Moving towards autonomous driving networks

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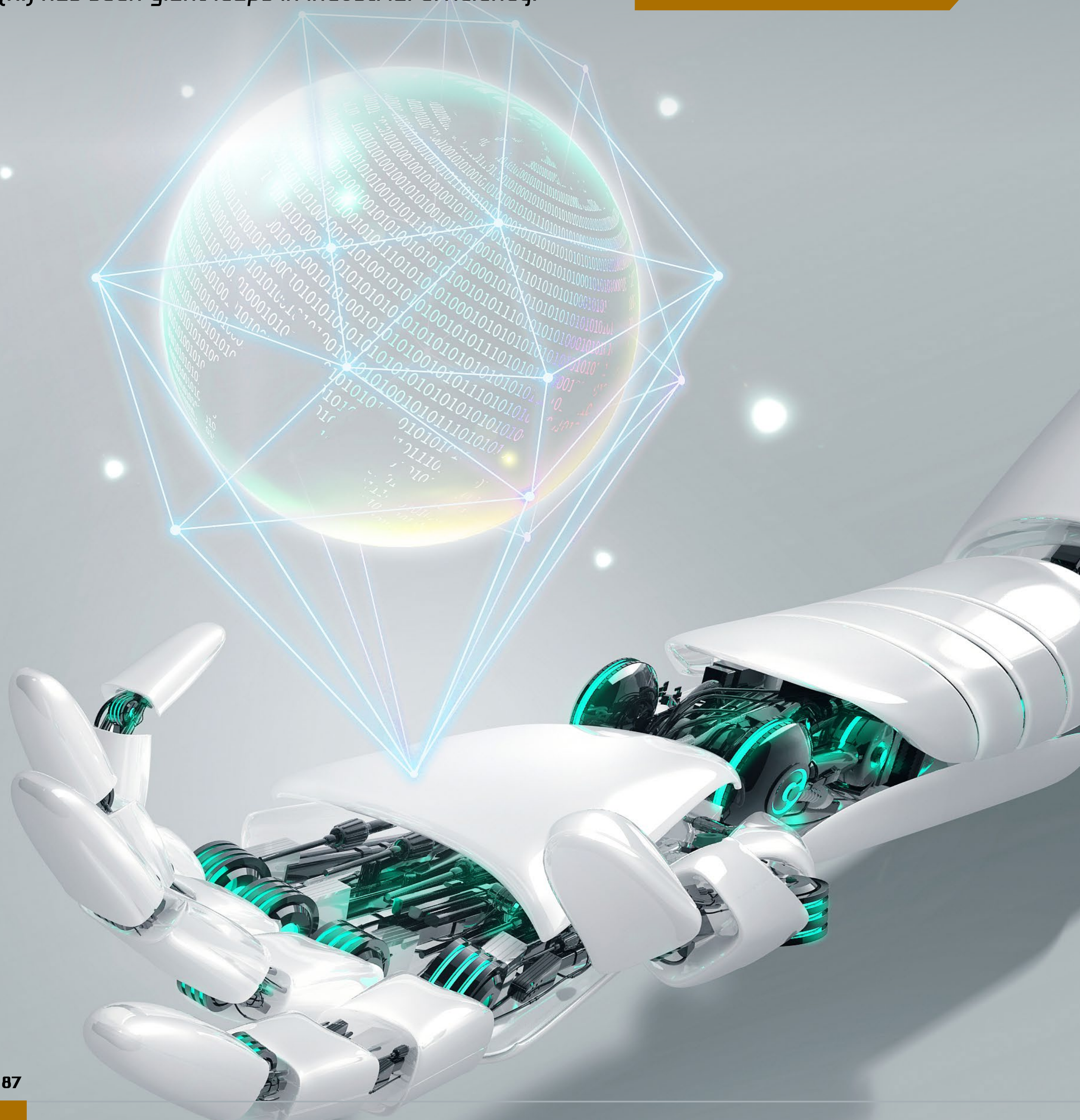
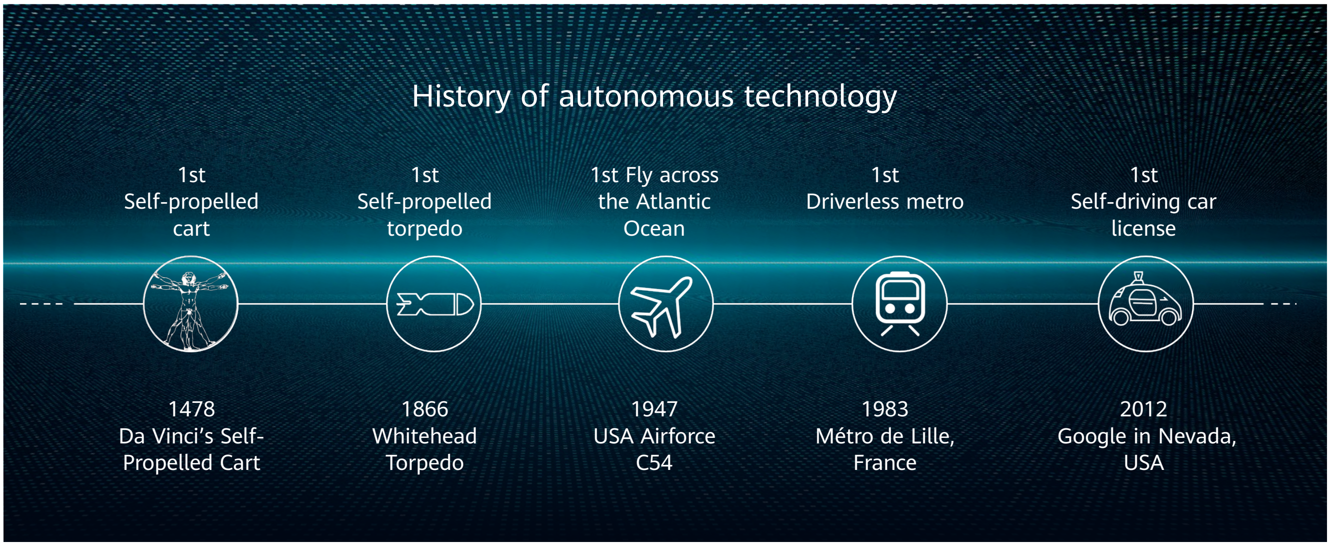
Each new industrial revolution from industrialization and digitalization to today's focus on robotics and artificial intelligence (AI) has seen giant leaps in industrial efficiency.





In 1947, the US completed the first autonomous transatlantic flight. In 1983, the world's first driverless metro, the Métro de Lille, went live in France. 2012 saw Google obtain the world's first self-driving car license in Nevada and by March 2018, its self-driving cars had traveled 8 million kilometers. Today, with the massive strides made in autonomous driving technologies, companies like Tesla are making it possible for people to travel in comfort in an eco-friendly way. In the fully connected and intelligent era, autonomous driving is becoming a reality.

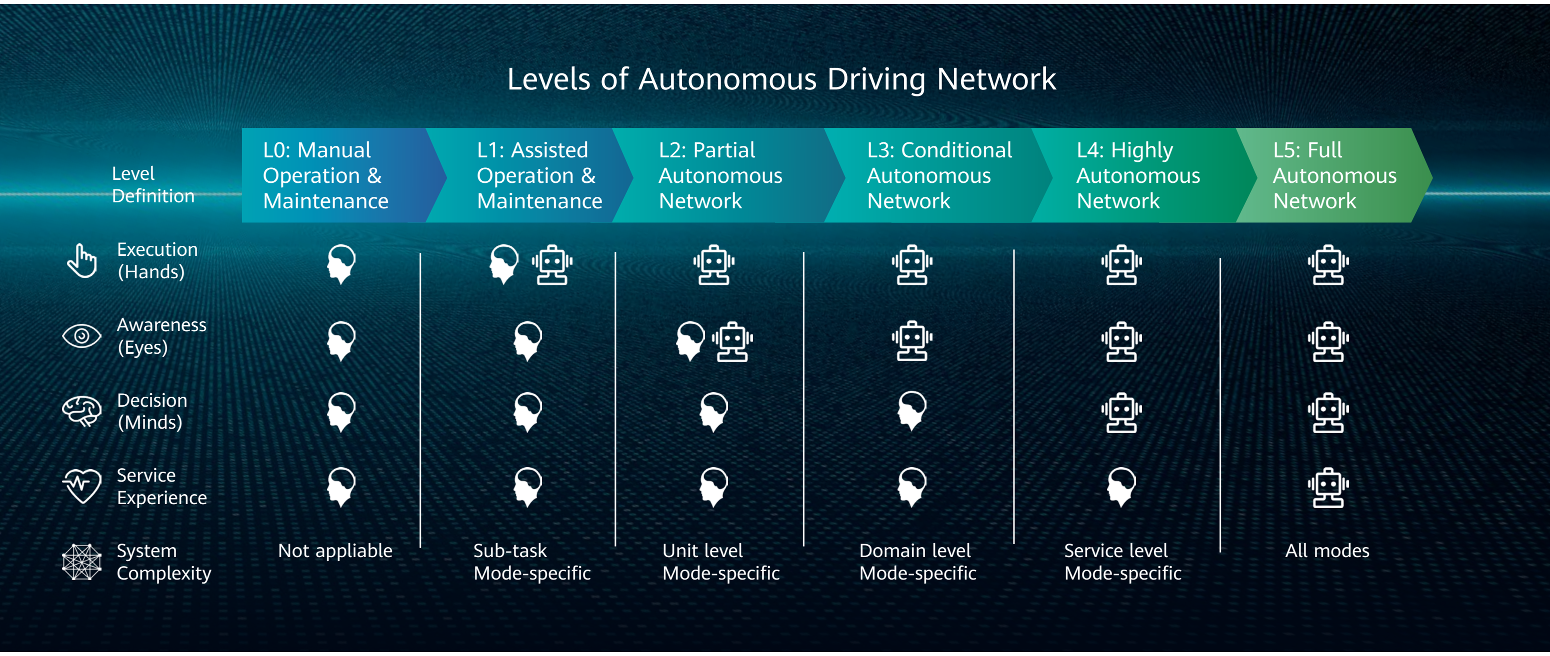
Why telcos need autonomous driving networks

As networks have increased in size, so has OPEX. Over the past decade, OPEX growth has always outstripped revenue growth for telcos, in turn causing structural challenges to the telecoms industry. For example, 249 engineers can maintain one million devices for OTT companies compared with about 300 engineers maintaining 10,000 devices for operators, as a result of the higher O&M skillset the latter requires.

Telecom networks also face huge challenges in managing user experience – 58 percent of people's problems with home broadband are only identified when they file a complaint.

Unlike the autonomous vehicle market, the telecom industry faces unique complexities. A telecom network provides multiple services such as mobile, home broadband, and enterprise services. Therefore, an autonomous driving system must accurately understand the intent behind different services. In contrast, the operating environments and road conditions of autonomous driving feature "highways" of data centers as well as "urban and rural roads" that provide broadband access for citizens. Therefore, autonomous driving systems must be able to adapt to complex environments that involve multiple technologies. From the perspective of full lifecycle operations, different roles, such as planning, O&M, and service provisioning, face different challenges.

Huawei has been exploring autonomous driving networks with operators in an attempt to address the structural issues of telecom networks through innovative architecture, helping operators achieve a better service experience and higher operational and resource



efficiency.

5 levels of Autonomous Driving Network

Autonomous driving networks go far beyond innovating a single product and are more about innovating system architecture and business models, which requires industry players to work together to define standards and guide technology development and rollout.

Huawei has proposed five levels of Autonomous Driving Network systems for the telecom industry:

L0 manual O&M: delivers assisted monitoring capabilities and all dynamic tasks must be executed manually.

L1 assisted O&M: executes a certain sub-task based on existing rules to increase execution efficiency.

L2 partial autonomous networks: enables closed-loop O&M for certain units under certain external environments, lowering the bar for personnel experience and skills.

L3 conditional autonomous networks: builds on L2 capabilities, so the system can sense real-time environmental changes, and in certain domains, optimize and adjust to the external environment to enable intent-based closed-loop management.

L4 highly autonomous networks: builds on L3 capabilities to accommodate more complex cross-domain environments and achieve predictive or active closed-loop management of service and customer experience-driven networks. Operators can then resolve network faults prior to customer complaints, reduce service outages, and ultimately, improve customer satisfaction.

L5 fully autonomous networks: represents the goal of telecom network evolution. The system possesses closed-loop automation capabilities across multiple services, multiple domains, and the entire lifecycle for true Autonomous Driving Network.

Step by step

Evolution towards autonomous driving networks must be scenariobased and follow three key principles. One, we should focus on major issues relating to OPEX. Having analyzed the OPEX structures of several typical operators, it appears that 50 percent of current OPEX challenges can be addressed through autonomous driving networks. Two, we need to start from single domains and tasks before moving to multiple domains and tasks, and then form a closed-loop system. Three, we must develop experience-driven and top-down data models and sharing capabilities.

Reference architecture of autonomous driving networks

One of the major difficulties when it comes to autonomous driving is sensors and how to deal with various uncertainties. Whether on a highway or a rural road, vehicles need to be able to accurately identify their surrounding environment and respond quickly. Sensors – radar, microwave, and laser – detect surrounding road conditions. Local, edge, and cloud computing enable vehicles to respond accurately to various scenarios such as emergency braking, pedestrian crossings, and uphill and downhill gradients.

Telecom networks today are encountering similar problems when developing autonomous driving. With perception, there are problems with unclear and inaccurate telecom network statuses. With O&M, discrete and closed systems cause data fragmentation and process separation. Cross-field and cross-vendor data flows are difficult to transfer and get value from. At the same time, telecom networks aren't completely intelligent – making decisions and processing uncertainties depends almost entirely on the experience of engineers and experts.

So, what's our solution?

Autonomous driving in the telecom industry requires us to systematically reshape and innovate the network architecture and key technologies, and to construct a three-layer intelligent system architecture.

First, we need to build an edge intelligence layer on physical networks to sense network status in real time, and simplify network architecture and protocols to improve network automation capabilities.

Second, we will use unified modeling to build digital twins on physical networks to make network status traceable and predictable. AI can also be introduced to enable predictive O&M and closed-loop optimization.

Finally, an open cloud platform is needed to train and optimize AI algorithms and develop applications for planning, design, service provisioning, O&M guarantees, and network optimization. The aim is to automate closed-loop network operations throughout the entire lifecycle.

The future of autonomous driving networks

At Mobile World Congress 2018, Huawei launched its Intent-Driven Network (IDN) solution, which builds a digital twin between

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physical networks and business goals, and helps evolve networks from SDNs towards autonomous driving networks. The solution also helps operators and enterprises implement digital network transformation centered on service experience.

The solution requires the industry to undertake four transformations: from network-centric to user-experience-centric; from open-loop to closed-loop; from passive response to proactive prediction; and, from skill-dependent to automation and AI.

Huawei's IDN solution covers various scenarios, including broadband access, IP networks, and optical and data center networks. It enables telecom networks to evolve towards Autonomous Driving Networks.

For example, in the broadband access field, for every 10,000 users, there's an average of 1,000 customer complaints and 300 door-to-door maintenance visits every year. Due to a lack of data, about 20 percent of customer complaints cannot be completely resolved. The IDN, however, perceives broadband services in real time. Big data and AI algorithms quickly locate faults and optimize the network, which reduces home visits by 30 percent and improves service experience.

In September 2018, Huawei upgraded its Intent-Driven Network (IDN) solution and proposed its "digital world + physical network two-wheel drive" strategy to speed up IDN innovation.

Huawei is also accelerating the deployment of autonomous driving networks in wireless network scenarios. At the 9th Global Mobile Broadband Forum, Huawei released the *Key Scenarios of Autonomous Driving Mobile Network white paper*, which outlines seven key sub-scenarios, such as base station deployment and network energy efficiency, to gradually realize network automation. As research advances, Huawei will continue to update its application scenarios and publish its research results.

Huawei and leading global operators have jointly launched the NetCity project aimed at promoting the application of new technologies such as big data, AI, and cloud computing in telecom networks. By defining business scenarios and implementing innovations following the DevOps model, Huawei and its operator partners have introduced cutting-edge technologies to improve users' service experience, driving telecom networks to evolve towards Autonomous Driving Networks.

As of the end of 2018, Huawei had joined forces with leading customers to launch 25 NetCity innovation projects. It will be a long journey to achieving autonomous driving networks. To make our dream a reality, the industry must work together. Huawei is committed to developing leading ICT solutions through continuous innovation, and taking on the complexity itself while making things simple for customers. Together, we will embrace a fully connected, intelligent world.