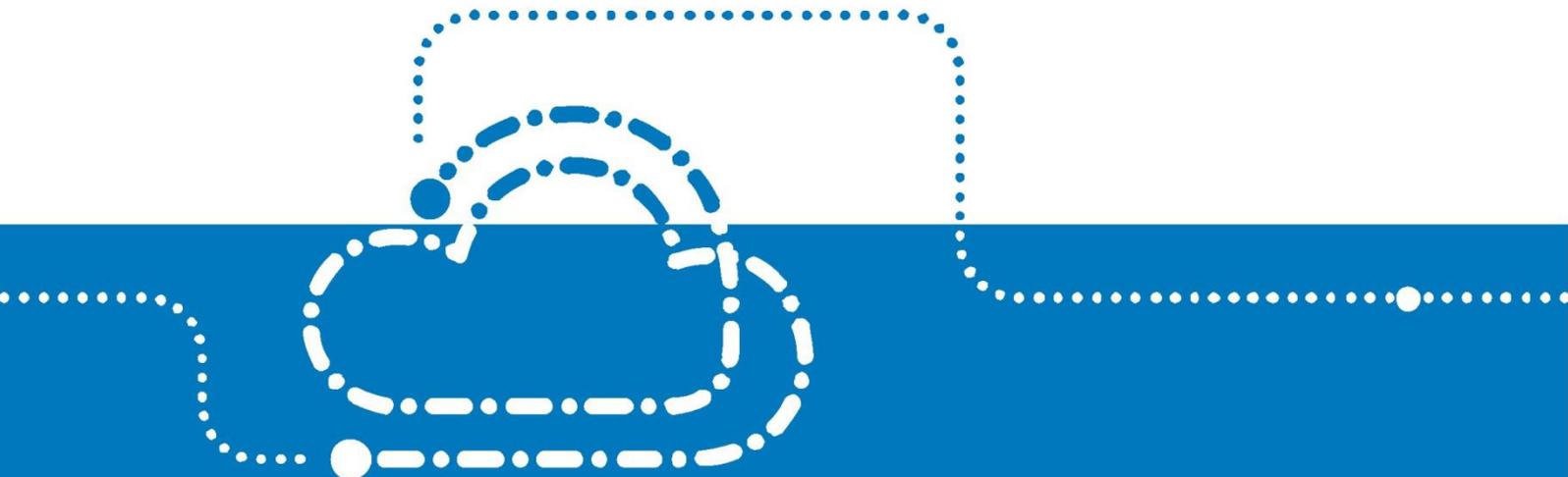


ZTE

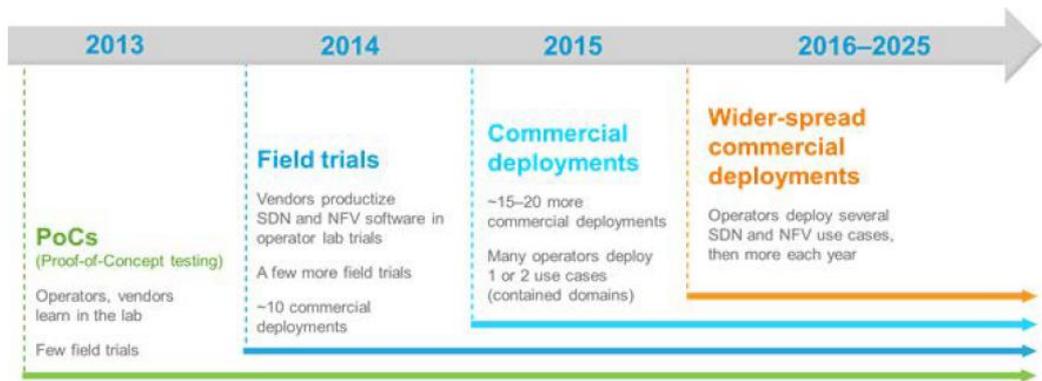
ZTE NFV System Integration White Paper



1 Transformation Trend of CSPs

With the network popularization and the network bandwidth increase, the consumer experience products based on video, VR (Virtual Reality), big data and IoE (Internet of Everything) become increasingly rich. CSPs (Communications Service Providers) not only need to cope with the exponentially increasing network traffic and the declining profit ratio, but also are impacted by new OTT (Over The Top) services. Under such circumstances, how to accelerate the pace of launching new products and services to answer the ever-growing expectation of consumers becomes an urgency for the CSPs. Transforming from the legacy network based on enormous dedicated equipments to the scalable cloudified network based on NFV (Network Function Virtualization) turns out to be an optimal choice for all the CSPs around the globe.

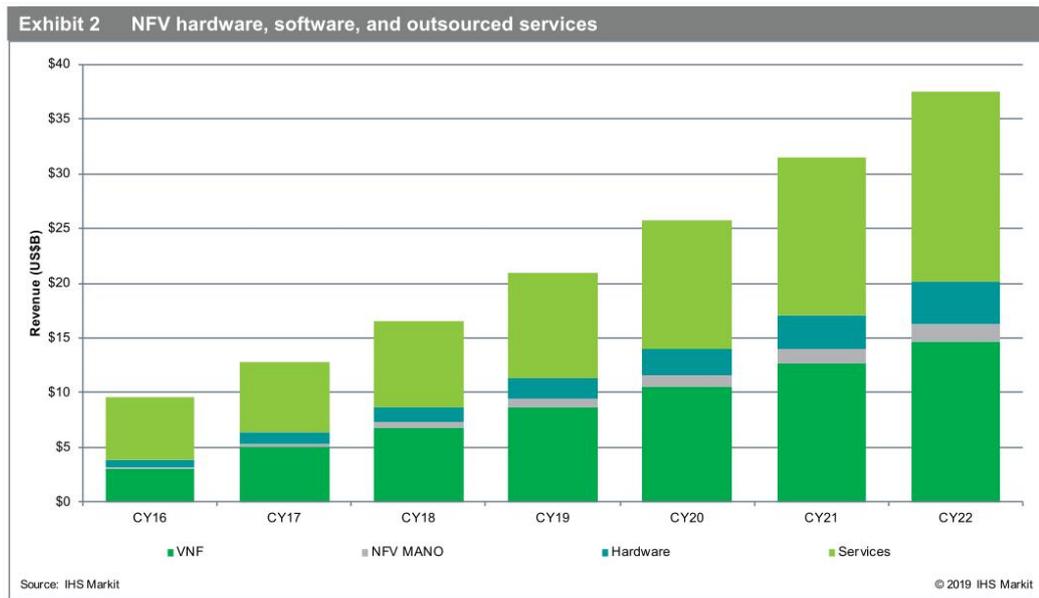
Exhibit 1 Operator SDN and NFV timeline, 2013–25



Source: IHS Markit

© 2019 IHS Markit

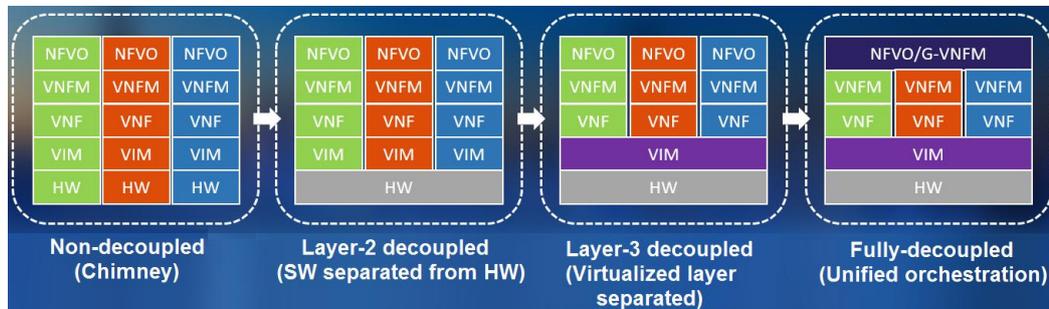
As predicted by the consultancy IHS Markit about NFV revenue growth in its "NFV Hardware, Software, and Services--Biannual Market Report: Regional, H2 2018" issued on Jan, 23, 2019: Japan is where SDN started with NEC and NTT. Japan has been active in deploying SDN in real but small commercial deployments. China is coming on strong, with many sizeable commercial deployments in 2014, so we expect that Asia Pacific will account for 38 - 39% of total NFV revenue in CY18 through CY22. Service providers in North America and Europe are also leading the charge to deploy NFV, and we expect North America and EMEA to each spend about 27% of the total 2018 - 22 NFV revenue for those five years



2 Transformation Strategy of CSPs

2.1 NFV Layered Decoupling Evolution

The following figure illustrates the layered evolution phases of CSPs transforming towards NFV technology:



- **Phase 1 (non-decoupled: chimney):** In this phase, solutions of all NFV providers are silo-based chimney mode, which means they provide an overall stack covering from hardware, VIM (Virtualized Infrastructure Manager), VNF (Virtualized Network Function) software, VNFM (Virtualized Network Function Manager) to NFVO (Network Functions Virtualization Orchestrator) by themselves, bringing a new vertical vendor locked scenario. The service innovation of CSPs depends on the service efficiency of the overall system by each provider.
- **Phase 2 (Layer-2 decoupled: software separated from hardware):** In this phase, by using universal COTS (Commercial Off The Shelf) hardware equipments, a universal standardized hardware resource pool is built, which makes the dependency on hardware of providers not so strong for CSPs to some extent and enhances the efficiency of launching services.

- **Phase 3 (Layer-3 decoupled: virtualized management layer software separated):** In this phase, the virtualized infrastructure layer is further decoupled based on the universal standardized COTS hardware resource pool. Instead of binding to each own virtualized management layer software, the VNF providers adopt a standardized API on the unified virtualized infrastructure resource pool (At present, the virtualized core technology virtualizes VNF with KVM of open source community, and the virtualized software management interface adopts OpenStack API of open source community). The VNF providers of different vendors take more consideration about the VNF service innovation, thus the CSPs launch services much faster.
- **Phase 4 (fully-decoupled: unified orchestration O&M):** As the final evolution objective of NFV, the unified management of orchestration system is implemented further more in this phase based on layer-3 decoupling. Usually, the CSPs have the ultimate control on the NFVO. Given the difficult integration, complex O&M, obscure fault locating boundary among vendors and hard-to-defined responsibility matrix of the NFV system solution in this phase, most CSPs around the globe would select one NFV (pre) integrator for the integration delivery of the overall stack NFV system.

See the table below for the comparison of benefits and difficulties in each NFV decoupling phase described above:

Decoupling mode	Benefit	Difficulty
No-decoupled	Easy integration, short delivery cycle time	Locked by vertical vendors, no good for service innovation
Layer-2 decoupled	Based on universal hardware, fast service innovation	Difficult unified O&M
Layer-3 decoupled	Based on universal hardware & virtualized layer, fast service innovation	Difficult unified O&M, difficult fault locating
Fully-decoupled	Unified hardware, virtualized layer and orchestration layer, more aware of service innovation	Difficult integration, complex O&M, much difficult fault locating

2.2 NFV Challenges

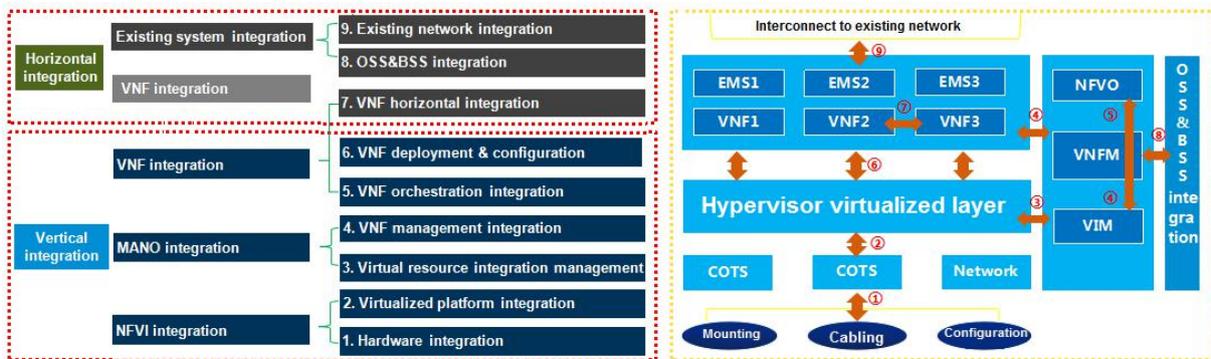
As an advanced and overwhelming technology revolution, NFV makes the network architecture more open and the service deployment more flexible for CSPs, but the current NFV development phase still faces many challenges:

- Immature standard
- Too many standard organizations and open source projects
- Incomplete ecosystem
- Complex integration among different vendors
- Obscure fault analysis and locating boundary

- More difficult unified O&M and management
- Frequent service deployment update
- Difficult optimization of data and storage performance
- Declined global system security
- Hard to maintained carrier-class reliability

2.3 **ZTE Simplified Way - NFV System Integration**

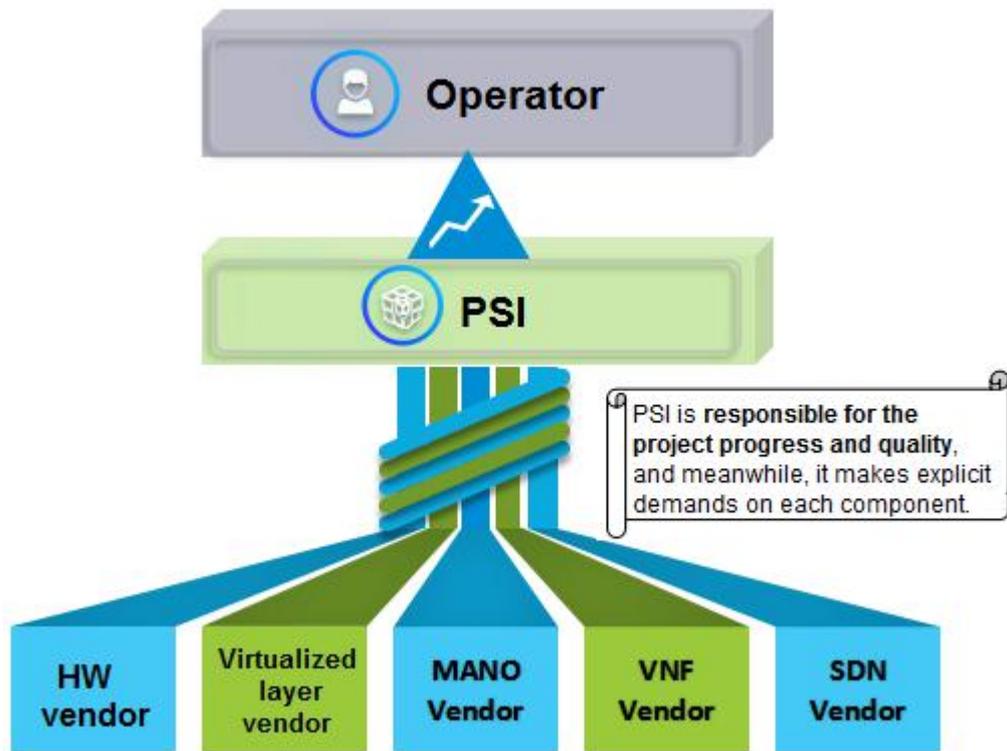
By selecting optimal sub-system components including hardware, virtualized layer, VNF and MANO, as required by the customers, a fully-functional, reliable and executable production system (end to end) is delivered through effective integration (including vertical/horizontal integration) and deployment.



3 ZTE NFV System Integration Solution

3.1 PSI Integration Service

PSI, known as Prime System Integration, is designed to solve the difficult management among MV (Multiple Vendors) and achieve fast NFV system delivery.



3.2 PSI Advantages & Highlights

ZTE provides premium PSI services, it is a strong PSI rival:

- ✧ Innovative integration methodology: Four management models, eight technical proposals, and two support platforms.
- ✧ Standard integration workflow: Covers marketing, business, R&D and delivery with over 200 delivery process documents.
- ✧ Professional, independent and neutral integration team: Integration team and engineering team run separately to ensure neutrality.
- ✧ Cooperation with operators for 30 years: Dedicated to communications business for 30 years, covering all products and services, thorough understanding of telecommunication services.
- ✧ Automated integration tool: One platform AIC, three tools, automated, integration interconnection efficiency enhanced by 70%.
- ✧ Abundant integration experiences: Integration experiences of 400 pilot and commercial sites in China and abroad

3.3 TaaS

TaaS (Test as a Service) refers to the integration verification service. The system integrator builds the customized test environment, and assists and guides the third party vendor in self-development, test and verification in it:

- ✧ Provides test environment, which saves the initial investment and later maintenance in the environment for operators.
- ✧ Leads the third party cooperation, ZTE complete project management process and experiences, which effectively shorten the time put by the operators.
- ✧ Assists or leads integration test, provides support based on R&D, which help solve faults faster. Automated tool achieves fast deployment and test.

3.4 Values of TaaS Service

- ✧ Cuts investment in fixed assets: TaaS provides flexible test delivery mode, which cuts the investment in fixed assets and facilitates the implementation of asset-light operation for operators.
- ✧ Provides complete test scope: TaaS provides innovative test method, which covers all network functions and services.
- ✧ Enhances test effectiveness: TaaS provides open test platform and rich test repository, which enhance test efficiency and test accuracy.

3.5 ZTE Advantages

3.5.1 OpenLab

- ✧ 4 global OpenLabs, 10+ professional labs
- ✧ 1000+ and over 30 types of server and storage
- ✧ 10+ cloud platforms, 100+VNFs
- ✧ Tens of millions of new equipments and software every year

3.5.2 Professional Team & Integration Capability

- ✧ Professional integration team, 200+ integration experts
- ✧ Integration experiences from 1000+ multi-vendor integration scenarios
- ✧ Thousands of integration test cases
- ✧ Professional NFV integration automated tool supports integration all by the third party

3.5.3 Ecosystem

- ✧ 40+ partners
- ✧ Participated in 50+ organizations and communities
- ✧ Numerous certificates from the third party

3.6 Customer Values in ZTE NFV System Integration Solution

3.6.1 Accelerating Service Launching

ZTE has set up mature spare part centers and logistics system all over the world, it adopts standard delivery process and visual quality monitoring & management system through the procedure. By pre-integration verification on NFV solution in advance based on NFV OpenLab, new CSPs requirements and services can be launched with quickest speed, helping seize the immediate market opportunities the first time.

3.6.2 Open Ecosystem

Based on NFV layered architecture, ZTE establishes NFV commercial ecosystem together with main-stream technology partners in the industry on each layer, and performs technology cooperation and innovation as well as united planning & verification of product integration solution with the mentality and principle of open and open source.



3.6.3 Carrier-Class Reliability

Based on NFV layered architecture, ZTE NFV system integration solution employs high reliable architecture design on each layer. By adopting disaster recovery mechanism in multi-geographic regions in NFVI resource pool and HA mechanism on VIM management layer, re-designing software architecture with lightweight stateless logic on VNF layer,

and combining software and hardware to realize performance acceleration, ZTE NFV system integration solution enables NFV new cloudified network to still feature with high reliability of legacy telecom devices.

4 Summary

ZTE NFV system integration solution selects technologies and products based on the communications industry's complete and end-to-end products lines and integration solution specifically for the customer's problems and challenges in its network virtualization. By taking the lead in coordination and integration of sub-systems from different vendors, and integrating them as a complete, reliable and effective virtualized network, it enables coordinated operation so as to exert overall benefit and realize optimal performance.