5G MAGAZINE

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Foreword

The major 5G developments this month come via the Far EasTone 5G services demo supported over 4G networks evolving to 5G, via iconic device launches from Apple and Samsung whose new features predict an evolution to 5G, and also via news from CTIA 2016 SuperMobility introducing 5G products and solutions as evolution from exiting solutions, just faster, better performing, cheaper and/or more optimized.

In the continuous stream of news about 5G testbeds, pre-commercial demos, and lab trials, the one that Far EasTone and Ericsson conducted stands out. They demonstrated 5G services over the 4G network, reporting a 1 Gbps throughput. What makes this demo unique is the vision of 5G as an evolution path from LTE. Technology wise, the evolution involves adding features like MIMO, beamforming and carrier aggregation incrementally. On the spectrum side, the operator says that the will start the evolution path in the 1800 MHz and 2600 MHz bands; because 5G spectrum has not been allocated yet in Taiwan, they expect alignment with the most commonly used bands for 5G internationally 3.6 GHz, 5.8 GHz and 28 GHz bands.

On the device side, this was a remarkable month for smartphones. Apple and Samsung, the largest cellular phone makers worldwide with 15.9% and 22.5% of the 2015 global share respectably - launched new devices. For Apple, we look at the new features of the iPhone 7 to predict the evolution to 5G of the smartphones. The most important trends are no wires, more computing power and VR, AR capabilities.

In the US, the mobile ecosystem gathered for the annual CTIA SuperMobility show, and 5G was everywhere. The FCC, transportation and automotive industries, and major telecom OEMs made announcements related to 5G with an evolutionary flavor along the lines of additional bands of spectrum, additional IoT network devices, improved enterprise solutions, and evolution of existing RAN, Core and Service architectures.

The common point of all this month's developments is that they position 5G as a natural "evolution" of 4G. However, in previous months we've been reporting developments that position 5G as a "revolutionary" approach such as Facebook's TIP, Spectrum Sharing from DARPA, and Cloud, Open Source Telco. For now, both approaches are present in the marketplace. At the end, will 5G be an evolution or a revolution?

iPhone 7 Predicts 5G

This month, Tim Cook revealed the latest Apple iPhone, the iPhone 7 during an invitation-only event in San Francisco. It is not 5G, however we are taking a close at its new features, and predict what will a future Apple 5G device will be like. Apple also revealed at the event the latest Apple Watch and its applications. In this second edition of the watch, Apple is moving away from a general-purpose lifestyle device to focus in a device whose role is to target fitness tracking use cases.

Image Credit: Apple Inc.

It's an All-Wireless World: The new iPhone 7 does not have a 3.5 mm headphone jack, the universal standard for personal audio, setting the trend that wireless interfaces are the end game. And the move towards wireless interfaces is not only for audio but also for power. 5G will be a world with little or no wires.

Faster Hardware and Larger Memory Closing on Laptop Computing: The iPhone 7 is expected to come with a faster A10 processor clocked at 2 GHz, and feature 3 GB of RAM, and up to 256 GB of storage. This moves mobile computing closer and closer to laptop computing, a trend that will accelerate as we come closer to 5G.

More Sensors and The Path to VR, AT Enablement in The Phone: User experience is at the core of Apple's brand thus better displays, improved cameras and more sensors are a given. Apple has been working on imaging and sensing capabilities including 3D, dual camera, bio-sensors, and all reside in the phone and not in additional specialized peripherals. For now iPhones, and

smartphones in general, are our primitive VR and AR devices. The trend is for these capabilities to continue improving residing the iPhone itself and this is a trend we see in the evolution to 5G.

Apple Watch Evolves from Being a General Lifestyle Gadget to an Activity Tracking Device: The Apple watch Series 2 was also introduced at the event. Its new GPS, water-proof and WiFi features tell that lifestyle and sports activity tracking use cases are the target of this new device.

The watch runs the new WatchOS 3 operating system and it is is powered by the new the S2 chip with a dual-core processor, and with a new GPU that offers up to twice the graphics performance to best support graphically intensive apps such as games.

Also introduced at the event was the new Pokemon GO app for the watch. "It's certainly been a hectic summer for us," said John Hanke, CEO of (the app developer) Niantic Labs said at the event. "Pokemon Go has been download 500 Million times since July around the world with users walking 4.6 Billion Kilometers while playing the game. Combine Pokemon gameplay while you're on the go, such as doing a run."

Far EasTone Demos 5G Services, Talks Evolution Path from 4G

The stream of news about 5G testbeds, and pre-commercial 5G lab trials, demos, and live-tests continues. This time is Taiwan's Far EasTone that, partnering with Ericsson, is announcing demos of 5G services over its 4G LTE network, and reporting a 1 Gbps throughput. What is different about this case from others we previously reported is that Far EasTone Telecommunications Co Ltd (遠傳電信), Taiwan's No. 3 telecom operator, is highlighting together with the 5G demo results their evolution path from LTE. With this evolutionary approach, the operator expects to start offering 5G services using its long-term-evolution (LTE) network technology in 2018, ahead of full commercial 5G operations in 2020. The company also hopes to offer some 5G pre-commercial services for its subscribers during the Pyeongchang 2018 Winter Olympic Games in South Korea.

Far EasTone Roadmap Includes a 5G Lab Demo and Steps from 4G to Commercial 5G Service: The operator announced the establishment of Taiwan's first 5G laboratory developed in collaboration with telecom equipment supplier Ericsson. Their telecommunications network and technology business group executive vice president Rao Zhonghua said that the company aims to operate 5G services by 2018, and provide 1Gbps transmission speed network by 2020. Far EasTone launched the demonstration at its 5G lab in New Taipei City's Banciao District (板橋) reporting to achieve 1 gigabit per second aggregate speed on their existing 4G network.

Far EasTone is the ninth partner of Ericsson's global 5G partners to launch the demo. We are assuming that for the demo, the latest Ericsson's testbed presented at this year's GSMA's Mobile World Congress 2016 is used including some of the radios with advanced features such as multi-user MIMO (MU-MIMO) and beamforming. Far EasTone is testing these advanced features in their own network environment with a 4G to 5G evolution plan in mind.

Commercial 5G Plans in Taiwan Take an Evolutionary, Incremental Approach from 4G to 5G : As the 5G spectrum has not been allocated in Taiwan, Far EasTone's Rao Zhonghua said that incremental spectrum bands and features roll out is planned as follows: an initial service phase running in the 2600 MHz and 1800 MHz bands with 20 MHz carriers reaching up to 450Mbps transmission service speeds; then by 2018 through multi-input multi-output (MIMO) base station and three carrier aggregation (3CA) integration, the transmission speed will reach 750Mbps; and finally in 2020 provide 1Gbps transmission speed of 5G services. With this incremental approach, "We hope to bring some new [5G] technologies or services to our customers as soon as possible. They do not have to wait until 2020," and because internationally 3.6 GHz, 5.8 GHz and 28 GHz bands will be the most commonly identified for 5G spectrum, Taiwan foresees aligning in this direction. Overall, Taiwan has aggressive plans for 5G rollout once spectrum is assigned, and aims for 5G adoption rates faster than 4G which took approximately 3 years to reach 50% penetration rate.

Services-wise, initially the company targets development of an audio-visual content platform; it will focus on serving transportation and water and electricity industries, through innovative technology research and development; and it will market 5G applications to R&D institutions, to the public sector and to private enterprises.

According to Ericsson's latest research report, “5G can play a key role in transforming industries, including automotive, utilities, public safety, high-tech manufacturing, digital networking, healthcare, finance, media and gaming.” and services and mobile capabilities such as the ones Far Easton is testing are the starting point of innovating and engineering a transformation towards 5G.

“We hope to bring some new [5G] technologies or services to our customers as soon as possible. They do not have to wait until 2020,”

RAO ZHONGHUA

EVP, FAR EASTONE

FCC Highlights Experimental Licenses, Infra Sharing, Spectrum for 5G

At this year's CTIA Super Mobility show, the message from the FCC to support 5G and innovation graved the spotlight. The FCC is putting attention into experimental licensing and sharing of infrastructure and spectrum. Chairman Wheeler, speaking at the show, said that supporting the antenna deployments envisioned for 5G might require to share infrastructure and spectrum. He also outlined a new experimental licensing system to foster 5G innovation among researchers, universities, OEMs and other innovators. For him, the "three keys for what the Commission can do to help unlock the 5G opportunity:

1. Ensuring ample availability of spectrum to a range of competitors;
2. Taking all steps to foster competitive provision of infrastructure; and
3. Removing unnecessary hurdles to [basestation infrastructure] siting.

In all these areas, the FCC has activities underway. Yet, let's be realistic, there is more to be done if 5G is to realize its promise,"

4G vs. 5G: Exciting Advances on the Horizon

	IMT-Advanced (4G)	IMT-2020 (5G)
Peak Data Rate	DL: 1 Gbps UL: 0.05 Gbps	DL: 20 Gbps UL: 10 Gbps
User Experienced Data Rate	10 Mbps	100 Mbps
Spectrum Efficiency	1 (normalized)	3X over IMT-Advanced
Peak Spectral Efficiency	DL: 15 bps/Hz UL: 6.75 bps/Hz	DL: 30 bps/Hz UL: 15 bps/HZ
Mobility	350 km/h	500 km/h
User Plane Latency	10 msec	1 msec[1]
Connection Density	100,000 devices/sq. km.	1 million devices/sq. km
Network Energy Efficiency	1 (normalized)	100X over IMT-Advanced
Area Traffic Capacity	0.1 Mbps/sq. m.	10 Mbps/sq. m. (hotspots)
Bandwidth	Up to 20 MHz/radio channel (up to 100 MHz aggregated)	Up to 1 GHz (single or multipole RF carriers)

[1]Per 3GPP TR 38.913 (V0.3.0, Mar. 2016), 0.5 msec for DL and 0.5 msec for UL for Ultrareliable and Low-Latency Communications and 4 msec for UL and 4 msec for DL for Enhanced Mobile Broadband.

Source: Rysavy Research

H**ow Infrastructure, Antenna Sharing Could Be Part of 5G:** In the area of infrastructure sharing, the FCC Chairman said "I'm not endorsing shared infrastructure in every and all circumstances, and certainly not opening a door to consolidation… But I am saying that if we're talking about thousands of antennas in a city, and you've got four carriers, and we are serious about leading the world in 5G deployment in our very large and spread-out country, we ought to explore creative options on how best to build that infrastructure."

Spectrum for 5G: Beyond antenna and infrastructure sharing, spectrum allocation and sharing has also being discussed for 5G. We reported earlier on 5G spectrum allocation efforts i.e. on July 14, 2016, the FCC enacted the Spectrum Frontier Preceding assigning for 5G operations the 28 GHz, 37 GHz, 39 GHz, and 64-71 GHz millimeter wave bands (mmWawe) and we also reported on spectrum sharing initiatives at DARPA. Additionally this month until September 30, 2016, the FCC was seeking comments regarding the use of additional frequencies up to 95 GHz for future mobile operations; other regulators around the world, e.g. OFCOM are also contemplating similar uses.

Experimental Licenses to Foster Innovation in 5G: Wheeler also announced to be launching soon an electronic filing system to accept applications for program experimental licenses to facilitate technology testing, integration and innovation. "Experimental licensing has led to countless wireless innovations through the generations of wireless technologies," Wheeler said. "The new program licenses will provide much greater flexibility for researchers, universities, OEMs, and other innovators to conduct experiments and field tests of 5G technologies at scale."

Smartphones, Cars, Bikes, Drones,… All Become 5G Network Devices

As far as devices, CTIA 2016 Super Mobility showed a wide range of new devices that will become network devices connected to current 3G/4G, and to 5G systems. The smartphone is still the king of network devices, but the show demonstrated that new network ones will be a standard part of it in the 5G ecosystem. The solutions we highlight here are largely meant to be deployed in 4G networks, and with enhancements evolve into 5G.

Self-Driving Connected Cars and Bikes: CTIA SuperMobility is not primarily an automotive or transportation-oriented tech show, but this year there were many of announcements related to transportation automation from the likes of wireless carriers, car manufacturers, and technology components makers such as IoT modules, panelists, and displays. Among those introducing products and solutions were Aeris, AT&T, Diversiti, Glimpse, Harman, KORE, Qualcomm, Streetline, Telit, W-blox, and ZTE.

AT&T announced that it will be the exclusive wireless carrier for LeEco Super Bike. With this announcement, LeEco continues their expansion into the US market aligned with their move earlier this year to acquire smart TV maker Vizio. The bike comes with a waterproof smart device with built-in 4-inch display, with Android, and with connectivity cellular networks. Features includes a smart riding system, laser lane markers, fingerprint identification, a smart lock, intercom feature, and a power management system. It is a sensor-rich device including an alarm triggered by movement, location tracker, fingerprint scanner, electronic parking brakes, heart rate monitor, accelerometer, gyroscope, temperature, humidity and compass.

An Android Bike as One of New Network Devices to Be Part of 5G (Image Source: LeEco)

Automotive Connectivity via IoT Modules: In automotive IoT modules, we highlight Telit which showed a LTE Cat 4 smart module part of what calls its portfolio of automotive-grade cellular IoT modules. The 150 Mbps capable product addresses automakers' growing demand for high-speed mobile data connectivity to support applications like advanced diagnostics and infotainment, remote software updates; and complies with eCall and ERA GLONASS which are emerging, mandated European and Russian emergency call systems. The new module will also be available in variants compliant with regulatory and mobile carrier-requirements in North American, European and Chinese markets. With built-in application processor, storage and memory, the IoT module, named LE920A4, includes the deviceWISE agent with access to a web portal for simple, secure and scalable automotive device and customer on-boarding.

Managing the Logistics of a Transportation Feet: In the fleet management space, KORE and Vis Tracks showcased a cloud-based app for electronic driver logs (ELD), hours of service, and vehicle inspections. In the announcement, KORE detailed that partnership between its division Position Logic — focused in on-demand, branded, precision location-based solutions for business-to-business applications — and VisTracks, a developer of tablet and cloud-based application for electronic driver logs (ELD), hours of service, and vehicle inspections.

Parking the Car: Vehicle parking solutions were also in the spotlight with ZTE that in addition to its well established smartphones and telematic devices, it was demonstrating at the show its ZTE's Smart City and Smart Parking solutions.

Shopping for 5G Gear? This is What You Could've Bought at CTIA 2016

We look here at the 5G products and emerging technologies on the way to commercialization that were presented during the CTIA 2016 SuperMobility Show. Major network OEMs (Ericsson, Huawei, Nokia and such) all made announcements of what is currently available either as evolution towards 5G or as pre-commercial. The important point is that 5G solutions are starting to emerge extending the 5G ecosystem to verticals like transportation. Even networking gear is showing targeted to 5G use cases supporting customers beyond mobile network operators, WISPs, and moving into the enterprise.

Nokia outlined more details on its plans to introduce 5G/4.9G to the mobile market. As part of its 5G product roadmap, Nokia has unveiled evolutionary plans to offer 4.5G, 4.5G Pro and 4.9G technology based on the AirScale radio access platform. Regarding launch timeframes for the 4.9G kit, "It's end of 2017, one year later than 4.5G Pro," Phil Twist, VP – Mobile Networks Marketing, Nokia. Twist added that its 4.9G kit will comply with 3GPP's Release 14 (dubbed LTE Advanced Pro 2), due for ratification March 2017. Earlier 4.5G technology (championed by Nokia and Huawei) was based on LTE Advanced Pro. "Release 14 has a lot of capabilities that get very, very close to 5G," added Michael Murphy, head of technology at the company's North American operation. Nokia claims its 4.9G offering will be capable of supporting theoretical peak download speeds of several Gbps, offering latency of less than 10ms. "4.9G takes LTE to the max," said Twist. "This is critically important because when the new 5G radio interface comes in there's an expectation that this is a complement to 4G networks and not a replacement for them. The previous generations saw 4G replacing 3G, and 3G spectrum would then be reformed… This service continuity is one of the key elements of 5G and keeps the door open for operators to react.

Ericsson 5G- Ready Gear, NR, Plug-ins: Ericsson announced for the show that it was launching the worlds first commercial 5G New Radio (NR) incorporating multiple-input and multiple-output (MIMO) technology and multi-user MIMO, with the first deployments coming in 2017. Together with the Ericsson 5G Plug-Ins announced in June this year and its commercially available Radio System Baseband 5216 — which currently powers Ericsson's Radio Test Bed — the company said in a statement that is first to deliver all components of a 5G access network. Arun Bansal, Head of Business Unit Network Products, Ericsson said "We are introducing the new hardware that 5G Plug-Ins will run on so that the first operators can start to deploy 5G infrastructure. We are also launching innovations that improve both the performance and efficiency of today's networks using concepts that will evolve into 5G,"

The "AIR 6468" 5G radio combines advanced antennas with a large number of steerable ports to enable 5G technologies of beamforming, Massive MIMO and multi-user MIMO.

5G Solutions for the Enterprise: Some of the emerging technologies at the show address enterprise mobility solutions for medium and small size businesses. We highlight a coverage an indoor cellular coverage solution by Nextivity. Their new product extends the cellular signal that scales to 200,000 square feet with a cost-effective approach to extend addressable market to enterprises that cannot afford elaborate distributed antenna systems. "The commercial mid-market has long lacked a truly affordable, enterprise-class indoor coverage solution-until now," says Werner Sievers, CEO of Nextivity. "Cel-Fi QUATRA bridges the gap for these organizations, eliminating the cost, complexity, and time involved with the installation of full-blown active DAS systems."

Emerging Technology Awards, Who Got the First Price: CTIA 2016 Super Mobility organizers announced award winners of their emerging technology award competition. For each of the categories they defined, the first price went to:

EVERYTHING INTELLIGENT

- In-Building Wireless (Small Cell, WiFi, LAN) - NUU Mobile, NUU Konnect i1
- Wide Area Networks (5G, 4G, LTE Advanced) - Nokia, Nokia Future Cell

EVERYTHING SMART CONSUMER:

- Accessories: Samsung, Samsung Gear VR, powered by Oculus
- Connected Life (Car, Transportation, Home, Wearables, Health); Samsung, Samsung Gear Fit2
- Devices & Gadgets - CAT, Cat® S60
- Entertainment (Games, Audio, Music & Video) - Speck, Pocket-VR™ with CandyShell® Grip

EVERYTHING INDUSTRIAL & ENTERPRISE:

- Industrial IoT (IIoT, M2M, Sensors, RFID, NFC etc.) - Silver Spring Networks, Starfish™ Platform
- Mobile App Development Platforms - Kony Inc., Kony Visualizer 7
- Mobile Cloud - Twilio, Twilio Wireless
- Mobile Customer Experience Management & Data Analytics - LogMeIn, LogMeIn Rescue Lens
- Mobility Management Solutions (MDM, MAM, access management etc.) -SOTI Inc., MobiControl
- Mobile Money (Payments, Banking, Retail & E-Commerce) - Samsung, Samsung Pay
- Mobile Security & Privacy - Sensory, TrulySecure 2.0: Voice+Face Authentication SDK
- Mobile Enterprise Innovation - HeyWire, Inc., HeyWire LiveText Agent for Salesforce

EVERYTHING FOR GOOD: Ericsson, Connected Water

CROWD FAVORITE by Popular Vote: Nokia, IMPACT IoT Platform with Nokia Motive®

Congratulations to all winners!

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