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ZTE TECHNOLOGIES

VIP Voice

MTN: Leading Digital Solutions for Africa's Progress

Expert Views

Cloud-Native Oriented Telecom Cloud Integration

Special Topic

Digital Integration

Cover Figure | *Mazen Mroue, CTIO of MTN Group*

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ZTE TECHNOLOGIES

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Success Stories

Press Clipping

ZTE Holds Global Industrial Innovation Forum at MWC 2023, Shaping Digital Innovation

1 March 2023 — ZTE held a Global Industrial Innovation Forum with the theme of "Shaping Digital Innovation" at Mobile World Congress (MWC) in Barcelona on February 27, 2023. The forum covers two sessions in terms of "Future Trends and Opportunities" and "Unleashing New Value", gathering experts from global telecom operators, leading consulting agencies, eco-partners and related industries to deliver keynote speeches and discuss around the trending insights, business development strategies and technologies in specific areas.

Xu Ziyang, CEO of ZTE, who delivered a welcome speech for the forum, said: "We are now facing the greatest digital wave ever, which will bring changes we have never seen before, and with these changes will come opportunities. To seize these opportunities, innovation will be crucial. That's why we named this session 'Shaping Digital Innovation'. The digital innovation essentially brings multiple benefits in terms of three aspects. First, it fundamentally boosts the development of the ICT industry, extends the boundaries of capacity, and safeguards sustainability. Second, it creates new values for verticals. By unleashing the power of digital innovation, we can drive massive increases in both efficiency and profitability. Third, it can unlock infinite possibilities beyond our imagination. With the continuous evolution of digital technologies, the real and digital worlds will converge and evolve faster, and finally reshape our entire society. ZTE remains open and committed to ensuring benefits for our customers and partners, and aims to build a digital and intelligent ecosystem for shared success."

ZTE Showcases Its NEO Cloud Card at MWC 2023

2 March 2023 — ZTE has demonstrated its native enhanced-cloud orchestration (NEO) cloud card at the MWC 2023 in Barcelona, Spain. This cloud card has been successfully put into commercial use in early 2023.

The NEO cloud card can build a new DPU-centric computing architecture to implement unloading and acceleration of virtualization, network, storage, and security while reducing the burden of CPUs and improving overall system performance.

ZTE Showcases uSmartNet 2.0 at MWC 2023

2 March 2023 — ZTE has showcased its latest generation of autonomous network solution, dubbed uSmartNet 2.0, at MWC 2023, paving the way for autonomous network (L4) and accelerating operators' digital transformation while significantly reducing OPEX through automation.

The uSmartNet 2.0 solution systematically focuses on ubiquitous connections, intelligent O&M, and agile operation in value scenarios.

Telkomsel and ZTE Strengthen Collaboration to Develop 5G Solutions

28 February 2023 — Telkomsel and ZTE strengthen the collaboration established through a collaboration commitment to developing the utilization of 5G services for the enterprise segment in Indonesia. This joint synergy was formalized through the signing of a Memorandum of Understanding which was carried out directly by Wong Soon Nam as Chief Planning and Transformation Officer of Telkomsel and Mei Zhonghua as SVP of ZTE.

ZTE, Ooredoo Group Extend Partnership Agreement for Further Five Years

6 March 2023 — ZTE has expanded the global frame agreement with Ooredoo Group for Ooredoo Algeria network modernization and related implementation and maintenance services as well as supply and delivery of Lithium Battery Products.

ZTE and Ooredoo will expand cooperation in the transport network, which includes the large-scale commercial deployment of SRv6. The new solution will transform the traditional transport network architecture into a 5G-oriented programmable one.

ZTE will partner with Ooredoo in the energy field. With ZTE's latest highly efficient power system and Smart-Li batteries, Ooredoo will improve energy utilization efficiency, increase battery life while protecting current battery investment, and realize its social commitment to building greener networks.

"Our close collaboration with ZTE has been significant in taking the next step for technological innovation in many Ooredoo Business Units. In choosing to continue working with ZTE's leading solutions, we're able to address new and developing markets and transform business in different Ooredoo Business Units. Together, we're creating a new digital area for our customers," said Sheikh Mohammed Bin Abdulla Bin Mohammed Al Thani, Deputy Group Chief Executive Officer, Ooredoo.

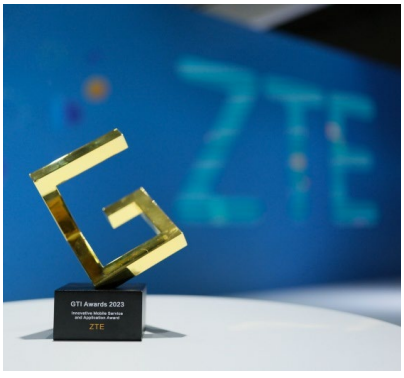
Xie Junshi, Chief Operating Officer, ZTE, stated: "ZTE has a long-standing and collaborative partnership with Ooredoo. To accelerate Ooredoo's digital transformation, ZTE will continue offering state-of-the-art solutions to the Opcos of the Ooredoo Group. These innovative solutions will deliver high-performance networks and superior user experiences thanks to ZTE's cutting-edge, cost-effective technologies and solutions."

ZTE: Perceiving the Past and Future via Metaverse

3 March 2023 — ZTE announced that, its Vice President Mr. Song Shijie and Technical Spokesman Mr. Tu Jiashun, have shared ZTE's prospects of innovative practices in tourism field at MWC 2023 in Barcelona, Spain.

At the event, Mr. Song explored how to perceive the ancient cultural capital of Chang'An and even China through the metaverse.

ZTE Scores Two Awards for Its Radio Composer Solution at the 2023 GTI Summit



1 March 2023 — ZTE has been rewarded with two GTI awards for its Radio Composer solution, specifically "Innovative Mobile Service and Application Award" and "Outstanding Awards", in recognition of the company's outstanding contributions to promoting 5G innovations and customer success.

The increasing complexity of 5G technology as well as diversified 5G applications has posed unprecedented challenges to operators' network services.

MTN: Leading Digital Solutions for Africa's Progress

Reporter: Tang Yanbin

Mazen Mroue, CTIO of MTN Group

Based on the belief that "everyone deserves the benefits of a modern, connected life", MTN , the largest mobile network operator in Africa, launched "Ambition 2025" strategy at the beginning of 2021 to accelerate its growth in the region. Mazen Mroue, CTIO of MTN Group, provides insights on the company's Ambition 2025 plan, and shares how his team is accelerating the execution of the strategy through the new technology framework PACE (an acronym for Platform, Agile, Connectivity and Experience). He also talks about expectations for partners including ZTE in facilitating the transformation of the African continent.

As an industry veteran who had worked across many markets including Uganda, Nigeria and Ghana, what have been the major changes you have observed in recent years, and how will MTN carry out its transformation journey in 2023 and beyond?

In recent years, most of African markets and specially where MTN is operating have experienced significant positive changes in their respective environments. One of the major changes is the rapid advancement of technology, especially in the Mobile, Internet and Fintech sectors. The increasing access to affordable smartphones and internet connectivity has led to a significant increase in the number of people using online services and connected the unconnected, which has created new opportunities for businesses to expand their reach and transform their commercial activities.

Another significant change is the increasing focus on entrepreneurship and innovation, as more young people are starting their own businesses and developing innovative solutions to address local demands and challenges. This trend has been particularly notable in the technology domains, where startups are emerging to provide solutions to problems such as fintech, education, healthcare, transportation, and agriculture.

Additionally, the successful investment in telecom infrastructure has helped to facilitate economic growth and development and became an example to attracting foreign investment and improving the business environment, which has further contributed to economic growth. Also, during the pandemic we have played an important role in supporting the surge in mobile data usage enabling customers and students to perform their duties remotely, which has accelerated the digital transformation trend and processes.

In 2023 and onward, we continue positioning MTN as a growth company and want to be seen as a business of connectivity and platforms with fintech and digital services prioritized to deliver the next level of sustainable success and growth. We are encouraged by the collaborative efforts driving the execution of our corporate strategy "Ambition 2025" which is embodied in four clear strategic priorities: Building the largest and most valuable platforms, driving industry-leading connectivity operations, creating shared value, and accelerating portfolio transformation.

As the major sponsor of PACE and Ambition 2025 strategy, what do you think will be the major challenge of the transformation of MTN as the biggest telecom giant in Africa? How do you think

this transformation will impact on the network evolution?

As MTN Group Technology team we have recently refreshed our Technology strategic framework & operating model, we have incorporated findings from deep dive analysis conducted and launched the PACE framework focusing on accelerating the execution of Ambition 2025 by identifying 15 strategic pillars which will enable the business to achieve sustainable growth in connectivity & platforms based on second to none differentiated Technology platforms and experiences supporting the overall purpose "Leading the digital solution for Africa's progress". We are actively working to transform our business to be evolved into platform business, accelerating growth in both traditional and new platform verticals: Digital, Fintech, Network as a service, API Marketplace—Chenosis and B2B. This is an essential transition given the major technological distribution trends around the globe, and several players are moving in the same direction—As MTN we have a great chance to continue leading the digital transformation here on the continent.

In parallel, there are still challenges that need to be addressed, such as inadequate infrastructure in some areas and the rapid pace of technological changes which are posing a challenge for us in some markets. As a market leader in an industry that continues to be evolved, we will need to continue investing in new technologies and services to stay competitive which is an expensive route and not easy to justify. Therefore, while we are actively investing in new technologies, we need to accelerate the commercial activities to monetize and deliver sustainable and profitable growth.

MTN has a strong and successful track record of adapting to changes in our markets, and with the right strategies, investments and partners, we believe we can continue to grow and succeed in the long run.

Looking into the future, what's your outlook of digital transformation in the African region over the next five years? What is your opinion on the role MTN should be playing during the process? How does MTN's underlying network strength differentiate it in the telecom space?

The African markets are currently going into a significant digital transformation program, with rapid advancements in technology and increasing adoption of digital solutions across different sectors and domains. Over the next five years, this trend is going to continue to be driven by several factors.

This includes the increasing availability of affordable access to internet and mobile connectivity which will facilitate the adoption of digital solutions across the continent. With more people having access to internet, there will be increased demand for digital services and solutions, including Fintech, e-commerce and online education.

Over the last years, MTN has invested heavily in building second to none networks across our markets allowing users to leverage the connectivity services to have access to digital solutions. We have also invested in advanced technologies such as 4G and 5G to ensure that our networks can support the growing demand for high-speed data services with low latency, opening the door to offer advanced services beyond access to internet, contributing to the drive of digital and financial inclusion programs across different markets.

We believe, with our network and technology strengths, we have managed to establish significant competitive advantage in the connectivity space providing the

foundation to offer advanced fintech, digital and e-commerce solutions to our consumer, business and wholesale customers.

Today, more than 60% of Africa's population is under the age of 25. By 2030, young Africans are expected to constitute around 40% of global youth. Therefore, the growing young and tech-savvy population in Africa is likely to play a significant role in driving digital transformation leading to increasingly using digital devices, and is more open to adopting new technologies and solutions. So the outlook of the digital transformation in the Africa over next years is positive, with significant opportunities for growth and development but it requires us to continuously invest in digital infrastructure and systems which are very crucial to realizing the available opportunities.

As a strategic partner of over 10 years, how do you see ZTE in the former cooperation? To meet those challenges, what is MTN's expectation on ZTE in future cooperation?

Overall, the supplier ecosystem is playing a critical role in supporting our business growth and development across all our markets. We strongly believe that with the right partners everything becomes possible. I would like to convey my appreciation so much to all our strategic partners including ZTE for the hard and close work delivered to MTN during recent years. We remained resilient under difficult macroeconomic conditions, and with the continuous support we have been able to continue delivering solid operational and business performance. I massively appreciate the partnership and looking forward to the future.

What is your suggestion on ZTE's opportunity and strength in the transformation of whole African area?

We expect our suppliers and partners including ZTE to remain robust and agile within the supply chain ecosystem to support business growth in Africa. We have commitment to transform our business landscape by delivering successful business and corporate social responsibilities. We encourage all our partners to increase their investment in research and development to help reduce costs and increase efficiency to accelerate the internet penetration, financial and digital inclusion specially in markets generating low ARPU. We encourage our partners to promote sustainability and social responsibilities, working with suppliers who share similar value and practices can help to advance our commitment toward ESG targets. We also call on our partners to invest in building national capacities and effectively use local talents in African markets where we operate. ZTE TECHNOLOGIES

Cloud-Native Oriented Telecom Cloud Integration

Zhao Cen
Vice Dean of ZTE Wireless Network R&D Institute

With the introduction of 5G service-based architecture, the growing desire of operators for rapid launch of new services and digital-intelligent transformation, as well as the maturity of cloud native in the IT field, telecom cloud is gradually evolving from virtualization to cloudification and then to cloud native.

Cloud Native Computing Foundation (CNCF) defines cloud native as a collection of technologies including containers, microservices, service meshes, immutable infrastructure, and declarative APIs. The introduction of these technologies in the telecom field means:

- Microservice and containerization of the applications can facilitate rapid iteration, deployment and launch, and accelerate service innovation.
- Operators and software providers gradually shift their focus from running applications in the resource pool in the cloud phase to service logic functions of the applications in the cloud native phase, thus devoting limited manpower and capital to core service competitiveness to maximize profits in digital and intelligent transformation.

After the preliminary use of the above technologies in the Cloud Native 1.0 phase, CNCF and telecom sectors have begun to explore the possibilities of Cloud Native 2.0:

- Introduce a large number of new technologies, including orchestration and management, security and monitoring, big data and artificial intelligence, database and storage, and network acceleration. These new technologies cover a full lifecycle of cloud native telecoms and form a complete technical chain.
- Deploy hardware acceleration down to the cloud platform, abstract the capabilities of heterogeneous resource pools, and enable applications after the emergence of iPaaS and lots of public services, so that the applications no longer need to care about infrastructure differences.

Through the above development, the full-stack digital platform capability from infrastructure to service enablement can be implemented in the telecom cloud scenario. This helps operators and software providers build an agile, automatic, secure and trusted, and highly reliable service operation environment, liberating personnel

from complex infrastructure O&M and focusing on service provision.

The evolution of telecom cloud to Cloud Native 2.0 is almost a qualitative change compared with the cloud phase. This brings more changes and challenges to telecom cloud integration. The continuous integration/continuous deployment (CI/CD) of applications becomes a must and cornerstone, based on which an end-to-end integration automation can be implemented. It should support hybrid deployment of CT and IT applications, as well as different deployment forms such as containers, VMs, and bare metal. It should support deployment in different areas (at the center or edge data centers) and in different networking environments, and also support new and old hardware, different cloud platforms, and different versions of cloud platforms.

The prerequisites for addressing these challenges include but are not limited to:

- The application itself should support containerization and orchestration, implement stateless design independent of the cloud platform, and support grayscale upgrade.
- A strong enough integration platform or automatic tool sets must be provided to deploy, configure, test, and upgrade on underlying hardware and network, cloud platform/infrastructure, and upper applications.

GitOps is a deployment model introduced to meet the above requirements. It breaks down an application into an image and a description template for deployment. Based on the template, a deployment configuration is manually generated to implement automatic application deployment, so that the application is insensitive to cloud infrastructure. Based on this concept, the CNCF's Nephio project proposes automation based on K8S Operator in the telecom field from cloud infrastructure to applications. This deployment mode enables CI/CD of applications under the same infrastructure, partially meeting the requirements of telecom cloud integration in the cloud-native 2.0 scenario.

iStream is a telecom cloud integration solution proposed by ZTE based on digital integration for the cloud native 2.0 scenario (Fig. 1). Unlike the GitOps and Nephio modes, the ZTE iStream solution supports automatic generation of application deployment descriptors, and automatic configuration of hardware and underlay

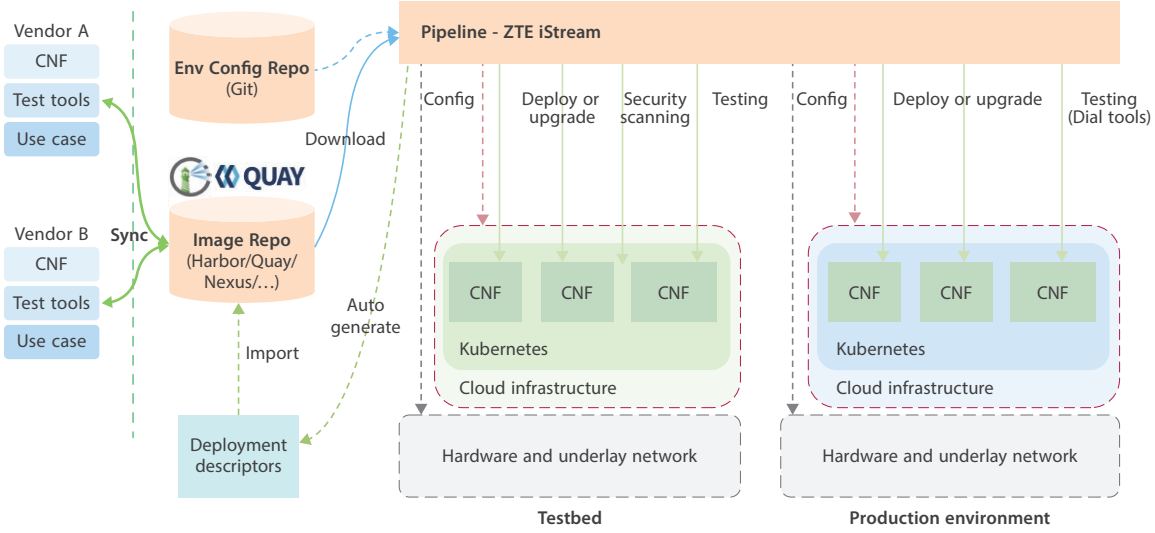


Fig. 1. ZTE iStream solution.

networks, thereby implementing automatic adjustment (such as splitting and aggregation) of a hardware environment required by an application and a cloud.

In the ZTE iStream solution:

- Instantiation configuration can be generated automatically to truly implement end-to-end automatic integration.
- With automatic configuration of hardware and underlay networks, the applications can be automatically deployed in different networking environments, different hardware environments, the environments having different hardware requirements (such as SR-IOV, RAID modes, and BFD protocols), or different cloud platforms, so as to truly realize one-time integration and multi-environment deployment of the applications.
- CI/CD of the hardware, underlay networks, and cloud platforms can be achieved.
- Different environments can be automatically deployed in accordance with the actual requirements of hardware, clouds, and applications.

Based on the ZTE iStream solution, ZTE can provide a variety of capabilities to meet operator needs of telecom cloud integration in different scenarios:

- **The application follows the cloud:** Different versions of applications can be automatically deployed in different cloud-compatible environments.
- **The cloud follows the hardware:** Different versions of the cloud can be automatically deployed in different hardware and underlay network environments to avoid hardware compatibility of the cloud platform or hardware differences in different areas.
- **The cloud follows the application:** Different cloud environments can be automatically deployed in accordance with the compatibility requirements of the applications.

The ZTE iStream solution based on digital integration can basically meet the needs of telecom cloud integration under the cloud native 2.0 architecture. ZTE will continue to pay attention to the long-term evolution of cloud native for telecoms and improve this solution. Also, it will consider promoting the implementation of this solution in CNCF, realize sharing within the industry, and jointly building the integration of telecom cloud. ZTE TECHNOLOGIES

Building AI-Empowered Digital Intelligence Capabilities of NFV Integration

Yang Jiaxiao
Deputy General Manager of ZTE BDS Products

A new round of industrial transformation is booming in the world today. New technologies such as artificial intelligence and digitalization have become the core driving force of the transformation, and are having a profound impact on the world economy, social operation and human life. At present, China has issued a series of planning guidelines for building a network power, digital China, and digital economy development. New-generation information technologies such as 5G network, big data, block chain and AI are gradually promoting the transformation of production modes and factors, making operators pay more attention to diverse businesses, quality experience and intelligent services. Therefore, it is an inevitable responsibility for the operators to build comprehensive intelligent information service across connections and promote intelligent and digital transformation to fulfill their corporate missions and social responsibilities.

ZTE is actively responding to China's digital transformation strategy, speeding up the transformation and upgrade of digital platforms, and building a digital service capability base from top to bottom. ZTE has independently developed the AI universal platform and enabled various kinds of industries through AI to build an ubiquitous AI capability system that helps traditional industries and products to move towards digital economy and promotes high-quality development of enterprises.

ZTE's AI platform integrates expert knowledge and evolutionary algorithm that can implement automatic data labeling, model structure search and hyper-parameter optimization. Through the Adlik reasoning tool chain, it compresses and compiles key models, and optimizes them during the reasoning operation, thus realizing computing power optimization for all scenarios. The one-stop self-evolving AI platform enables end-to-end AI-empowered business flows, and its advantages lie in algorithm, computing power and data:

- **Algorithm:** The self-developed automatic learning framework integrates expert knowledge and evolutionary algorithm to implement automatic data labeling, model structure search, and hyper-parameter optimization. It increases

the efficiency of algorithm development by more than 200%.

- **Computing power:** ZTE has initiated and led the Adlik open source community project at the Linux AI Foundation, improving the model operation efficiency by more than 400%. The project optimizes computing power in different cloud-edge-end scenarios, greatly reducing the cost of AI models.
- **Data:** Through the capability evolution platform, running data of the model can be collected online. Key data can be independently selected and labeled through active learning technologies, and model performance can be improved online through federal learning.

Empowering is the essence of AI. AI applications are entering the era where scenarios are dominant. The success of AI application mode requires in-depth combination of technologies, closed-loop data, and scenarios (industry knowledge). The effect of cognitive intelligence is sensitive and related to scenarios. To obtain cognitive results, it is necessary to extract implicit knowledge or based on background relevance knowledge. In the post-deep learning era, in addition to the computing power, algorithms and data, AI-empowered scenarios and industry experts (knowledge) are particularly critical.

With the evolution of telecom networks towards virtualization, virtualized integration services are also transforming towards digital and data-driven services. The introduction of AI in integration services becomes an inevitable trend for future product development. AI can perform deep learning based on a large amount of training data generated in the process of network functions virtualization (NFV) integration, continuously upgrade the algorithm, and reverse-apply it to the scenario to become an integration capability multiplier. After analyzing the core requirements of operators for hierarchical decoupling, intelligent integration, and agile delivery in NFV integration, ZTE has proposed the plan of building AI-empowered intelligence

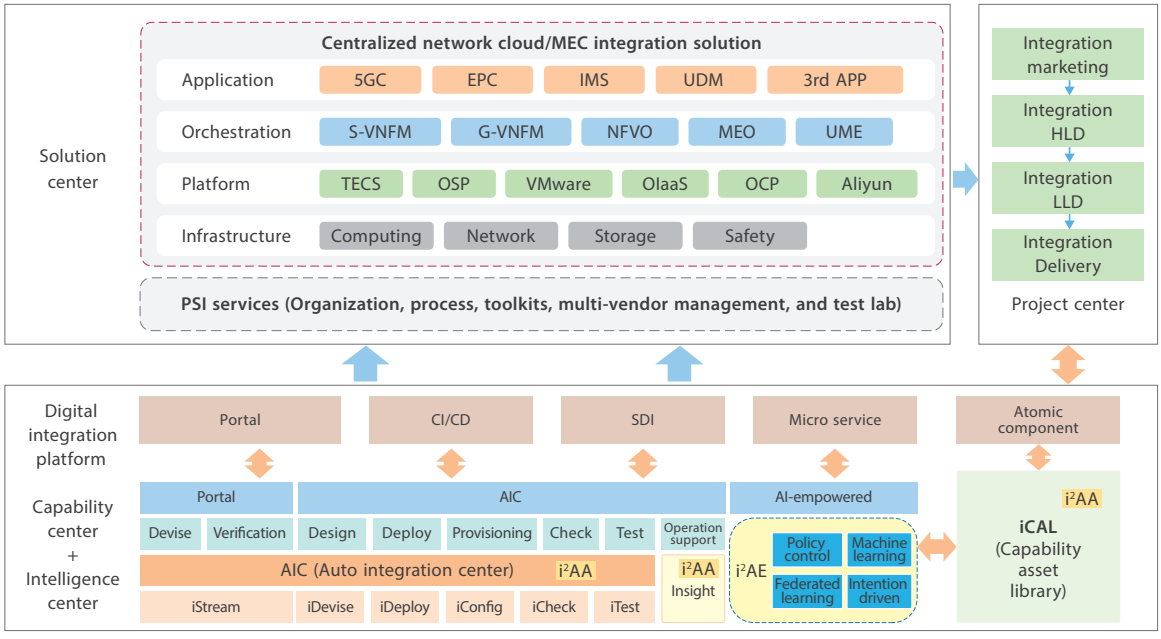
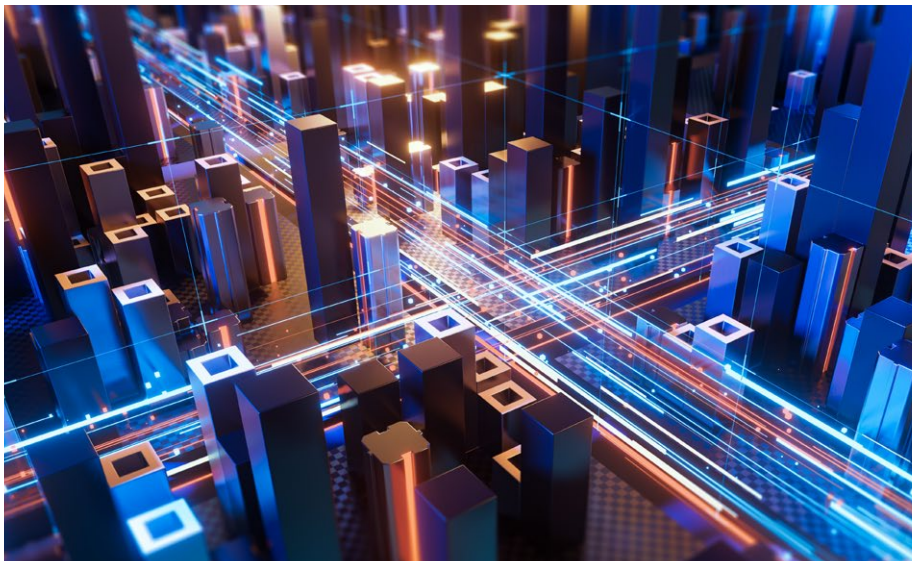


Fig. 1. Digital integration services with AI introduced.

capabilities of NFV integration in combination with the digital transformation and development path of virtualized integration services. AI is introduced upon the digital integration platform, and based on NFV components, self-intelligent hierarchical integration capabilities of native intelligence, hierarchical autonomy, and cross-layer collaboration is implemented. ZTE can work with operators worldwide to build an open, win-win new integration service ecosystem.

A digital integration center is the capability support platform after the digital transformation of virtualized integration services. The key to AI-empowered integration services is to introduce AI capabilities into the integration center to build self-intelligence capabilities of NFV integration and promote the evolution of digital integration to digital intelligence.

ZTE's digital integration platform has built an integration capability center with the integration capability asset library (iCAL) as the core, and an integration project center with the integration software defined integration (iSDI) as the core. In the future, the platform will add the integration intelligent analysis engine (i^2AE) and the integration intelligent analysis agent (i^2AA), as shown in Fig. 1. The i^2AE introduces AI capabilities, offers AI data analysis tools and training model libraries, and provides self-intelligence support for integration services based on data mining and deep learning of integrated digital assets fixed in the iCAL through algorithms such as policy control, machine learning, federal learning and intent-driven. The i^2AA calls data between the AI-empowered digital integration platform module and the i^2AE. As an interoperable interface for data interaction, the i^2AA is also used to interconnect internal and external general AI platforms and to call external AI capabilities to



continuously empower integration scenarios. In addition, the i^2AA builds an intelligence center for digital integration based on the AI capabilities. Through the architecture of "capability center + project center + intelligence center", the digital integration platform will combine digital integration with AI technologies to build a ubiquitous NFV-integrated AI capability system and facilitate operators in their digital transformation.

Compared with application scenarios such as virtual assistant and machine processing automation, telecom operators' requirements for AI are still focused on efficiency improvement and costs reduction. Therefore, after the introduction of AI capabilities, the virtualized digital integration platform will adhere to digital and intelligent integration, focusing on the improvement of core technologies concerning system architecture and end-to-end self-evolution. The platform helps operators build a "smart brain" for integration services, which can better improve the efficiency of NFV network construction and reduce integration costs. As a result, operators can jointly build integration capabilities and tap the value of integrated data, so as to expand more business opportunities and drive changes in service model. ZTE TECHNOLOGIES

ZTE's Practice in Digital Transformation of Virtualization Integration Service

Guan Huimin

Director of ZTE Cloud Core Network Integration Service

Zhou Xueyin

Chief Market Engineer of ZTE Virtualization Integration Service

As the digital economy has become an important driving force of the global economic growth, the new technological and industrial revolution characterized by digitization is accelerating. Telecom operators as the enabler for the transformation of the whole industry are continuously expanding their network scale. However, the cross-vendor and cross-component integration is becoming increasingly complex with the uncertain integration quality and the continuously increasing integration costs. Introducing digital methods to improve the efficiency has become imminent.

By extracting the experience from its global virtualization integration projects, ZTE has established an end-to-end and one-stop virtualization integration service system to automate the planning and design, network deployment, and acceptance tests. To facilitate the development of cloud-network integration and the digital economy as well as to tackle the problems faced by the operators, it is urgent for the virtualization integration service to introduce new technologies and models with the existing resource investment scale unchanged. Therefore, digital transformation with innovation at its core is inevitable for the virtualization integration.

ZTE's Digital Integration Methodology

The digital transformation of the virtualization integration service is a systematic revolution triggered by information technologies. With the digital platform, the resource structure and work mode can be changed and the limitations of the business models under the old technology system broken, reducing integration costs and improving integration efficiency.

Values of Digital Integration

For enterprises, digital integration can solidify the integration assets, make full

use of the full-service data flows, explore new value scenarios of digital integration assets, and push products into a new phase of digital operation. For the industry, digital integration can promote the standardization and automation of integration processes, make integration capabilities procedure-based and tool-oriented, reduce the multi-vendor interoperability difficulties, and drive third-party collaboration and cooperation. For operators, digital integration can reduce risks caused by human errors during project construction, improve construction quality, rapidly complete compatibility and interoperability verification among software and hardware manufacturers, and rapidly launch new

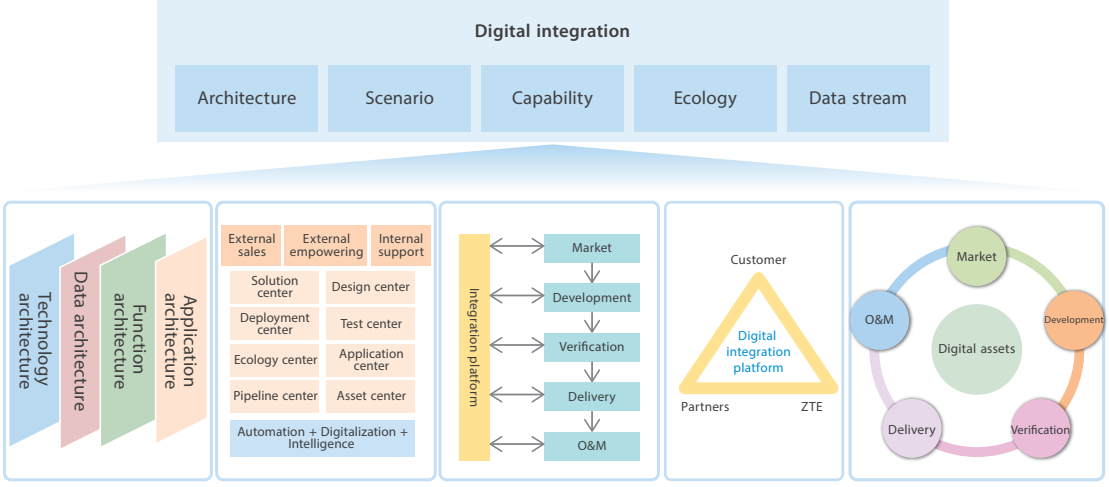


Fig. 1. ZTE digital integration model.

services, new products, and new versions.

Digital Integration Model

For the virtualization integration service, ZTE has proposed its own digital integration transformation model with a reference to the digital transformations thoughts of the industry. The model (Fig. 1) covering the application architecture, function architecture, data architecture, and technology architecture offers a full view of the digital integration platform, and it links the data from different domains to form measurable digital assets. In addition, the model divides the service applications into eight logical centers to implement full-process orchestration and software-defined integration. A shared ecosystem can be built based on the digital integration platform, and a new business mode created based on the capability assets.

ZTE's Digital Integration Platform

ZTE's independently developed digital integration platform through changing the structure and work mode of the integration service reduces network integration costs and improves integration efficiency, which effectively solves the pain points of NFV network integration.

The ZTE digital integration platform is logically divided into asset layer, execution layer, orchestration layer, and service layer (Fig. 2). The asset layer contains a rich accumulation of asset data, including the integration solution libraries, use case libraries, O&M knowledge libraries and specification libraries, which can be flexibly used by projects. The execution layer has a large number of integration tool suites and configuration scripts to implement the automatic design, deployment, and test of mainstream products, and tools such as big data analysis, O&M monitoring, and intelligent engine will be introduced in the future to continuously improve the level of integration automation and intelligence. The orchestration layer based on the concept of software defined integration achieves interconnection of the integration service processes, fast service content transfer and service orchestration in a visible way. At the service layer, ZTE provides customized solutions for its customers, and also opens the capabilities to assist them in building their independent integration systems.

- **Asset digitalization**

The integration capability asset library on the asset layer provides databases and information support, digitally models the assets, implements centralized management of asset information through the asset information management platform, supports asset allocation, analysis, and early warning for improved usage efficiency.

- **Tool-based capabilities**

The NFV integration system management products provide a series of integration tools such as planning, design, deployment, configuration, test, and check, forming a fully automatic tool chain and end-to-end continuous integration (CI) and continuous deployment (CD) capabilities.

- **Orchestration-based services**

Digital methods are used to refine the work contents of five scenarios of the NFV network construction process, including integration design, deployment, test, acceptance, and management. The integration tasks are divided into several minimum executable units, cascaded into a pipeline task through the orchestration, and periodically executed according to the predefined scheduling policy with the outputting of task reports, completing

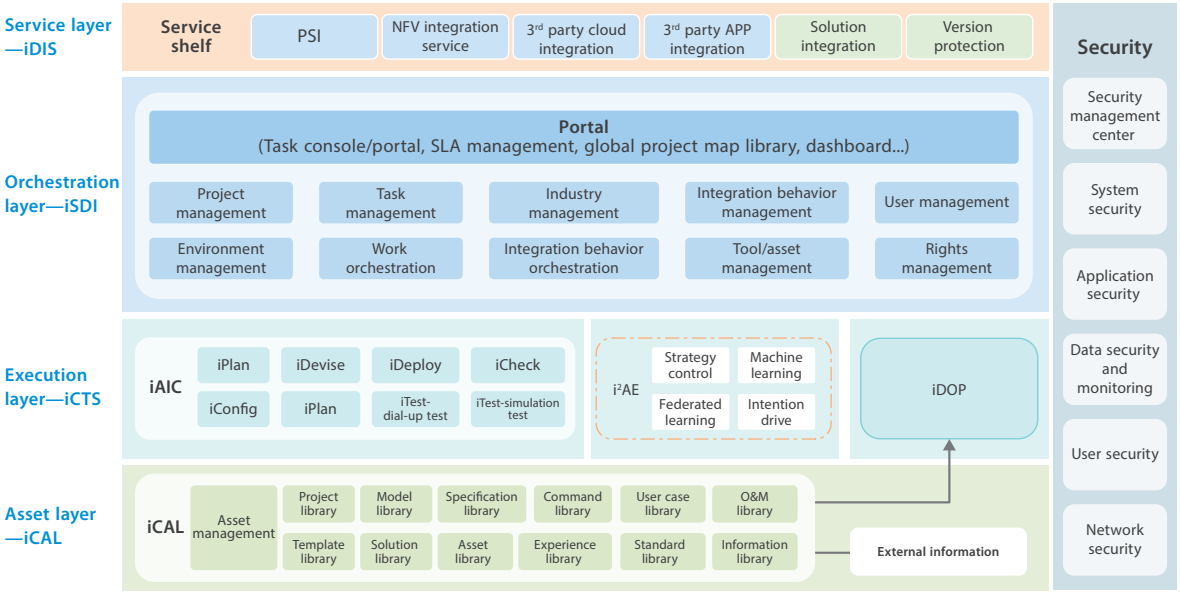


Fig. 2. ZTE digital integration platform architecture.

highly automated CI or CD deployment tasks.

- **Service independence**

Each assembly line at the orchestration layer is encapsulated externally to create a visual portal based on the project dimension. A digital service interface is formed by providing personalized application functions in accordance with different service scenarios while extracting the common features of service capabilities to support flexible service orchestration and service innovation. In addition, a new integration mode is established based on "independence and cooperation", helping customers build independent and controllable integration service systems.

Digital Integration Service Solution

The digital integration platform is logically divided into eight service application centers, including the solution, design, delivery, test, ecology, application, assembly line, and asset centers. They are digitally connected, and customizedly orchestrated to meet the integration requirements of different customers.

- **Consultation:** Based on the customer requirements and digital assets, the platform provides the consultation on the integration technologies and service processes.
- **PSI:** Through the project cycle actions such as "planning and design, integration verification, integration implementation, and integration handover", the platform enables the products of different manufacturers to deliver a complete, operable, and maintainable production system to customers under the framework of digital integration tools.
- **Cloud platform integration:** The platform can design, deploy, test, and verify the hardware, Hypervisors, VIMs, SDNs, VNFs, and MANOs based on the mainstream cloud platform, and make the system operate efficiently.
- **APP integration:** Based on the digital integration framework, quick integration of third-party APPs can be achieved through such means as requirement

> With the digital platform, the resource structure and work mode can be changed and the limitations of the business models under the old technology system broken, reducing integration costs and improving integration efficiency.

investigation, integration solution design, virtualized network function descriptor (VNFD) creation, third-party package import, and integration test and verification to accelerate the service launch.

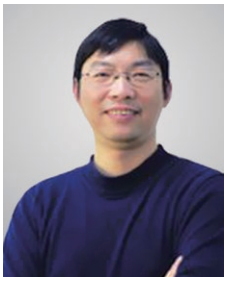
- **TaaS:** Test-as-a-Service (TaaS) provides an external portal and a hierarchical account, and provides service test experience and charging modes in a telecom cloud environment similar to a public cloud service.
- **Pre-integration:** The platform provides customers with a customized digital test environment, instructs or assists third-party manufacturers in completing activities such as testing and verification in this environment, outputs test reports, discovers integration risks in advance, and implements pre-integration solutions.
- **CI/CD pipeline:** The system provides a decouplable CI/CD pipeline and an open-source xTesting framework. It can be interconnected and integrated with the operators' CI/CD environments as required to meet the operators' requirements for establishing their own integration pipeline.
- **Independent integration by the operators:** The platform empowers the operators in establishing their independent and controllable integration service system.

In addition, the digital integration platform is embedded with the capability center, tool center, and version libraries. The upper layer implements digital integration verification, automatic version protection, remote integration service, and normalized O&M simulation through the integration project management system, pipeline orchestration and scheduling system, remote delivery center, and O&M simulation system, providing good integration service support for ZTE's marketing and engineering departments.

Conclusion

ZTE builds a digital capability collaboration and sharing platform to integrate technologies with resources. Based on the digital platform architecture, ZTE and its partners can achieve low-cost and efficient resource integration, cooperative development, independence of key technologies, capability complementation, and healthy service competition to guarantee the long-term healthy development of the digital system. In the future, ZTE will work with more partners to explore new virtualization integration technologies and models, and continuously build an open-source and shared virtualization network integration ecosystem. ZTE TECHNOLOGIES

Building Operators' Independent Integration Capabilities



Zhu Jing

Chief Engineer of ZTE Cloud Core Network Integration Planning

As telecom networks develop, operators' network architecture is more open, but it also faces challenges such as multi-vendor management, process coordination, vertical integration, inconsistent data models and incomplete ecosystem. Standardizing the process, increasing the integration efficiency, strengthening professional skills of personnel and improving independent integration capabilities are urgent problems for operators to solve.

History of Independent Integration

Independent integration means that operators can assemble and integrate each component of the NFV network by relying on their own capabilities, and independently and efficiently complete the NFV network construction. Independent integration capabilities are not built overnight, which require long-term technology accumulation and manpower investment. Up to now, the independent integration of telecom networks has undergone three phases:

- **Phase I:** This is the phase of integrating software with hardware, where operators completely rely on a complete set of hardware/software devices supplied by equipment vendors, and also rely on the vendors to build NFV networks. Therefore, operators have low independent integration capabilities.
- **Phase II:** As software and hardware are gradually decoupled, operators introduce the primary system integrator (PSI) who can coordinate and supervise the NFV network construction. In this phase, operators rely heavily on PSI and their independent integration capabilities are improved but limited.
- **Phase III:** According to the service requirements, operators introduce third-party system integration products or develop them independently, and gradually cultivate and improve their independent integration capabilities, master core integration technologies, and improve their competitiveness.

How to Improve Independent Integration Capabilities

Operators need to improve their independent integration capabilities from the following aspects:

- Formulate a standard integration process to specify the responsibilities

of related parties in each phase of the process and the document templates required in each phase.

- Build a professional team for independent integration. The team should not only have professional technical skills, but also accumulate rich experience in integration.
- Formulate technical specifications and acceptance criteria, or introduce international standards to reduce the difficulty in multi-vendor integration.
- Develop the tools related to integration or introduce the tools from third-party vendors to implement integration automation and improve the efficiency.
- Construct an integration center and introduce the continuous integration/continuous deployment (CI/CD) or DevOps concept to gradually improve the standardization, automation, and intelligence of the integration, achieve full automation of applications verification, deployment and launch, and accelerate the innovation and implementation of new services.

Recommended Model for the Integration Center

A recommended reference model for building the integration center is shown in Fig. 1. Operators can build an integration center at the headquarters as a platform for integrating technologies and resources, which can implement pre-integration verification of the devices of their partners. After passing the pre-integration verification, the partner's devices can run trials and stress tests in the pre-production environment. Finally, commercial deployment or version upgrade in the production environment can be completed in the production center.

In addition, the integration center supports multi-project management. The resource pool of the integration center is divided into several logical test environments, and each project orchestrates its own pipeline and scheduling strategy. Integration tests and verifications of multiple projects can be carried out at the same time, which greatly improves resource utilization of the integration center.

Responsibilities of the Integration Center

After the completion of the integration center, it will fulfil the following three responsibilities:

- **Pre-integration verification:**

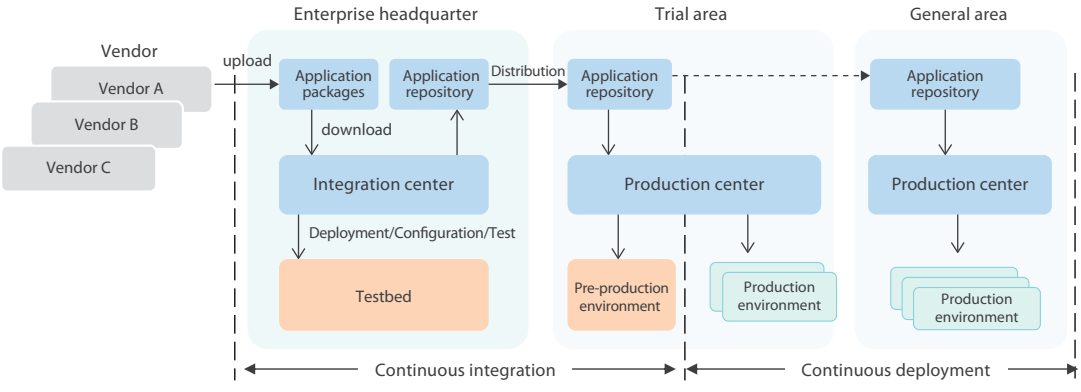


Fig. 1. A reference model for building the integration center.

According to network construction requirements, operators implement the integration verification of the devices or components from multiple vendors, discover and solve multi-vendor interoperability and reliability problems in advance, and reduce commercial risks.

- **Software/hardware product certification:** Operators complete the integration verification of shortlisted devices in advance, gradually build and expand the enterprise ecosystem through the certification mechanism, and promote the collaborative development of the enterprise industry chain.
- **Building a CI/CD work chain:** Operators introduce CI/CD to realize a new network construction mode involving integration, testing and deployment.

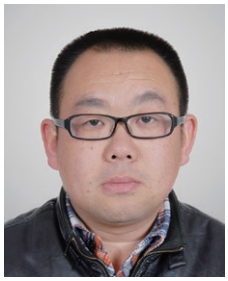
Value of the Integration Center

Building the integration center can bring multi-dimensional value to operators.

- **Promoting coordinated development of NFV network construction:** Independent integration is a major trend in the development of operators. Through the integration center, operators can effectively integrate personnel, self-developed products/tools, third-party devices and technical experience to drive the integrated and coordinated growth of NFV network construction.
- **Accelerating new service innovation:** The incubation of innovative services requires operators to respond quickly and have sufficient independent integration capabilities. The powerful continuous delivery capability ensures that enterprises can rapidly respond to changes in market demand for innovation services, grasp the direction of technological development, and take the initiative in the market.
- **Improving core competitiveness of operators:** The integration center introduces the concept of automation and intelligence, and gradually evolves to DevOps to ensure that the R&D, O&M, and quality monitoring departments work together efficiently. This not only enhances independent capabilities of operators, but also gradually improves their core competitiveness.
- **Expanding the ecosystem/industry chain:** Independent integration capabilities help operators select partners and expand the ecosystem according to their own needs.

Relying on years of technology accumulation and industry experience, ZTE has specially developed digital integration center products for cloud networks. With the project-based management, the products implement fully automatic NFV network construction by introducing task orchestration and workflow orchestration. Operators can introduce ZTE's digital integration center products to rapidly build new NFV network integration centers that meet their requirements through the "independent + cooperative" mode, and gradually establish an enterprise-independent and controllable integration service system. ZTE TECHNOLOGIES

The Path to Digital Transformation of Virtualization Integration Service



Hu Bing

Product Manager of ZTE Virtualization Integration Service

Network Function Virtualization (NFV) is a trend in the evolution of networks. With NFV, operators can share general hardware resources to reduce investments, and decouple software from hardware to enhance the scalability and responsiveness. But the introduction of NFV also brings about problems such as large-scale network construction, multi-vendor integration, and too many interface specifications. At present, the industry usually uses automated tools to implement NFV integration planning, design, deployment and acceptance testing, which can improve the efficiency and quality of integration and solve the pain points of virtual network integration.

At the same time, digital transformation is becoming the focus of all industries. Operators are taking the construction of 5G network as the starting point to promote the digital transformation of their business. Therefore, the integrators must consider how to introduce digital methods into NFV integration services.

To better understand the digital transformation of the integration services, we need to clarify the concepts of automation, informatization and digitalization and the relation between them, and then discuss the digital transformation ideas and paths of the virtualization integration service.

Informatization, Automation and Digitalization

Informatization is to process the services through information system in the enterprise's production, supply, management, finance and marketing processes, generate new information resources, help personnel at all levels of the enterprise quickly understand dynamic service information for reasonable resources allocation, fix the service processes, reduce difficulties of the front-line work and enhance enterprise management capabilities.

Automation is the process and result of replacing human work and action by technical means. The system operates or controls the machines or devices automatically according to specified procedures or instructions without human intervention to release people from repetitive tasks and dangerous work environments, greatly improving the productivity.

Digitalization is to model the enterprise or product management experience with information system,

automatically record and analyze various data of the service process, and provide analysis conclusions and solutions. Digitalization quantifies the entity services, and then converts them into data. Based on the data recorded by a large number of information systems, it performs mathematical modeling for the operational logic of enterprises or products, learns the process data repeatedly and optimizes service models to assist enterprises in decision-making and operation.

The digital transformation of products needs to complete the product digitalization first, and then process the digitized service data based on the information system while introducing the automation technology into the service process, so as to change the business model of the product, realize the digital transformation of the product form and improve the product competitiveness.

Therefore, digital transformation of products can be achieved only by effectively combining informatization, digitalization, and automation.

Digital Transformation Thoughts

After understanding the relevant concepts of digital transformation, there are two issues to consider: whether ZTE virtualization integration services need digital transformation; and how to perform the digital transformation of them.

By combining its integration experience from multiple NFV projects around the world with a deep understanding of the needs of industry customers, ZTE has established an end-to-end, one-stop NFV automated integration service system. The system has achieved the automation of NFV planning and design, network deployment and acceptance testing, effectively solving the pain points of operators in virtual network integration. But compared with product digitalization, the current integration services still have three disadvantages: First, the electronic workflow of the integration services achieves the automation and informatization of the technical actions, but with insufficient automation of the management actions; there is a lack of unified planning on the information collection, storage and management in the integration process; and there are not effective means to accumulate and transfer the skill data and process assets generated in the integration process, making it impossible to further explore the value of the assets.

Digital transformation is urgently needed to solve all these problems of the virtualization integration services. Here are three steps to perform the digital transformation:

- **Service datamation**

  First, perform integration service datamation, and build a digital integration platform to achieve the indexation of the service-related information, and then establish service models so that the integration service data can be used, analyzed and improved for a more refined product management.

- **Data-driven services**

  Based on the digital integration

platform, the integration services take data as the trigger point, and data is used to trigger the service actions as well as to find, analyze and solve problems to improve the integration efficiency and quality. In addition, data monetization can be realized through the accumulation of data assets, exploration of data applications, and build-up of digital integration capabilities.

- **Service intelligence**

After the completion of the above two steps, the virtualization integration service has basically achieved the digital transformation. The next step is to accumulate digital integration assets, introduce intelligent technology to expand the value of digital assets and improve the digital capability of products so that the products will move towards digital intelligence. Intelligence is the final goal of product informationization, digitization and datamation.

Digital Transformation Models and Paths

For the digital transformation of the virtualization integration service, ZTE has defined its model by referring to the industry's digital transformation ideas (Fig 1).

First, clarify the transformation vision and objectives, and determine the implementation path. Second, make a comprehensive plan from five directions, including technical planning, ecological development, security planning, organizational guarantee, application scenarios and transformation value.

ZTE's vision for the digital transformation of the virtualization integration service is to become a leading industry integration solution

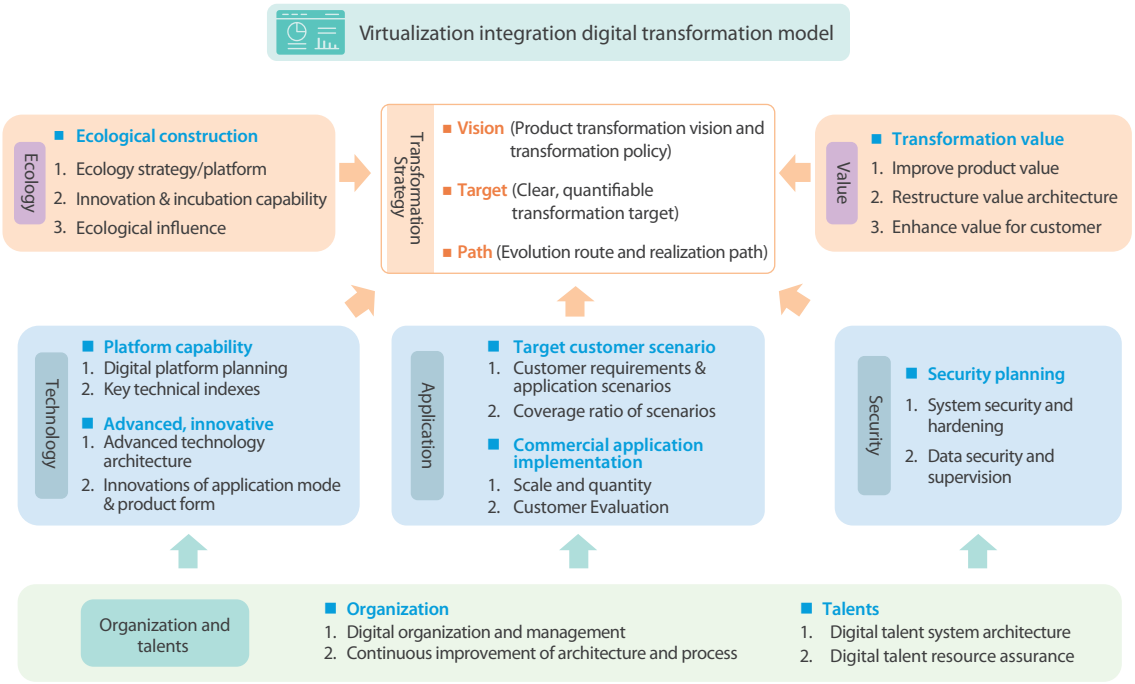


Fig. 1. Digital transformation model of ZTE virtualization integration service.

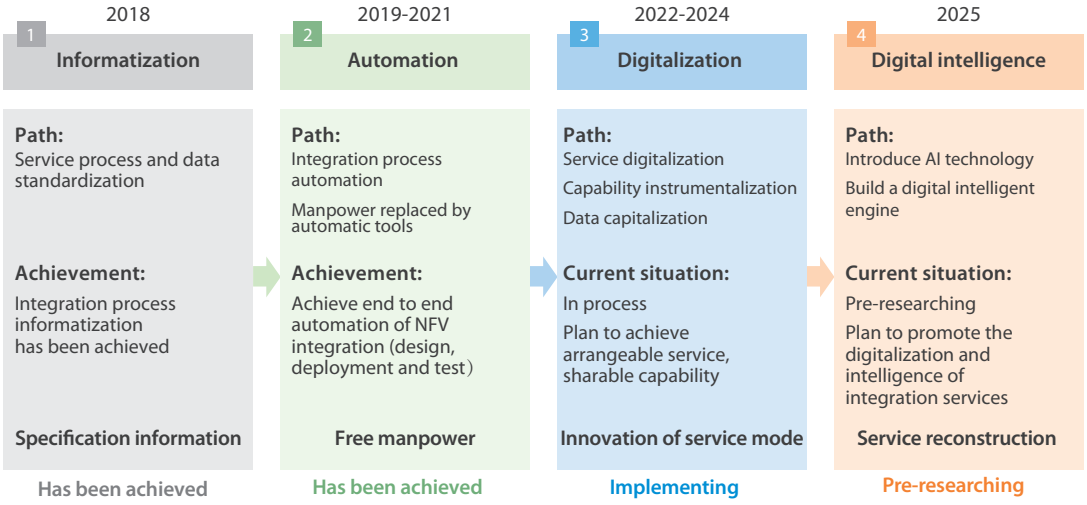


Fig. 2. Digital transformation paths of ZTE virtualization integration service.

supplier in terms of technology, model and value by introducing the digital methods into the NFV integration service to achieve the digital transformation of products.

The digital transformation path of ZTE virtualization integration service can be divided into four stages (Fig. 2).

- **Informatization stage**

Through the information system, record the integration information in the electronic table while standardizing the integration process.

- **Automation stage**

Through the automatic integration tools, implement automation of the integration services and solidify the integration ability so that the manpower can be replaced by automatic tools, the integration cost decreased, and the integration efficiency and quality improved.

- **Digitalization stage**

Digital transformation enables the shift from offline to online integration services, from being task-driven to data-driven, and systematic management of the integration process data, so as to accumulate the digital assets, and establish end-to-end, programmable, and automatable digital integration capabilities.

- **Digital intelligence stage**

AI technology is introduced to realize the intelligent development of the integration service, fully explore the digital assets of the integration services, and build an ubiquitous AI-enabled NFV integration capability system. In this stage, an open, new and win-win integration service ecosystem will be built.

The digital transformation of products is a complex and long-term process. Together with operators, ZTE will continuously improve the methodology of digital integration, explore and expand the application scenarios and scale, and promote the co-construction and sharing of the integration capabilities to achieve the digital and intelligent transformation of the virtualization integration service. ZTE TECHNOLOGIES

ZTE Virtualized Network Integration Center: Taking the Lead in Digital Integration

Du Yu

Manager of ZTE Virtualization Integration Solution

Liu Daofeng

Chief Engineer of ZTE Virtualization Integration Solution

Telecom networks have entered the cloud era. Implementing fast and high-quality network functions virtualization (NFV) integration is the primary concern in current NFV network construction. ZTE has independently developed its virtualized network integration center that can help operators standardize, informatize and automate integration delivery, improve the efficiency and quality of NFV network construction, and explore new modes of digital NFV integration.

Construction Goal

ZTE virtualized network integration center achieves asset digitalization, management digitalization, and production digitalization through the introduction of digital means.

- **Asset digitalization:** The center digitally models the assets in the process of NFV network construction and O&M. Through the asset information management platform, it implements centralized management of asset information, supports asset allocation, analysis and early warning, and improves usage efficiency of the assets.
- **Management digitalization:** Through the project management platform, the center implements end-to-end task-driven closed-loop management, including task allocation, progress feedback, output archiving, tracking of pending issues and task audit to ensure that the task progress and quality achieve the goal.
- **Production digitalization:** The center introduces a pipeline to orchestrate production operations. It eliminates tool islands, forms a fully automatic tool chain, and achieves end-to-end fully automated production capabilities of NFV networks ranging from demand input, planning and design, installation and deployment, data configuration, integration testing and service launch.

System Architecture

ZTE virtualized network integration center is a digital management suite that implements end-to-end NFV integration. It covers the lifecycle management of NFV resource pool, including NFV network planning, deployment, configuration, testing, O&M and monitoring.

The capability layer consisting of iCAL, AIC and iDOP supports upper-layer applications (Fig. 1).

- **Integration capability asset library (iCAL):** It classifies and manages all objects involved in the NFV network, provides external APIs for access and operation to upper-layer applications, and achieves resource and service sharing.
- **Auto integration center (AIC):** It provides a series of integration tools such as planning, design, deployment, configuration, testing, and inspection as

required in NFV network construction to achieve continuous end-to-end integration and deployment capabilities and improve the efficiency.

- **Integration digital operation platform (iDOP):** It is an O&M support platform that implements digital management and analysis of NFV networks. Through the iDOP, a large number of NFV networks can be monitored in a centralized manner, which improves O&M efficiency while reducing the costs.

The application layer supported by the capability layer provides common application functions for implementation and management of integration services, including the information management platform, service orchestration, and data statistics and analysis.

The information management platform manages and maintains asset and information libraries, including:

- **Asset management:** It manages and maintains all hardware and software.
- **Project management:** It adopts multi-project management mode, and each project is managed and maintained independently without interference.
- **Environment management:** It builds the test environment by allocating resources from the asset library. The resources are allocated to different projects and returned to the asset library after use.
- **Use case management:** It manages and maintains use cases and automated scripts they use.
- **Tool management:** It allocates resources in the resource pool, completes the installation and configuration of the tools, and supports self-developed and third-party tools.

Service orchestration includes task orchestration and workflow orchestration. Task orchestration is to break down the work of project and orchestrate the tasks in accordance with project objectives as well as the procedure and time requirements such as requirement analysis, solution design, environment building and integration test. It creates a list of tasks and assigns the tasks to different recipients who output relevant solution documents or design files as required. Workflow orchestration is to define the workflow in

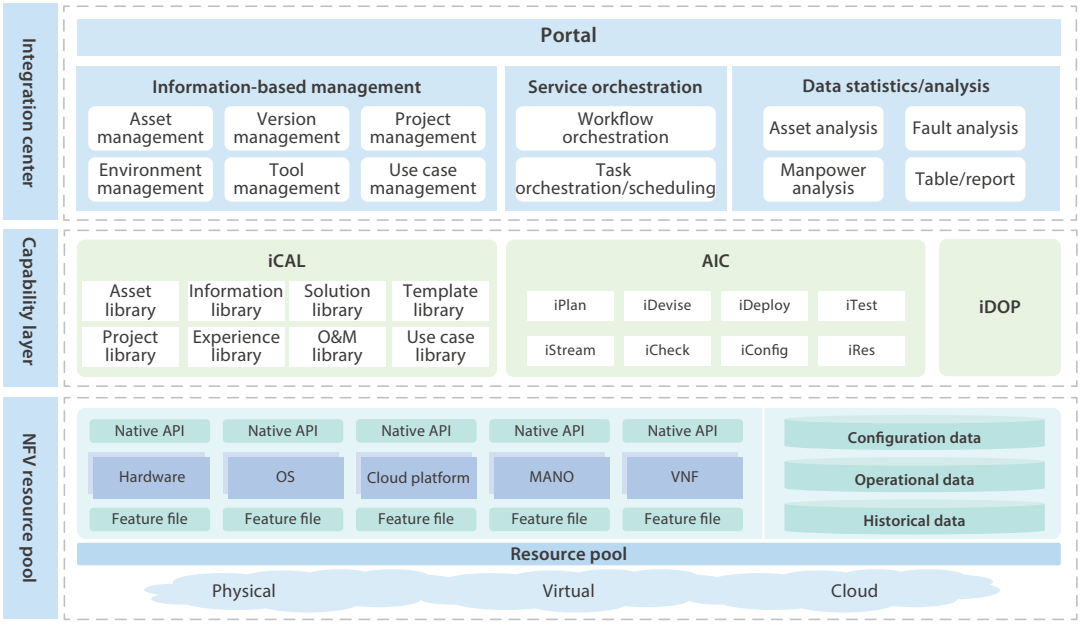
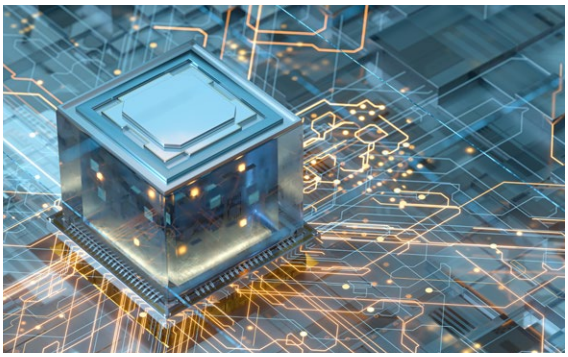


Fig. 1. Reference architecture of ZTE virtualized network integration center.



five scenarios such as integration design, deployment, test, acceptance, and management in the process of NFV network construction. Based on the digital means, the integration work within a task is divided into several minimum units that can be executed. These minimum units are cascaded into a complete pipeline through orchestration, so that these units can be periodically executed and output reports in accordance with the predefined scheduling policy. In this way, highly automated continuous integration or continuous deployment tasks can be implemented.

Data statistics and analysis can help enterprises make auxiliary decisions and improve equipment utilization and personnel efficiency through visual charts, statistics and analysis of the asset utilization of all kinds of equipment as well as the occupancy of human resources.

Application Scenarios and Value

The virtualized integration center can help operators improve integration efficiency, reduce the costs, and ensure integration quality during their NFV network construction. Typical application scenarios are as follows:

- **Pre-integration verification of multi-vendor devices based on the OpenLab:** As NFV network decoupling increases, integration verification of multi-vendor devices has always been a major difficulty in commercial use of NFV networks. Through task orchestration in the virtualized integration center, a complete task flow involving requirement analysis, solution design, environment building, test verification, and document output can be arranged. This helps to implement pre-integration verification among multi-vendor devices.
- **CI/CD based on the virtualized integration center:** For customized integration scenarios, automatic production operations are orchestrated in advance in the virtualized integration center to implement continuous integration (CI) covering from inspection, deployment, testing to version delivery. In addition, in the commercial environment, after the hardware in the resource pool is installed and connected, the production operation pipeline for commercial deployment can also be orchestrated in the virtualized integration center. For the versions that have been verified in the center, a series of operations in accordance with the CI sequence such as deployment, configuration, and testing of the commercial NFV networks can be completed automatically to implement continuous deployment (CD). This automated continuous verification and deployment workflow can implement version iteration and commercial deployment of NFV networks. Through the effective connection between CI in the test environment and CD in the commercial environment, the efficiency of NFV network integration is significantly improved while reducing the verification cost.

Up to now, ZTE virtualized integration center has been applied in commercial networks around the world, helping operators achieve rapid construction of NFV networks. ZTE will continue to work with operators worldwide to promote further development of virtualized integration services towards digitalization, automation, and intelligence, and lead digital integration to create new business value. ZTE TECHNOLOGIES

Functions and Applications of Automatic Integration Center

Shang Guanghui

Senior Test Manager of ZTE AIC Products

Zhang Xuelang

Development Manager of ZTE Virtualization Integration Tools

The digital transformation of virtualization integration is a systematic change triggered by information technologies, and its core path is to build new capabilities through new digital integration tools. ZTE has developed an auto integration center (AIC) that can be interconnected to the lower asset layer of the digital platform and collaborates with the upper orchestration layer of the digital platform. AIC also introduces the pipeline operations to form a fully automatic tool chain and empower end-to-end continuous integration and continuous deployment (CI/CD).

AIC Overview

AIC supports an end-to-end electronic workflow of environment deployment and service commissioning, outputs digital assets in each step to form a digital closed loop, and becomes a powerful tool for digital integration. A full view of AIC is shown in Fig. 1.

Intelligent Design—iDevise

In the integration planning phase, the component iDevise can be used to plan and design data in the DC according to the hardware, bearer, virtual layer and VNF, and directly output LLD files needed for final deployment. It provides template-based design, supports hierarchical design, adopts the minimum input principle, and supports parameter verification. The design files can be imported into the automatic deployment tool iDeploy for automatic deployment and accumulated onto the asset layer as digital assets.

Efficient Deployment—iDeploy

In the deployment and implementation phase, the LLD files, version files, and necessary VNF plug-ins are imported to implement end-to-end automatic deployment. This improves deployment efficiency, reduces technical barriers, and significantly shortens the construction period. iDeploy supports multi-layer end-to-end automatic 'one-click' deployment, automatic check of the environment before deployment, one-click rollback, and one-step retry.

Batch Configuration—iConfig

AIC provides the functional component iConfig to implement automatic configuration of VNF NE data. Its application scenarios are as follows: After instantiation of VNF NEs, the iConfig function is used to configure first call or commercial office data. The LLD data deployed in the NEs can be imported into iDeploy at the

same time. After the deployment of the NEs, continuous office data configuration can be carried out. The configuration scenarios supported by LLD can be expanded, so that iConfig can be used for capacity expansion in the O&M phase.

Test as a Service—iTest

iTest is a full-scenario end-to-end automatic test platform based on the TaaS concept, covering the full lifecycle scenario of VNF networks such as pre-commercial test, commissioning test, and O&M test. The iTest system consists of a terminal dial-up test APP, the cloud, a client, and an iSimulator. Diverse tools are used to test the functions, performance, and security of the VNF networks to meet the hierarchical tests of the network devices, cloud platform, MANO, and VNF NEs as well as the verification of real services.

AIC Solution

AIC can implement various digital integration tasks to meet the needs of the integration scenarios, including automatic software/hardware integration, automatic deployment of an all-in-one (AIO) environment, automatic service configuration, and automatic tests.

Automatic Hardware Integration

Automatic hardware integration involves three fields: server field (configuration of server addresses and host names), network field (configuration of network devices and switches), and check field (check of devices and connections).

Automatic hardware integration is based on the 'pipeline diagram' and driven by scenarios. It completes data modeling of various hardware resource pools through LLD, and

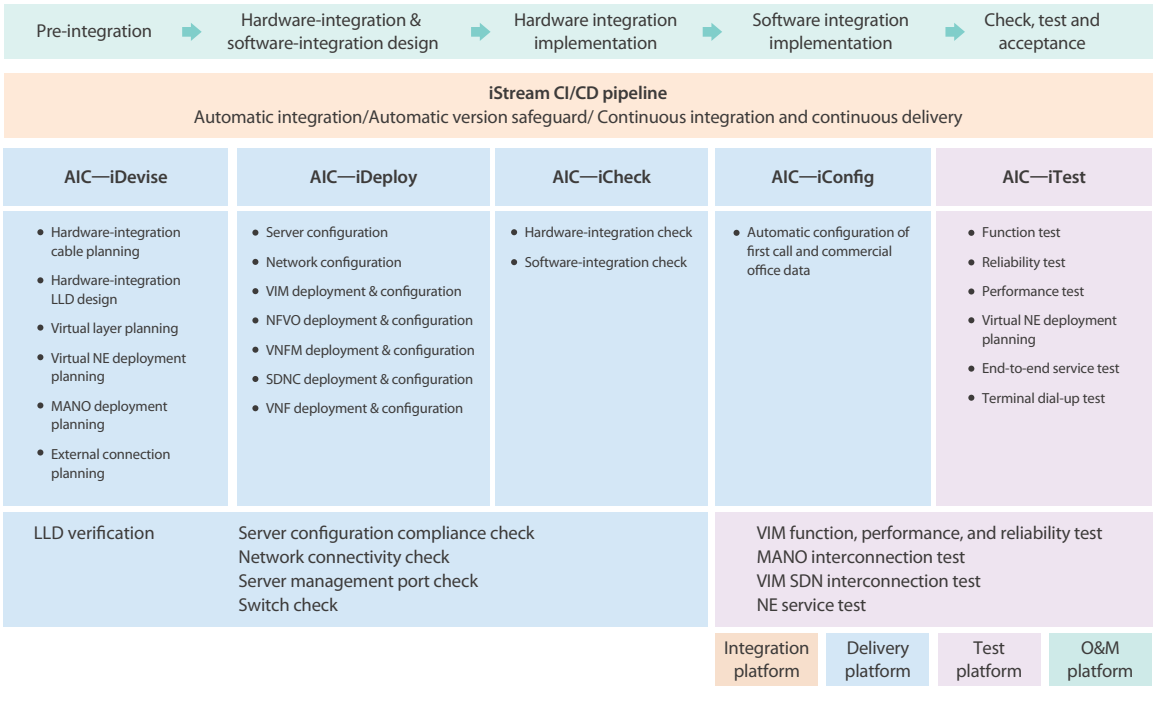


Fig. 1. A full view of AIC.

generates the corresponding model parameters. iDevise integrates the LLD data of each field uniformly and outputs the final version of LLD to meet the requirements of full-scenario resource pool deployment. The whole process is executed automatically without manual intervention.

Automatic Software Integration

In accordance with the operators' networking and configuration specifications, AIC automatically integrates software of general resource pools. The key areas it supports include automatic configuration of network devices such as TOR, EOR and DCGW, automatic deployment of the cloud platform and automatic interconnection with storage backends, automatic deployment of CEPH storage, and automatic deployment of MANO, EMS and VNF.

Software integration basically covers the deployment and configuration in all fields and adapts to the networking requirements of different operators, which can meet the differentiated needs of markets in China and abroad.

Automatic Deployment of AIO Environment

A variety of AIO solutions are developed to meet different 5G application scenarios. The solutions require faster commissioning and deployment. Based on the AIO networking solutions, AIC can implement automatic commissioning and deployment from hardware, network, virtual infrastructure management (VIM), management and orchestration (MANO), to virtualized network function (VNF). Currently, the main AIO scenarios AIC supports include AIO i5GC, AIO dedicated U-plane, AIO L-type iMEC edge cloud, and AIO cloud-network cabinet iCube.

Automated Service Configuration

After instantiation, AIC needs to configure office data for core network NEs to make the first call/first download (FC/FD). After the FC/FD is completed, it is necessary to clear the old data and configure commercial office data. iConfig supports automatic configuration of office data of core network NEs, and configures commercial office data efficiently and normatively.

Automated Service Test

After completing the NE deployment and service configuration in a virtualization network, AIC can use real UEs for dial-up test or use a simulation tool to quickly verify the service.

- **Dial-up test on real UEs:** AIC can create a dial-up test task on the cloud, and trigger the service tests in one-key mode on the mobile UEs, such as data service, VoLTE, VoNR, SMS, MMS, and 5G messaging.
- **Simulation test:** AIC can use a simulation tool to test the functions and performance of virtualization network hardware, network devices, cloud platform, and NEs. This tool supports out-of-the-box, reducing complex network interconnection configuration.

The digital transformation of virtualization integration is divided into four phases: informatization, automation, digitalization and intelligentization. As an execution capability in the digital integration platform, AIC will continue to evolve to be platform-based and intelligent, helping operators have complete end-to-end capabilities of digital integration service. ZTE TECHNOLOGIES

CI/CD Requirement Analysis and Deployment Suggestions in Telecom Field

Fan Dongming

Project Manager of ZTE Virtualization Integration Service

Shen Fei

Market Solution Manager of ZTE Virtualization Integration Service

In the field of IT software development, the deployment pipeline characterized by continuous integration and continuous deployment (CI/CD) is being applied and practiced. The core is to speed up software development and iteration, and continuously deliver products to users to give full play to their product value.

With the introduction of automation and digital technologies into telecom networks in recent years, the CI/CD concept is also being accepted in the telecom field. Similar automation frameworks and design ideas are put forward in an attempt to continuously build and deploy telecom network elements (NEs) in an automated way to meet the changing needs of business development.

Requirements for Building CI/CD Platform

According to statistics, more than one-third of operators around the world are considering automated network planning and deployment, and building the CI/CD platform is regarded as a very important measure that is being gradually applied in projects.

For example, international operators have put forward their requirements for CI/CD and automation testing in multinational branch projects. The main idea of their implementation is to introduce the CI pipeline, interconnect with the xTesting framework, integrate vendors' testing tools or open-source testing tools to automatically test NEs and correct problems, and verify the integration solution and NE version. This reduces the integration risks of pushing NEs to the actual commercial environment.

An operator in China is also actively exploring the application of CI/CD mode in the project. It considers building the continuous integration-continuous testing-continuous delivery (CI-CT-CD) pipeline based on the self-developed automatic platform, interconnecting with open-source tools and vendors' automatic deployment and testing tools, and integrating, testing and deploying network functions virtualization infrastructure (NFVI) and virtual network function (VNF).

Many operators worldwide have made requirements for CI/CD and automated testing solution. Their core requirements focus on the CI integration and verification phase, building an automated testing framework, integrating the vendors' automated deployment and testing tools, and completing the integration and verification of NEs.

New Features of CI/CD in Telecom Field

According to the requirements of operators for CI/CD construction, several main features of the CI/CD solution in the telecom field can be summarized:

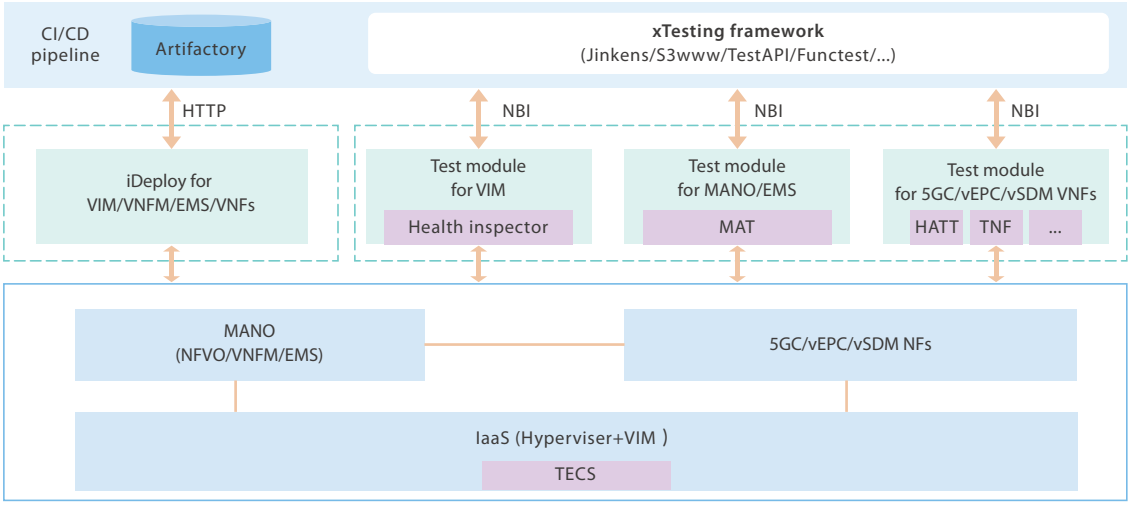


Fig. 1. Architecture of ZTE's end-to-end CI/CD solution.

- The version can be released and managed uniformly. Once a change occurs, the integration and testing process can be triggered automatically.
- The integration pipeline can be orchestrated to implement automatic task control during the integration phase and perform integration actions as required.
- The automatic testing framework can be established to satisfy the automatic tests of the system under test in various application scenarios.
- Data collection and analysis can be integrated to facilitate fault location and develop and update the NE functions in a timely manner.

ZTE End-to-End CI/CD Solution

ZTE has developed the end-to-end CI/CD solution based on its own digital integration framework (Fig. 1). Through the idea of software defined integration, the solution separates the orchestration domain from the execution domain. The orchestration domain focuses on orchestration of the CI/CD pipeline, while the execution domain continues to enrich integration tools and NE assets according to application scenarios to meet the customization needs of different NEs in different scenarios.

ZTE's end-to-end CI/CD solution is implemented as follows:

- Develop, test and construct codes for NEs on the ZTE side according to the requirements of the project, pack the codes into an image package, put it into the project version repository, and synchronize it with the artifactory or APP store of the operator through VPN for unified NE version management.
- Orchestrate the CI/CD pipeline automatically at the orchestration layer according to the requirements of the project, and automatically trigger or manually enable the continuous integration process to call in the tasks orchestrated as required once detecting that a new version of package needs to be updated in the APP store or artifactory.
- In the continuous integration phase, use different testing frameworks in accordance with the NE type. Import the image package under test, call in the automatic deployment tool iDeploy, LLD files and configuration files to deploy NEs such as NFVIs, VNFs, CNFs, and MANO, call in automation testing tools such as inspector, MAT, HATT and TNF as

required, import the corresponding test cases and test scripts, complete test operations necessary for service launch such as functions, performance, security, stability, and service dial-up tests, and output the test reports. The test operations in this phase are completed in the test environment or pre-production environment. Determine whether or not to pass the test results through manual inspection or a quality evaluation mechanism set by the system. If not, continue troubleshooting and testing until the test results are passed.

- In the continuous deployment phase, the NEs under test can be continuously delivered in the operators' production environment. In most cases, operators have several commercial resource pool nodes, which make networking more complex and have larger traffic. The CI/CD solution will introduce more complete automatic design, deployment, testing, and O&M monitoring tools to assist the NEs in continuous delivery and implement service launch and monitoring management.

Suggestions on Deploying CI/CD Platform

It is necessary for operators to build a CI/CD platform suitable for their own network development to realize continuous integration and continuous deployment of telecom networks. The CI/CD platform is an essential choice for the operators to achieve digital integration, build automatic and intelligent networks and improve the efficiency and quality of network construction.

ZTE deploys the CI/CD platform in the following phases:

- **Phase I:** Establish the integration test environment, introduce vendors' testing tools or open-source automation testing tools, improve automation level, provide pre-integration testing capabilities, and identify and reduce integration risks as soon as possible.
- **Phase II:** Establish the continuous integration pipeline, break tool silos, interconnect with the vendor's artifactory, continuously introduce the vendor's automatic deployment and configuration tools, form an automatic tool chain, cultivate continuous integration capabilities, and speed up the efficiency of version iteration.
- **Phase III:** Establish the continuous deployment pipeline, make available the production environment network, interconnect with automatic orchestration, testing, and O&M monitoring tools at commercial nodes, implement end-to-end NEs deployment, testing and monitoring in production environments, and support rapid commercial network deployment.
- **Phase IV:** Construct the digital integration center, adopt Microservice, containerized orchestration and AI technologies and architecture to continuously build a closed loop of DevOps capabilities in the telecom field, promote unified and efficient digital integration of the devices of multiple vendors, and achieve consistent integration and management of NE versions of multiple vendors in different environments. This helps to fully improve digital intelligence of network construction.

The construction of a CI/CD platform depends on the continuous development of telecom automation technologies and the support of operators' network construction and O&M management capabilities. ZTE is willing to work with operators worldwide to actively explore the path to network construction automation and jointly build a new future of digital integration. ZTE TECHNOLOGIES

PSI Service Facilitates Turk Telekom's Digital and Intelligent Transformation

Chen Xuan

Marketing Manager of ZTE NFV Integration Service

Turk Telekom, the largest integrated telecom operator in Turkey, has more than 23 million mobile users and more than 10 million fixed-line voice users. Its user traffic is growing rapidly, with a compound annual growth rate of 38%. As global telecom networks evolve to the cloud era, it is urgent for Turk Telekom to have a cloud transformation to meet the increasing user needs. At present, Turk Telekom adopts siloed architecture for its network, and the deployment of APPs is bundled with the platform, resulting in inflexible and inefficient service deployment. Therefore, Turk Telekom urgently needs to build a Common NFVI resource pool based on the third-party mainstream cloud platform to support the rapid launch of existing and future service applications.

ZTE has provided end-to-end prime system integration (PSI) service for building 5G trial and commercial networks in many countries such as China, India and Austria, helping customers achieve digital and intelligent network transformation. As a strategic partner of Turk Telekom, ZTE has customized the PSI service based on third-party cloud platform for Turk Telekom. Based on the Redhat OSP16 cloud platform, ZTE PSI service can integrate Turk Telekom's existing network system with Cisco network devices, ZTE cloud management system, and hardware and APPs of third-party manufacturers like Mavenir. As a prime system integrator, ZTE has established a joint project operation team together with Turk Telekom, the third-party software and hardware system suppliers, and ZTE's local delivery team to rapidly and efficiently promote commercial implementation of integrated service solutions based on mainstream third-party platforms and ensure digital and intelligent

transformation of the network.

Digital Integration Center Supports Best Solution Customization and Implementation

The digital transformation of Turk Telekom's network involves a large number of third-party software and hardware manufacturers, resulting in complex networking solutions, many integration interfaces and heavy work of multi-vendor integration. Based on the best practice library of fixed and orchestratable project management and operation processes in ZTE's digital integration center, ZTE's customized solution takes full advantage of Turk Telekom's existing network systems to provide end-to-end PSI service and delivery capabilities in complex multi-vendor scenarios.

Considering the complexity and difficulty of project implementation, the project team made a systematic analysis of project requirements based on the integrated digital asset library, identified integration risks, produced and customized integrated solutions that were more suitable for customer needs, and started integration pre-verification and on-site deployment and delivery. ZTE set up an integrated project operation team at the early stage of the project, clarified the integration process and responsibility matrix, and listed the integration marketing, solution and verification work at the front of the process. In addition, ZTE also created tasks for the project in the integration asset library to achieve lossless transfer of project information from the market to the entire R&D process. The delivery capabilities of each link was fixed through digital means such as template library, user case library, experience library and automatic tools to reduce delivery risks.

It has been proved that efficient and reliable PSI service solution customized based on the digital integration platform and customers' actual requirements can achieve rapid evaluation of integration requirements and agile iteration of integration solutions, and reduce delivery risks through the digital experience database. These are the guarantees for rapid promotion and implementation of project delivery.

Third-Party Cloud Platform Enables Integration Capability Iteration and Enhancement

Turk Telekom planned to deploy multiple services in the Common NFVI resource pool, which would involve multiple vendors. After full evaluation, Turk Telekom decided to select Red Hat as its cloud platform vendor. ZTE has accumulated experience in deploying the Red Hat platform in some projects that have been successfully delivered. However, Turk Telekom's project scenario is more complicated, because it not only needs to deploy the latest OSP version of Red Hat, but also customizes and deploys the cloud management platform for the resource pool and integrates third-party network devices and many third-party APPs. With powerful third-party cloud platform integration capabilities, ZTE has adopted the template-based Red Hat cloud platform integration solution based on the digital assets of the delivered projects in the digital integration platform to automatically generate standard HLD&LLD files and integration test solutions for end-to-end integration planning and design, verification, implementation, and handover services in such a complicated scenario. This can fully meet the network construction needs of Turk Telekom to integrate multi-vendors' software and hardware on the common cloud platform.

In addition, through digitized records and continuous verification during the actual project implementation, new experience in integration has been gained and added to the project database, which will provide more digital assets and experience for future project.

Remote Delivery Improves Efficiency and Reduces Integration Risks

ZTE has always advocated an open and sharing mode and is actively building a diverse and shared Openlab. There are more than 1000 servers and 600 switches in ZTE Openlab, including mainstream hardware and cloud platforms. They can provide a deployment environment for pre-integration and perform interoperability testing with mainstream vendors in the industry. Meanwhile, a demilitarized zone (DMZ) can be set to support partners' access to ZTE Openlab from external networks for integration debugging.

The overall solution of Turk Telekom's project is highly decoupled and involves many vendors and products. To improve the integration efficiency and reduce commercial risks, the project team has built a pre-integration environment in China's ZTE Openlab and Turkey's existing network, and conducted the integration verification and interoperability testing through the Openlab remote delivery center. Relying on the complete integration test environment and rich IoT integration experience of the Openlab remote delivery center, the project team has successfully implemented pre-integration verification of the solution in a remote and centralized manner. This greatly reduces the skill requirements and costs of on-site personnel, and makes a great contribution to shortening the time of on-site integration deployment, reducing TCO and commercial risks, and improving project delivery efficiency.

In constructing Turk Telekom's Common NFVI resource pool based on the third-party mainstream cloud platform, ZTE has provided end-to-end PSI service from integration design to acceptance based on the digital integration center. At present, ZTE and Turk Telekom continue to work in open and sharing mode, and continue to cooperate with Red Hat to build a cloud integration verification environment based on RedHat OCP platform in the Openlab remote delivery center to verify container cloud platform and NE functions. They will continuously develop a stable and excellent container cloud integration solution to meet microservice-based needs in the telecom industry.

In the future, Turk Telekom and ZTE will continue to carry out joint technological innovations and deepen the digital and intelligent transformation. ZTE TECHNOLOGIES

Remote Delivery of Network Cloud Digital Integration for China Mobile

Lu Xiaoyan

Marketing Manager of ZTE Virtualization Integration Service

To enable the digital transformation of thousands of industries with 5G, China Mobile launched the phase-3 project of centralized network cloud resource pool construction in October 2021. This project planned to add nine service nodes and two independent service areas (Beijing and Xinjiang) to the original network, covering hardware devices and software products from ZTE, Inspur, H3C, Ruijie and Maipu. As an important partner of China Mobile, ZTE undertook the system integration of 29 resource pools and 15,300 computing servers in this project. To solve the pain points of large-scale network cloud construction, short delivery time, decentralized offices, and multi-vendor equipment integration, ZTE, capitalizing on its domestic and overseas engineering experience, innovatively proposed the remote delivery solutions based on the auto integration center (AIC) digital integration platform.

Steps: Remote Design + Remote Deployment

Based on the digital integration platform, ZTE proposed a remote integration delivery solution (Fig. 1). The delivery team can be divided into remote delivery team and on-site delivery team. The two teams jointly develop and deliver the integration solution based on the AIC platform. Remote team members can access the AIC platform through the cloud, and design network solutions offline and online. Based on the automatic remote deployment function of the AIC platform, the remote delivery team can also work with the local delivery team to deploy the solution with one click, enabling more diversified integration delivery scenarios and a more convenient and flexible delivery mode.

During the project implementation, the remote delivery center based on the ZTE digital integration platform can be connected with the network under the on-site delivery environment on the condition that the customer's network security compliance requirements are met. In addition, the remote design and debugging team were created, pulling together the experts who will complete the LLD design of resource pool integration remotely through the AIC platform, and import the LLD design into the deployment tool to realize automated and remote deployment and configuration. The remote integration mode makes the resource pool design more unified and accurate, reduces the skill requirements for on-site front-line engineers, and makes the resource pool deployment smoother and faster, and solves problems timely to ensure the efficient integration delivery.

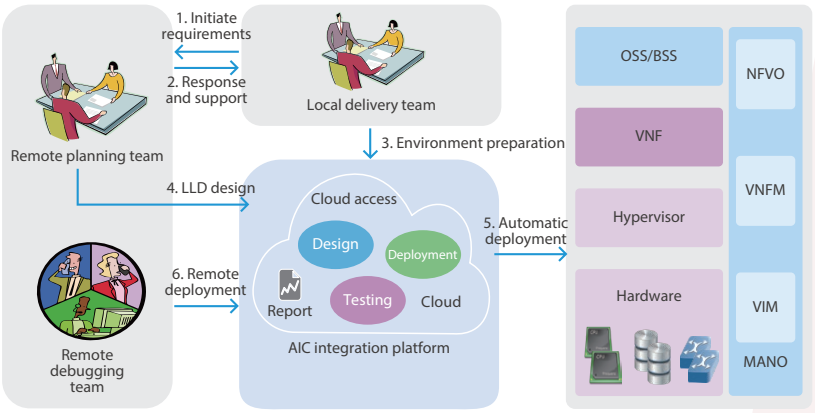
Software-Defined Integration

The ZTE digital integration platform uses the B/S architecture, with the process orchestration tool for software-defined integration at its core. Based on a deep understanding of the requirements of industry customers in the NFV construction process, ZTE has introduced digital methods to specify the work contents of five scenarios in the NFV network construction process including integration design, integration

deployment, integration test, integration acceptance and integration management. An integration target task is broken down into several minimum executable units, which are cascaded into a complete pipeline through orchestration. This pipeline can be periodically executed in accordance with the predefined scheduling policy, and task reports can be output, thus implementing highly automated continuous integration or continuous deployment tasks.

The process orchestration tool invokes different integration tools based on different integration tasks. At present, the execution layer contains a series of integration tools that can meet the end-to-end automation requirements of integration processes, such as integration planning, design, deployment, check, service configuration and test. In addition, the platform also accumulates integration process assets and integration capabilities into the asset library and capability library respectively while executing integration tasks. The asset library includes various resources, such as ICT infrastructure, tool library, expert team, management processes and regulations. The capability library includes the project library, model library, template library, solution library, instruction library, test case library, experience library, standard library, and O&M library.

At present, the digital integration platform enables the end-to-end automated operations of network planning and design, deployment and check and test acceptance with no manual intervention involved, and there is no need to distinguish between local and remote services, achieving globally equidistant services.



▲ *Fig. 1. Remote delivery of digital integration.*

Improving Delivery Efficiency Significantly

In the delivery of China Mobile's phase-3 network cloud resource pool integration, the resource pool in Baoding, Hebei Province was ZTE's first SDN network resource pool that completed the software integration acceptance test. It includes 500 ZTE computing servers, 108 ZTE storage servers, 114 ZTE top of rack (TOR) servers, six ZTE end of rack (EOR) servers, two SDNGWs, as well as export devices and security devices. ZTE integration team entered the site on November 1, 2021. Based on the ZTE AIC digital integration platform and the one-click remote delivery mode, the team quickly completed the integration of the resource pool network, CEPH, and virtual layer, the multi-vendor MANO&EMS deployment, the integration of MANO with the virtual layer as well as the silent instantiation of APPs. On November 14, the team completed the resource pool system integration and check, which lasted ten workdays.

In the multi-vendor equipment networking environment involving ZTE, Inspur, H3C, and Ruijie, the overall integration efficiency increases by 70% compared with the traditional delivery mode. The efficiency of LLD integration for software integration increases by 75%, the software and hardware integration efficiency by 50%, the L-type platform integration efficiency by 60%, the EMS resource pool integration efficiency by 66.6% and the NE instantiation integration efficiency by 75%. This delivery mode has also been successfully applied to other resource pool construction practices of China Mobile.

The remote delivery of network cloud integration for China Mobile is the first-of-its-kind practice of ZTE in the field of digital integration. The innovative remote delivery mode breaks through the single delivery scenario with the network delivery quality and efficiency greatly improved. In the future, ZTE will work with China Mobile to continuously innovate and explore in the field of remote delivery of integration service. ZTE TECHNOLOGIES

ZTE Executive Insights: Shaping Digital Innovation

Source: Light Reading

We are now experiencing a surging digital wave. Digital transformation is changing the world faster than ever before, driving new growth in various fields, from life to production, from individuals to organizations. ZTE executives shared deep insights at MWC 2023.

Digital economy is gaining vitality despite the uncertainty. Driven by digitalization, networking, and intelligence, the real and digital worlds are converging and evolving at a fast pace, which is reshaping the entire human society.

As a digital native company, ZTE will always stick to the business philosophy of "Simplicity, Agility, and Openness for Win-Win," and speed up its evolution by riding the trend.

In the fields with business certainties, we keep with innovation for simplicity. Coming from our decades-long efforts in DICT innovations, we promote computing and network convergence, redefine hardware and software integration, to work out optimal, end-to-end solutions.

In the fields with business uncertainties, we act agilely to explore new opportunities. Internally, we step up efforts to enhance underlying capabilities with highly flexible components for fast implementation. Externally, we launch minimum viable products and make constant iterations for different scenarios.

Joining hands with customers and partners, we aim to build a digital and intelligent ecosystem for greater openness and shared success.

In this era of data explosion, there are many challenges, for example, the slowdown of Moore's Law, closing the gap to the Shannon Limit, and pursuit of sustainable and green growth, and digital security.

Shaping digital innovation essentially depends on the computing and network convergence and upgrade of digital infrastructure. This is also crucial for us to fully embrace and lead the digital era.

At the infrastructure level, the key is performance and efficiency.

One focus is the mode of chipset design plus domain specific architecture, aiming for the continuation of Moore's Law. The other is hardware acceleration through smart network interface cards and DPUs, to optimize both hardware and software.

At the application level, the key is service extension.

First, through 5G-Advanced, 6G, all-optical mesh networks, RIS, and space-air-ground integrated networks, the network boundary is extended. Second, with deterministic network, and the integration of sensing, communication, computing, and control, the application boundary is extended. Finally, through DPU-centric architecture and more advanced cloud-network convergence, the capability boundary is further extended.

At the ecosystem level, the key is a diverse and robust value chain.

Even in multi-vendor and multi-cloud environment, quality services with integrated "connectivity, computing, and digital capabilities" are available. At the same time and as always, ZTE, together with partners, safeguards sustainable development with green, intelligent, and secure business operations.

The year 2023 will be full of challenges and opportunities. By sticking to its strategy, ZTE will make targeted and pragmatic efforts for steady growth, and continue to promote its digital transformation. In this way, we aim to make greater progress in product planning, market expansion, and organizational design.

Regarding product planning, we will keep improving our core ICT capabilities, and build solid competence in product design, R&D, and delivery, to meet different customer demands. On this basis, we will develop a full series of DICT products and integrated solutions, to guarantee technological leadership in the first curve, and enhance competitive edge in the second curve.

As for market expansion, ZTE will explore more digital scenarios, together with global operators, enterprises, consumers, and partners. Tapping into our stronger product capabilities, we will further expand into new fields, such as automotive electronics and renewable energy.

As to organizational design, we will strengthen our efforts in digitalization, to build a highly resilient and green company. Based on industry insights, application scenarios, and integrated operations, we will give full play to our special teams, to adapt to the needs of customers and markets.

From large-scale 5G SA networks, to highly-efficient, green computing hubs and edge nodes, and diverse industry applications, ZTE is dedicated to providing integrated solutions involving cloud, network, edge, and terminal. As a driver of digital economy, we are always on our way to create greater value. More open, agile, resilient, and intelligent. ZTE is willing to work with all partners in the industry and ecosystem, to shape digital innovation and embrace a new digital future. ZTE TECHNOLOGIES

To enable connectivity and trust everywhere