GSMA

GSMA 5G TRANSFORMATION HUB The world's most innovative 5G solutions

5G-Advanced to Enable Industrial Internet

Prototype 5G-Advanced network consistently delivered air interface latency of just 4 milliseconds

China Unicom and Huawei worked with EA Automation (a leading automotive parts manufacturer in China) to pilot 5G-Advanced ultra-reliable and low-latency communications (URLLC). The three companies tested a prototype network in a production line for automobile welding, marking the first application of 5G for the core links of industrial control and the first technical verification of all-wireless flexible production employing 5G-Advanced URLLC.



GSMA 5G Transformation Hub - 5G-Advanced to Enable Industrial Internet

5G-Advanced to Enable Industrial Internet

CASE STUDY LEAD: CHINA UNICOM, EA AUTOMATION, AND HUAWEI

• CHALLENGE

As wired connections are expensive and inflexible, manufacturers are looking to use 5G to help them harness advanced digital technologies, such as machine vision and remote control systems, to boost efficiency and flexibility. But the commercial 5G networks in use today aren't responsive enough to support many key manufacturing use cases, according to China Unicom. To take on a central role in manufacturing plants, 5G networks may have to consistently deliver a latency of less than 10ms, compared with the 20ms offered by commercial 5G today.

⊕ SOLUTION

In the first half of 2022, China Unicom and Huawei deployed a prototype 5G-Advanced URLLC network in EA Automation's plant in Baoding, Hebei Province. The network employed two TDD (time-division duplexing) carriers, which complemented each other to enable immediate service packet transmission over the air interface. In the test bed. the production line's main PLC (programmable logic controller) was connected wirelessly to the PLC on the robotic arms and further to the frontend valve islands.

IMPACT & STATISTICS

In the tests, the solution achieved air interface latency of just 4 ms with a reliability of 99.999%, according to China Unicom. "This success marks a major step towards bringing 5G to industrial intranet," says China Unicom Big Data's Chief Scientist Fan Ji'an. Using 5G to reduce downtime and minimise the use of wired devices could potentially enable a typical automotive factory to save about CNY700 million (US\$103 million) each year, according to EA Automation.

WIDER IMPLICATIONS

Releases 18 and 19 of the 3GPP standards will support enhanced URLLC capabilities, paving the way for 5G networks to be expanded from the periphery to the core of industrial manufacturing. As they further develop new energy vehicles and upgrade their factories, automobile manufacturers could begin to use 5G-Advanced URLLC to lower their production costs and boost their flexibility. Other manufacturing sectors, as well as other industries, could also see major benefits from wireless connectivity that is both very responsive and very reliable.

• STAKEHOLDERS

China Unicom, EA Automation, and Huawei

SOURCES & FURTHER

He Feng hefeng@huawei.com

5G-Advanced to Enable Industrial Internet

Prototype 5G-Advanced network consistently delivered air interface latency of just 4 milliseconds

Manufacturing, mining and other industries are looking to harness advanced digital technologies, such as machine vision and remote control systems, to boost efficiency and flexibility. 5G-Advanced networks could provide these systems with the ultra reliable low latency communications (URLLC) they need.

To support large numbers of production devices, wired networks generally have to be deployed in several layers, which is expensive. Installing these networks in an 80,000 square meter workshop with 17,000 nodes, for example, would cost about CNY20 million (almost US\$3 million), according to EA Automation. Further, a traditional industrial Ethernet can't support IT and operational technologies (OT) at the same time.

Compared with wired networks, 5G is designed to have a much flatter architecture, greatly simplifying networking structures. In addition, 5G can support non-real-time IT and real-time OT services over the same network, thereby reducing costs and improving efficiency.

In the first half of 2022, China Unicom and Huawei worked with EA Automation (a leading automotive parts manufacturer based in Baoding, Hebei Province) to test whether a prototype 5G-Advanced URLLC network could support a flexible production line for automobile welding. Coordinated by the China Academy of Information and Communications Technology (CAICT), the test was the first application in China of 5G for the core links of industrial control. In the test bed, the production line's main PLC (programmable logic controller) was connected wirelessly to the PLC on the robotic arms and further to the frontend valve islands. In the tests, the solution achieved air interface latency of just 4 ms with a reliability of 99.999%, according to China Unicom. "This success marks a major step towards bringing 5G to industrial intranet," says China Unicom Big Data's Chief Scientist Fan Ji'an.



EA Automation is looking to use 5G to help automate the production of mainframes and other automotive parts. The automotive welding process needs flexible equipment for various purposes, such as robot tool change and work-holding pallets of stereoscopic warehouses.



Recognising the cables attached to the robotic arms in the automobile production line are easily worn out, interrupting routine production, EA's workers have proposed replacing southbound industrial buses with 5G connections. However, this C2IO (industrial controller to input/output) connectivity needs "deterministic" low latency that current commercial 5G solutions cannot provide.

Many other manufacturing use cases, such as mobile terminals in stamping workshops, and machine vision-based capture in welding workshops, also require a latency of less than 10ms, whereas the commercial 5G networks used by businesses today deliver about 20ms, according to China Unicom.

"In over 99% of industrial 5G projects, 5G networks are not integrated into enterprise intranets, and they are far from replacing them," notes Fan Ji'an. "At this stage, 5G is not used industrially on a large scale."

However, the results of the tests at EA's plant in Baoding suggest that could change with the deployment of 5G-Advanced URLLC networks in the next few vears. An all-wireless set-up could deliver major cost savings. With a traditional wired network, an automobile factory could experience 60 hours of downtime as a result of cable dragging and wearing every year, according to EA Automation. Using 5G to reduce this downtime and minimise the use of wired devices. such as cables, pins, and repeaters, could potentially enable that factory to save about CNY700 million (US\$103 million) each year.

In over 99% of industrial 5G projects, 5G networks are not integrated into enterprise intranets, and they are far from replacing them. At this stage, 5G is not used industrially on a large scale

Fan Ji'an - China Unicom Big Data's Chief Scientist



New 5G configuration **reliably Iowers latencycy**

The 5G-Advanced solution tested by China Unicom and Huawei involves configuring two TDD (time-division duplexing) carriers¹ to complement each other and enable immediate service packet transmission over the air interface. This configuration allows for simultaneous downlink and uplink traffic, whereas a conventional TDD system alternates between the downlink and the uplink (see graphic). As well as reducing latency, the new solution makes the TDD uplink and downlink channels reciprocal, which can help achieve reliability and capacity gains, savs Huawei.

For the test bed, the production line's master PLC was connected through the user plane functions (UPF) of the prototype 5G- Advanced network provided by China Unicom Hebei. The onsite devices were connected through Huawei's 5G-Advanced user equipment. The solution was designed to enable real-time, wireless industrial control between the main PLCs and onsite devices in a flexible production line.

Of the two million packets sent from the PLC to the device, 1,996,353 were delivered correctly in 4 ms and only a small portion (3,642) timed out or were lost, without leading to a system downtime, according to China Unicom. That equates to an overall packet reliability of 99.99975%. That level of stability shows that 5G-Advanced URLLC networks could meet the service demands of an industrial controller to input/output (C2IO), according to Huawei.
Traditional TDD
Complementary TDD

F1
Image: Complementary TDD

F2
Image: Complementary TDD

Wait
Image: Complementary TDD

Wait
Image: Complementary TDD

Image: Complementary TDD
Image: Complementary TDD

F2
Image: Complementary Image: Complementary Wait

Image: Complementary I



5G-Advanced URLLC test bed

¹ TDD uses the same frequency for each duplex direction, with a frame that includes different time periods and slots for uplink or downlink communications.

Industry could go entirely wireless

Releases 18 and 19 of the 3GPP standards will support enhanced URLLC, paving the way for 5G networks to deliver a guaranteed air interface latency of 4 ms. China Unicom is confident that these networks will be able to meet the real-time control requirements in most industrial automation scenarios.

"If applied at scale, 5G applications will be expanded from peripheral production to the core control of industrial manufacturing," adds Yu Xiaohui, President of CAICT. Via a 5G-Advanced connection, the PLC and I/O could exchange data in real-time. "The current latency is about 4 ms," he notes. "We plan to put this technology into use this year, which will be a milestone in the development of 5G and automation systems."

As they further develop new energy vehicles and upgrade their factories, automobile manufacturers could use 5G-Advanced URLLC throughout their workshops. China Unicom envisions that 5G could be used to support motion control, machine vision/video surveillance and other onsite equipment and services, such as MES/SCADA (manufacturing execution system/supervisory control and data acquisition). "Flexible/intelligent PLC-to-I/O applications could also be connected over 5G, to streamline northbound and southbound PLC services and integrate real-time/non-real-time services on one network," notes Yu Xiaohui. "In this way, automobile factories will be more automated, flexible, and intelligent."

5G-Advanced URLLC could also enable factories to better leverage cloud-based computing power and real-time networks to support more flexible multi-process capabilities, such as collaborative transportation. Reliable and responsive wireless connectivity would reduce the cost of deploying cloud-based robots, including automated guided vehicles (AGVs). "Smooth support of cloud-based computing and real-time



Flexible/intelligent PLC-to-I/O applications could also be connected over 5G, to streamline northbound and southbound PLC services and integrate real-time/non-real-time services on one network. n this way, automobile factories will be more automated, flexible, and intelligent

Yu Xiaohui - President of CAICT







Investing in the **future** of URLLC

Liang Baojun, Deputy General Manager of China Unicom, says his company will invest CNY1 billion (US\$150 million) in research to further develop industrial control applications based on 5G URLLC. In particular, Unicom intends to combine software-defined control with 5G to implement cloud-based PLCs.

The telco also plans to provide "one-stop network and computing power orchestration and scheduling services" to bring about industrial computing-network convergence. "For industrial big data, optimised production processes and predictive maintenance will be achieved to reduce costs, improve efficiency, and bring more benefits," predicts Liang Baojun.

There should also be scope to improve 5G URLLC capabilities and system testing methods, such as URLLC industrial modules and

cross-laver collaboration between URLLC and industrial protocols. to increase capacity and scale 5G URLLC deployment in industry. China Unicom and Huawei anticipate that 5G URLLC-based flexible and intelligent applications will be developed, such as parallel production scheduling of work-holding pallets, 5G-based tool changes, remote I/O-based transportation systems, such as AGVs and electrified monorail systems, and dynamic intelligent manufacturing processes.

"The next generation 5G can bring more benefits to enterprises. We hope that more enterprise customers and partners will join us to build fully-connected 5G factories and develop a new 5G industrial Internet ecosystem," concludes Fan Ji'an.



The test bed 5G-Advanced URLLC network used prototypes of Huawei's LampSite base stations with a distance between each pico remote radio unit (pRRU) of 10–12 metres.





About the GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

For more information, please visit the GSMA corporate website at **www.gsma.com**.

Follow the GSMA on Twitter: @GSMA.

GSMA 5G Transformation Hub

The GSMA 5G Transformation Hub is a source of information on some of the most innovative 5G solutions in the world. This portal contains case studies detailing design, benefits, key players, measured value and the future impact of scaling up these 5G solutions worldwide. The 5G Era is now firmly established and this family of standardised GSM technologies, including mmWave, are being rolled out successfully across the globe. The GSMA 5G Transformation Hub, launched at MWC Barcelona in 2022, provides details of how 5G is best placed to deliver real value for a range of key sectors including manufacturing, energy, transportation, media and live entertainment, smart cities and construction. Many more case studies will be added, in the coming months, covering even more industries and the GSMA is asking Members to nominate innovative 5G case studies to add to this global digital showcase. The 5G Transformation Hub and this particular Case Study are both sponsored by Qualcomm.

www.gsma.com/5GHub

About this case study

This case study is for information only and is provided as is. The GSM Association makes no representations and gives no warranties or undertakings (express or implied) with respect to the study and does not accept any responsibility for, and hereby disclaims any liability for the accuracy or completeness or timeliness of the information contained in this document. Any use of the study is at the users own risk and the user assumes liability for any third party claims associated with such use.