TNOVA

NETWORK FUNCTIONS AS-A-SERVICE
OVER VIRTUALISED INFRASTRUCTURES

GRANT AGREEMENT NO. 619520

Deliverable D8.11

Market Assessment

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Executive Summary

This is the first outcome deliverable from WP8. The main goal of D8.11 is to make an assessment of the market areas and opportunities related to the T-NOVA solution and prepare a common ground for the interim and final versions of the current deliverable. The deliverable defines the importance of Network Virtualisation and Network Function Virtualisation (NFV) by analysing the benefits they have to offer. Further to that it identifies similar solutions to T-NOVA, NFV market trends and opportunities; it describes the benefits that T-NOVA has to offer to Network Operators, Network Vendors, Software Developers, Start-Ups and Customers. It defines of a general business model that will be used in the future to define the T-NOVA business models. Finally it reports a detailed commercial exploitation plan with focus on the network operators and equipment manufacturers within the consortium also as academic exploitation plan by the T-NOVA consortium.

These results are expected to establish a common ground on which the remaining T-NOVA T8.1 deliverables, D8.12 and D8.13.

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1. INTRODUCTION

1.1. Motivation, objectives and scope

In order to support the proliferation of powerful applications and mobile devices that demand high speed internet access, telecom operators have traditionally extended their network capacity, which requires huge capital investments. They are faced with the challenge to support a large base of subscribers accessing data-intensive applications during peak times and not wasting expensive resources during non-peak times.

In order to maximize utilization, the network equipment needs to be transformed for better efficiency. The technique which optimizes the usage of hardware resources is called virtualization. Network Operators are also required to upgrade their infrastructure to keep up with the rapid development of new platforms and applications which means high expenditures. By virtualising their network, they can easily implement new virtual systems to deploy new services and provide software upgrades without the need of investing on new hardware solutions.

Current networking infrastructures rely on hardware-based devices as building elements; most in-network functionalities (routing/switching, filtering, analysis, adaptation, signaling control, security provision, etc.) are carried out by stand-alone hardware appliances. This approach, while having worked well for several decades, is now seen as a major factor which contributes to the so-called *"ossification"* of the Internet. Solely relying on hardware platforms with fixed resources/capabilities significantly slows down and hampers the introduction of new network services. The advent of network innovations in the context of Future Internet (new protocols, algorithms and standards) calls for continuous upgrades (or even replacement) of the existing appliances in a much faster pace than their average lifetime.

The T-NOVA project will allow operators to deploy virtualised network functions, not only for their own needs, but also to offer these virtual functions to their customers, as value-added services. Virtual network appliances (gateways, proxies, firewalls, transcoders, analysers etc.) will be provided on-demand "as-a-Service", eliminating the need to acquire, install and maintain specialised hardware at customer premises.

The purpose of this deliverable is to make an assessment of the market areas and opportunities to be addressed by T-NOVA, identify the T-NOVA benefits, and make an assessment of the existing market also as look into relevant solutions and market trends in the relevant area. More specifically, the deliverable will define the importance of Network Virtualisation and Network Function Virtualisation, it will identify NFV market trends and opportunities. Further to that the deliverable will define a general business model that will be used in the future as a base to define the T-NOVA business models and implement the T-NOVA business plan. Finally, a detailed commercial exploitation plan focusing on the network operators, IT service providers and equipment manufacturers within the consortium will be defined along with an academic exploitation plan by the T-NOVA consortium.

1.2. Document structure

Following this introductory section, the remaining part of the document is structured as follows:

- Section 2 highlights the importance of network virtualisation and its benefits.
- Section 3 describes the benefits that T-NOVA offers to network operators, network vendors, software developers, start-ups and their customers.
- Section 4 identifies a general business model that will be used to elaborate on the business plan which will be developed in the interim report of this deliverable.
- Section 5 conducts a market assessment by looking in to T-NOVA's competitive environment and similar solutions; it identifies the market drivers and barriers and defines the trading mechanisms that will be implemented in T-NOVA.
- Section 6 describes the exploitation plan of the partners involved in T-NOVA, mainly industrial partners as well as academic partners comprising research institutes and universities.
- Section 7 provides general conclusions regarding this work.

2. NETWORK VIRTUALISATION

Virtualisation is the ability to emulate a hardware platform such as a server, storage device or network resource with software. All the functionality is decoupled from specific hardware, and is implemented through s a *virtual instance* fully replicating the capabilities and resources offered by the virtualised hardware element. A single hardware platform may be used to support multiple virtual devices or machines, which are easy to spin up or down accordingly making virtualised solutions more portable, scalable and cost effective than traditional hardware-based solutions [SDNCentral].

With Network Virtualisation the virtual network is entirely provisioned using software. The same software tools already provisioning the application's virtual machines (*hypervisors*) can simultaneously provision both compute and network resources together. By virtualising network solutions, network resources can be deployed and managed as logical resources instead of physical resources. By this, companies are able to enhance enterprise agility, improve their network efficiency, reduce CAPEX and OPEX and maintain high standards of security, scalability, manageability and availability.

The business benefits behind virtualising a network are huge. Organisations can save on costs by requiring less hardware, can utilise bandwidth more efficiently and streamline the network provisioning processes. Disaster recovery provisions are embedded in the architectural fabric of the network and inherent scalability fits with the cloud mode for service delivery.

A Virtualised Network Environment (VNE) is a collection of multiple heterogeneous network resources from different service providers. Each service provider obtains resources from one or more infrastructure providers and creates a virtual network.

The VNE encompasses two actor roles: the infrastructure provider and the service provider. The Infrastructure Provider (IP) deploys and manages the physical network resources. He offers its resources to different service providers and delegate to their customer's tools to use or manage those resources. The Service Provider (SP) leases resources from various IPs, creates and deploys virtual networks by allocating network resources to offer end-to-end services to its end users.

3. NFV MARKET

Network Operators are facing the issue that they are gathering a large and increasing variety of proprietary hardware appliances. Launching a new service requires space and power consumption, increasing the energy costs and the capital investment challenges. Further to that it requires skills to design, integrate and operate the complex hardware-based appliances which reach end of life and require the repetition of the design-integrate-deploy cycle to be repeated with little or no revenue benefit [ETSI.a].

3.1. Defining NFV

The above issues are aimed to be addressed by Network Functions Virtualisation. NFV leverages standard IT virtualisation technology to consolidate network equipment into industry standard high volume servers, switches and storage that may be located in Datacenters, network nodes and end users premises.

Network functions virtualisation (NFV) is an initiative to virtualise network functions previously carried out by proprietary, dedicated hardware. Developed by the European Telecommunications Standards Institute (ETSI), NFV decreases proprietary hardware required to launch and operate network services, leveraging standard IT virtualisation technology to consolidate many network equipment types onto industry standard high volume servers, switches and storage. Network Functions Virtualisation is applicable to any data plane packet processing and control plane function in fixed and mobile network infrastructures [ETSI.a].

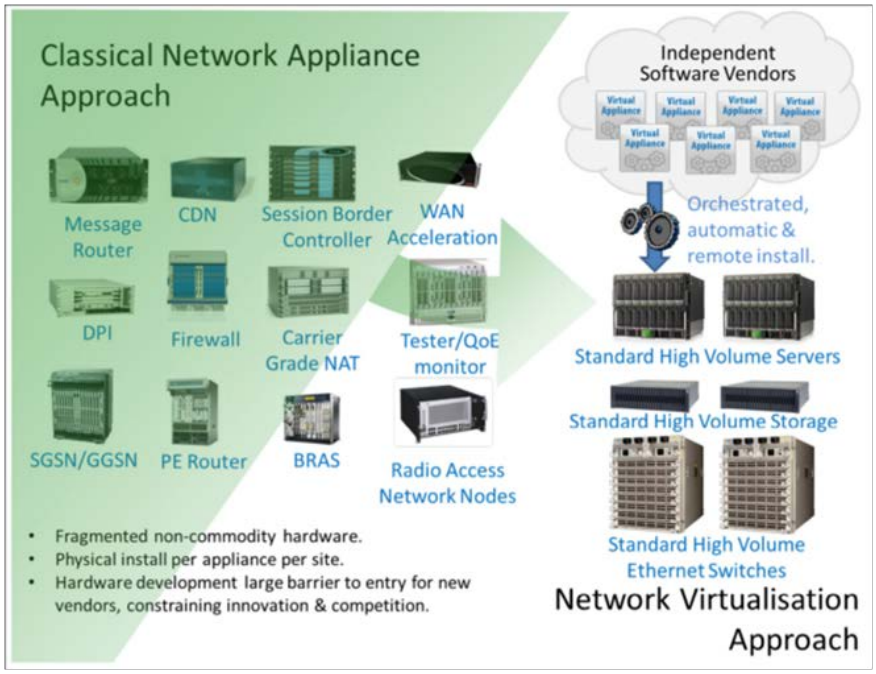

Figure 1: ETSI-NFV-Approach - Vision for Network Functions Virtualisation

In order to accelerate progress, the Network Functions Virtualisation Industry Specification Group (NFV ISG) was founded under the auspices of the European Telecommunications Standards Institute (ETSI). The key objectives are to achieve industry consensus on business and technical requirements for NFV and to agree common approaches to meeting these requirements, combining the complementary expertise and resources of the IT and Networks industries.

3.2. NFV Benefits

According to ETSI [ETSI.a]., NFV offers many benefits and will revolutionize the way telecommunication networks are built and operated. NFV can offer many potential benefits to network operators contributing to a strong change in the telecommunications industry landscape including the following:

3.2.1. OPEX Savings

NFV allows running production, development, testing and service upgrades on the same infrastructure using virtualisation. This reduces the time required to set up a new sandbox and will allow developers to run the software on the actual hardware, making testing results more efficient and reliable. Centralised management and configuration are much easier and more efficient compared to using vertical or proprietary tools. NFV lowers power consumption with the user of power management features in standard servers and rebalances dynamic workload by routing the workload to a subset of available resources and powering down the rest.

3.2.2. CAPEX Savings

Combining multiple network functions into a single server automatically reduces floor spacing and power cable routing requirements. The support of multiple users on the same hardware platform makes it capable to provide tailored services and connectivity with secure separation of application execution environments. The support of multiple users allows the network operator to support a large number of customers with less equipment.

3.2.3. Automation gain

NFV also increases automation, which results in the simplification operation, business agility and faster time to market. Service providers may use the virtualised network and cloud technologies in order to adopt tools similar to those used by the IT industry in order to automate many aspects of operations and management. This leads to the reduction of the operational expenses and enables service providers to meet the needs of the telecommunications market through faster service introduction, the automated scaling of resources up and down to meet changing demands and the ability to continuously optimize resource allocation.

3.2.4. Reduced Time to Market

Minimizing the typical network operator cycle of innovation, leads to reduction of Time to Market. Economies of scale required to cover investments in hardware-based functionalities are no longer applicable for software-based development, making other modes of feature evolution feasible. Network Functions Virtualisation should enable network operators to significantly reduce the maturation cycle.

3.2.5. Availability of network appliance multi-version and multi-tenancy

This means that a single platform is able to support different applications, users and tenants. This allows network operators to share resources across services and across different customer bases.

3.2.6. Flexibility

Greater flexibility to scale up, scale down or evolve services, targeted and tailored service introduction based on geography or customer sets.

3.2.7. Wide variety of eco-systems

Enabling a wide variety of eco-systems and encouraging openness, NFV opens the virtual appliance market to pure software entrants, small players and academia, encouraging more innovation to bring new services and new revenue streams quickly at much lower risk.

3.2.8. New & Flexible Business Models

With the introduction of new and flexible business models, CSPs (Communication Service Providers) will be able to offer services based on customer demand and supporting pay-as-you-grow business models, opposed to capital expenditure tied to under-utilized equipment

3.3. Relationship with SDN (Software Defined Networks)

Network Functions Virtualisation is highly complementary to Software Defined Networking (SDN), but not dependent on it (or vice-versa). NFV can be implemented without SDN, although, according to ETSI, the two concepts and solutions can be combined to produce greater benefits.

Network Functions Virtualisation is able to support SDN by providing the infrastructure upon which the SDN software can be run. Furthermore, Network Functions Virtualisation aligns closely with the SDN objectives to use commodity servers and switches.

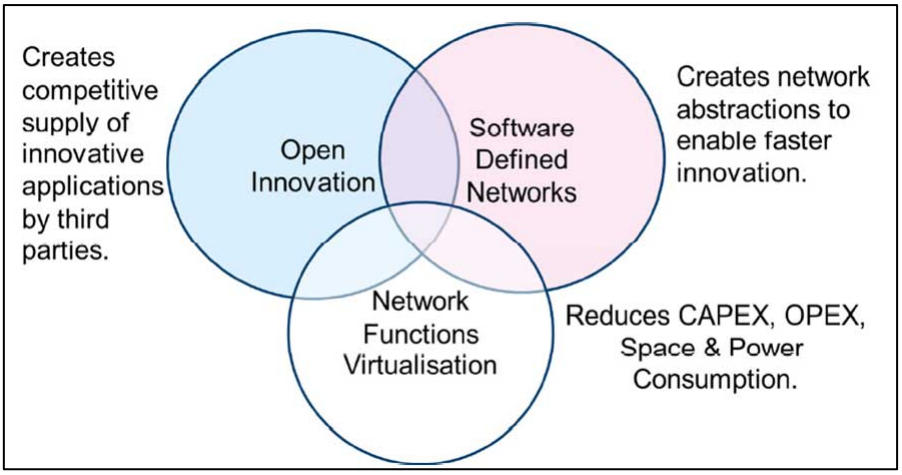

Figure 2: Network Functions Virtualisation Relationship with SDN

Although NFV can be achieved without SDN, and SDN can be achieved without NFV, when they overlap, SDN with NFV offers a way for CSPs to break out of their established, inflexible business models. A new business model may result where network functions are dynamically allocated on generic servers and paid for as needed, as opposed to being paid with network line cards in static and sliced architectures that are often inefficient. .

Network Operators face challenges in both CAPEX and OPEX which play a huge role in their cost structure. According to Huawei Technologies [Huawei] SDN/NFV should be a building block for a service provider's business transformation bringing the following benefits:

- **New business mode** by providing real-tile online customizes services and an open platform featuring innovation and agility in order to achieve network monetization.
- **New business areas expansion** providing services that transcend voice and data, expanding in to new markets and services. This will create new opportunities for them and help them increase their revenues and transform their IT systems.
- **Automated and intelligent networks:** with a centralized network control will allow network management and control in a global view whist as the same time provide programmable network interfaces so that networks can provide better services.
- **Maximum optimisation** for network resources utilization will provide a unified hardware platform and achieve flexible sharing of resources improving resource utilization, lower hardware costs and increase network service upgrade and provisioning efficiency.

3.4. NFV Market Trends

3.4.1. Forecast Overview

Gartner [Gartner] forecasts CSP CAPEX for SDN and NFV of more than $11.5 billion worldwide by 2017. CSPs' may choose to deploy the carrier infrastructure by leveraging traditional deployment models until the SDN and NFV features become mature in terms of carrier-grade reliability and scalability, deployments gain momentum and case studies demonstrating ROI for these solutions occur. Through to 2017, CSPs will make moderate investments in SDN/NFV solutions and will take more time to adopt these technologies, while a majority of telecom equipment providers have announced plans to support SDN and NFV. Gartner believes that the year 2017 will be the inflection point that rapidly increases the SDN and NFV solutions adoption within the CSP environment. Large CSPs, such as Verizon and Deutsche Telekom, have started testing SDN and NFV solutions, but they will initially look for small scale deployments to demonstrate the reliability of the solutions. The early SDN and NFV deployments will mostly be in router and switch carrier network infrastructure, followed by access and transport providing bandwidth-on-demand in the future. As showed in the chart below, about the carrier network infrastructure spend driven by SDN and NFV, the primary growth is coming from service provider routers, switches and core mobile infrastructure.

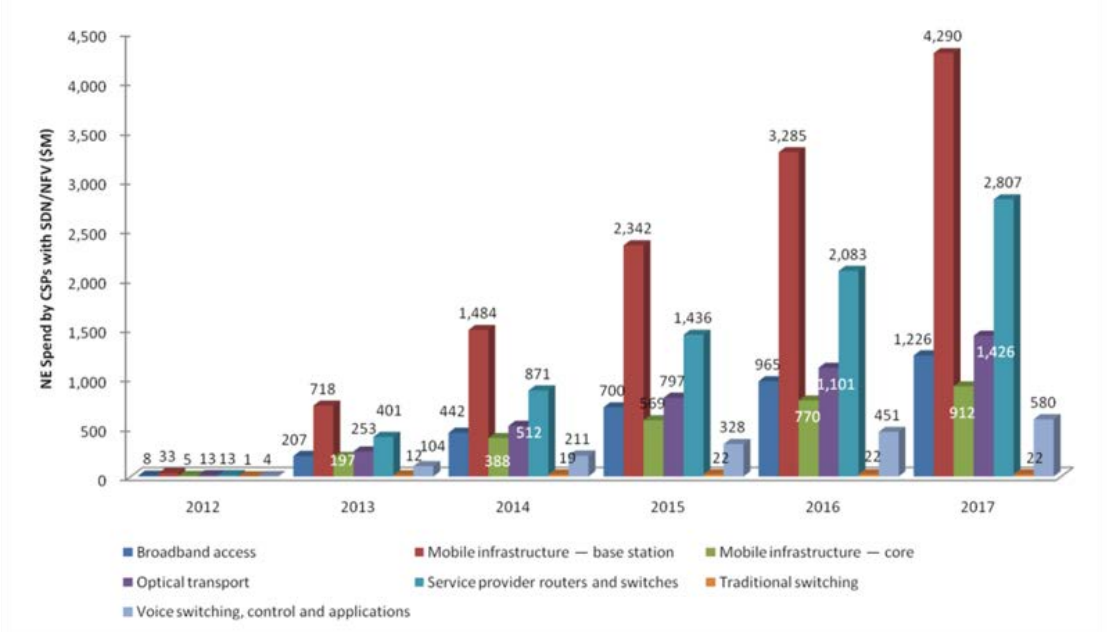

Figure 3: Network Equipment Spend by CSPs with SDN/NFV, 2012-2017 [Millions of Dollars]

For the carrier network infrastructure spend driven by NFV (excluding SDN), the growing market segments will be primarily within voice switching, control and applications, mobile infrastructure — base station and SPRS [GARTNER].

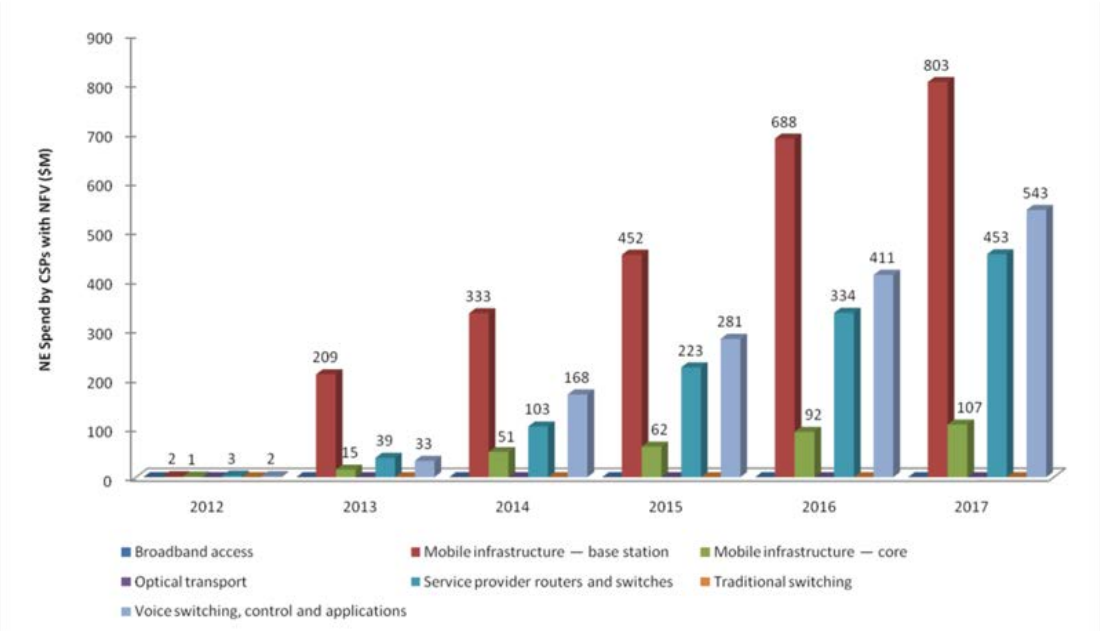

Figure 4: Network Equipment Spend by CSPs of NFV (excluding SDN), 2012-2017 [Millions of Dollars]

Operators in mature markets such as the European one are suffering from revenue shrinkage and persistent competition. Revenue from voice and messaging services is clearly declining. Delivering services with traditional hardware-intensive networks is increasingly complex and costly, which further impacts margins. As far as regulation is concerned, the European Commission is calling for measures aimed at creating a European single market for electronic communications [EC].

This new regulatory framework is bound to change the landscape of the telecom sector in Europe by eliminating borders by establishing common rules across different Member States. At first sight, the Connected Continent framework will most probably result in more strict regulations within the sector, although it is expected to benefit citizens and to foster the creation of the required infrastructure for Europe to become a connected community. Obviously, this will have a major impact in Europe in the social, cultural and business domains. As for traffic volume, the forecast is that it will reach 1.4 zettabytes per year in 2017 [TMForum].

Video, M2M, cloud computing, etc. are services that operators willing to go beyond commodity will be offering and this requires important investments as far as infrastructure is concerned. In this background landscape, NFV emerges as a technology that helps overcome these problems, at least from a network infrastructure perspective having a positive impact on cost and agility. HP has carried out a global survey in January 2014 [HP] among communication service providers -50 CIOs (heads of IT) and 50 CTOs (heads of operations)- in order to find the main priorities . Among the main findings of this survey, we can cite that 80% of these executives (including 84% of CIOs and 76% of CTOs) said that the move to NFV is a top trend impacting their role, as shown in the following picture:

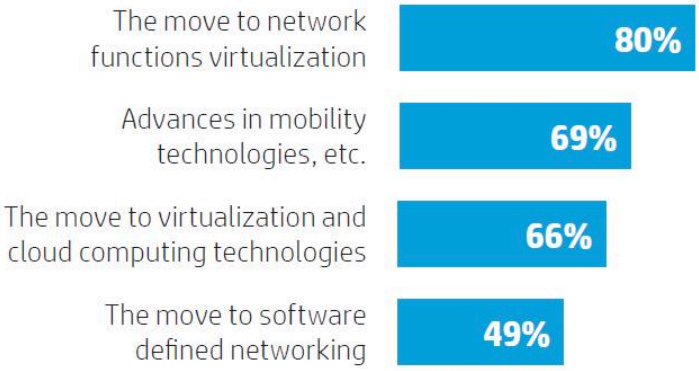

Figure 5: Trends impacting your role as CSP CIO and CTO [HP]

36% of the respondents considered that NFV is currently the most important trend, as shown in the next figure:

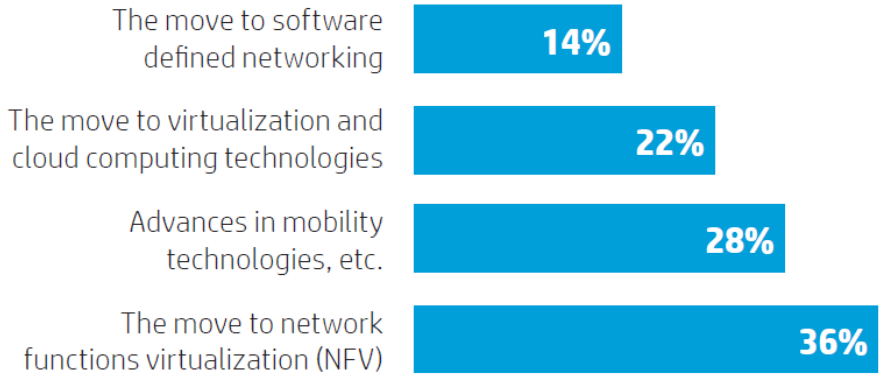

Figure 6: Single most important trend affecting your role -as CSP CIO and CTO [HP]

When asked about when NFV will be a major player in the market, 49% answered in 2-3 years (which means 2016-2017) whereas 36% believe that it is a matter of 1 or 2 years only. The transition of NFV is complex and requires time to acquire the skills and to sort out the complexity. Moreover, it requires network and IT groups working more closely together.

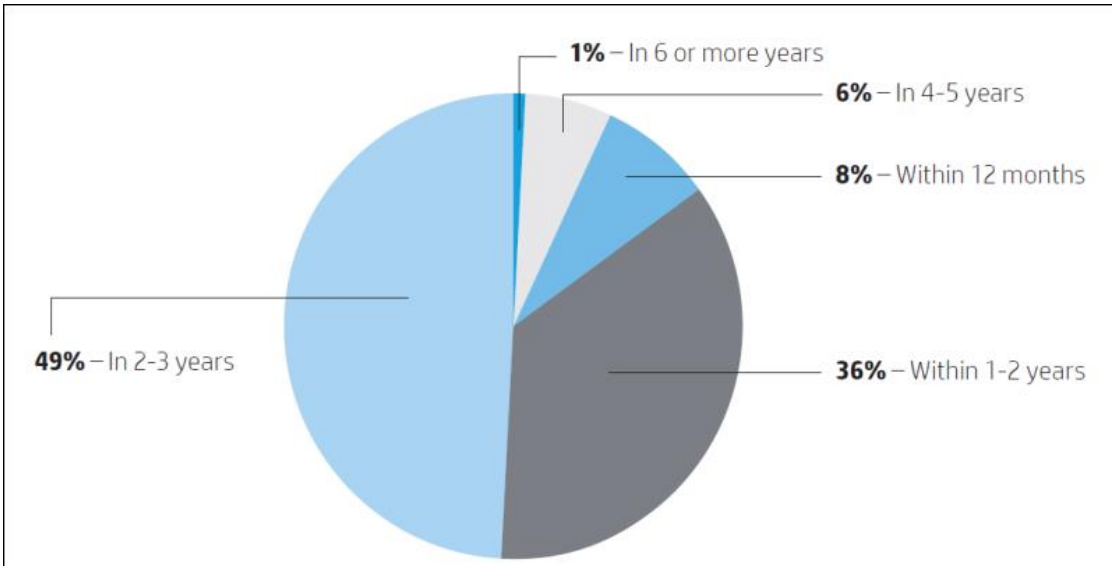

Figure 7: When will NFV be a major player in the CSP market

3.5. NFV Opportunities

According to [FienceTelecom], NFV is an opportunity for network operators to change their business models. It aims at targeting the two big issues that network operators are facing, bringing cost in line with revenue growth expectations and improve service velocity.

Home virtualisation will replace the STB (Set-Top-Box), including storage for video recorder and residential gateway, with a simple low-cost on-premise device driven by cloud-based functionality. Currently each TV requires a separate STB.

Upgrading home network subsequently means high costs and logistic challenges, causing fixed network operators to lose grounds relative to OTT and mobile network providers. NFV breaks through these costs and logistic barriers by employing self-installed hardware priced between 18 - 30 EUR, driven by highly scalable cloud-based software [FienceTelecom].

The goal of NFV is to provision virtual services and applications within minutes instead of months. This will make it more cost-efficient to run and scale networks since operators will be able to provision and de-provision bandwidth on demand based on the user's needs. When the customer affords to pay more they will be offered better services. This means that NFV is linked to revenue generation in addition to network efficiency [SearchSDN].

4. NETWORK FUNCTIONS AS-A-SERVICE OVER VIRTUALISED INFRASTRUCTURES (T-NOVA)

The T-NOVA project aims to design and implement integrated management architecture, based on an Orchestrator platform in order to jointly manage and allocate networking and IT resources for the automated instantiation and accommodation of Network Functions.

4.1. T-NOVA Benefits

T-NOVA is expected to offer a lot of benefits to business entities such as a network operators, network vendors, software developers, start-up companies and customers.

4.1.1. Network Operators

Network operators and telecom service providers are expected to generate attractive revenue by monetizing their infrastructure and by offering new services and charging customers depending on their usage of in-network resources, charge flat fees for plain connectivity services.

New services will be planned, implemented and tested without the need of hardware. Network operators will be able to allocate in-network computing resources for function implementation and charge them according to usage. Services will be easily scale-up as a matter of complexity and amount of traffic handheld, as user's needs grows. Each virtualised component will be able to run in its own protected resource space hence potential security breaches will not impact other functions that will run on the physical platforms. Finally, restarting and updating software for a given function can be performed without affecting other services and functions on the same platform.

4.1.2. Network Vendors

Network vendors who develop specialised networking equipment will have the potential to virtualise their platform and gain the opportunity to widen their targeted customer groups such as network operators. This will strengthen their position in the global market. Via the function store, virtual appliances may be advertised and instantly exposed to the global marketplace, lowering time-to-market down to minimum. Appliances which are still in a beta version are possible for even faster introduction with continuous updated and fixes which promise long term support.

4.1.3. Software Developers

Network appliance virtualisation has the potential to open the networking market to software developer entrance. This opening is expected to stimulate sustainable growth and reinforce the competitiveness of EU players by creating new business opportunities. With the establishment of a common architecture and framework for network services, T-NOVA supports the creation of new business opportunities via its Function Store and Marketplace.

4.1.4. Start-ups

NFV opens up new opportunities for start-ups to enter the networking market by building virtual network appliances which implement a highly innovative algorithm or protocol. T-NOVA supports this by introducing the NFV Market place and function store, aiming to open up the virtual appliance market to thousands of developers, primarily individual programmers or start--up SMEs. It will provide the potential to individuals and SMEs to use the marketplace and generate revenue under several billing models.

4.1.5. Customers

T-NOVA will provide significant benefits for its customers by outsourcing required network-level functions to the T-NOVA virtualised infrastructure, instead of employing specialised equipment at their premises. Up to now, various operations such as firewalling, media adaptation etc. have been undertaken by separate dedicated equipment which was purchased and installed at the customer's premises. With T-NOVA these tasks will be off-loaded to the service provider and the customer will not have to own any network equipment.

By offering network service bundles, connectivity and functions, this will shift the cost of customers from CAPEX to OPEX allowing finer control of expenditure and avoid costly equipment acquisition and maintenance.

With a pay-as-you-go model customers may gain the capability to build up cost according to the actual consumption of NF resources.

4.2. T-NOVA Roles and Stakeholders

As stated in D2.1 [T-NOVA-D2.1] several roles are involved in the T-NOVA value chain, which are illustrated in Figure 8 and described below.

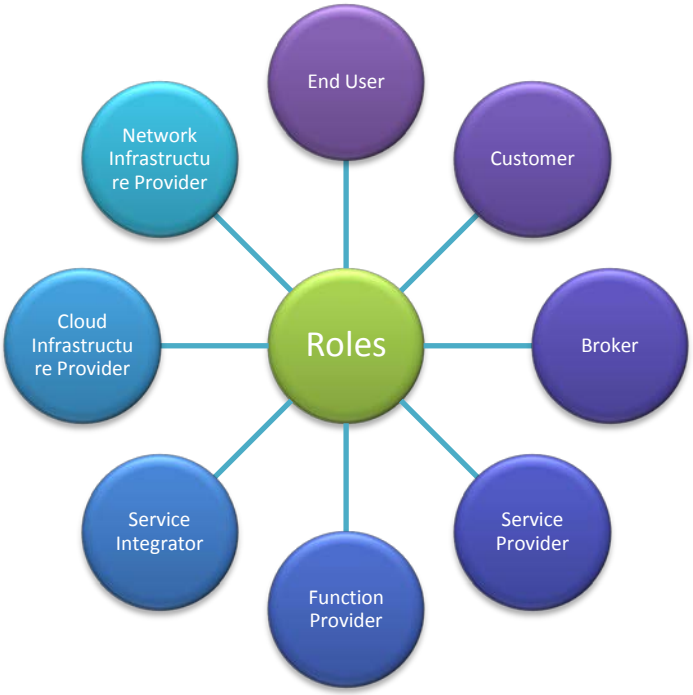

Figure 8: T-NOVA Roles [T-NOVA-D2.1]

- **End User (EU):** This is the end consumer of the purchased service, which is acquired by the Customer (C).
- **Customer (C)**: The T-NOVA Customer who purchases T-NOVA services.
- **Service Provider (SP)**: The SP provides a finished product to end customers. Services offered to end customers can be single network functions, or bundles containing a combination of functions from different Function Providers (FP), or a complete end-to-end network service.
- **Function Provider (FP)**: The FP supplies virtual network appliances (gateways, proxies, firewalls, transcoders, etc.) eliminating the need for the customer to acquire install and maintain specialised hardware.
- **Broker (B)**: The broker role performs trading between the customer and the service providers and between service providers and function providers. The broker fetches offerings matching the customer requirements and, depending on the applicable trading-policies, carries out the necessary actions for the customer, the SP and the FP to agree on definite SLAs and prices to be applied.
- **Cloud Infrastructure Provider (CIP)**: The CIP provides the cloud infrastructure where the NF will run on.
- **Network Infrastructure Provider (NIP)**: The NIP provides the physical connection to the cloud infrastructure.
- **Service Integrator (SI)**: The SI matches the suppliers providing the substrate for running the virtualised functions for the SP. Depending on the function features and requirements (SLAs included) and taking into account the

different available possibilities, the SI makes the match so that the service can finally be delivered.

These roles interact among them in order to build the T-NOVA landscape. Depending on how they may be grouped to be played in some cases or not by the same business entity (stakeholder), different business scenarios will arise.

For example, in residential scenarios, the C and the EU could be played by the same business entity. Another example is that the T-NOVA SP may also act in the role of the CIP and the NIP. This would be the case of a telecom operator who provides NF over his own infrastructure (cloud and network resources). Also the role of the SI is most likely played by the SP. As for the broker, the most normal situation is that this role is not played by the SP. In a multi-SP scenario, the broker will foster competition among SPs, so this would typically be a third party.

There will be interesting relationships to explore as far as SLAs are concerned. For example, C agrees an SLA with the T-NOVA SP who, in turn, agrees an SLA with each FP and also with the CIP and the NIP.

These different business cases that can be arisen from different ways of T-NOVA roles be played have been introduced in [T-NOVA-D2.1] – section 3.3] but will be extended in deliverable D8.12, from the basis of next section 4.3.

Figure 9 represents the relationship among the T-NOVA roles as it has been defined in D2.1 [T-NOVA-D2.1], when each role is played by a separate stakeholder.

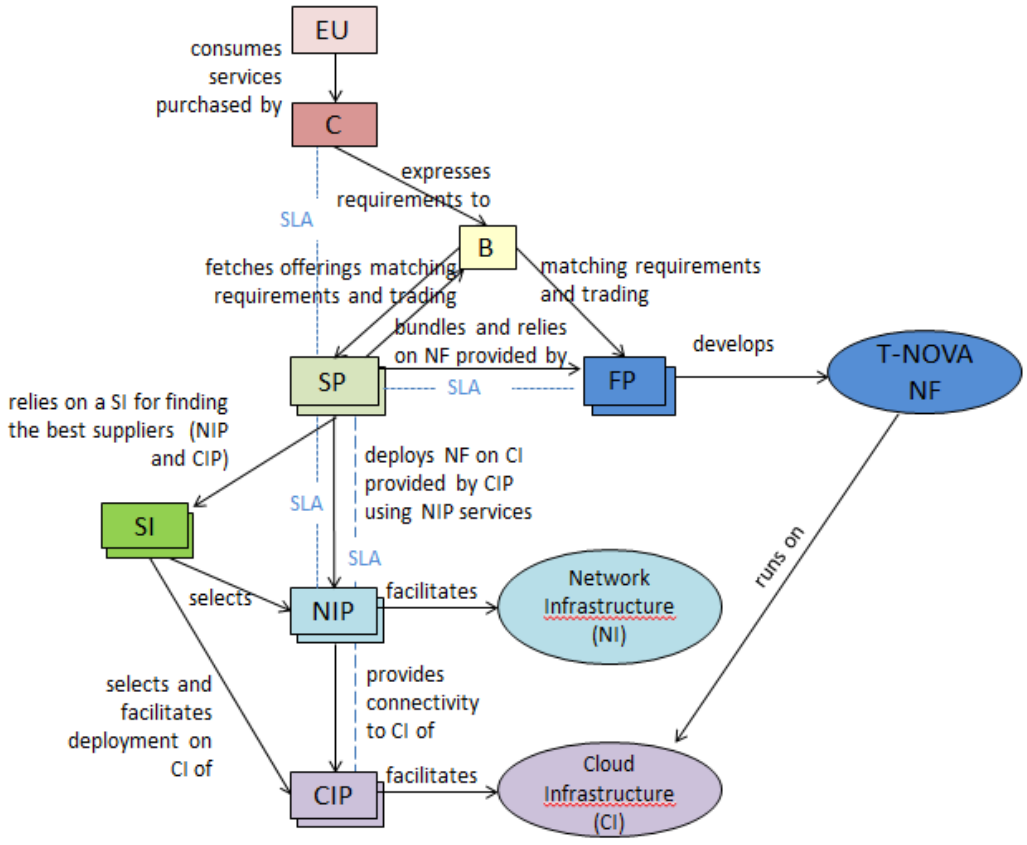

Figure 9: T-NOVA business roles

According to the analysis done in [T-NOVA-D2.1 – section 3.3], in T-NOVA some of the stakeholders are considered to be basic, in the sense that they are likely to play a role in all use cases playing at least one role but could also play several. The remaining stakeholders may be included or not.

Table 4-1 summarizes basic and not basic stakeholders in T-NOVA:

Stakeholder name	Comment
Service Provider (SP)	Basic
Function Provider (FP)	Basic
Customer	Basic
Broker	Basic if the business scenario has several SPs. Optional if there is only one SP. The SP can contract or not a third party to perform trading among FPs to purchase VNFs. If the broker is not contracted, the SP will perform itself the trading among different FPs.
Service Integrator	Optional (likely to be a function played by the T-NOVA SP)
Network Infrastructure Provider	Optional (likely to be a function played by the T-NOVA SP)
Cloud Infrastructure Provider	Optional (likely to be a function played by the T-NOVA SP)
End User	Optional (may be needed only in some specific scenarios)

Table 4-1 – T-NOVA Stakeholders

4.3. T-NOVA Business Modelling

[T-NOVA-D2.1] specified the set of T-NOVA stakeholders interested in new business opportunities offered within the T-NOVA approach. This section aims to explore the business interests and relationships for the business stakeholders which have been previously defined in [T-NOVA-D2.1] and described above in section 4.2.

The T-NOVA business model indicates potential opportunities for the T-NOVA stakeholders described in [T-NOVA-D2.1]. It describes a general business model based on the relationship between the T-NOVA stakeholder and how each of them will benefit from the proposed partnerships along with the potential revenues that will be generated for each stakeholder.

This deliverable provides a business model structure based on the Business Model Generation approach of Osterwald [Osterwald] that will be used to define all the T-NOVA business models in D8.12.

4.3.1. Customer Segments

The customer segments involve the roles which have been identified in D2.1 [T-NOVA-D2.1]. These include the Customers **(C)** who wish to purchase a service from T-NOVA, the Broker **(B)** who establishes commercial relationships with Service Providers **(SP)**, service providers who provide services to the end customers, Function Providers **(FP)** who wish to offer their functions through the T-NOVA platform. Additional roles include Service Integrator **(SI),** who will match the suppliers providing the substrate for running the virtualised functions on behalf of the SP, the Cloud Infrastructure Provider **(CIP),** who will provide the cloud infrastructure the NFs will run on, and finally the Network Infrastructure Provider **(NIP),** who will provide the physical connection to/from the cloud infrastructure.

4.3.2. Value Propositions

The value propositions describe how T-NOVA will create value for the specific customer segments and result in the rationale why a segment may choose T-NOVA.

The following specify how T-NOVA can create value for its segments.

1. The Customer has the opportunity to get the best offers by participate in bargaining or auctioning processes in order to negotiate a final price and SLA.
2. The SP will create alliances and share revenue between the Function Provider and the Broker by providing services to the Customer.
3. The SP will be able to offer a variety of services
4. The FP shares revenue with the SP by having their functions used or purchased via T-NOVA.

4.3.3. Channels

Channels describe how the Service Provider communicates with the customer to deliver the value propositions. These channels comprise an interface with customers and play an important role in the customer's experience with T-NOVA. Keywords for

these channels are: awareness of the services (Virtual Network Functions), value proposition evaluations, the purchase of the VNF, the delivery of the value proposition and providing support to the customer.

Communication links have been previously analyzed and exploited by Telecom companies in order to maintain the same channels as current companies and establish interaction between service providers and customers. Traditional communication links include web-based communications, telephone conversations, video conferencing etc. These channels will be also used to establish the SLAs to set the basis of the offered services.

4.3.4. Customer Relationships

The following list outlines the relationships that will be established and maintained within this business model:

- Sale/purchase between the Customer and the Service Provider
- Partnerships between the Service Provider and the Function Provider
- Partnerships between the Service Provider and the Cloud Infrastructure Provider
- Partnerships between the Service Provider and the Network Infrastructure Provider
- Partnerships between the Service Provider and the Service Integrator.
- Partnerships between the Broker and the Service Provider.

The **establishment** of a customer relationship can be driven by:

- Acquisition of new customers by advertising the offered services

The **maintenance** of a customer relationship can be driven by:

- Support (Personal assistance, Dedicated personal assistance, Automated services)
- Service upgrades and new features in order to maintain customers

4.3.5. Revenue Streams

The revenue streams part represents how revenue will be generated from each customer segment.

The customer will purchase and pay for a service provided by the SP under the agreement of an SLA. A set of pricing and procurement mechanisms will support customers in selecting the service best fitting their needs. Mechanisms such as real-time bidding, auction based selection, fixed pricing and service bundling will allow the customer to select the best service, and pay per its use, according to the actual consumption of NF resources. More information regarding the pricing mechanisms which are considered for T-NOVA can be found in section 4.4

SLA compliance verification may impact the billable items appearing on the invoice, meaning that in case customer requirements have not been met he/she can be entitled to a discount on his/her bill.

The SP will provide the service to the customer creating alliances with FP's and the B and will share the created revenue with these roles.

The SP will provide the FP with its revenue share in different billing modalities that will depend on the pricing model to the final customer. E.g. a monthly fee will be applied to an offering therefore the FP will be paid monthly. The payment for offerings with punctual services will be very precise.

The FP will provide their functions via the SP and share the revenue between them.

4.3.6. Key Resources

The following describes the most important assets critical to a successful implementation of the business model. These will allow the creation and offering of a consistent value proposition, outreach of other markets, and relationships strengthening with customer segments, ultimately driving to increase revenues:

- The Broker must duly understand the Customer's NF requirements.
- The Broker must select the best offer and conditions matching with the customer's requirements.
- The Function Provider must have available functions for the Service Provider, compliant with the T-NOVA function store model,
- The CIP must have a commercial relationship with the Service Integrator or with the Service Provider
- The NIP must have a commercial relationship with the Service Integrator or with the Service Provider
-

4.3.7. Key Activities

The key activities include the most important things and actions that will make a business model to operate successfully.
They are required to create and offer a Value Proposition, reach markets, maintain customer relationships and earn revenues.

- The C should indicate their network function requirements to the Broker.
- The Broker should fetch the NF from the SP depending on the C's requirements.
- The Customer should be able to purchase and pay for a VNF (or a more complex service) from the Service Provider
- The SP should be able to provide NFs to the C and guarantee QoS
- The FP should be able to provide network functions to the SP
- The SP should deploy NFs on the cloud infrastructure of the CIP
- The NIP should provide connectivity to the CIP

- SLAs should be established between
  - Customer ←→Service Provider
  - Service Provider ←→Network Function Provider
  - Service Provider ←→Network Infrastructure Provider
  - Service Provider ←→Cloud Infrastructure Provider

4.3.8. Key Partners

Key Partnerships identify and describe the partners that will be required to deliver T-NOVA services to customer segments. These partnerships will form the base for the described business model. The identified partnerships within T-NOVA are among

- **Service Provider**
- **Customer**
- **Function Provider**
- **Cloud Infrastructure Provider**
- **Network Infrastructure Provider**

4.3.9. Cost Structure

In order to create and deliver value, maintain customer relationships and generate revenue within a business model, some costs must necessarily be incurred. These costs are defined by key resources, key activities and partnerships in the proposed business model and include Capital Expenditures (CAPEX) and Operational Expenditures (OPEX).

More information regarding the cost structure will be investigated in the second version of the Market Assessment deliverable, D.12.

4.4. Trading Mechanisms

The T-NOVA Service Provider, the Function Providers (3rd party NF developers) and the T-NOVA customers will be able to interact via the brokerage module in the T-NOVA Marketplace as illustrated in Figure 10. The Function Providers will be able to sell or assign available NFs under several trading policies. The T-NOVA trading framework will allow the players to deal directly for Network Functions as Service, or as part of a Network Service, establishing a secondary market for network resources. This will enable SMEs and individuals to enter the networking market and trade their virtual appliances under several pricing mechanisms, hence boosting competition and innovation.

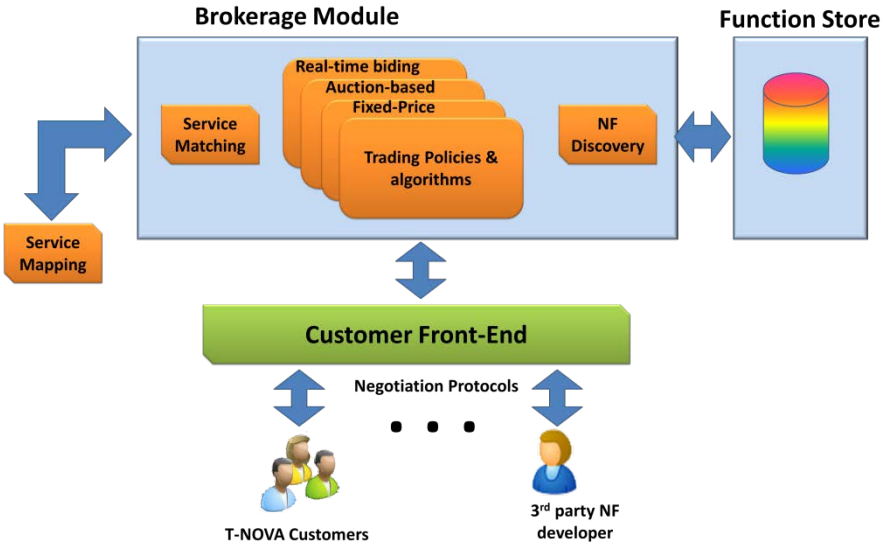

Figure 10: Brokerage module interactions [DOW]

T-NOVA is specifying the Brokerage Module resource matching algorithms and trading mechanisms necessary to facilitate efficient NF exploitation and planning, by studying different trading policies e.g. long-term lease, scheduled lease, short-term lease or spot markets (pricing and auction strategies) and selecting the most suitable ones for T-NOVA landscape.

These trading mechanisms shall allow the customers to choose service levels adequate to their needs and economic requirements, and achieve efficient network resource allocation in Quality of Service (QoS) enabled networks.

Next, some of the trading mechanisms that are going to be studied in T-NOVA are introduced, though extended information about them will be included in [2.41].

4.4.1. Real-time biding

From the bidder point of view, network functions are requested repeatedly for specific time intervals. Bidders request different network functions. Various NFs will

be auctioned in real time allowing advertisers to gain control over their target audience.

4.4.2. Auction based

The auction-based mechanism will allow customers to bid in a competing format in order to access restricted set of infrastructure resources within a predetermined time-frame. Reserve prices can also be used to set a minimum bid that must be reached in order the timed-bidding process to be successfully completed.

4.4.3. Fixed-Price

With the fixed pricing mechanism the Function Provider will determine a fixed price for the network functions and the customer will simply have to pay for the specified price. In this case, an efficient pricing mechanism is required in the Function Provider's side, which will be able to determine the fixed price for the available resources and support a secure pricing scheme.

4.4.4. Bundling

The bundling strategy has more than one function packed together and priced as a single one. It's aimed for buyers with low reservation prices and it's expected to maximize sales.

5. T-NOVA MARKET ASSESSMENT

5.1. Competitive Environment

Nowadays, Network Function Virtualisation (NFV) plans to change the way deployment and operation of the telecom networks is applied, by introducing not only technological innovations, but also an environment that enables the development of new business models and services and prompts the industry vendors of telecom equipment to provide new solutions for their customers.

ReportsnReports [reportsnreports] conducted a market research regarding NFV and identified that by 2020 SDN and NFV will be able to enable service providers to save up to $32Billion per year in CAPEX investment. By 2017 it's expected to see significant price and gross margin for traditional hardware based network equipment that will be driven by software based solutions.

Currently, most of the equipment vendors design their products and solutions that combine software, hardware and networking in a single box. Their products are designed to meet specific performance and reliability requirements based on the associated SLAs. In a virtualised environment, application software is decoupled from hardware and hypervisor software, additionally, distributions of the VMs across different resources/equipments. The evolution of NFV products has profound implications on the way reliability and SLAs are managed. More specifically:

- Focus will shift from reliability and availability per network elements to end-to-end service availability. This will require new systems for monitoring, analyzing and managing the end-to-end infrastructure.
- The industry will need to define also new frameworks for expressing the reliability and availability metrics of individual components, such as hypervisors, VMs, VNFs and networking domains, in a way that enables operators to specify requirements on those components and predict the availability of an end-to-end service.
- Service providers will likely have different operations teams for the physical infrastructure and for the virtualised software layer which will have a significant impact on the way they operate.

The following table presents different types of network functions in today's telecom solutions and the varying timing demands those functions require to maintain end-to-end QoS.

Table 5-1 T-NOVA Stakeholders

Category	Requirements	Examples
Management	Non-real time	EMS, device management, postpaid charging systems
Application	Real time	IMS Services
Control & Signalling	Real time	Session control, subscriber databases,

		policy management systems
Media Services and packet processing	Real time	Media gateways, session border gateways, deep packet inspections
Networking Infrastructure	Real time	Routers, switches.

Management plane functions (e.g. OSS, EMS) have been designed to have high tolerance to long response time and delay, with the minimum impact on the end user experience and QoS. Network function in application and control/signalling plane can tolerate small timing delays. Media services and networking infrastructures functions (including media gateways, session border controllers) have a very low tolerance for long response times or timing delays.

Main industry equipment vendors are moving towards to provide solutions in the based on NFV concepts.

Technavio [Technavio], the global NFV market is expected to grow by 51.57% within the period of 2013 - 2018. Some of the companies which are expected to fuel market growth during the forecast period are mentioned below along with their proposed solution.

5.1.1. Alcatel Lucent CloudBand

Alcatel Lucent provides a NFV solution that addresses the challenges in this domain, regarding compute and storage and the networking aspects of the NFV infrastructure [Cloudband]

- Alcatel Lucent CloudBand provides a carrier-grade cloud management and orchestration solution that supports lifecycle management and other NFV PaaS services, among other things. It is the stepping stone towards a new, cloud focused OSS.
- Nuage Networks provides also SDN-based network solutions, based on software-based overlay that works with any existing vendor equipment and provides the functionality such as abstraction and programmability.

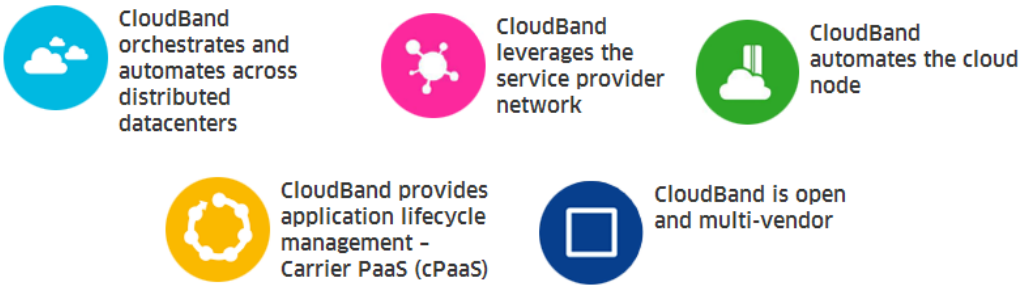

Figure 11: CloudBand [Cloudband]

5.1.2. Broadcom Open NFV

Broadcom introduced an Open NFV platform designed to accelerate creation of NFV applications across multiple system on chip (SoC) processors. This platform aims to telecom providers and network operators who will eventually move to carrier cloud architecture, the chip manufacturer is collaborating with ARM and others to develop a low cost chip and development of platform that supports NFV [Broadcom].

With BroadCom's Open NFV solution, ecosystem vendors can migrate virtual functions between platforms based on various vendor solutions. The platform provides scalability, workload flexibility and interoperability for the successful implementation of NFV.

The Open NFV platform provides open sources components such as Linux, KVM and OVS giving customers a consistent platform independent of the target SoC's ISA, allowing vendors to develop portable NFV applications. Portability and flexibility play a significant role to the successful role out of new solutions based on NFV.

The platform supports open API standards ensuring that customers can take advantage of the market leading capabilities that Broadcom has to offer. Broadcom provides a fully virtualised high performance multi-core processor SoC with tightly couples accelerators that will be available in a wide range of server form factors as well as standardized Open Compute Platforms (OCP) [Broadcom].

5.1.3. Cisco Evolved Platform

Cisco is providing its Cisco Evolved Platform as part of its NFV strategy that virtualizes functions across a CSP's enterprise architecture. The Cisco Evolved Services Platform is a comprehensive virtualisation and orchestration software platform that creates, automates and provisions services in real time, across compute, storage and network functions to deliver desired business outcomes and create new business models. It covers video, mobile, cloud and fixes networks. Its solution is ETSI compliant and includes OpenStack and OpenDaylight SDN protocols [CiscoESP].

The Cisco ESP uses software-defined networking (SDN), Network Functions Virtualisation (NFV), and advanced orchestration capabilities to forge a flexible and modular platform. With the Cisco ESP, service providers can quickly deploy new personalized offerings through services modules [CiscoESP].

Figure 13 illustrates the elements of the Cisco Evolved Services Platform.

The **orchestration engine** automates the creation, monitoring and assurance that all physical and virtual infrastructure, functions and resources are needed.

The **catalog of virtual functions** is an extensible and modular set of virtualised network and application capabilities which links to service profile in order to create the 'offers' that can be deployed anywhere and scaled on demand.

Finally, the **service broker** functions as the service provider's storefront, translating business intent into actionable service initiation and chains the orchestration engine.

Figure 12: Cisco Evolved Services Platform Elements [CiscoESP]

5.1.4. CENX

CENX provides new generation software and services solutions that orchestrate Ethernet transport services across today's IP networks and next generation software-defined networks, as a common on service orchestration platform. The provide Service Orchestration solutions combine Ethernet inventory management, transport network setup and deployment, such as automated ordering and provisioning and also service monitoring analytics. Furthermore, it supports inter-carrier service monitoring and SLA assurances.

5.1.5. Ericsson

Ericsson is providing Evolved Packet Core solution in a virtualised mode based on NFV standards. According to Ericsson, this solution opens new opportunities to operators in the area of M2M [Ericsson].

5.1.6. HP OpenNFV

HP is providing solutions in the domain of NFV orchestration, with their product HP NFV Director. HP OpenNFV incorporates industry intellectual property (IP), service and partners programs for independent software vendors (ISV) and relationships with NEPs and application developers. HP's solution provides a common point to ensure consistent management and behavior of VNFs, regardless vendor, by enabling each VNF to efficiently run on heterogeneous hardware platforms and virtualisations environments. HP's solution is designed to meet ETSI specifications for the NFV orchestrator functionality. This includes the orchestration and management and consistently applying global, cross-VNF and VNF-specific policies [HP_NFV].

5.2. Market Drivers

HP has carried out a global survey in January 2014 [HP] which shows that a big majority of CSPs consider NFV a possibility of new revenue generation, which is a key factor for determining the success of this new technology.

The reminder of the section analyses the main market drivers for NFV, based on the drivers illustrated in Figure 13: NFV key business drivers [HP].

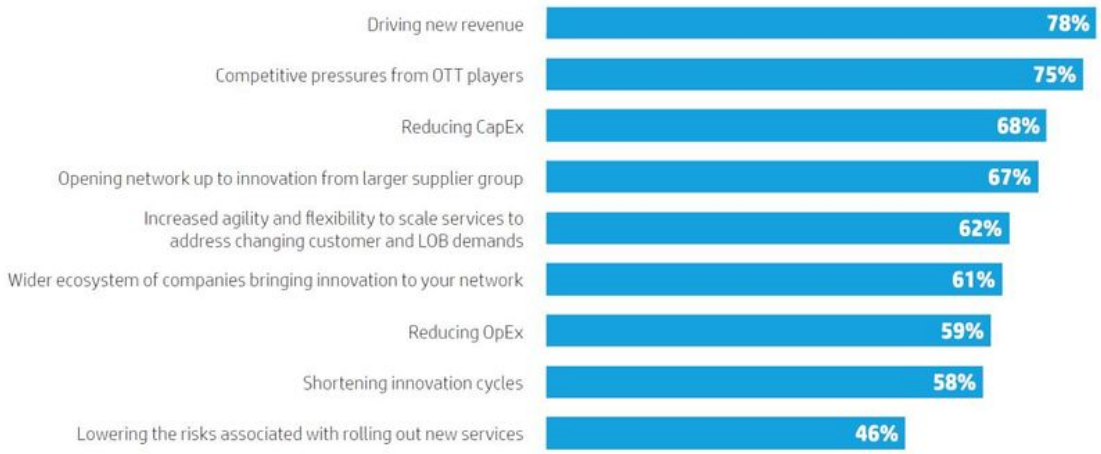

Figure 13: NFV key business drivers [HP]

5.2.1. CapEx & OpEx Reduction

The economic benefits achieved via cost reduction thanks to the T-NOVA approach can be identified from both the customer and the service provider side.

For the customers of the T-NOVA platform, significant cost reduction is achieved by outsourcing certain network-level functions to the T-NOVA virtualised infrastructure, instead of employing specialised equipment at their premises. Up to now, operations such as firewalling, Denial of Service (DoS) protection, media adaptation, proxying/caching, application classification, etc. have been mostly undertaken by separate dedicated equipment purchased and installed. In T-NOVA, all these tasks can be off-loaded to the service provider and actual ownership of network equipment from the customer side can be avoided. In this context, the offering of network service bundles (connectivity + functions) shifts the cost of customers from CAPEX to OPEX which allows finer control of expenditure and avoids costly equipment acquisition and maintenance.

For Service Providers / T-NOVA Platform Operators, the main factor for cost reduction is the use of a virtualised network infrastructure. Virtualisation brings increased availability because the uptime does not depend on an individual physical component anymore. Increased utilization, availability, resilience, operability, and agility simply outweigh all the overhead associated with adoption of the new technology [CISCO].

Another aspect leading to cost reduction is the employment of commodity server nodes for function deployment, instead of expensive specialised networking equipment; this also allows easy upgrade and replacement, but also deployment of new innovative functions and protocols into the network –and also upgrading of existing ones- with minimal delay and cost. Moreover, energy efficiency in T-NOVA is promoted via the use of the cloud infrastructure for accommodating network functions. When traffic processing is performed by specialised gateways, processors, concentrators etc., their under-utilisation may lead to energy wastage.

5.2.2. Innovation and new revenue

NFV allows carriers to offer new revenue-generating services with less risk and investment required. Services can be created using software rather than dedicated hardware based on an agile, programmable network that can dynamically adapt to the context thanks to the elasticity brought by cloud technology. T-NOVA provides the foundation for fostering new services based on NFV that generate new revenue streams and deliver additional value to both customers and service providers. In T-NOVA, innovation is promoted by leveraging NFV, which opens a part of the networking market and transforms it to a novel virtual appliance market, facilitating the involvement of software entrants. In NFV, several providers get together and offer a service. According to the survey by HP [HP], CIOs and CTOs consider that this creates a rich environment for creating new business opportunities resulting from joint innovation. Another example of this is the recent agreement between Telefonica and Alcaltel-Lucent in order to boost the adoption of NFV [Alcatel]. Moreover, the marketplace and the brokerage carried out in T-NOVA helps customers and providers meet and exchange information concerning requirements and existing products.

T-NOVA enables the rapid creation and deployment of new, intelligent network services by providing:

- An abstracted view of virtual network which, by softwarising network functions which provide a seamless, unified and cross-domain view of network features and functions.
- Interfaces to the abstracted network that applications can use
- The possibility to create new services based on virtualised network functions that can easily be orchestrated through their APIs.
- Eliminating proprietary technology, which facilitates the adoption of Big Data solutions for network optimization.

5.2.3. Competition with OTT players

Another very important driver is the competition with OTT players. CSPs make huge investments in network equipment and OTT service providers leverage from these infrastructures to reach customers and provide their services, which, according to the CSP, affect their monetisation cycle [ZDNet]. By introducing NFV, CSP will have wider opportunities for innovation.

5.2.4. Improved Time to Market and risks reduction

T-NOVA reduces the innovation cycle required for a network operator. Economies of scale required to cover investments in hardware-based functionalities are no longer applicable for software-based development, making feasible other modes of feature evolution. T-NOVA and NFV enable network operators to significantly reduce the maturation cycle by allowing an agile introduction of novel network functions (including upgrading of existing ones) at much lower cost and lower risk, leading to significant decrease of the Time-To-Market (TTM) for new solutions. New experimental services can co-exist in the same infrastructure with operational ones.

5.2.5. Increased agility and flexibility

T-NOVA leverages from the dynamic flexibility brought by virtualisation. Resources can dynamically adapt to the demand, scaling up and down as demand changes and providing the required network topology by allocating the resources according to the requirements.

Moreover, with NFV, most of the operations associated with lifecycle components (which are based on software rather than hardware) involve configuration changes and not manual tasks, enabling automation and fostering increased agility and resiliency.

T-NOVA also incorporates accounting and billing mechanisms to charge customers according to their usage.

5.2.6. Energy Reduction and Improved Operational Efficiency

Energy efficiency in T-NOVA is promoted via the use of the cloud infrastructure for accommodating network functions. When traffic processing is performed by specialised gateways, processors, concentrators etc., their under-utilisation may lead to energy wastage. In T-NOVA, all these operations are off-loaded to IaaS cloud platform, where the "statistical multiplexing" gain is obvious: a single physical server, thanks to virtualisation, may handle traffic processing for several customer services.

Relying on the above mentioned approach, energy efficiency could be further improved with specialized plug-ins aiming to optimize the energy consumption in Virtualised environments. An orthogonal investigation area could explore the applicability of specialized low energy consumption platforms, even if this could go beyond the conventional NFV approach. We propose to explore these aspects in the Market Analysis phase, to possibly address some specific task in the subsequent project phases. Also in this case we propose to assess the availability and suitability of commercial "off the shelf" components to enrich the T-NOVA eco-system.

5.3. Market Barriers

There are several inhibitors that might slow down the adoption of NFV. As shown in Figure 15 [TMForum] the Quick Insights publication by TM Forum, some of the main issues that operators have to face are related to the lack of standardised tools and to the complexity involved.

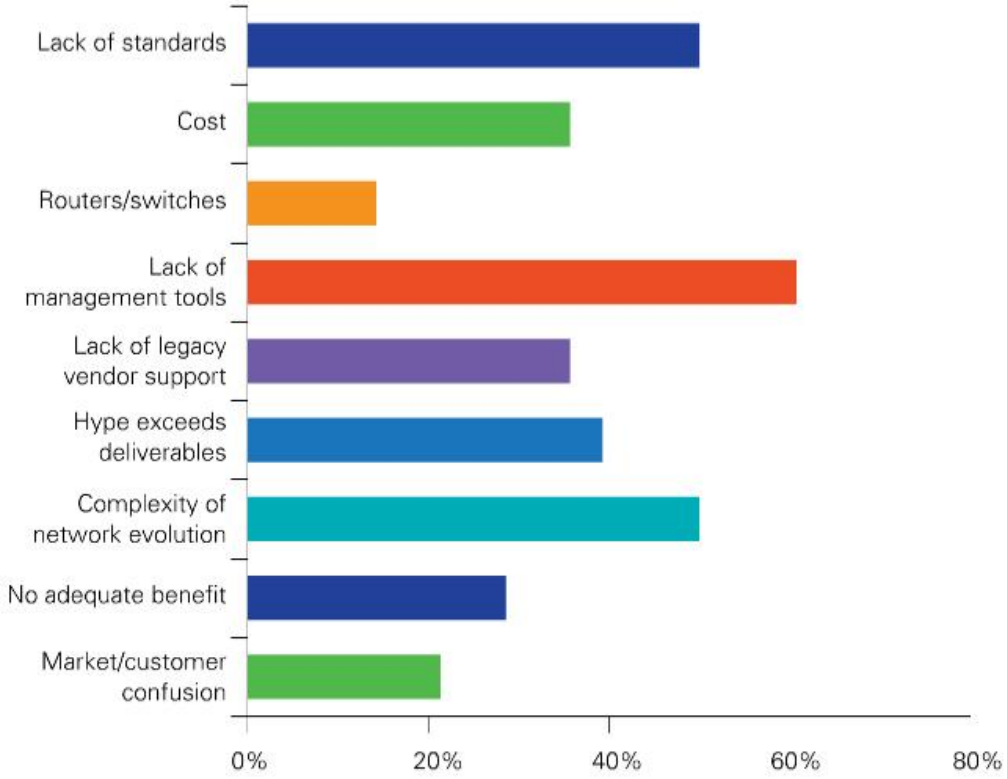

Figure 14: NFV inhibitors

Some of these aspects are analysed in the remainder of this section.

5.3.1. Lack of standardisation and technology maturity

Although this is has always been a barrier for the adoption of NFV, the ETSI Industry Specification Group for Network Functions Virtualisation (ISG NFV), which includes not only operators but also vendors, is developing requirements and architecture specifications for the hardware and software infrastructure required to support virtualised functions, as well as guidelines for developing network functions. This effort incorporates existing virtualisation technologies and existing standards as appropriate and will co-ordinate with ongoing work in other standards committees. The first specifications are available on the ETSI NFV website [ETSI Web].

They include use cases, an architectural framework, terminology, virtualisation requirements and proof of concept framework. T-NOVA is fully aligned with these standards. As far as cloud computing is concerned, one of the main barriers is interoperability and portability across providers and products. Both at PaaS and IaaS levels there is common lack of standardized APIs; a great diversity of frameworks,

programming languages, toolsets and virtualisation mechanisms; a wide range of data types and storing methods; as well as non-interoperable accounting, billing and metering systems. As demonstrated by AWS outage in 2011 (Rightscale), moving services to one locked cloud has the potential to introduce a single point of failure where none previously existed. This can be avoided, but may require careful design and, preferably, the use of multiple clouds. In order to address the above points, openness and interoperability across cloud platforms is essential. However, cloud interoperation and federation technologies are relatively immature. Multiple standardization bodies are currently proposing diverse solutions at multiple levels, but still these solutions do not have a wide adoption in public cloud offerings. Finally, another important aspect, according to a report by IDC for the European Commission, is the fact that slow connectivity seems to be a constraint to cloud adoption (mainly for SMEs). Eliminating the coverage gaps of broadband networks across Europe and insuring high-speed networks diffusion is a key requirement for a cloud-friendly environment and thus for the adoption of T-NOVA technology.

As for maturity, production deployment references will enable carriers to more confidently adopt the technology (no one wants to be the first to try). Further experience, references and feedback from end users is essential for this technology in order for other players to lose fear in general.

5.3.2. Network and technical complexity

Today's networks consist of myriads of proprietary equipment such as network switches, HLRs, NGN IN & IP Signaling platforms, RNCs, etc. Telecom networks have evolved, new networks have replaced or complemented old networks and new services have emerged. Besides, OSS environments require integration with BSS environments. These are extremely complex systems and their virtualisation is not a trivial task, and it is even more difficult taking into account that the systems to virtualise are based on proprietary vendor solutions that must fully interoperate.

As NVF is up taken, virtualised functions will coexist with legacy systems and both will have to be interoperable and management considerations will be crucial.

NFV has of course its limits. There are certain network elements that cannot be virtualised or that cannot simply be taken to a dynamic context such as the one proposed in T-NOVA. For example, elements that require physical hardware (e.g. antennas) or critical systems that require extreme performance, since NFV might also bring additional delays compared to hardware equipment.

5.3.3. Complexity of business models

The other side of the cost reduction expected for telecom operators with the adoption of NFV is a revenue decrease for vendors, who might opt for other opportunities, such as offering managed services to operators. Vendors will have a very important role in the final adoption of this technology. As shown in Figure 8, operators expect legacy vendors to provide enough support. Moreover, the value chain with NFV gets more complex. When CSP rely on application developers and

cloud providers in order to make offerings to their end customers, there is an additional complexity as far as responsibilities and revenue share are concerned. The customer agrees a Service Level Agreement (CSP) with and is charged by the CSP who, in turn, trusts other providers with whom other Service Level Agreements and revenue sharing must be agreed. This trust framework is essential for the take up of T-NOVA therefore the platform includes an SLA management module and accurate accounting for all the parties.

6. T-NOVA EXPLOITATION

The T-NOVA exploitation will be classified into individual partner and joint consortium exploitation:

- Individual exploitation involves the exploitation from the project consortium partners, in order to enhance their own activities and products and to provide better services to their customers. This has the aim to provide a competitive advantage of the individual consortium partners and effectively contribute to the benefit of the targeted users.
- Joint consortium exploitation involves the exploitation activities of the project results, which are jointly carried out by the partners of the project. The T-NOVA test-bed is a specific example of such a framework: partners will jointly evaluate the proposed architecture and the components that will be developed in the context of the project.

The project beneficiaries will target to exploit different project outcomes depending on their specific interests. A distinction is made between the partners involved in T-NOVA, namely industrial partners as well as academic partners comprising research institutes and universities. This triggers an additional classification of exploitation in commercial and non-commercial exploitation.

6.1. Commercial Exploitation

Commercial exploitation *(industrial)* is mostly relevant to industrial partners and aims at transferring research results and outcome into new products and services. Therefore, T-NOVA's industrial partners (i.e., operators, manufacturer, and SME) are focusing their exploitation activities on improving their current operation and business position in existing markets, and on the creation of and preparation for new markets, with the intention to secure a strong leadership position in these new markets.

6.1.1. Network Operators

6.1.1.1. Portugal Telecom Inovação (PTIN)

PTInS' exploitation of T-NOVA results is expected to address its dual research / industrial role:

- Contribute to reinforce PT's technological leadership by preparing the transition to new service paradigms supported by network functions virtualisation and software defined networking;
- Exploit new business opportunities offered by the integration of Cloud and network services, with a focus on the enterprise and residential market segments;

- Prepare the evolution of PTInS' product portfolio (e.g. network control systems, network transport systems, OSS/BSS) to the next generation, leveraging on the new possibilities offered by the network virtualisation, such as on-demand provisioning and service elasticity;
- Enhance PTInS' SDN & Cloud Networking testbed and research activities by integrating T-NOVA developments.

6.1.1.2. PrimeTel (PTL)

PrimeTel is interest in exploiting the SDN paradigm for network management, as enabled by the SDN Control Plane to be developed in T-NOVA. PTL will design and develop SDN components for traffic monitoring and resilience in such a way that they are beneficial to the company's Network Department besides the considering the project needs. This will allow for exploitation of the development for improving network control. Through T-NOVA PTL will be in position to gain more awareness on SDN based network control & management something which is not currently used by the company.

PrimeTel is expected to generate revenue by commercialising the T-NOVA platform as a Service Provider offering virtualised network functions as a service to its subscribers and charging them based on their usage.

Based on the project's outcomes the R&D department will frequently set internal meetings with the Network Department for presenting the proposed technologies and associated advantages for deployment as compared to existing methods and mechanisms used.

6.1.2. Manufacturers

6.1.2.1. Italtel SpA (ITALTEL)

Italtel designs, develops and implements solutions for networks and next-generation telecommunication services based on IP protocol. It offers solutions and proprietary products, professional services dedicated to the design, development and maintenance of telecommunication networks, services and IT System Integration activities of Network Integration and Migration. It has a position of excellence in unified communications, collaboration and treatment of Video and HD voice to accompany customers (in particular PA) for a rapid adoption of these services. The company counts among its customers more than 40 of the largest operators and service providers. In Italy Italtel is also reference partner of Enterprises and Public Administration in realization of next generation networks and the development of multimedia services and convergent to their customers. Italtel is present in 25 countries around the world. Italtel has an extensive experience in collaborative research projects both on national, on Eureka clusters (ITEA and CELTIC) and on EU Framework Programmes. Within the latter, in FP6 and FP7, Italtel participated in

MEDIANET IP, PANLAB SSA, WEIRD IP, PANLAB Infrastructure Implementation IP, ANIKETOS IP (on-going) and MCN IP (on-going).

Interests in T-NOVA

T-NOVA matches the Smart Networks and Products Unit portfolio, in particular with NetMatch-S and i-MCS products. NetMatch-S, as a Session Border Controller, is provided in both hardware equipment and virtualised version. The interest with T-NOVA is to enhance the virtualised SBC for providing more flexible, high scalable product solution embracing the concept of Marketplace and Virtual Network Function Framework for reducing deploying time and improving function composition according to customer's needs. Also i-MCS product, as a IMS/NGN suite, fits well with T NOVA concepts. It is a complex product that includes also SBC features. The interest of Italtel is investigating how T-NOVA concepts could help in simplifying the product configuration and deployment in a pure cloud environment. Besides, a logical application of the cloud concepts into its product portfolio, Italtel's interest in T-NOVA embraces also SDN adoption for extending the effectiveness of the collaboration and interaction between the service logic and the IP transport network that supports the actual multimedia communication.

Exploitation plan

Italtel expects to exploit the following results from its work and participation in T-NOVA:

- SBC evolution towards ETSI NFV specifications. Integrate in our product the management of cloud resources in a convergent approach with traditional TLC ones according to ETSI NVF ISG.
- T-NOVA vNF framework, adopting of T-NOVA framework in our portfolio. Start from developing a meaningful subset of SBC features and promote T-NOVA framework and concepts with our customers and in national and international workshops.
- Service Orchestration. Develop a service orchestrator able to optimize provisioning, deploying and runtime managing both generic and specific applications.
- Flexible product feature composition. Use the concepts of Marketplace and Virtual Network Function Framework for providing automated and flexible deployment of the product features that best fit customer's needs.
- Elasticity. Develop algorithms to scale up or scale down service resources needed by applications, in conformance with ETSI NFV approach.
- Automatic and dynamic network management. Use SDN to enhance QoS/QoE of our applications, both in provisioning and in runtime use cases, modifying the network configuration and using the information/events generated by the network.

6.1.2.2. Intel Performance Learning Sols. Ltd (INTEL)

Intel is the leading global semiconductor manufacturer. Intel's microprocessors, chipsets, SOC's, storage and related software technologies play a leading across a wide range of network and cloud related products and technologies. Intel plays a

leading role in enabling the ecosystem through cross-industry initiatives. In the network and cloud computing domains, Intel works in partnership with other companies to develop reference architectures and to share best practices in the development and deployment of Cloud, SDN and NFV through our network builders (networkbuilders.intel.com) and cloud builders (www.intel.com/cloudbuilders) programs. Intel also plays a leading role the development evolution of standards in the industry relevant to networking and cloud computing such as ESTI NFV.

Interest in T-Nova

As NFV and SDN deployments are being rolled out into carrier networks a variety of challenges are emerging, a number of which are of specific interest to Intel and its partners. For example a key challenge is ensuring the orchestration layer within a network environment fully exploits the capabilities of the servers it manages. Typically orchestration layers can identify only basic infrastructural features (e.g., CPU type, RAM size and host operating system) and are unaware of platform specific features and attached devices, like acceleration cards or network interface cards (NICs). This lack of platform awareness results in reduced intelligence in orchestration process and non-optimal placement of workloads. For example an orchestrator maybe unable to proactively load an application on a platform capable of accelerating its performance, such as assigning an IPsec VPN appliance to a server with cryptographic algorithm acceleration capabilities. The lack of platform and infrastructural awareness is a major drawback since many virtual appliances have intense I/O requirements and could benefit from access to high-performance instructions, accelerators and NICs for workloads such as compression, cryptography and transcoding. The NOVA project provides an opportunity to implement a system that can act as references implementation for enhanced platform awareness to enable more intelligent deployments of NFV and SDN workloads. T-NOVA also presents an opportunity develop knowledge on how to efficiently manage hosted virtualised network functions operationally, and to expose these as value-add services from the operator to OTT or Net App service providers.

Exploitation Plan

- The T-NOVA project will enable Intel to identify the key challenges for operators to deploy and manage new service offerings based on NFV and SDN architectural approaches. Identification and definition of these challenges will enable Intel to focus and target specific areas for future research and innovation.
- Intel will use the T-Nova project as a reference implementation which demonstrates platform affinity for Intel architecture for VNF workloads by exposing platform features and attributes that can be used by network orchestration to make intelligent placement decisions with respect to key performance indicators.
- Intel will use the output and learning from T-NOVA to drive contributions to the open source cloud community and build on existing blueprint contributions (nova/xenapi-gpu-passthrough, nova/pci-passthrough, nova/pci-passthrough-and-sr-iov) on enhanced platform awareness to OpenStack.

- The learning's and findings from T-Nova will be of significant interest to Intel business groups that are developing products to meet the needs of customers who are deploying NFV and SDN solutions.
- Intel will use the output and learning from T-NOVA to develop a greater understanding of how to driving service and SLA awareness into the network/cloud and to reflect these needs in its product offerings such as Data Centre Service Assurance Administrator (DC-SAA)
- T-Nova will help Intel to Identify insertion points for SHV and other IA which delivers efficiencies to the operators and optimizes the network platform
- Intel will use the T-Nova project to identify and evolve instrumentation and telemetry requirements to improve platform awareness, automation and improve manageability of NFV and SDN workloads at the orchestration layer and above.
- Intel will use the learning and outputs from T-NOVA to identify opportunities for the development of new standards or enhancements of existing standards to meet emerging ecosystem needs through leading industry standards bodies such as ESTI ISG.

6.1.2.3. Hewlett-Packard IIC (HP)

HP is one of the top vendors in NFV and SDN technology segments, so the results of T-NOVA have a very high potential of business exploitation. HP's offering in this segment is multi-level, spanning from single products to integrated solutions, wrapped up under the OpenNFV framework. Therefore, different components of the offering can benefit from T-NOVA acknowledgements, as well as the offering of a whole integrated platform.

In terms of targeted customers, HP is mainly looking at carriers and telecommunication providers willing to operate as network service providers. HP is positioned as technology vendor and solution provider for such customers, supporting them in building up their service platforms and possibly even in operating or outsourcing them or part of them. HP's Italy Innovation Center, the group mostly involved in T-NOVA, is part of the Technology Consulting business unit, which is the lead BU for bringing the portfolio to market in this specific segment.

Additionally, as a secondary exploitation path, T-NOVA results could be exploited in single products or solutions, like e.g. a SDN controller, or products including OpenStack-based capabilities.

The OpenNFV framework encompasses most of the key functionalities delivered by the T-NOVA system. The most promising areas for taking advantage of T-NOVA are expected to be virtualisation infrastructure, cloud resource management, the orchestrator, OSS and security/resilience of the NFV environment. OpenStack is an exploitation niche particularly interesting to HP, which has a strong commitment into OpenStack technology, not only as one of the top community contributors, but even for embedding OpenStack components into its solutions, as the recent Helion announcement strongly highlighted. Also SDN developments could be leveraged to improve HP offering (HP has recently announced its platinum sponsorship of OpenDaylight).

6.1.3. IT Services

6.1.3.1. ATOS Spain S.A. (ATOS)

ATOS aims to apply a differentiation strategy expecting to gain a strategic position in supporting customers with future demands for adopting this new approach. Experience has shown that outcomes of R&D projects have the potential to become solutions or services of ATOS portfolio. ATOS' interests within T-NOVA can be regarded from three different axes:

- Marketplace: As such the marketplace is an ideal sales channel for developers to distribute functions. The business case for the provider is that the marketplace can be a standalone solution or bundled as part of a wider offering including a turn-key solution or outsourced management of virtualised network functions offerings. Atos intends to evaluate the marketplace and tools from an enterprise client perspective. Atos does not only provide software products but also concentrates on integrating third party products for bespoke customer solutions, consultancy and outsourcing projects. In this context the potential to form an integral part of a outsourced NFV solution or a turn-key consultancy offering is very interesting.

- Virtualised network functions: Atos' interests here are related to understanding and acquiring the expertise in NFV applied to Next Generation Intelligent Networks. We expect to gain a strategic position for supporting customers with future demands for adopting this new approach and study possible applications in Atos' portfolio, which includes a Next Generation Networking platform (NGIN) that can deploy new generation services over heterogeneous networks. ATOS has integrated NGIN for Vodafone in many countries and Vodacom (Southafrica) on top of IMS mainly for centrex and fixed telephony. Some of these functions within the NGIN portfolio can potentially be offered using a virtualised approach. ATOS has also proven expertise in helping its customers commercialise innovative products and services within ATOS Consulting brand.

- Cloud: ATOS Cloud Services include a range of platforms, delivered at IaaS, PaaS and SaaS levels, which can be integrated with legacy and/or traditional IT environments, to provide an environment to host bespoke functionality as compliant and orchestrated end-to-end set of services. Within T-NOVA, ATOS could play the role of CIP (Cloud Infrastructure Provider).

These three different Atos' products would benefit from the T-NOVA approach. A combination of these is also possible.

6.1.4. SMEs

6.1.4.1. Space Hellas S.A. (SPH)

SPH is a network and IT value-added services provider, offering integrated telecommunications and IT solutions. The primary activities of Space Hellas SA include: Network infrastructure and data networking, telecommunication services at national and international level (a BT Alliance Partner), IT Applications and Services, Enterprise telephony, Information/network security and Security and surveillance systems. T-NOVA results have a direct relevance to Space Hellas' service and product portfolio. In specific, SPH will seek to exploit both the knowledge gained as well as the technologies developed in T-NOVA in three different ways:

- to enhance its domestic and international connectivity services portfolio with value-added Network Functions (virtual network appliances) to be provided on-demand to corporate customers, thus gaining a major advantage against competitors, who are offering plain connectivity;
- to expand its Managed Cloud Services portfolio by integrating Infrastructure-as-a-Service (IaaS) offerings with virtual network functions, such as virtual firewalls, virtual load balancers etc.
- to extend its in-house ".pulse" IT Monitoring & Intelligence Platform to effectively manage and monitor cloud-hosted applications and especially Virtualised Network Functions. Up to now, the applications of ".pulse" are restricted in the IT domain, and T-NOVA presents an excellent opportunity to expand the applicability of the product to the networking segment and especially to the emerging NFV market.

6.1.4.2. Viotech Communications SARL (VIO)

The technology stemming from the T-NOVA project will represent a major asset for VIOTECH exploitation strategy.

The core business activity of the company is based on “Media connected”-focused solutions for home, extended home and non-home’s premises (offices, hotels, transportation means) including media delivery, adaptation and management. In this sense, we constantly endeavour to propose solutions improving End-Users interaction with “Digital Home”-related multimedia services and technologies.

VIOTECH’s multi-awards winner *My eHome*® solution, allows End-Users to access, via a personalised interface, all familiar acquired & downloaded media content, stored in a central Home Gateway located in their home and accessible on different terminals (PCs, TV sets, laptops, PDAs, etc.). Marketwise, My *eHome*® is a complete, user-friendly, plug-and-play Multi-Play (multi-users, multi-terminals, with total customization capacities) services solution with breakthrough storage and social network sharing capacities and is easily adaptable to each End-User specificities. *My eHome*® is commercialized both through Triple-Play/genuine operators and Service Providers within the hotel industry.

Nonetheless, the key success factor in the eyes of existing and soon-to-be Media Actors (Service Providers, Content Providers, and operators) in the Digital Home domain is sliding towards the capacity to deliver:

- Truly innovative solutions and convergent applications;
- While offering control over usability, support, price;
- Through automated, reactive & large-scale deployment of appliances within an operational infrastructure.

The T-NOVA project represents, in that sense, a decisive step forward.

Indeed, through the implementation of the NFV concept within our Multi-Play offer, VIOTECH be able to propose hardware-free virtual appliances to customers, and in doing so, offer validated competitive assets, the prime of which being the consolidation of hardware resources, leading to reduced equipment investment and maintenance costs (reduction of both CAPEX and OPEX) and power consumption. Through this, given the implementation of standards and the interoperability of the project resulting platforms, VIOTECH will dispose of complete plug-and-play solution that could be directly included within any operator/content provider/cable operator's offer willing to integrate the Digital Home Market or service provider offering deployed multi-play solutions (accommodation facilities providers, on-flight multimedia experience, etc.).

Important primary communication efforts will be dedicated to the new offer, with attention drawn onto (first) European promotion so as to generate notoriety through demos towards important market key actors within specific events (international fairs, etc.).

6.1.4.3. Future Intelligence Ltd (FINT)

FINT expects to obtain significant insight from the results of the T-NOVA project, which will reinforce the company's position in the communication and networking field, and generate a greater understanding of the viability of such solutions to its customers' network architectures.

Specifically by participating in T-NOVA project, FINT aims to understand, gain expertise and exploit the software developed components for control and monitor of vNodes based on OpenStack and OpenFlow frameworks.

The company's already provided networking solutions, based on programmable hardware and FPGAs, will be enhanced with T-NOVA approaches introducing new series of customer oriented virtualised solutions and applications. In light of this, FINT will investigate innovative, heterogeneous platforms, based on FPGAs and/or GPUs, which can be used in the framework developed within the T-NOVA project to offer increased performance in comparison to typical x86-based solutions.

Solutions like these will target mainly data centers which provide computing, networking and other resources to third parties as a service. Moreover the T-NOVA project will position FINT as a key expertise partner in the area of virtual infrastructures providing the opportunity to establish/contribute to future widely accepted standards. This will enable the capacity of transforming company's current

line of business applications in the field of networking solutions to virtualisation specific.

Additionally, FINT has already performed technical studies and is scheduling to introduce to the market an end-to-end communication solution involving short range and long range communications for monitoring remote sites combining wireless sensor networks and long range communication systems for transferring data to a control center. FINT is aiming to extend its product regarding intelligent control of street and outdoor lighting by combining such networks with 4G technology in order to support or extend services and unifying IP-based networks having QoS features. Services like these can be complemented by a T-NOVA compatible virtualised node, which can perform forwarding and analysis on the data accumulated by the sensor networks and even enhance the level of control over such networks by introducing an autonomic element in their operation.

FINT by participating in the project is aiming to exploit its results for enhancing the company's business models and offered services and for becoming part of a team that may exploit the platform for commercial purposes.

The company's exploitation plan can be summarized to the following points:

- acquiring knowledge on SLA specifications, as well as on the definition of a common reference model and of terms in the contract and service level agreements
- research and development in innovative platforms, which will be used in future virtualised ecosystems and which will enable dynamic, high-performance services to be provided in a dynamic and rapidly changing IT environment.
- gain knowledge on platform management services, extensibility of services, rapid development of new services, resource and performance management

6.1.4.4. CloudStreet Oy (CLDST)

CloudStreet Oy CLDST aims to enhance its bandwidth exchange platform (for fixed and mobile networks) to support new demands of customers based on NFV concept. CLDST to gain expertise in NFV services by applying T-NOVA module, such as marketplace, in order to create a unified platform that different players, including network operators and service providers, to be able to provide to their customers efficient and sophisticated services and generate more revenues by achieving better utilization of their network resources (bandwidth, network elements, etc). Furthermore, CLDST aims to contribute for the standardization of these technologies by participating to different consortium, like Metro Ethernet Forum (MEF), Tizen Association, etc, based on its experience that will be gain from T-NOVA and explore possible synergies with other projects.

6.2. Non-commercial Exploitation

Non-commercial exploitation *(academia)* is mostly carried out by universities and research institutes and aims to explore novel approaches and innovative solutions, addressing the technical challenges that the project is focusing on as well as answering open technical questions. Academic partners are aiming to focus and intensify their activities in thematic areas of interest for both the industrial and research communities building at the same time strong technical expertise and presence in the relevant fields. In addition, they are interested in the creation of relevant intellectual property as well as in transferring associated knowledge and know how to enhance their education and training activities.

6.2.1. Higher Education

6.2.1.1. Gottfried W. Leibniz Universität Hannover (LUH)

LUH will exploit the project results in the following ways:

- Publishing results at prestigious conferences and journals gaining higher reputation and thereby increasing the ability to hire more competent research and academic staff, which in turn will be able to produce even better results in the future.
- Integration of technical developments into teaching curricula from which a very large of students will benefit each year. Furthermore, LUH's IKT group will exploit the results, technologies and novel approaches developed within T-NOVA in tutorials, seminars, invited talks and conference panels.
- The integration and deployment of new technologies and platforms developed by T-NOVA into the FILAB experimental facility will form an appropriate educational platform that will allow undergraduate and postgraduate students to obtain hands-on experience with network virtualisation, flow processing and in-network function development.

6.2.1.2. Tech. Ed. Institute of Crete (TEIC)

TEIC intends to exploit its participation in the T-NOVA project for exposing its graduate engineers and researchers in high-level technical work in the area of Network Resource Trading and Brokerage. In particular, MSc courses will be enhanced with tutoring on the specific concepts, and extensions on the related aspects will be offered for PhDs. In addition, PASIPHAE lab is to pursue further R&D along those lines based on the know-how obtained within the project. TEIC will also exploit the T-NOVA results in a number of ERASMUS+ Actions for Life-Long Learning in adult education, training and internship of Early Stage Researchers, including Strategic Partnership programmes Knowledge Alliances. Last but not least, TEIC will also try to exploit the T-NOVA results for spearing sustainable growth and development both at regional and national levels, by transferring know-how to related industrial and SME actors, as well as by raising awareness to stakeholders and decision makers.

6.2.1.3. University of Milan (UNIMI)

UniMI intends to exploit the results reached within the T-NOVA Project in both activities in which it is involved, research and teaching. In particular, UniMI intends to:

- Contribute to scientific literature, by submitting its project achievements in the fields of advanced networking, data processing with parallel computing architectures, and optimisation, for publication on international scientific conferences and journals.
- Disseminate the innovative results achieved by the project through its teaching activities, like university courses for undergraduate/graduate/PhD students, as well as seminars on specific themes, addressed to students and/or professionals from the local IT industry.

6.2.1.4. Zurich Univ. of Applied Sciences (ZHAW)

The Institute for Information Technology (InIT) and the Service Engineering (SE) focus area is responsible for preparing and delivering the undergraduate lectures for course in Cloud Computing. Software defined networking (SDN) together with NFVs are a part of the curriculum. InIT and SE are also preparing a certification course in Cloud Computing for working professionals. The theory, architecture and the tools developed in T-Nova will be utilized in the curriculum as part of the lectures as well as hands on laboratories for the students. The advances in the field of NFVs will be used in the lecture series planned on the similar lines for the Masters students starting from the next year.

InIT's SE team is very active in transferring the knowhow to the Swiss SMEs, and the technology foundations, and the knowledge base generated by the T-Nova project will allow us to enable Swiss SMEs by transfer of knowhow through the Swiss KTI funding tool for such projects.

6.2.2. Research Centres

6.2.2.1. NCSR Demokritos (NCSRD)

NCSRD will improve and complement its technology and research expertise in the field of innovative solutions for SDN and NFV mechanisms that will be developed within the framework of T-NOVA. NCSRD will consider two different exploitation domains, namely education/training and research output.

In the direction of the education/training, NCSRD will provide vocational training at graduates and IT professionals in the field of SDN/NFV, focusing on the Openflow switch programming and other similar topics relevant to T-NOVA. Special summer schools organised annually by NCSRD and other similar events will be the roadmap for the delivery of these courses.

In the direction of the research output, the T-NOVA research results will be published in international conferences and prestigious peer reviewed journals. This research activity is vital for NCSRD, since the performance of the Institute of Informatics and Telecommunications is monitored regularly by independent committees for the quality of research output, which is evidenced by the quality of the published papers. It is envisaged that publications will arise from work on SDN and NFV, as well as at the overall T-NOVA architecture.

6.2.2.2. Fraunhofer FOKUS (FRAUNHOFER)

FRAUNHOFER is seeking opportunities for prototyping leading-edge technologies providing value-added cloud services at the global scale. These prototypes are turned into pre-product implementations within projects with industrial partners (Deutsche Telekom, Hitachi, NEC, etc.) and as the basis for future spin-offs from Fraunhofer.

The participation in the T-NOVA project provides FRAUNHOFER the unique opportunity to share expertise with the project partners in Next Generation Networks and virtualisation technologies. These synergetic opportunities will allow FRAUNHOFER to shorten the R&D cycle of its products, mainly in the area of virtualised security appliances and service composition.

The close collaboration between FRAUNHOFER and various industrial partners will ensure that the project receives useful feedback from major network and service providers, regarding trial results, marketing opportunities, user benefits and wide-scale implementation feasibility.

FRAUNHOFER will also exploit T-NOVA results in other projects related to clouds, and Bring Your own Device (BYOD) technologies. As the later has been attracting both the public and the private sector, FRAUNHOFER is willing to build a solid expertise in this area to offer consultancy to the mentioned sectors. The security platform that will be developed by Fraunhofer will be the basis for a commercial product.

6.2.2.3. Consorzio per la Ricerca nell'Automatica e nelle Telecomunicazioni (CRAT)

T-NOVA will give the opportunity to the partners of the project to form a real company pool; in this respect, the CRAT finds a great motivation in developing research studies in this environment having the privilege of sharing with other prestigious partner's research interests and efforts. T-NOVA will also give opportunity to CRAT to reinforce the already existing cooperation and to create new relationships with the manufactures, SME and operators both in the surrounding area and in remote areas aiming at stimulating these companies towards advanced research topics and new market opportunities, as well as, at creating new employment opportunities especially for the young people.

In addition, CRAT intends to exploit the results of this project for didactic and teaching purposes. In particular, many master degrees and PhD theses are expected to profit from the documentation and the background coming from the project in

question. Moreover, project results will be exploited to upgrade and update the programs of several courses and to hold thematic seminars on these matters both at the University of Rome "La Sapienza" and in the surrounding companies. In particular, participation to this project will allow new generation engineers to acquire know-how on telecommunication and informatics and more specifically on QoE/QoS/resource management, service/content management, interworking management and SDN related topics.

Dissemination will be also assured by extensive publications especially on the major international reviews and conferences and by the participation to the main events organized by the European Union as well as by other institutions.
Last but not least, CRAT intends to sponsor the technology transfer of the most interesting results produced by CRAT in the framework of the project, by fully supporting start-ups managed by the same young researchers as the ones involved in the project; the aim will be the commercial exploitation of the above-mentioned project results.

6.2.2.4. Fundació i2CAT, Internet i Innovació Digital a Catalunya (i2CAT)

The board members of the i2CAT Foundation comprise infrastructure providers, network operators, applications developers and users. Through the T-NOVA participation, i2CAT will extend, mature, and improve the know-how and technological developments based on the OpenNaaS framework, which will be presented to the board members. T-NOVA project, and in detail the orchestrator entity and its associated functionalities, will contribute to the extensions of the open source framework managed by i2CAT, which will be based by the different T-NOVA open-source developments. Furthermore, through the participation in the T-NOVA project, i2CAT will keep on extending the knowledge on Network Functions Virtualisation; mainly focusing on different techniques to schedule, compose, and manage dynamic virtual network functions through software techniques. The orchestrator proposed within T-NOVA fits perfectly the new business requirements emerging in the networking realm, and thus i2CAT plans to extend and integrate the open-source T-NOVA orchestrator developments within the OpenNaaS framework.

Additionally, the participation in the T-NOVA project will enable new relationships with different partners within the consortia, enabling also the opportunity to increase the OpenNaaS community, which is led by i2CAT and is currently composed by several international partners, including network vendors, network operators, and national research and education networks, among others.

i2CAT is always looking ahead towards the creation of regional spin-off companies focused on offering enhanced services to infrastructure providers and network operators using as basis the exploitation and dissemination benefits from the T-NOVA project. Finally, i2CAT is also expecting to validate and demonstrate within regional deployments the outcoming advancements from T-NOVA that are integrated with the OpenNaaS framework.

7. CONCLUSIONS AND FUTURE WORK

NFV aims to control costs and accelerate revenue growth by leveraging IT virtualisation and orchestration technologies to consolidate network equipment functions onto high-volume servers, switches and storage. NFV will increase productivity, efficiency and task satisfaction since most of the tasks will be performed automatically reducing the network complexity.

It may reduce equipment costs and power consumption since equipment will be consolidated. The use of lower-priced hardware, the ability to share computing resources between functions, the reduced energy consumption and the ability to leverage widely available skills base for operating cloud infrastructures will help in the saving of OPEX and CAPEX.

The T-NOVA solution is expected to be an attractive revenue source for European network/telecom service providers, who are able to monetize on their infrastructure by offering new services and by charging customers according to the actual usage of in-network resources, as opposed to claiming low, flat fees for plain connectivity services providing applications "over-the-top" with no QoS guarantees and no in-network treatment.

The following two versions of this deliverable (D8.12 & D8.13) aim to address objective 9. They will study a business model and elaborate on the associated business plans for the T-NOVA architecture addressing all the involved actors. More specifically,

- D8.12 will elaborate a business plan for the involved actors towards adopting the T-NOVA architecture and recommendations during the first 18 months of the project. The business plan will include the T-NOVA business description, a value chain, a SWOT analysis, competitor analysis, marketing plan and financial plan. Further to that, the next version will elaborate a migration plan from legacy to future technologies.

- D8.13 will elaborate a detailed business plan for the involved actors towards adopting the T-NOVA architecture and recommendation after having the output/results of the project.

8. LIST OF ACRONYMS

Acronym	Explanation
CAPEX	Capital Expenditure
CSP	Communication Service Provider
DoS	Denial-of-Service
DOW	Description of Work
EMS	Element Management System
ETSI	European Telecommunications Standards Institute
QoS	Quality of Service
IaaS	Infrastructure as a service
IT	Information Technology
IP	Intellectual Property
ISA	Instruction Set Architectures
ISG	Industry Specification Group
ISV	Independent Software Vendors
KVM	Kernel-based Virtual Machine
NFV	Network Functions Virtualisation
OCP	Open Compute Platforms
OPEX	Operational Expenditure
OTT	Over-The-Top
OVS	Open vSwitch
OSS	Operations Support System
PaaS	Platform as a service
SLA	Service Level Agreement
SoC	System on Chip
STB	Set Top Box
SWOT	Strengths, Weaknesses, Opportunities, Threats
TTM	Time-To-Market
VNE	Virtualised Network Environment

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