

Huawei Autonomous Driving Network: Standards-Based but Differentiated

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EXECUTIVE SUMMARY

This is the fifth in a [series of articles](#) on the TM Forum's Autonomous Networks vision and Huawei's product roadmap for achieving the Autonomous Driving Network. We focus on the key characteristics that make Huawei's product plan a multivendor, standards-based roadmap for achieving Autonomous Networks that provides advantages to current and future Huawei network technology customers.

The TM Forum's Autonomous Networks vision is well on its way to being accepted by the major global and regional standards development organizations. Huawei's Autonomous Driving Network (ADN) plan provides a roadmap for implementing the vision of fully autonomous networks in near-perfect harmony with the vision. ADN is based on standards and presents directions of how to implement multivendors' autonomous networks. The Autonomous Driving Network offering differentiates itself through seven key characteristics:

- 1. Control software and network functions together:** It is a full plan that includes both the software control layer, the domain managers, and cross-domain orchestrators, as well as the network itself and underlying cloud technology.
- 2. Artificial Intelligence (AI) everywhere:** It implements a distributed multilayer AI inference platform.
- 3. Builds on proven data and automated processes:** Provides a ready-to-go Day 0 architecture to enable seamless interoperations and immediate benefits.
- 4. Series of comprehensive solutions:** It supports efficient operations for each domain and across domains, providing what Huawei calls "single-domain autonomy with cross-domain collaboration."
- 5. Includes Huawei's comprehensive professional services:** Optional services are available to help operators at any stage of their digital transformation.
- 6. Includes cloud-native training and tools:** It can guide and train CSPs' network and software engineers to move to modern software techniques such as DevOps through CI/CD process based on open APIs and programmability capability.
- 7. Provides an evolution roadmap:** Includes a plan that evolves a CSP's current Huawei plus other vendors' networks to full, integrated operations autonomy.

The Telecoms Industry's AN Vision and the Huawei ADN Plan

This is the fifth in a [series of articles](#) on the TM Forum's Autonomous Networks vision and Huawei's product roadmap for achieving the Autonomous Driving Network.

The first article describes the TM Forum AN vision and why the time has come to push AN implementation, articulating a set of current challenges to implementing the vision.¹ The second shows how the AN vision is an essential supporting communications infrastructure for Industry 4.0 implementation in several industries.² The third evaluates the Huawei ADN against the TM Forum AN vision in three areas: goals, architecture, and implementation approach, finding them in near-perfect harmony.³ The fourth⁴ article discusses the Huawei implementation plan for Autonomous Networks, its Autonomous Driving Network product roadmap, and its major architectural characteristics. It describes Huawei's plan for addressing the implementation issues identified in the first article.

This article outlines the major differentiators of the Huawei Autonomous Driving Network product roadmap that makes it a credible platform on which to base a CSP's journey to becoming a DSP's digital network platform for its own autonomous networks.

What CSPs Want from the ADN

Communications service providers (CSPs) are moving to autonomous networks to meet their business, operational, and technology goals, Figure 1. The business strategy is to implement 5G based and other new services, focusing on growth from the enterprise sector, estimated at a one trillion dollar growth opportunity. They also want to move from being CSPs to being modern digital service providers, which means both delivering new digital services, as well as providing new and old services with a digital experience for both the customers and employees.

¹ Mortensen, Mark H, *Autonomous Networks: Now is the Time*. ACG Research, December 2020. <https://www.acgcc.com/reports/autonomous-networks-now-is-the-time/>

² Offredo-Zreik, *Autonomous Networks Power Industry 4.0*. ACG Research, January 2021. <https://www.acgcc.com/reports/autonomous-networks-power-industry-40/>

³ Mortensen, Mark H, *Huawei AND & TM Forum AN Vision: An Evaluation*. ACG Research, April 2021. <https://acgcc.com/blogs/2021/05/03/huawei-adn-tm-forum-vision-evaluation/>

⁴ Mortensen, Mark H, *Huawei ADN Solution Approach to Implementing Autonomous Networks*, ACG Research, September 2021. <https://www.acgcc.com/reports/huawei-adn-solution-approach-to-implementing-auton/>

The technology strategy uses the new cloud technology platforms and techniques to the maximum extent possible to provide a network that can be defined and implemented by automated software control, utilizes cloud-native technology (microservices-based software, built with DevSecOps processes and delivered via CI/CD mechanisms) for quick, secure updates to the network technology. The operational strategy provides the agility to:

- Offer a range of new services at unprecedented short time scales as well as quickly scale the successful services as rapidly as possible,
- Provide self-service operations for both consumers and enterprise customers,
- Apply AI based intelligent analytics to planning, prediction, and problem resolution,
- Provide closed-loop network and business automation, turning most of the moment-to-moment and day-to-day operations over to machines without human involvement,
- Implement a network that is intrinsically secure from external and internal attacks,
- Implement the goals of the 10xNetwork⁵ to provide an order of magnitude improvement in agility, operations speed, and scale at one-tenth the cost.

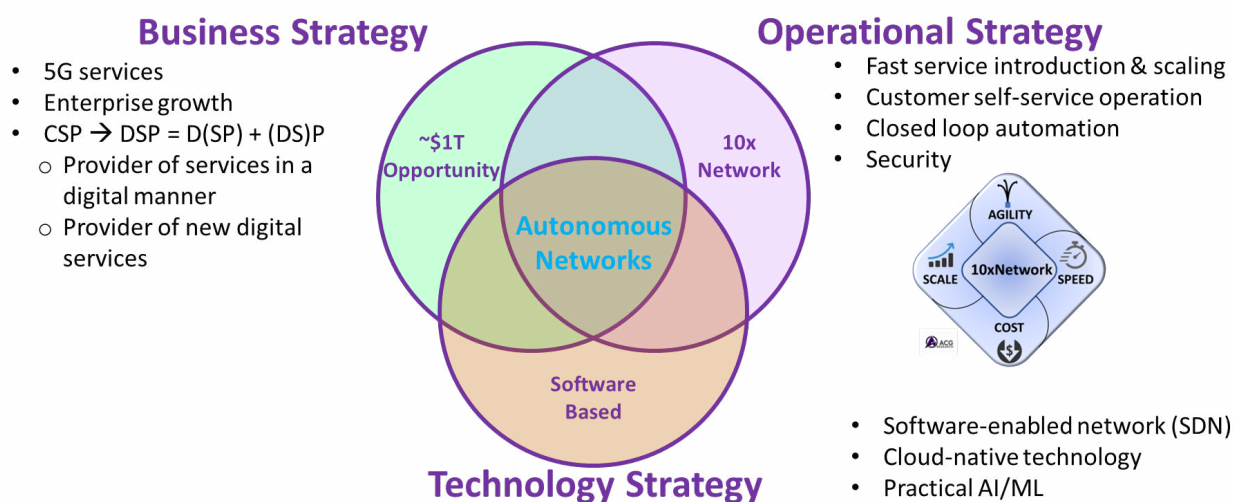


Figure 1. Drivers for AN (Source: ACG)

These three form the basis of the drivers for autonomous networks and the reason for the implementation of Autonomous Networks via ADN.

⁵ Mortensen, Mark H, *The ACG 10xNetwork Project*, May 2020.

Key Elements of ADN

The ADN is built on several key concepts:

- **A domain/cross-domain architecture and comprehensive product set, the iMaster family**
 - Autonomous domains with cross-domain orchestration, a layered control architecture that has domains (fixed networks and mobile networks) and subdomains (by technology, access, transport, and core) with the domains being as autonomous and intelligent as possible.
 - Domain controllers that, for the most part, are provided by the dominant vendors of the network equipment in that domain. For minority vendors in a domain, the Huawei iMaster controllers can easily interface equipment that meet modern standards and can be adapted to work with nonstandard interfaces. The iMaster product solution can also support the role of super-controller, enabling service collaborating across multiple domain controllers.
 - Cross-domain orchestrators that provide coordination across the domains, where needed, as well as providing negotiated equilibrium among the various AI agents in the domains to provide overall optimization of network resources while preserving the QoS guarantees for the services.
- **Comprehensive domain coverage from a single platform:** The iMaster family members, all built on a single technical platform with common components, provide automation across the entire set of fixed and mobile domains and are pre-integrated for cross-domain automated operations. This provides a single operational paradigm across the CSP's operations and flexibility in deployment timing for the various domains.
- **Ubiquitous artificial intelligence throughout the architecture** with a central coordinating structure (the iMaster NAIE), built on a general platform, the Huawei Generic Digital Engine to facilitate sharing of tools and applications across all domains. The AI coordination, machine learning training (and the repository of the result) is provided as an optional service.
- **Autonomous operations** to further support operations and maintenance beyond what we know possible by AIOps, extending to the full life cycle of management of network services.
- Extensive use of **Open APIs** to take advantage of the rich ecosystem of all type of services.
- Support of **service programmability** that can bring new services at very short time-to-market window with low-code or no-code implementation.
- **Cloud-based:** Network services, today, support for cloud-based services is mandatory. Huawei's ADN is an early pioneer in supporting a cloud-network synergy IT architecture and integration to create cloud services ubiquitous and AI ubiquitous.

- **ADN maturity evaluation system:** ADN is a bold vision but a practical plan to get there over the next decade. ADN inherits the autonomous network maturity evaluation system approach defined by TM Forum by its autonomous network level measurement from ANL0 to ANL5. It provides a standardized method for the industry to assess network autonomy and in some cases the ability to demand higher premiums for certain ANL qualifications.
- **ADN is standards-based and multivendor:** The ADN solution implementation is in near perfect harmony to the TM Forum AN vision, which is the result of industry collaboration by a group of standards organizations. Industry standards are the basis for large-scale applications.

Key Differentiators of ADN

The ADN has seven key differentiators that make it a strong choice as the basis of an implementation plan for a CSP's autonomous network, Figure 2.

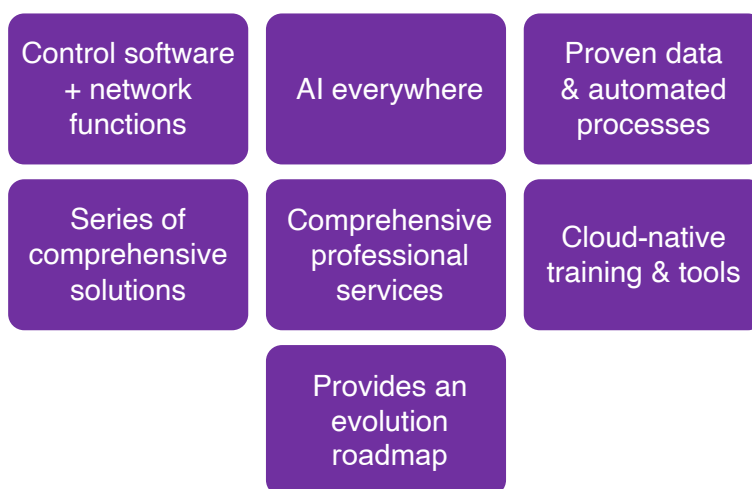


Figure 2. Autonomous Driving Network Differentiators (Source: ACG)

Control Software Plus Network Functions

ADN takes a holistic view of the evolution of the network and the support software, harmonizing their evolution in a cloud-network synergy context. In the network services of today, support of cloud-based services is prevalent. Huawei's ADN enables cloud-network synergy with IT architecture and integration, not only simplifying but also maximizing the usage of the telco cloud landscape. It also provides a one-stop service to support multicloud.

AI Everywhere

The ADN architecture envisions AI everywhere, even in the network equipment via a distributed, three-layer AI system. The ADN solution comes with full coverage of AI via its iMaster NAIE. The iMaster NAIE has a three-layered open architecture delivering intelligence for networks and platforms for O&M, enabling telecom operators to accelerate their digital transformation. The three layers are cloud intelligence, network intelligence and NE intelligence.

Cloud intelligence builds telecom knowledge assets that are aggregated in the cloud to generate an intelligent platform for data training as well as model generation and optimization. The results are then synchronized to the network and network element layers, ensuring the optimal utilization of up-to-date models.

Network intelligence gives the network management and control layer ability for big-data analysis, intelligence algorithms, and service APIs to achieve service-intent automation, network O&M intelligence augmentation, and network virtualization. It reinvents the traditional network management system (NMS) architecture by building a digital twin of a network where pre-event simulations, post-event verification, prevention and prediction, and proactive optimization can be done.

Network Element (NE) intelligence forms a lightweight intelligent inference framework that is embedded at the device layer to provide NE level short-period awareness analysis and inference capabilities with inference completed in microseconds. AI is introduced to NEs to create digital intelligent NEs. In this way, each NE and the entire network are endowed with more precise insights, processing, and inference execution.

Proven Data & Automated Processes

The ADN evolution plan has been created in close cooperation with Chinese CSPs, who are among the world leaders in implementation of the AN concept, as well as many other CSPs around the world.

The ADN MCA design unifies the manager, controller, and analysis components onto a single digital operations platform that performs data integration across the network to provide a single source of truth with a consistent and common management of database on the network data information, eliminating the inefficiency of traditional data silos.

The autonomous network processes and data structures, if desired, can be brokered by Huawei among its clients to continuously provide the best-in-class operations processes and automation capabilities.

Series of Comprehensive Solutions

ADN represents a flexible mix of on-premises, private cloud, public cloud, and SaaS options that can be combined to provide a custom fit for a CSP's operations.

ADN products are built from common elements base platform to support wider and diversified range of network management and control systems that are being evolved to a microservice architecture. The system has the flexibility to manage and control any combination of network domains whose network infrastructure takes on the SRTE based technology. Its product packages are available as iMaster NCE-FAN, iMaster NCE-IP, iMaster NCE-T, iMaster NCE-Super, iMaster NCE-Fabric, iMaster, NCE-Campus, NCE-WAN, iMaster NetEco, iMaster MAE-M, iMaster MAE-CN.

Its General Digital Engine provides a mid-level digital network service platform to facilitate effective managed services across multiple domains and multiple vendors. The iMaster AUTIN and iMaster NAIE, and other application tools such as ADO, SmartCare, can select to run on this platform and share resources over the entire domains it controls.

Digital Twin implementation on ADN products makes a digital copy of the network in real time or near real time to maintain high precision duplication of network topology and service status. It enables simulation and verification before changes are actually taking effect, playback of historical data of critical moment before failure occurrence and focuses on predictive analysis of the correlation models between the actual physical and the digital twin version.

The ADN solution offered by the iMaster NetEco provides unique intelligent energy saving to diversified location of data centers, integrated with the traffic usage and behavior of network service to help operators save significant cost amounts each year.

Comprehensive Professional Services

Extensive GTS services support technology planning and implementation as well as personnel training and cultural changes. Training is given to an operator's personnel to become data scientists and AI model experts so that they can generate more value for their network services.

Cloud-Native Training and Tools

A key challenge in the implementation of cloud technology is the training of a CSP's personnel in the new software technology, tools, and processes. Huawei offers a comprehensive training program and systems and process consulting and technologies to support that transition.

Provides an Evolution Roadmap for Huawei's Customers

ADN provides a practical evolution plan for current Huawei customers with deployed Huawei EMS and NMS systems toward autonomous network operations. ADN introduces a seamless evolution path for legacy management and control systems to evolve incrementally and systematically into microservice-based management and control systems for all domains. This solution stands out in allowing operators to maximize their use of existing assets while supporting the extensive innovation in all-scenario, full-series system architectures, O&M models, and business experience. Key to the seamless evolution is the ADN two-layered hierarchical controller concept. This is not a unique concept, but it enables an operating principle of the single-domain autonomy with multidomain collaboration with the support of open APIs and open programmability for third-party collaboration on full life-cycle closed-loop automation, making use of the underlying EMS and NMS systems as they are evolved to become full domain controllers.

ADN Example Use Cases

Huawei has been engaged in implementing its ADN with many CSPs in China and the rest of the world. These implementation projects are being done iteratively with ADN technology and principals being implemented in specific projects that focus on a combination of customers' offerings and technology domains, Table 1.

Scenario	Use Case	Loop	Self-X	Operator
Customer Experience	Customer experience intelligence+	User	Zero-friction	HKT
Cloud-Network Convergence	Smart operation of cloud-network convergence	Service/Resource	Self-config Self-healing	China Telecom
	Cloud private line convergence	Service/Resource	Self-config	MTN
	Automatic provisioning of cloud-network service for enterprise customers	Service/Resource	Self-config	China Mobile
Home Broadband Services	Intelligent diagnosis of network quality for home broadband services	Resource	Self-healing	China Mobile
Cloud Core Network O&M	Intelligent O&M solutions	Resource	Self-config Self-healing	China Mobile Henan China Mobile Jiangsu China Mobile Zhejiang China Unicom Jiangsu
Transmission/ Bearer Network	Digital quick optical distribution network	Resource	Self-config Self-healing	MTN
	Smart operation of 5G bearer network	Resource	Self-optimize	China Unicom
Data Center Energy Saving	Smart cooling intelligent DC refrigeration	Resource	Self-optimize	China Mobile Anhui
Wireless and 5G Networks	New radio network coverage optimization	Resource	Self-optimize	China Mobile
	Base-station online energy saving	Resource	Self-healing	Multiple
	Zero-touch reliability guarantee of 5G network	Resource	Self-healing	China Mobile

Table 1. ADN Use Cases (Source: Huawei)

China United Network Communications Co., Ltd.

Facing the development opportunities of digital transformation in myriad of industries, China Unicom Hebei cooperated with Huawei and industry partners to consolidate all-optical infrastructure networks and introduce the autonomous network solution based on the iMaster NCE all-optical intelligent and automation network. It enables the building of high-quality enterprise leased-line products that feature higher bandwidth, lower latency, higher reliability, and more intelligent operation to serve a wide range of industries, benefiting hundreds of thousands of households and accelerating the development of the digital economy.

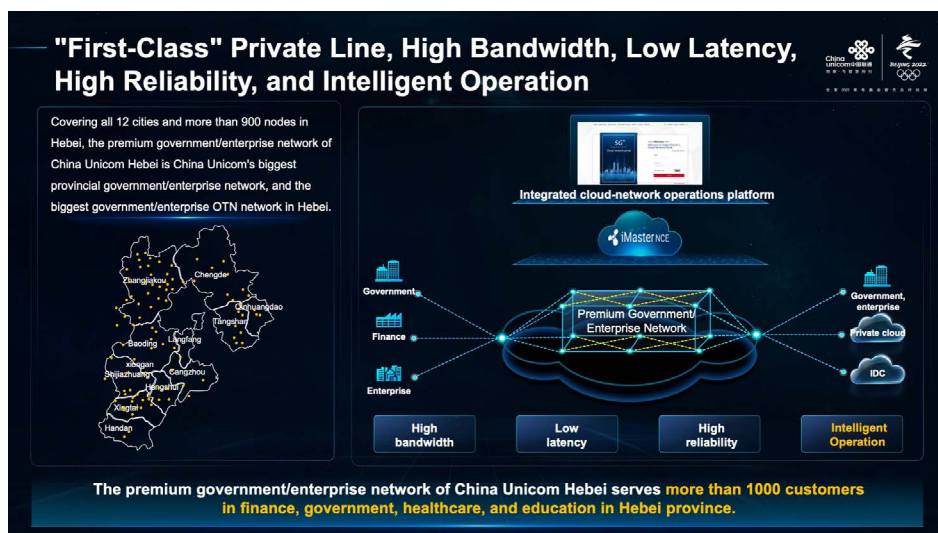


Figure 3. China Unicom Intelligent Private Line Network (Source: Huawei)

Zain KSA

ZAIN Kingdom of Saudi Arabia (KSA) has been successful in 5G since launching the largest 5G network in the region in 2019. ZAIN KSA is building an agile and intelligent transport network based on SRv6 and automation, intelligence technologies to cope with the explosive 5G traffic growth and the emerging 5G new services and applications. To transform Zain KSA's network into a leading unified network that supports long-term service evolution, Zain KSA introduced IP segment routing (SRv6) to simplify the network deployment. Together with SRv6 network programming and SDN controller centralized path computation and network automation capabilities, Zain KSA can provide on-demand SLA assurance for customers and easily design a new business model. By introducing the iFIT and AI technologies to the transport network, advanced features, such as fast fault diagnosis, are implemented to improve O&M efficiency and business innovation capabilities.

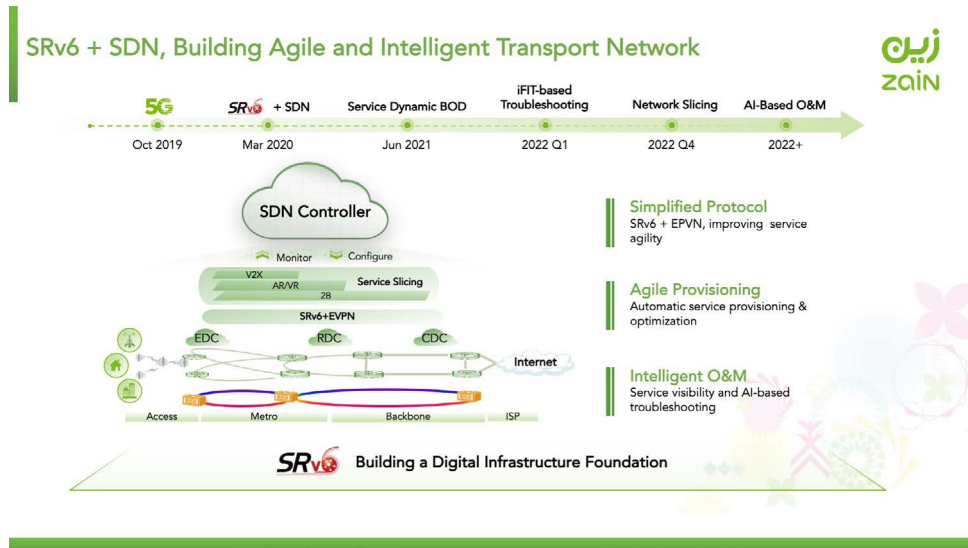


Figure 4. Zain KSA SDN Using IP Segment Routing (Source: Zain)

The ADN Journey

The ADN journey to fully autonomous networks is not being done in a vacuum but as part of an initiative to create the carrier digital operations platform of the future, providing Network as a Service capabilities to enterprise customers. The goal is to make the ordering, implementation, and operation of a network as easy to use as the web scalars are providing for computing and storage resources. Together, they will provide the infrastructure for the enterprise digital enablement platforms of the future. The journey will take the implementation of cloud intelligence working together with increased network operational intelligence.



Figure 5. Key Characteristics of the ADN (Source: Huawei)

As CSPs move through the autonomous networks of the future, following the ADN roadmap and evaluating themselves against the ADN maturity model, they will do so in a series of iterative steps, ensuring that each step pays for itself incrementally in reduced costs, increased customer satisfaction, and the ensuing increased revenue. Huawei has a realization framework for implementing the ADN, Figure 6, with available professional services to plan and accomplish the major tasks.

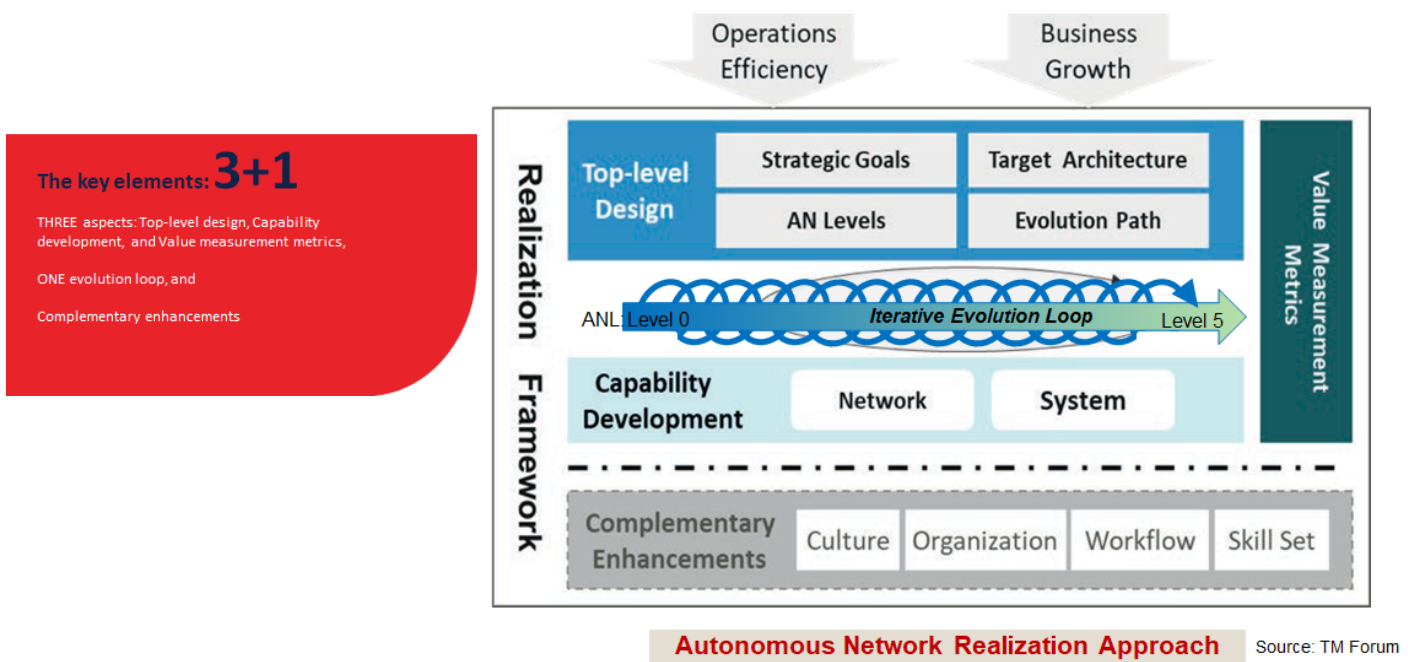
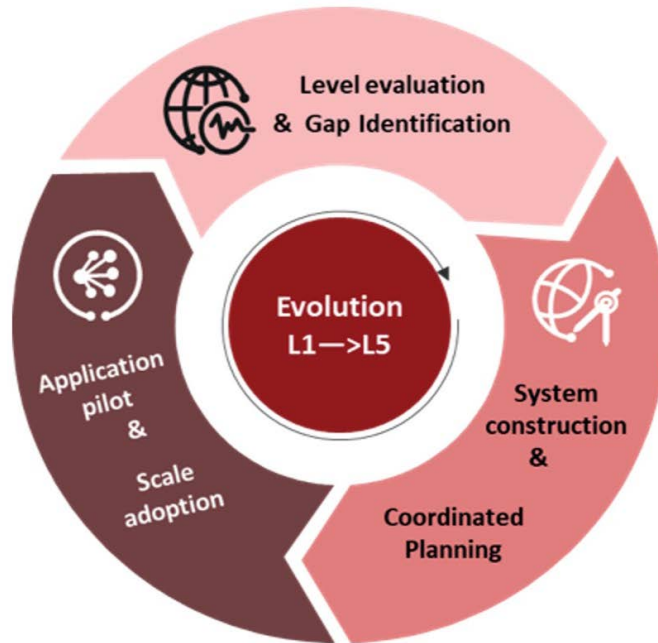


Figure 6. The Iterative Nature of ADN Implementation (Source: TM Forum)

Each of these iterative loops can follow a pattern, as described by the TM Forum⁶ and summarized in Figure 7:

1. Identify shortcomings: Based on the quantitative evaluation of scenario-based autonomous capability for O&M processes, common problems and shortcoming differences are identified and targeted measures and deployment plans developed.
2. Plan the system construction: Create a plan for the network management systems specific to the CSP and determine detailed needs in network elements for RFPs to network function vendors.
3. Pilot the applications and scale up: Pilot the advanced automation and intelligent technologies in collaboration with network equipment suppliers and network management system integrators. Focus on selected geographic regions or technical areas before rolling out in scale, then expand the territory to scale.

⁶ TM Forum, *A Whitepaper on Autonomous Networks: Empowering Digital Transformation*, September 2021.



Steps of Evolution Loop

Source: TM Forum

Figure 7. The Iterative Process for ADN Implementation (Source: TM Forum)

Conclusion

The journey to fully autonomous networks will take a decade or more, but examples of their benefits to consumers, enterprises, and CSPs are already evident. The Huawei ADN represents a credible, evolutionary plan for achieving a fully autonomous, multivendor, network of the future.

About the Author



Dr. Mark H Mortensen (mmortensen@acgcc.com, [@DrMarkHM](https://twitter.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.

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