps in the NTAF implementation process

Levels of NTAF Support

In designing the solution, High Plains has identified which features it needs to access through its NTAF implementation. Once the solution is designed, we come back to where we left off High Plains facing an assessment of the best ways to secure an NTAF-enabled lab environment given the various levels of NTAF support across its vendors.

High Plains' assessment of the state of the market across all lab component types characterizes it as evolving with regard to NTAF support. The service provider finds that

it is useful to view vendors with an existing level of NTAF support as fully enabled or partially enabled.

Fully enabled vendors implement all of the publically available NTAF harnesses in a given functional domain for a given type of tool. In contrast, partially enabled vendors support only a subset of the functional domain provided through NTAF harnesses for their product. Guided by these practical definitions, High Plains categorizes vendors in the following groups, based on the required approach to secure NTAF support for their products:

- **Group A:** For vendors whose products provide NTAF support for all of the features required by the customer, there is no need for a specific strategy. Such vendors already provide all of the harnesses High Plains requires and implementation can begin immediately.

- **Group B:** Another approach is required to work with the partially enabled NTAF vendors. In this case High Plains needs to stay informed with the vendor on their roadmap for implementing the available harnesses for their class of entity. This approach is mostly based on visibility into the vendor's roadmap and on general alignment between the vendor's roadmap and service provider own implementation plan. In the cases where the vendor's roadmap is not acceptable, High Plains needs to create a strategy to influence, collaborate and move the vendor towards accelerating the roadmap. This more detailed strategy can be discussed in a separate paper.

- **Group C:** This group represents vendors that do not yet provide support for NTAF in their products. High Plains in that case has to find a feasible path to enabling NTAF for those products. This will be mission-critical and we will discuss this situation in details further below.

- **Group D:** Finally, High Plains has been using for years some legacy home-grown tools that are not NTAF-enabled, as is very typical for any test lab beyond a certain size. Enabling those tools, as is the case with Group C, would be mission-critical.

We will discuss the decision-making High Plains will apply to arrive at the best approach for achieving NTAF support for the products in Group C and Group D.

Integrating Varying Levels of NTAF Support

The decision-making process illustrated below represents only one way of addressing the problem. Multiple factors figure into the approach. A service provider of a different size than High Plains, or a network equipment manufacturer, may choose a different approach.

For products coming from the vendors in Group C and for the internally developed tools in Group D, High Plains is likely to be required to do the work on its own to adapt the products to the NTAF specification.

From a technical perspective, this is accomplished by implementing a proxy which communicates with the tool through the tool's API. The proxy acts as the NTAF entity through which the required harnesses are executed or provided. The proxy needs to implement the specification as a client entity, in the way referenced in the previous section. Given the level of sophistication of the tool, the number of harnesses, and the scale of the lab, this task may require a certain level of expertise and effort. The cases of both Group C and Group D require a similar type of effort in order to achieve NTAF enablement.

From a business perspective, High Plains' needs may not be necessarily in alignment with the level of support for NTAF and the NTAF roadmap of a vendor in Group C. Working to secure NTAF enablement within such of relationship can be treated with the appropriate level of detail elsewhere. At minimum it should be said that in this case High Planes is likely to make those tools NTAF-enabled independently of the vendor. In doing that, High Plains will have to decide whether to rely on internal development resources, or whether to outsource the implementation to a solution provider.

Choosing how to deliver the implementation of course depends on the individual details of each case. Factors to consider are the availability of internal resources with the appropriate expertise and their cost. Fortunately, as discussed in the previous section, the NTAF specification has the advantages that, first, it is an open specification, and second, that it is based on a well-established technology where the key infrastructure components are available as open source off-the-shelf software. This provides a good starting point for any internal or outsourced implementer and contributes to an affordable and cost-effective solution.

In the case of Group D, legacy home-grown tools cannot be expected to be NTAF-enabled. Handling this challenge is similar to the approach High Plains takes with the Group C products. High Plains, as a mid-size service provider, does not maintain a large internal development team. Although the NTAF deployment it is contemplating appears sufficiently large, High Plains will consider a form of mixed sourcing, where the implementation of proxy entities for mission-critical Group C products only may be fully outsourced, while the implementation of the NTAF entity network and adapting the home-grown tools will be done internally.

Finally, another important consideration for High Plains is its long-term capability to support and evolve the solution. High Plains understands that with NTAF adoption increasing, the trend will be for growing segments of the network testing industry, including vendors represented by Group C, to support NTAF. High Plains is confident that with flexibility to expand the solution at its own pace and with broadening adoption across the network testing industry, it is equipped with the right technology to meet today's and tomorrow's interoperability challenges in its test lab.

SUMMARY

The growing complexity of test labs is a key challenge in reducing time to market for service providers and the lack of interoperability is a barrier to realizing synergies in heterogeneous test lab environments. NTAF helps manage this challenge by providing an open specification-based technology to enable interoperability between diverse commercial and internal test tools and test lab infrastructure. Through the example of High Plains Networks, a collective image of a typical mid-size service provider, we illustrated the process of thinking about the problem, of choosing a standard-based solution, and creating strategic approaches for achieving a level of interoperability that puts the lab on a sustainable path to increased productivity.

ABOUT NTAF

Our Mission

The mission of NTAF is to promote interoperability of commercial network testing tools and testing infrastructure, by defining and facilitating adoption of technical specifications.

Overview

The goal of NTAF is to facilitate and promote the interoperability of commercial testing tools and test infrastructure for the data communications and telecommunications industry. NTAF will bring together commercial testing vendors, test equipment vendors, and other industry experts to create interoperable testing solutions for service providers, network equipment manufacturers (NEMs), and other enterprise organizations with large network deployments.

The objectives of NTAF are:

- Build consensus and unite service providers, network equipment manufacturers, and test equipment vendors on network test automation technical specifications and interoperability
- Create, facilitate and enable the implementation of network test automation specifications.
- Enhance market awareness of the benefits of interoperable network test automation.

For more information

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