Propelling Operators to L3 Operations Autonomy and Beyond with Huawei ADN

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EXECUTIVE SUMMARY

The idea of an autonomous network (AN), requiring no human intervention, has been around for a long time, but advances in technology and standards are putting the vision within reach. A consortium of leading telecoms operators, standards development organizations, and vendors have created a shared vision of the autonomous network. Huawei offers a set of network and software technology, evolution plans, and a repeatable, sustainable process for achieving automated Level 3 operations autonomy, calling it the Huawei Autonomous Driving Network. Operators have adapted the vision to their own operations, aiming at L3 by 2023 and L4 by 2025. Several operators are well on their way to achieving ubiquitous L3 operations autonomy through a set of targeted, practical projects that span their entire operation, and they see their path to L4 in selected areas. These operators came together at the Huawei Global Analysts Summit in May 2022 to share their vision, plans, and experiences. Their message was clear, now is the time.

What Is Operations Autonomy and Why Now?

Very simply put, an autonomous network is a communications network that configures itself in response to customers' requests (self-configuring), fixes itself if problems arise (self-healing), all the while doing so in the most efficient and sustainable manner (self-optimizing). This gives the customers an enhanced user experience of instant service (zero-wait), nearly 100% availability (zero-trouble), all while being done with no human intervention (zero-touch).

Aaron Boasman-Patel VP of AI and Customer Experience and Data at the TM Forum described how the industry has been working toward these goals ever since the end of the last century with the development of computers and software instantiated into operations support systems (OSSs) and business support systems (BSSs) with increasing levels of capabilities and constantly lowering costs and striving for a network that was self-aware, self-provisioning, and self-optimizing. Various other projects have advanced these ideas over the years, most notably in the self-organizing/self-optimizing (SON) network vision.
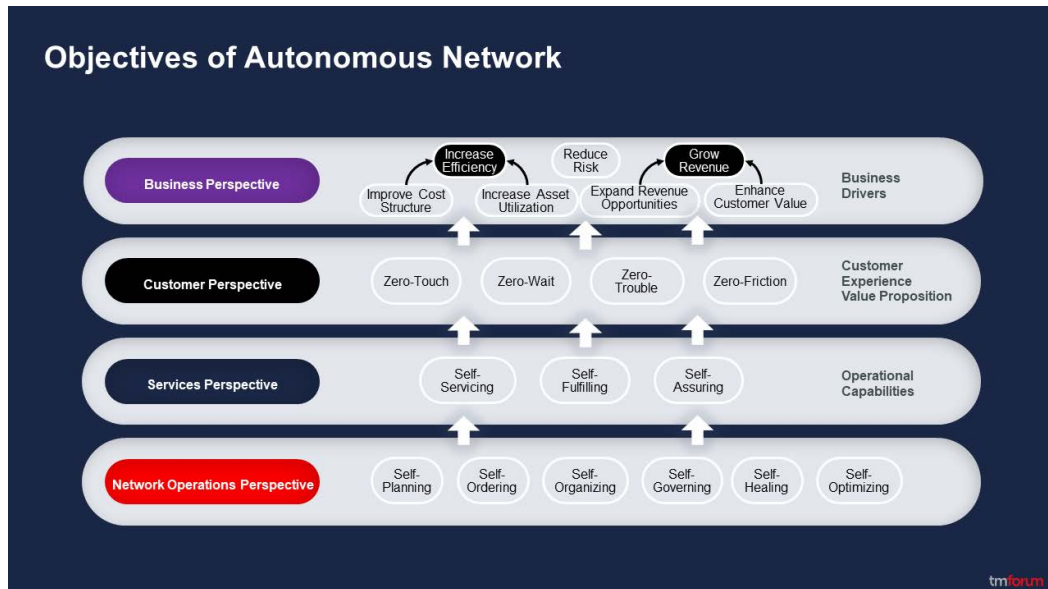
Figure 1. Autonomous Network Vision (Source: TM Forum)

But only now with major advances in technology are we close to realizing the goal: [1]

- Computing and storage infrastructure are inexpensive and available on demand,
- Software development, integration, and support costs have dropped by orders of magnitude with new techniques, the latest of which are cloud-native architectures with DevOps development, CI/CD deployment,
- Artificial intelligence (AI) neural networks, coupled with machine learning (ML) have exceeded human abilities in certain areas and are constantly expanding and being deployed in AIOps powered network and business operations,
- Operators and vendors are working together, using newfound practical methodologies, to define and quickly implement standards.

Telecoms operators and their vendors are utilizing these new technologies to push toward operations autonomy in this decade.

Creating the Autonomous Network

Creating the autonomous network is a global challenge, requiring the involvement of software technologists, operators, vendors, systems integrators, and standards development organizations (SDOs).

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[1] Mortensen, Mark H, *Autonomous Networks: Now is the Time,* https://www.acgcc.com/reports/autonomous-networks-now-is-the-time/

Standards

The TM Forum has been leading the industry in the definition of the AN, along with the specification of high-level APIs, although many other SDOs have similar and increasingly coordinated efforts. These include the ETSI (zero-touch network), MEF (standards for broadband service ordering), IETF (IP and SD-WAN standards), 3GPP (mobile networks), and the Broadband Forum (broadband networking standards).
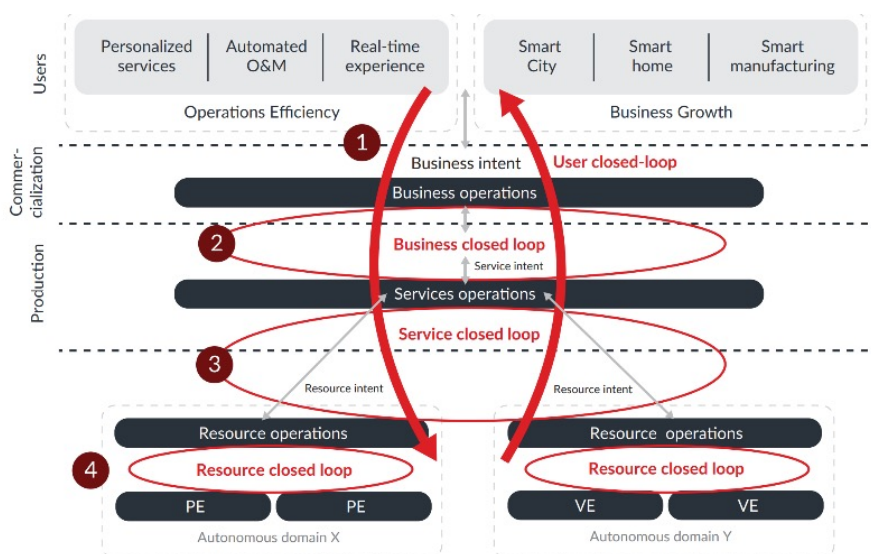
Figure 2. Vision

A shared vision of AN has been developed by a consortium under the auspices of the TM Forum[2]. It provides a set of goals (the three self-Xs and the three zero-Xs) and a design philosophy of pushing operations autonomy as far down in the customer-service-network hierarchy as possible, Figure 1. The network, a combination of physical and virtual network elements, is divided into domains that have their own closed-loop control to make them as autonomous as possible. Above the domains is another autonomous closed loop at the service level that controls and orchestrates operations across the domains. Above these exists the services and business operations closed loops.

Junfeng Ma, of the SDN/NFV Industry Alliance, sponsored by the China Academy of Information and Communications Technology in China (CAICT) and CCSA TC610, described the efforts to bring together these standards with other industry alliances, research institutes, and vendors. The CCSA TC610 AN project is creating a set of group standards for AN level assessment and certification as well as ensuring that the AN of the future meets the needs of the broad set of industries that use the increasingly important communications backbone for their digital transformation. [3]

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[2] https://www.tmforum.org/resources/whitepapers/autonomous-networks-empowering-digital-transformation-for-smart-societies-and-industries/

[3] For a discussion about how AN provides the infrastructure for enterprise digital enablement of a wide variety of enterprises, see Offredo-Zreik, Liliane, *Autonomous Networks Power Industry 4.0* https://www.acgcc.com/reports/autonomous-networks-power-industry-40/
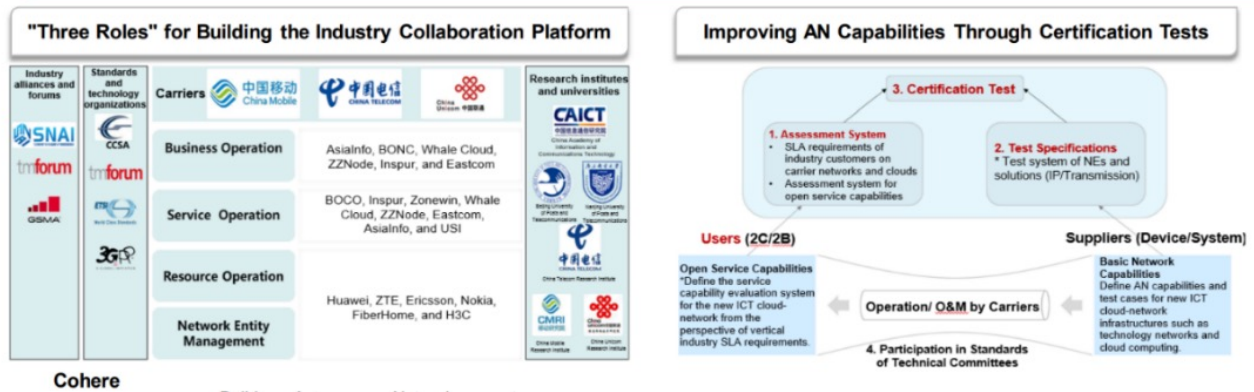
Figure 3. Synergy Platform

Huawei's Autonomous Driving Network Vision and Implementation

Three presenters described the Huawei Autonomous Driving Network, discussing the basic concepts, the technology and product offerings, how the business case for operations autonomy is done, and revealing how Huawei professional services engages with the operators with a standard, sustainable transformation process.

Sam Wang, the Director of ADN Solution, General Development Dept at Huawei, described how Huawei has been a major industry contributor to the AN vision and how its contributions both to the AN standards as well as its ADN implementation of the standards has garnered attention and awards.[4]

MyTake: The Huawei Autonomous Driving Network is fully in synch with the TM Forum Autonomous Network concept and should be viewed as a credible implementation path to the AN of the future.
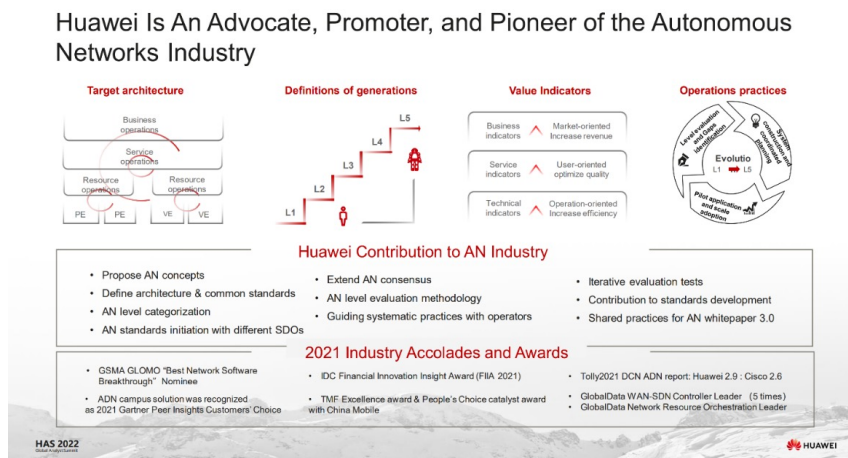

Figure 4. Huawei's Promotion of AN

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[4] For a discussion of the overall concepts of AN and the Huawei ADN, see Mortensen, Mark H, *Autonomous Networks: Now is the Time* https://www.acgcc.com/reports/autonomous-networks-now-is-the-time/

Technology

Aleksandar Milenovic, Director of the Huawei Ireland Research Center in Dublin, Ireland, covered the Huawei ADN architecture and products, describing the iMaster line of domain controllers for domain autonomy, cross-domain orchestration for overall service implementation and management, and the management of the many AIs that has formed the intelligent service platform at the infrastructure, network, and cloud layers, extending agile network intelligence all over the systems. He also described how the Huawei network equipment, both physical and virtual, is being enhanced with operational intelligence, including embedded AI, to work with the software control iMaster systems. [5]
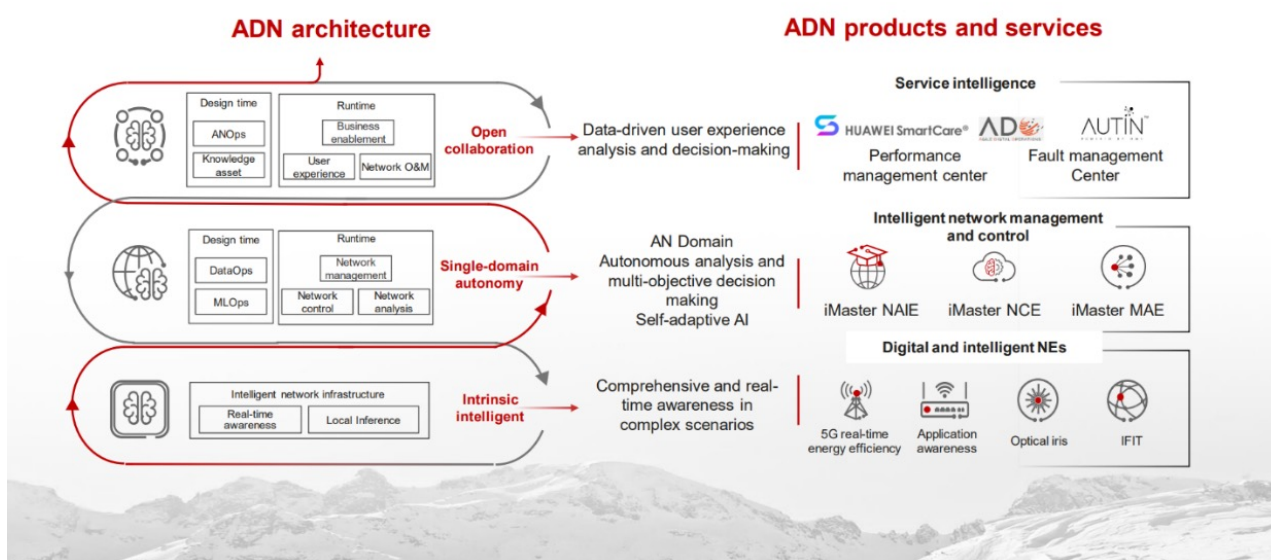
Figure 5. The Huawei ADN

MyTake: Huawei has made great strides in creating a credible product road-map that includes a comprehensive set of modern software and hardware products. Its commitment to standards creation and implementation are second to none.

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[4] For more information, see Mortensen, Mark H, Huawei *Autonomous Driving Networks: Standards-Based but Differentiated* https://www.acgcc.com/media/reports/files/ACG-Huawei_Autonomous_Driving_Network-_Standards-Based_but_Differentiated_11-2021.pdf.
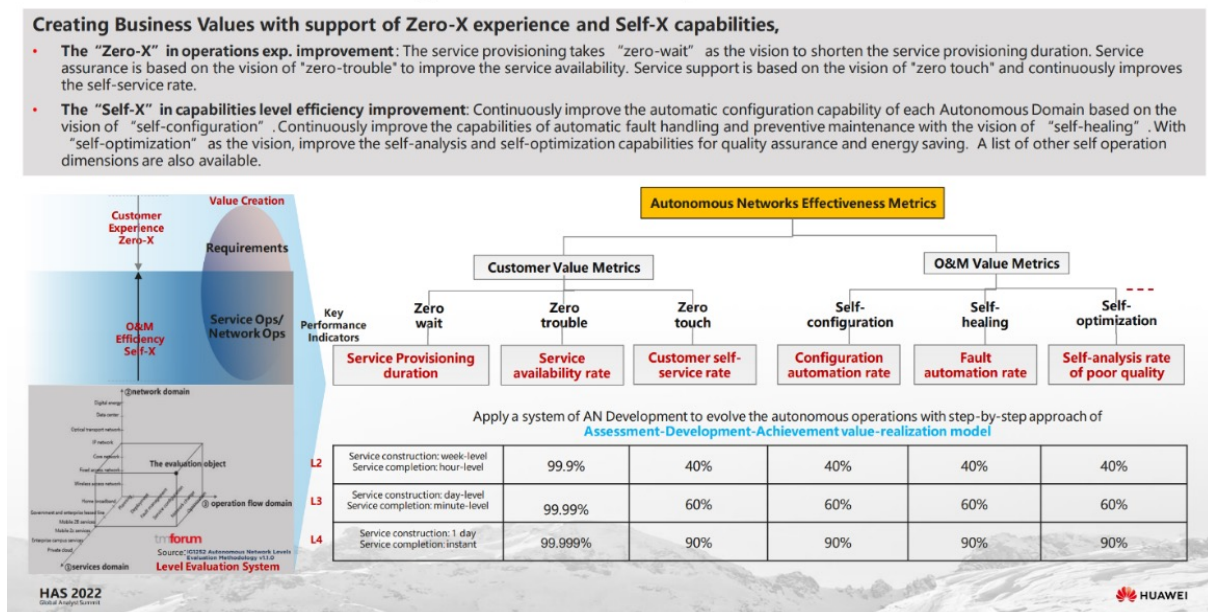
Business Case

Samuel Chan, Senior Marketing Manager of General Development Dept at Huawei, detailed the business case approach to implementing Huawei ADN and demonstrated the methodology of AN level evaluation with different CSPs in order to prove that L3 autonomous networks are well examined and impending. To be sustainable, digital transformation projects must match the benefits of ADN deployment with the implementation; each step in the transformation must pay for itself through the combination of:

- Operations or energy cost reductions,
- Increased revenue from increasing customer satisfaction or competitive position,
- Increased agility to bring new or improved services to market.

These goals must be quantified as improvements in internal key performance indicators (KPIs) of the operations.[6] Then these improvements must be implemented and measured.

Figure 6. Measurement of Evolving Autonomous Operations

MyTake: Digital transformation is a difficult road. There has been a tendency of technology companies to create large, multiyear projects with lofty goals that required large up-front investments. Then, when the benefits did not appear quickly, the projects were scrapped or downsized. Huawei has a very practical methodology for ensuring that benefits are achieved quickly and that those benefits directly tie to the requirements of a CSP's business.

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[6] For a discussion of the levels of operations autonomy, see https://www.tmforum.org/resources/standard/ig1252-autonomous-network-levels-evaluation-methodology-v1-1-0/

Process

Since the process of ADN implementation takes a series of projects spread out over several years, it is critical to have a transparent, repeatable, but flexible model for digital transformation. The Huawei Value Realization Model embodies such a process. [7]
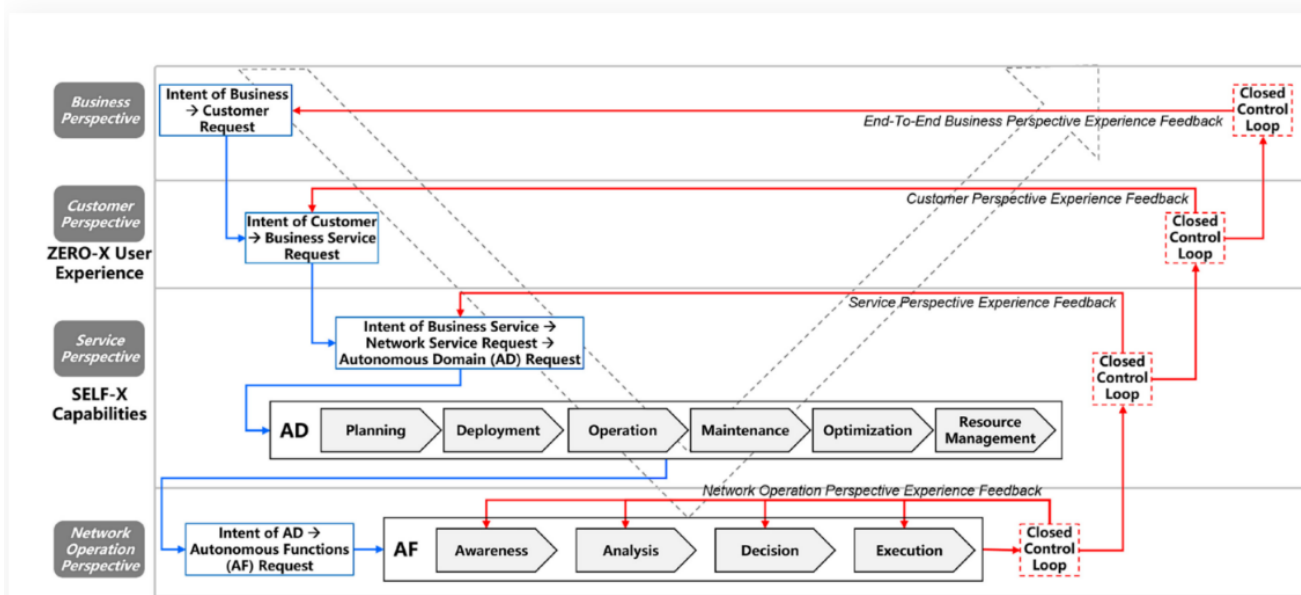

Figure 7. Huawei Value Realization Model

MyTake: The V-Model of the Huawei professional services organization is the only model I have seen that provides a proven methodology for a CSP to transition to Level 3 operations autonomy.

Implementing the AN: Three Approaches

The TM Forum AN vision does not specify the set of domains to be implemented, discuss the technologies employed or require any particular software technologies or architectures; those are left to the vendors and the operators. Today in the industry there are three main approaches for implementing autonomous networks. It is probable that the optimal path for a CSP will involve all three of these, depending on a CSP's specific needs, desired approach, and automation maturity in the various network domains. [8]

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[7] For more on the Huawei V-Model and how it is used, see Mortensen, Mark M, *Best Practice: Achieving Level 3 Autonomous Operations, , TM Forum February 2022.* https://inform.tmforum.org/research-reports/best-practice-achieving-level-3-autonomous-operations/

[8] For a fuller discussion, see, Mortensen, Mark H, *Implementing Autonomous Networks: Three Approaches,* https://acgcc.com/blogs/2022/03/18/implementing-autonomous-networks-three-approaches/

The three main approaches are:

- Top-down automation tool driven
- Bottom-up network driven
- OSS refresh

Top-Down Tool Driven

Automation tool vendors see a set of OSS capabilities that need to be driven by robotic process automation (RPA), workflow systems, and AI driven analytics, adding them onto the existing operations infrastructure and replacing the human technicians that now interact with the OSSs. They would add these onto the existing EMSs, NMSs, domain controllers, cross-domain orchestrators (if implemented yet), and OSS systems to automate the operations.

Bottom-Up Network Driven

Network vendors have found that most CSPs want them to provide a domain control system (roughly a next-generation EMS/NMS that provides SDN control and advanced telemetry) optimized for their equipment that is also capable of controlling other vendors' equipment reasonably well within a network domain where that manufacturer is dominant. These vendors are adding analytics and automation features to their SDN control capabilities to provide as much network operations autonomy as possible.[9]   Some of these vendors, most notably Huawei and Juniper (soon to be joined by Sedona as a per of Cisco), also provide cross-domain orchestration for provisioning as well as network and service assurance. Huawei, as a network vendor that covers all areas of telecoms with a full solution for mobile and fixed networks, has a full solution set for SDN control of the entire network.

OSS Refresh

Vendors that have all-in-one OSS suites call for replacing parts or all the OSS infrastructure with their multipurpose offerings. In all cases, these are decomposable suites[10] with a full set of provisioning, assurance, inventory, and design (P-A-I-D) functionality for overall network operations, including slicing.

Optimal Plan

There are good examples of implementations of Level 2 and 3 operations autonomy implemented via all three of these approaches.

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[9] Having closed-loop autonomous operations autonomy as low in the architecture as possible is a basic concept in the Autonomous Networks definition. See https://inform.tmforum.org/research-reports/autonomous-networks-exploring-the-evolution-from-level-0-to-level-5

[10] A decomposable suite is an integrated suite in an architecture that admits certain cleave points among the suite components, usually at the TM Forum defined API points. This allows a CSP to replace one or more components of the suite with other vendors' or their own components.

The approaches optimal for a particular CSP vary greatly by how sophisticated and up to date a CSP's current operations are and how much the CSP wants to take part in creating and optimizing the autonomous operations workflows. The best approach is to combine these three, applying them to each part of the operation. In general, it is usually best to:

- Choose OSS refresh where the OSS infrastructure needs major enhancements, especially in common functions such as inventory, data lake, and overall network assurance.
- Automate the individual network domains using the bottom-up network-driven approach, using RPA and other workflow technologies to automate individual tasks and build them up to the domain level.
- Automate the end-to-end service-level operations using sophisticated orchestration tools.
- Judiciously apply AI/ML where needed in all three cases.

What Areas Are Successfully Being Automated to L3/L4?

Presenters from three operators that are engaged in their own ADN transformations shared their goals and experiences at the summit. Some of their key projects are shown in the Figure 7. They cover both the network and the service levels across the various domains and support both the enterprise and consumer businesses.
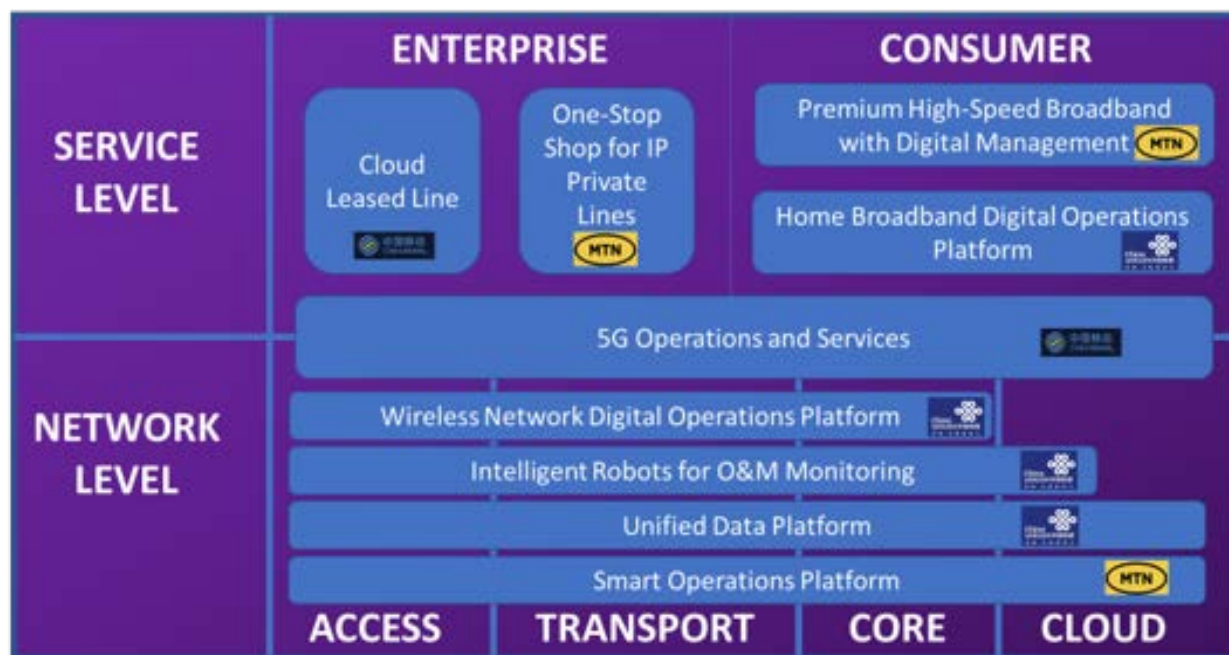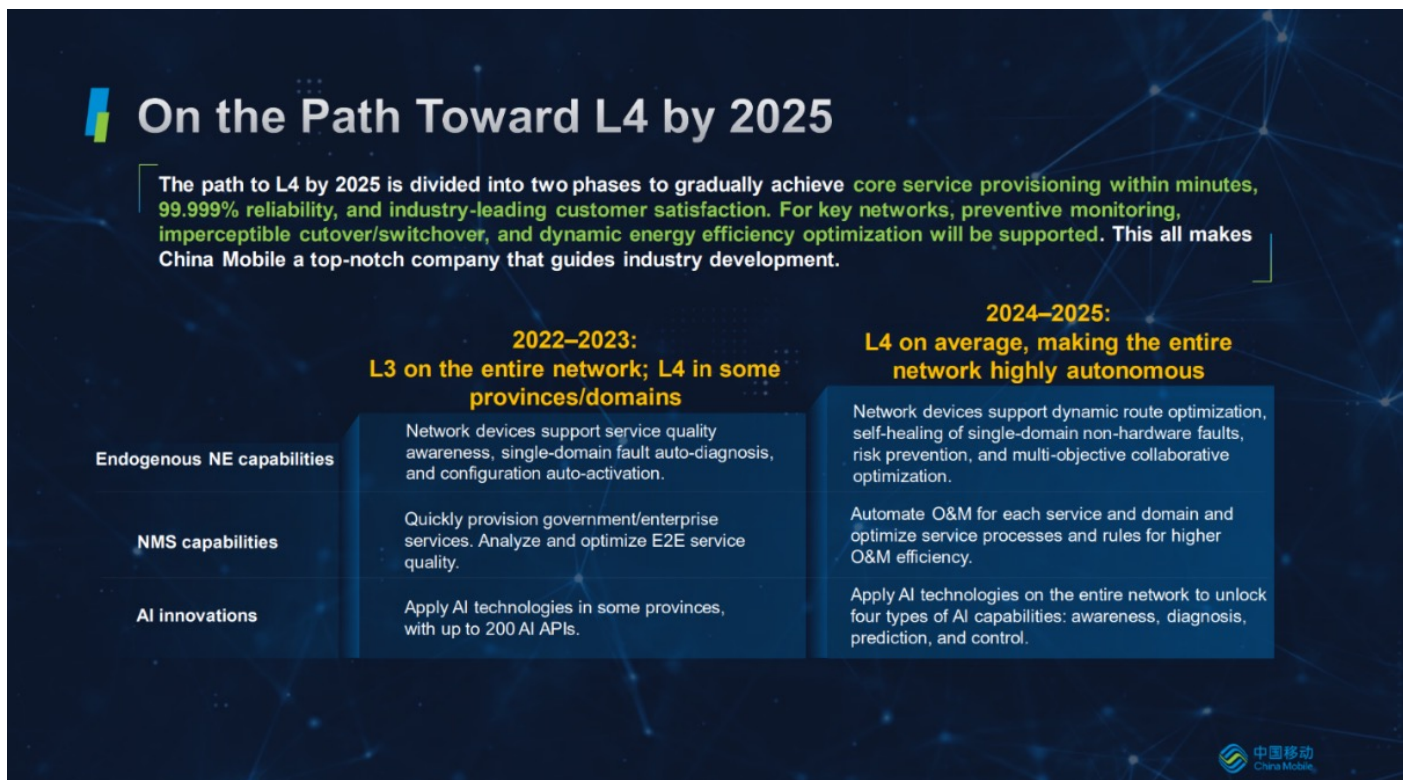

Figure 8. Key ADN Projects Underway

China Mobile

Lingli Deng, Director of SDO collaboration, AI Center of China Mobile, described China Mobile's strategic goal to move its network operations to L4 (on average) by 2025. [11]

Figure 9. China Mobile' Goals

To accomplish this goal, China Mobile worked with Huawei professional services and product teams:

- Assessed the AN maturity level for 300 areas: Five O&M scenarios (planning, construction, maintenance, optimization, and operation) across 12 services across three service types (individual, home, government and enterprise), and five network domains (wireless network, core network, network cloud, transport network, IP network). Found that the maturity level varied from L2.1 to L2.7.

- Set goals and projects to:
    - L3 on the entire network by 2023, L4 in some areas.
    - L4 on average by 2025.
    - Goals of service provisioning within minutes, 99.999% reliability, and industry-leading customer satisfaction.

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[11] For more details, see https://www.tmforum.org/resources/standard/ig1218b-china-mobiles-practice-on-autonomous-networks-v1-1-0/

China Mobile then decided upon several pilot projects:

- Cloud leased line operations, which suffered from:
    - Slower service provisioning than its competitors (14 days vs competitors' 5 days).
    - Labor intensity from having to manually inspect the configurations of the more than 7,300 servers and 9,400 virtual machines. This took over four hours for manual inspection and only provided a 60% accuracy.
- 5G network operations, which suffered from:
    - Complex network fault handling that often missed the four-hour Level 1 fault alarm handling time KPI.
    - Labor intensity (over three hours) for 5G cut-overs that were needed to be done over 30 times per month during a five-hour time-frame overnight.
    - Customer complaints on 5G services that were over doubling but have a tight SLA for resolving over 95% of the complaints in less than eight hours.
- Two projects were completed in the pilot:
    - Cloud-leased line self-provisioning reached Level 3, providing five-day provisioning lead times, which had the benefit of increasing the orders by over 100% with a revenue enhancement of over USD3M.
    - 5G fault handling reached Level 3, with an 80% reduction in fault locating time on over 9,000 daily alarms, reducing the staffing from three to one.
- Three additional projects were completed, with Level 3 compliance, but with a 50% reduction in roll-out time by following the v-method:
    - Self-inspections for cloud resource pools to increase inspection accuracy from <60% to over 98%while reducing the manual labor by 80%.
    - Cut-over management robot for reducing the cut-over duration to less than three hours.
    - 5G network complaint management robot for cutting the fault demarcation time by 80% while handling over 10,000 cases per day.
- 15 other projects were completed in 2021 in other areas with 30 projects targeted for 2022.

MyTake: The China Mobile transition to L3 operations autonomy has been well documented [12]. Starting with pilot projects to prove out the methodology was particularly important, especially for a multiregional carrier such as China Mobile. Doing even 30 projects a year is unlikely to meet the vision of full L4 operations autonomy by 2025.
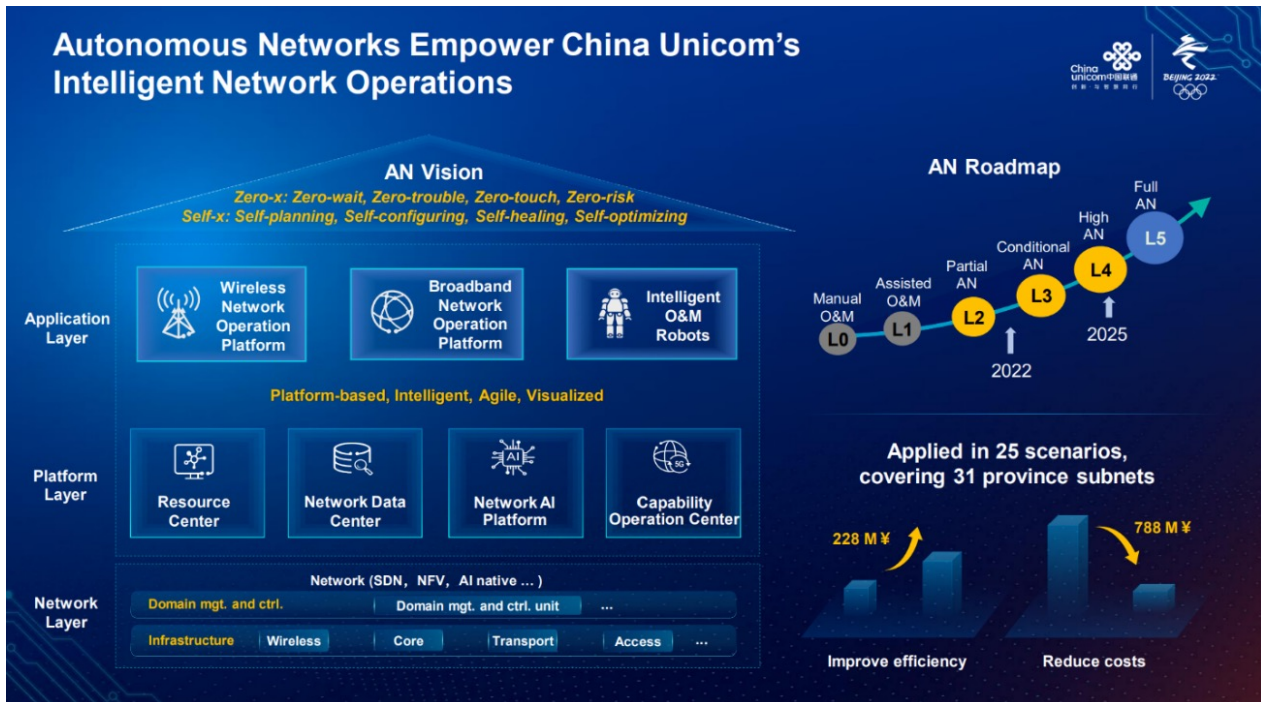
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[12] See, for example, https://www.tmforum.org/resources/how-to-guide/ig1218b-china-mobiles-practice-on-autonomous-networks-v1-1-0/

China Unicom

Pei Zhang, Director of Intelligent Network Innovation Center of China Unicom's and, plans to reach essential L4 operations autonomy by 2025.

Figure 10. China Unicom's Goals

The set of projects that China Unicom chose spanned 25 scenarios throughout their 31 provinces. Some of the key ones were:

- Created a unified network data platform that supports 70 applications, collecting 400 TB/day of data but providing simple query responses in less than three seconds and complex ones in less than one minute.

- Created a wireless Network Digital Operations Platform, consisting of over 20 intelligent analysis algorithms and models. Provided high-value site identification that increased 5G traffic of high-value subscribers by 10%. Self-configuring sites with AI based inspections that halved the time to construct a new site. Self-optimizing that identified 32,000 poor quality cells that were optimized.

- Implemented a Home Broadband Digital Operations Platform that provided operations with home network monitoring that reduced complaints by 20%, supported targeted marketing, and self-service for one-day provisioning and fault recovery in over 99% of the cases.

- Installed and programmed intelligent robots for network O&M monitoring, inspection, and optimization that increased service availability by 15%, reduced users' complaints by over 100,000, and cut power consumption by $100 million.

MyTake: The China Unicom implementation model followed roughly the same path as China Mobile but focused more on the operations infrastructure rather than on the services, in accordance with its current business needs.

MTN

Mohamed Salah, Senior Manager, Network Operations Assurance of MTN Group, the largest telecoms group in Africa, detailed MTN's plans to move to L3 autonomy and beyond.
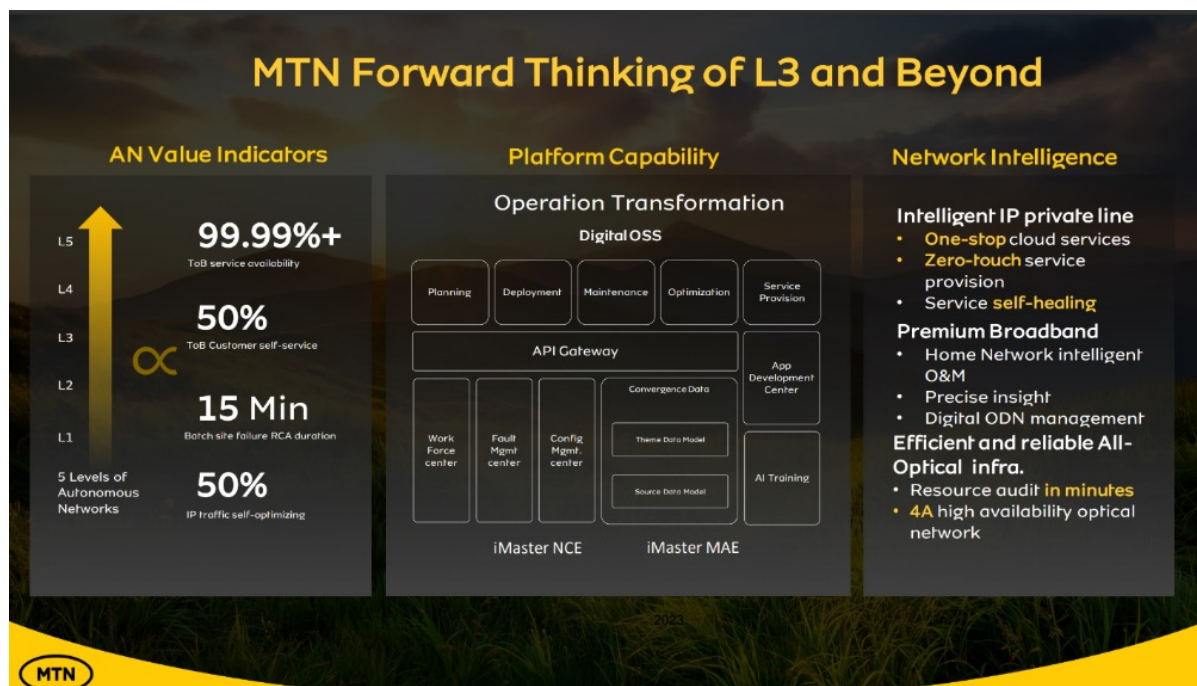

Figure 11. The Goals of MTN

The key projects were:

- One-stop cloud service for intelligent IP private lines with zero-touch provisioning.
- Transport for 5G readiness with 50% self-optimization of IP traffic and all-optical resources capable of providing a resource audit within minutes and root-cause analysis within 15 minutes.
- Premium home high-speed broadband with digital management.
- AI for smart operations of the network.

MyTake: These were projects that would have made sense to implement even without the push to L3 operations autonomy. The push toward AN provided a good focus for the projects.

What Will It Take to Achieve Level 4 Autonomy?

Preliminary work indicates that artificial intelligence will be necessary in many areas to attain Level 4 operations autonomy. Of course, machine learning will be needed.[13]   AI/ML technology has been practically applied for those problems where the data volumes are large (where humans cannot process all the data), where required response times are short, and where the answers can afford to be only approximately correct.

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[13] We have had AI technology, in several forms (including expert systems, neural nets, natural language processing, and cognitive systems) for many years. What is new and exciting is HOW these automata are taught, via machine learning, although there are many issues still in play.

There is still much push-back by managers for implementing closed-loop operations, however.[14] AI systems lack the ability to describe why they come up with an answer. This will take some time and operations structures where the managers still feel in control of the operations, their KPIs, and their SLAs for which they are responsible.

AI is looking like the best way automate the analytics portion of network automation—deciding on what to do. The RPA and workflows built at Level 3 will be reused and extended to do the tasks that are decided on by the AIs.

To achieve the goal of having autonomy in the lower layers with only abstracted views in layers above (i.e., the interfaces between the resource/service, the service/business, and the business/customer layers) will require intent-based interfaces.[15] Such work is underway in both the TM Forum and in many vendors, including Huawei, which is placing significant resources in these areas. In such interfaces, the upper layers do not have to know the details of the implementation of underlying layers. At the customer-to-business interface, a natural language interface is expected to be useful, where the customer describes in a disciplined way the services desired and their expected behaviors Similarly, at the business-to-service interface and the service-to-resource interface, where the current programmatic APIs will be replaced with more intent-based APIs.

Summary

Operators' digital transformation journeys to operations autonomy via the autonomous networks standards will take time. Leading-edge companies are already engaged, and several have set a goal to achieve L3 by 2023 and substantial L4 maturity by 2025. The Huawei ADN vision and product road-map, along with the processes to implement it, are unique in the industry. The experiences of the CSPs that described their L3/L4 goals and transformation processes reported good movement toward autonomous operations, achieving L3 operations autonomy across the board and good movement toward L4 autonomy. These will achieve the goals of the 10x network: 10 times the service, 10 times faster, at one-tenth the cost. [16]

Operators that engage in this complex journey will find themselves in a favorable competitive position with lower costs, higher customer satisfaction, and much more agile in the increasingly complex and fast-moving world of industrial digital transformation.

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[14] See, for example, https://www.acgcc.com/blogs/2020/01/28/five-barrier-questions-to-ai-adoption/

[15] For a full discussion of intent-based interfaces in autonomous networks, see Cooperson, Dana, *Intent in Autonomous Networks,* https://inform.tmforum.org/research-reports/intent-in-autonomous-networks/

[16] Mortensen, Mark H, *The ACG 10x Network Project,* https://www.acgcc.com/blogs/2020/05/18/acg-10xnetwork-project/

Huawei is the only vendor that offers a proven methodology and associated network and service technology for evolving Communications Service Providers towards network operations autonomy. CSPs around the world have used the Huawei Autonomous Driving Network and strive for Level 3 and beyond. The TM Forum, China Communications Standards Association, and several CSPs recently shared their motivations and experiences at the Huawei Global Analyst Summit in April 2022.

This article was sponsored by Huawei

About the Author:

Dr. Mark H Mortensen (mmortensen@acgcc.com, @DrMarkHM) is an acknowledged industry expert in communications software for the TMT sector, with over 40 years of experience in OSS and BSS specifications, software architecture, product marketing, and sales enablement. His work has spanned the gamut of technical work at Bell Labs, strategic product evolution at Telcordia, CMO positions at several software vendors, and as a research director at Analysys Mason. Most recently, Mark has focused on the technology and processes of digital transformation for Communications Service Providers and the growing automation and orchestration of network and business processes. He joined ACG Research in 2018 where he has been responsible for Communications Software research and consulting. He recently, with his colleague, Paul (PJ) Parker-Johnson launched a new syndicated research program, *Domain Control and Orchestration*, that characterizes the state of the industry, profiles vendor solutions, and tackles many of the network management issues described in this paper.