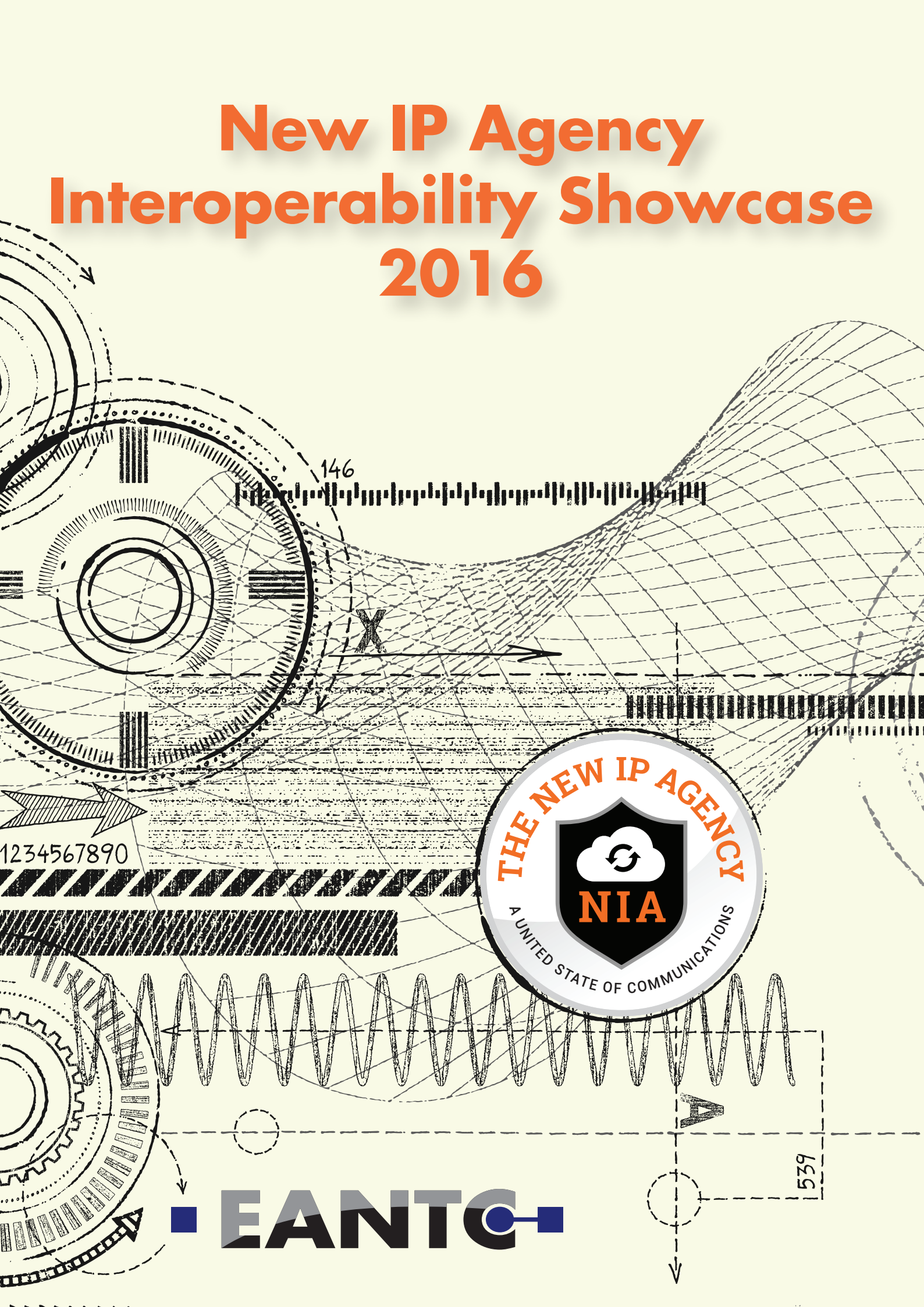
New IP Agency Interoperability Showcase 2016



Editor's Note

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Welcome to the second publication of the New IP Agency (NIA) testing program!

I am very happy (and somewhat relieved, to be honest) that we have successfully completed the next round of NIA testing thanks to the outstanding support of all participants:

This report includes solutions by 12 vendors, having achieved six multi-vendor combinations of orchestrated service function chains (SFCs) on a range of NFV infrastructure (NFVI) solutions. Vendors successfully interoperated to create advanced virtual CPE combinations with virtualized firewalls, deep packet inspection filters and other add-on VNFs.

Following our initial evaluation of NFVI to virtual network function (VNF) interoperability six months ago, a number of NIA's service provider members urged us to broaden the scope for this showcase. The request was to validate a fully functional, multi-vendor, orchestrated use case of SFCs, primarily focusing on virtualized customer premises equipment (vCPE) and added-value services.

There have been a number of proof of concept (PoC) exercises published in this area previously. Taking the presumed industry experience into account, we opted for an advanced test plan including SDN interaction and dynamic service chains. Having entered the fourth year of NFV, we believed one week of hot-staging (with all vendors in one room) would be sufficient to get all tests completed.

We were so wrong. The hot-staging turned out to be a challenging experience in terms of logistics, IT installation, and integration for the NFVIs. It dawned on us that we had neglected three important differences between our interoperability test and previously published PoCs:

- NIA's interoperability program is the first in the industry with open participation: Instead of being constrained to a vendor or open-source ecosystem where a lot of integration work takes place over extended periods of time, we encouraged ad-hoc any-to-any test combinations. This creates more uncertainty.
- Hardware and IT installations are far from being straightforward yet. OpenStack is great (without it, NFV would not be what it is today), but not a plug-and-play software. There are still many hardware options, maybe even more than with physical network functions before, causing interoperability issues. The installation requires IT skills for x86 servers, Linux and OpenStack. This is a different skill-set than telecom engineers have traditionally been educated for. In any case, we learned that bringing up a commercialized OpenStack installation from scratch takes multiple days.
- Integrating multiple software components on a single NFVI is a time-consuming task. This time, vendors which brought their own NFVI to host their NFVO did not have an installation advantage. Integrating an NFVO software to run on a third-party NFVI took an equivalent time.

Once these challenges had been overcome, onboarding of VNFs via third-party orchestrators and service chaining on arbitrary NFVIs worked well. Clearly, vendors are aligned both by OpenStack de-facto standards and standardized service paradigms that have been introduced by the ETSI NFV ISG.

EANTC will follow-up to all these test areas in future NIA interoperability testing campaigns. We have achieved a milestone — clearly there is more work to be done to reach the vision of an industry-wide, multi-vendor enabled NFV ecosystem.

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Introduction

The NIA live interoperability showcase addresses Service Function Chaining. It follows the footsteps of the preceding NIA test campaign to provide a realistic and vendor-neutral set of tests based on public standards; open-source community developments and feedback from NIA service provider members.

When designing the test plan, the EANTC team took into account references from ETSI, IETF and ONF. The test plan got rigorously reviewed by NIA service provider members and vendors who signed up for the test.

As a result, eight test cases focused on two verticals: Network Service Orchestration and Service Function Chaining. Additionally, the functional focus was on virtual Customer Premises Equipment (CPE) deployment and its applicable functions.

We kept in mind while developing the tests that not all vendor combinations would be ready to

participate in every test. Therefore, the test plan was built around three complexity paths, each consisted of sequential set of test cases that advance gradually. We collected positive results in five of the eight original test cases described later in this report.

It is no secret that network virtualization and service orchestration are still taking shape and face many challenges in the process. Participating in such an extensive test requires, more than anything else, courage — something market leaders tend to have plenty of.

Participants and Products

Vendor	Products
ADTRAN	ADTRAN vCPE
ADVA Optical Networking	ADVA Icehouse OpenStack Ensemble Orchestrator Ensemble Connector
Allot Communications	Allot Service Gateway - Virtual Edition (SG-VE)
Ciena	Blue Planet
Cisco Systems	Cisco NFVI Elastic Services Controller (ESC)
Dell	Dell NFVI
Fortinet	Fortigate
Ixia	IxNetwork IxNetwork Virtual Edition (VE)
Juniper Networks	Contrail Cloud Platform (CCP)
NetNumber	TITAN
Nokia	CloudBand
UBIqube	MSActivator

Note that Nokia's CloudBand Virtualized Infrastructure Manager (VIM) software which includes OpenStack was installed on Dell's NFVI hardware. The test combinations achieved with Dell NFVI and Nokia CloudBand are marked as "Dell NFVI/Nokia CloudBand".

Interoperability Test Results

Similar to previous reports on public interoperability tests by EANTC and the NIA, this white paper aims to document positive test results and successful test combinations. Failed or incomplete tests are intentionally omitted. Instead, we anonymously refer to any challenges to help the reader sense the current state of the industry. Our experience shows that participating vendors quickly proceed to solve interoperability issues after our test so there is no point in punishing them for their willingness to learn by testing. Confidentiality is also vital to encourage manufacturers to participate with their latest solutions and enables a safe environment in which to test and to learn.

Test Equipment. All of the tests in this campaign were verified by generating traffic using physical and virtual Ixia test equipment.

Virtual CPE Tests

The virtual CPE application has received a lot of attention from service providers due to its potential operational and deployment benefits. But many challenges still lie in the interoperability between the vCPE and the infrastructure in which the service provider may have invested. vCPE interoperability was one of the focus areas in this test campaign.

The vCPE can perform a wide range of virtualization layer and application-layer functions. The scope of this test was limited to the interoperability of vCPE life-cycle management with orchestration solutions and interoperability of the virtual network functions with the NFV infrastructure.

Initially, we tested pairs of vCPEs from the same vendor on various NFVIs and with various NFVOs, representing two interconnected sites. We examined two bandwidth provisioning modes, static and dynamic. The following two subsections describe each configuration.

Point-to-Point Connectivity. To demonstrate inter-site connectivity, the participating vCPE vendors created a dedicated connection between two sites. The two sites ran similar vCPE functions, or virtual appliances. The configuration of the tunnel between the vCPEs was left to the participating vendors' discretion. Understandably, a simple setup with direct IPv4 connectivity was the vendors' choice.

Adva, Cisco, Dell, Juniper and Nokia provided the NFV Infrastructures (NFVI) for this test. Adtran, Allot and Fortinet successfully instantiated their vCPE-flavored VNFs. The NFV Orchestrators (NFVO) were used to deploy the

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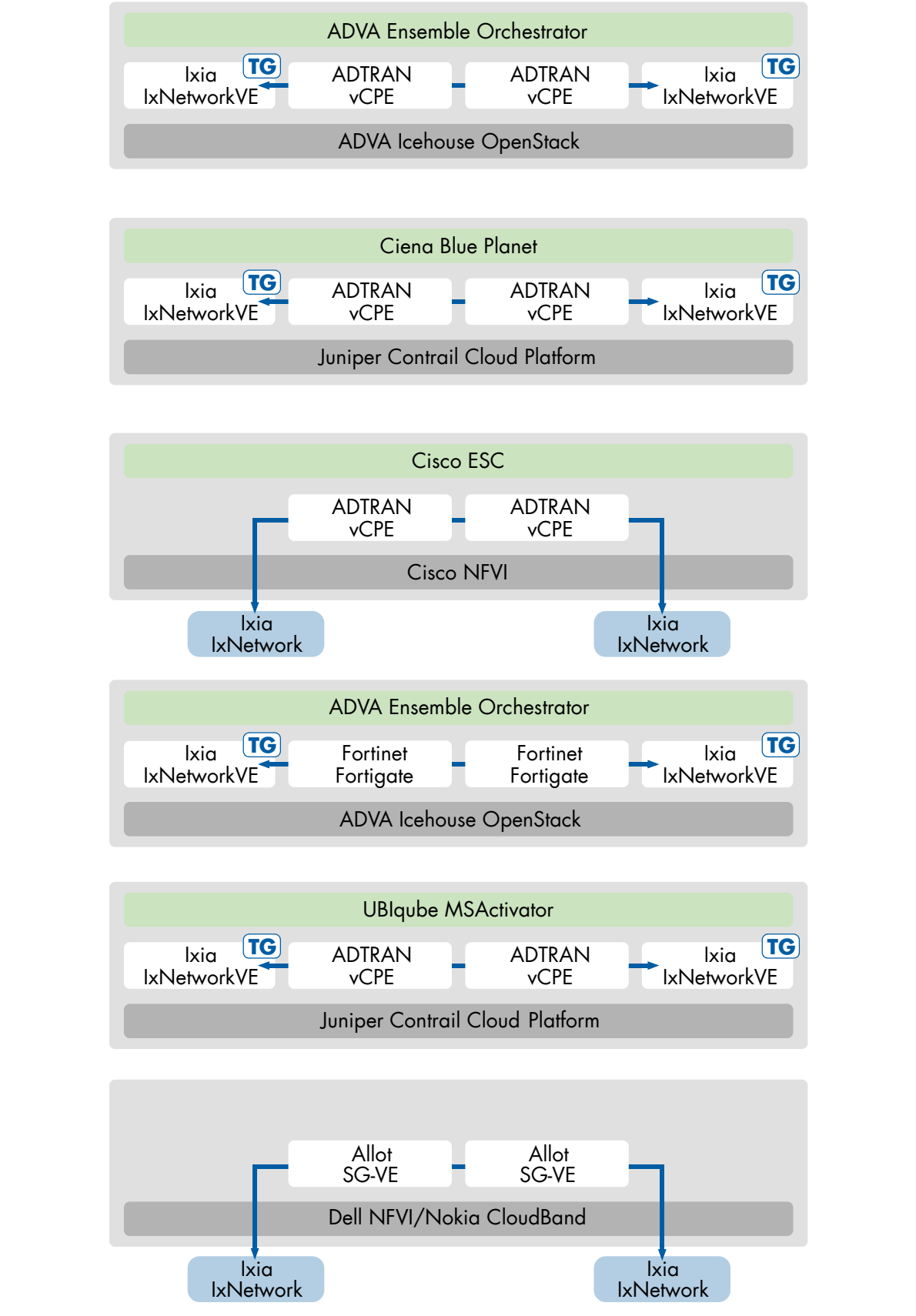

Figure 1: Virtual CPE — Point-to-Point Connectivity Test Combinations

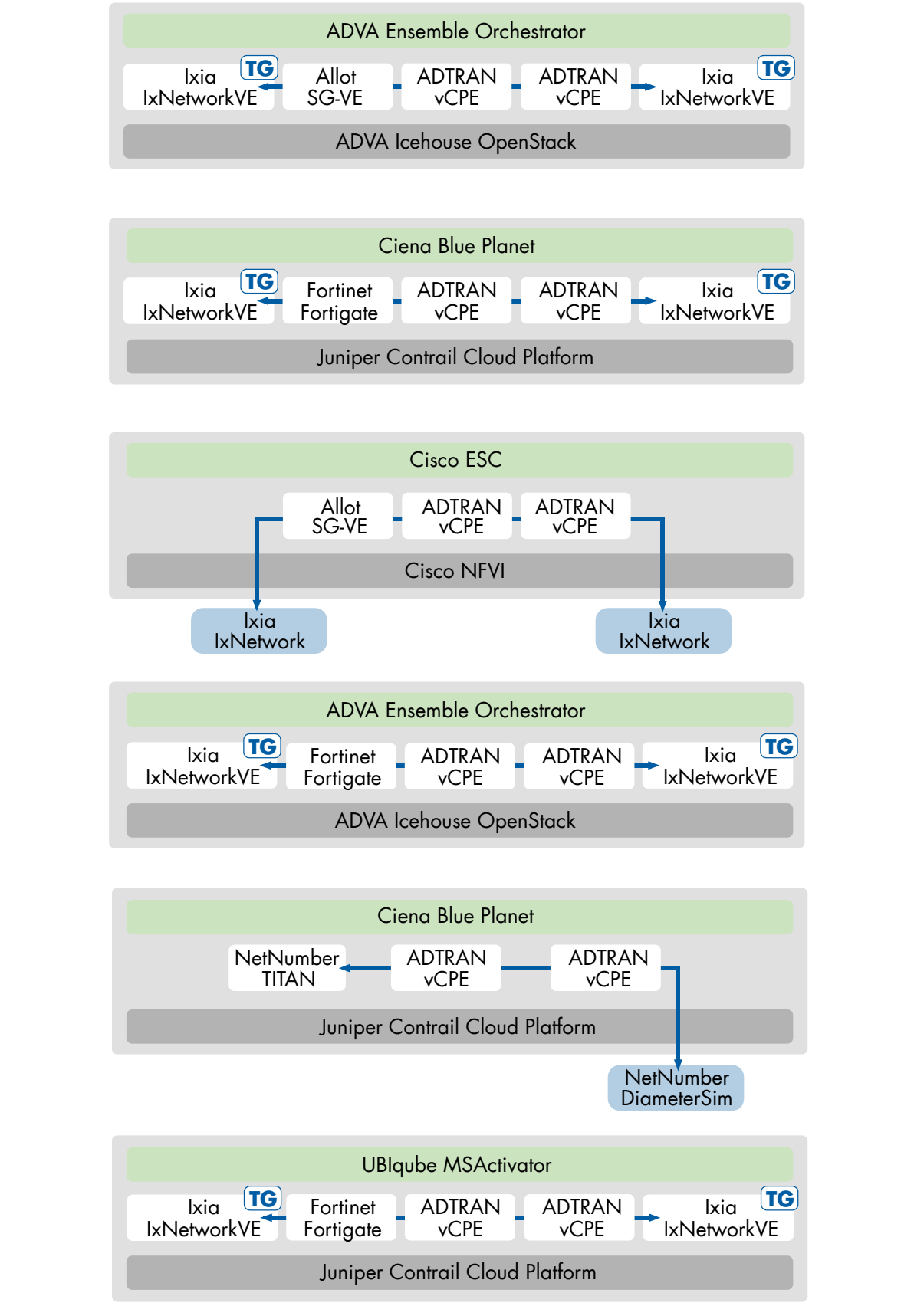

Figure 2: SFC – Static Forwarding Graph Test Combinations

vCPE instances on the NFVI platforms in most cases. Due to limited time, Allot's SG-VE was deployed using a Heat orchestration plug-in on Dell NFVI/Nokia CloudBand. The configuration of the instances was applied both through Cloudinit and manually using the vCPE's management interface. This was due to the limited support for Cloudinit on some NFVI platforms. Figure 1 depicts the successful test combinations.

Unsuccessful vendor combinations faced two main challenges during this test. The first was complexity in setting up some orchestration templates, a time-consuming task that did not fit the test schedule. The second issue was a more serious inconsistency between two different virtual instances in global VIM settings requirements. This global parameter specifies how the VIM handles file-system types. That caused these virtual functions not to run simultaneously using the same global NFVI configuration.

Static Bandwidth Provisioning. It can be debated how the virtual infrastructure should handle shared resources. Most would agree that traditional network operations — such as bandwidth control and QoS — must function correctly if virtualization is to be considered seriously by service providers.

Two vendors participated in this test successfully with their NFVI products, Adva and Juniper. The orchestration of the vCPE was performed by Adva, Ciena and Ubiqube (taking turns). The vCPE function was provided by Adtran and Fortinet, respectively.

We chose two bandwidth profiles (10 Mbit/s and 20 Mbit/s unidirectional) and asked the vCPE vendors to apply the configuration on the virtual equipment. We verified the correct traffic behavior for the first bandwidth profile then asked the vendors to update the provisioned bandwidth to the second profile. The profile update process was performed manually and the result was verified using the test traffic.

Multiple vendors managed to successfully deploy this service as per Table 1:

Table 1: vCPE – Static Bandwidth Provisioning Test Combinations

NFVI	NFVO	vCPE
ADVA Icehouse OpenStack	ADVA Ensemble Orchestrator	ADTRAN vCPE
ADVA Icehouse OpenStack	ADVA Ensemble Orchestrator	Fortinet Fortigate
Juniper Contrail Cloud Platform	Ciena Blue Planet	ADTRAN vCPE
Juniper Contrail Cloud Platform	UBIqube MSActivator	ADTRAN vCPE

Dynamic Bandwidth Provisioning. Service providers are on a constant lookout for innovative and flexible services to deliver to their subscribers. Dynamic service provisioning can be considered as a tool to manage bandwidth plans on demand.

In this test case we verify the successful provisioning of a dual bandwidth profile that starts with 10 Mbit/s and automatically extends to 20 Mbit/s when bandwidth thresholds are exceeded.

We observed a traffic throughout temporarily capped at the 10 Mbit/s limit (for a predefined duration of one minute) before increasing to 20 Mbit/s.

Adva and Juniper took part in this test with their NFVIs. Adva, Ciena and Ubiqube provided the NFVOs and Adtran the vCPEs.

Adtran implemented a scripted configuration that maintained port usage. Once the predefined bandwidth utilization limit had been reached, the configuration on the Adtran vCPE got updated on the fly. Adtran's team explained that this script can also be expanded to trigger an API call towards the management tools (such as the NFVO).

Table 2 lists the successful NFVI, NFVO and vCPE combinations.

When the intended test was completed, Fortinet demonstrated a bandwidth sharing configuration on the Fortigate instance where one traffic flow can borrow unused bandwidth the other flow.

Service Function Chaining (SFC) Tests

The concept of chaining a series of network functions is a major shift from the traditional networking paradigm. The dynamics of this model could simplify the deployment of network services at the customer premises. Many network services such as firewalls, web filters or service testers can fit in an SFC deployment scenario.

There are plenty of studies on the pros and cons of SFC, but as service providers search for potential deployments, interoperability becomes a major concern.

We focused on two SFC modes in the scope of this showcase: Static and Flow-based. The resulting Forwarding Graphs (FG) differ in the way they handle and forward matched traffic.

Static Forwarding Graph. When the network service is applied to all the traffic passing through the customer equipment, static SFC profiles can be sufficient. This configuration does not require the traffic path to be flow-aware.

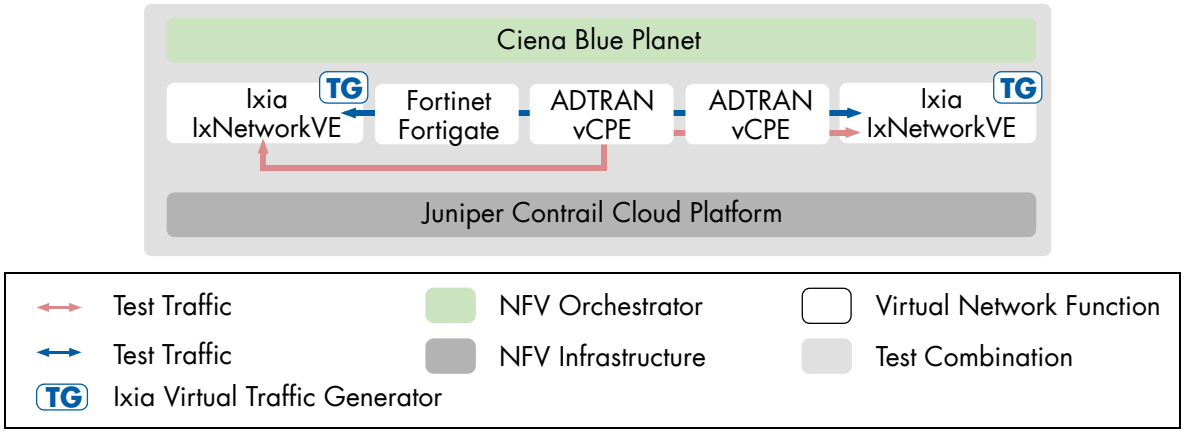

Figure 3: SFC– Flow-based Forwarding Graph Test Combinations

10 vendors lined up in six combinations to perform the static FG test. Adva, Cisco and Juniper provided the NFVI platforms. Adva, Ciena, Cisco and Ubiqube provided the NFVOs. The different test configurations were used to create a composite network service made out of two back-to-back Adtran vCPEs chained to the VNFs provided by Allot, Fortinet, Ixia and NetNumber. Figure 2 on Page 5 illustrates the different product combinations that successfully took part.

Table 2: vCPE – Dynamic Bandwidth Provisioning Test Combinations

NFVI	NFVO	vCPE
ADVA Icehouse OpenStack	ADVA Ensemble Orchestrator	ADTRAN vCPE
Juniper Contrail Cloud Platform	Ciena Blue Planet	ADTRAN vCPE
Juniper Contrail Cloud Platform	UBIqube MSActivator	ADTRAN vCPE

The VNFs were instantiated by the service orchestrators. The configuration was applied manually or using a shell script as part of the orchestration process.

Test traffic was used to verify the state of the Forwarding Graphs. The variance in the nature of VNFs required adaptations to the test verification process accordingly. In some cases, this involved introducing different types of test traffic through the two vCPEs and the chained VNFs. An example is Diameter traffic for NetNumber's signaling platform, TITAN.

From a service testing perspective, we opted to use a combination of physical and virtual testers by Ixia. This demonstrates how testing can also become an integral part of the overall service orchestration process.

Flow-based Forwarding Graph. Virtual environments can draw big benefits from natively embedding complex SDN properties into their architecture. Of course, this also requires the introduction of multi-site and cross-platform SDN capabilities, but we would like to overlook this challenge for now — largely because participating vendors had enough on their plates for a single test campaign.

We focused on testing the capability of the NFVI's switching fabric to carry UDP and TCP traffic over two different service chains.

Ciena's Blue Planet orchestrator instantiated a service consisting of four VNFs on Juniper's CCP: Two Adtran vCPE instances, one Fortinet Fortigate and one Ixia IxNetworkVE instance.

Ciena then created the two service chains. The first connected the Adtran vCPEs to the Fortigate instance, then on to the IxNetworkVE tester. UDP traffic traversed through this Forwarding Graph.

The second chain connected the Adtran vCPE instances directly to the IxNetworkVEs. TCP traffic traversed this Forwarding Graph.

Figure 3 depicts the successful vendor combinations and the traffic flows.

Lastly, it is worth mentioning again that other vendor combinations which did not make it to the tables or diagrams did not necessarily fail. Resources and logistics factors created a major challenge for many of the participating vendors.

Acronyms

CPE Customer Premises Equipment
FG Forwarding Graph
NFV Network Function Virtualization
NFVI NFV Infrastructure
NFVO NFV Orchestrator
NIA New IP Agency
ONF Open Networking Foundation
SDN Software Defined Networking
SFC Service Function Chaining
TCP Transmission Control Protocol
UDP User Datagram Protocol
vCPE Virtual CPE
VNF Virtualized Network Function
WAN Wide Area Network

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