
5G MAGAZINE

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Foreword

5G speed records of 9.83 Gbps and 20 Gbps from China and Europe, respectably; the OpenCellular platform to disrupt radio access; a White House backed \$400 Million initiative for advanced wireless research; new, innovative, open hardware for IoT and wearable chips; OpenCellular project announcement; spectrum allocations in US and UK from regulators FCC and OFCOM; and Pokemon Go is now the largest mobile app, ever!

These are all major mobile industry moves in the last few days. We are in the middle of the Summer but no one in the mobile industry seems to be taking vacation. We are not on vacation either but working day and night to put together this first issue of the 5G Magazine

China and Europe report 5G Peak Speed Record of 9.83 and 20 Gbps

Out of the Mobile World Congress in Shanghai, there are reports of steady progress towards 5G with a Cellular IoT demo, a 5G NR sub-6 GHz trial system, VR live demos during the 2018 Olympics, and a basestation to be used in Shanghai Mobile's test network that can reach peak speeds of 9.83 Gbps. The record continues to highlight China's commitment to drive wireless innovation, and to incorporate the latest technologies in their products.

Shanghai's Mobile World Congress 2016 (MWCS16) showcased progress in pre commercial 5G networks and 5G applications like smart cities, IoT and sensors. China Mobile was demonstrating a next-generation cellular IoT based on LPWA (Low Power Wide Area) standards. Qualcomm highlighted its 5G New Radio (NR) prototype system and trial platform operating in the sub-6 GHz spectrum bands, which the company says is a critical part of allowing for flexible deployments with ubiquitous network coverage; the prototype will closely track 3GPP study item as part of Release 14 and will feed into Release 15 work items.

*MWCS16 showcased
technology progress
towards
commercialization of 5G*

Another 5G speed record, this time the report comes from Europe. Vodafone says that working with Huawei they have completed a 5G field trial that demonstrates the capabilities of a system operating at 70 GHz. In those tests they have been able to reach data rates of over 20 Gigabits per second (Gbps) for single-user multiple input multiple output (SU-MIMO) with a strong reflection path; and also to support multi-user multiple input multiple output (MU-MIMO) for long-range UE that received 10 Gbps each.

The use of high frequency spectrum is still quite new in cellular systems which have been using frequencies under 3 GHz in previous generations (1G to 4G). Writing on the Vodafone Group blog, 5G Research Manager David Lister shares that there are significant engineering challenges associated with using these frequency bands. The radio signal is less capable of penetrating obstructions and the radio beams must be able to track the location of a device that is moving quickly. As a result, researchers are working to address these challenges as part of ongoing work to determine how best to deploy and operate 5G networks.

Facebook Announces OpenCellular, Wireless Access Addition to TIP

Facebook reports that they have designed and tested an open source and cost-effective, software-defined wireless access platform aimed to improve connectivity in remote areas of the world. This access platform has two major components:

- A general-purpose base-band computing (GBC); and
- A radio frequency (RF) with integrated analog front-end.

Plans are to open-source the platform enabling telecom operators, entrepreneurs, OEMs, and researchers to locally build, deploy, and operate wireless infrastructure.

“In our journey to connect the World, Today we announced OpenCellular...”

MARK ZUCKERBERG
CEO, FACEBOOK

Little is known to this date, about architecture, specifications and other technical details. So far Facebook points in their Developer website. What we know is that OpenCellular is being added to the ongoing Telecom Infrastructure Project (TIP) efforts such as Aries, Terragraph, and OpenR which were announced at the F8 Facebook Developer Conference together with the 10-year connectivity roadmap.

In a post to his Facebook page, CEO Mark Zuckerberg says that this is part of their connectivity efforts towards the more than 4 billion people that still don't have basic internet access and to the 10% of the world's population living outside the range of cellular coverage.

A US Public-Private Consortium to Invest \$400M in Wireless Research

Private and public institutions are convening a consortium to advanced development of next-generation mobile technologies, some of which promises up to x1000 speed improvements over Today's technology. The National Science Foundation (NSF) will lead the consortium and the initial topic areas include:

- mmWave (millimeter-wave) in bands about 26 GHz with a target of 100 Gbps in small-cells;
- Dynamic Spectrum in sub-6 GHz bands including co-existence and protection;
- Architectures in data networks;
- Mobility-at-Scale from transport to MAC (Medium Access Control) layers;
- Wide-area Whitespace demonstrating 1 Gbps to remote location with mesh networking;
- Network Metrology; and
- Applications/Services for cyber-security, IoT, robotics, connected health and big data.

Research in these topics will take the bulk of the \$400 budget. Close to \$80 Million will be allocated to building four test sites (four US cities will be selected at a later time for this purpose) with the aim to validate the research quickly and accelerate commercial deployments of 5G.

IoT and Wearable Chips for 5G Built on Open Platforms

Could IoT and Wearable semiconductors be made more cost-effective and with faster turn around times to fit the requirements of a fast-pace highly innovative ecosystem like 5G? This month, MIT hosted a RISC-V(*) workshop to explore these goals based on the RISC-V open hardware platform. At the same time, startup SiFive is launching the firsts products based on this platform. “The semiconductor industry is at an important crossroads. Moore’s Law has ended, and the traditional economic model of chip building no longer works,...” says SiFive co-founder Yunsup Lee.

Open Hardware for Embedded Microcontrollers: To realize the promise of billions of IoT devices in the 5G ecosystem, both scholars and industry are working to optimize current solutions and/or propose new ones addressing challenges that go from long development cycles, to high power consumption, to expensive manufacturing processes. In the IoT semiconductor industry, embedded microprocessors are being looked at with ongoing focus to define open microcontroller cores. These open cores are worth noting because they redefine the traditional SoC technologies and business models, and reverse the industry’s increasingly high licensing, design and implementation costs and impact commercialization plans. The RISC-V Foundation (*) is coming together together to coordinate academia-industry efforts. MIT hosted its latest workshop this month.

At the same time, products based on RISC-V are seeing the light. SiFive launched two products part of their Freedom FOSS SoC platform a few days ago targeting the embedded micro controller for IoT and wearable devices in the 5G ecosystem. Their press release highlights that their platform leverages the free and open RISC-V(*) architecture and ecosystem to democratize access to custom, state-of-the-art semiconductors. This has the potential to be a game-changer challenging ARM as well as other existing approaches to IP cores.

(*) RISC-V is a non-profit foundation



Spectrum Allocations for 5G in US and UK

Regulators in US and UK make important announcements during July 2016, with positive developments in their efforts to identify spectrum for 5G services. The FCC ruled that over 10 GHz of spectrum across 4 different bands – 3.85GHz of licensed and 7GHz of unlicensed frequencies, across the 28GHz, 37GHz and 39GHz bands, as well as new unlicensed bands at 64GHz-71GHz – are now available for 5G across US. In UK, Ofcom issued a consultation to identify 5G spectrum for fixed wireless services. These actions could speed up 5G rollouts in America and Europe but these could still lag behind South Korea and Japan who said to deploy 5G by the time they host the Olympics, in 2018 and 2020, respectively. These actions by FCC and Ofcom are also key towards ITU's WCR-19 and IMT-2020.



FCC Spectrum Frontiers Identifies Over 10 GHz of Spectrum for Wireless Use: To support the development of 5G networks, the FCC this month moved forward on high-band spectrum issuing an order – Spectrum Frontiers proceeding – to open over 10 GHz of high-band spectrum for innovative mobile use. The order contemplates both licensed and unlicensed allocations, and creates opportunities for sharing among different kinds of users such as fixed/mobile, federal/nonfederal, terrestrial/satellite; and public/private networks. As far as technical rules in these bands, it is worth noticing that for TX Power at the basestation CTIA, Ericsson, Fiber Tower, Intel, Qualcomm, Nokia, Samsung, Straight Path, TIA, Verizon, and XO's representatives requested greater than 62 dBm/100MHz EIRP level; it appears that the FCC accepted this requirement.

Regarding usage, the FCC is addressing spectrum in the 28 GHz, 37 GHz, 39 GHz, and 64-71 GHz bands separately as follows:

FCC	Licensed			Unlicensed	
GHz	27.5 - 28.35	37 - 38.6	38.6 - 40	57 - 64	64 - 71
Platform					
EIRP	BS 75dBm/100MHz			BS 82dBm	
Max Tx	UE 43dBm			UE 31dBm	
	Mobile				
	Mobile/Satellite			Previously allocated to WLAN	Allocated on July 14 as an extension
	Fixed				

28 GHz licensed band currently assigned for LMDS (fixed broadband wireless service)

and FSS (Fixed Satellite Services), the Commission authorized use of the spectrum for mobile services and integrated new uses directly into the existing licensing scheme. Incumbent LMDS licensees may begin mobile operations, and new mobile operators can apply for county-based geographic-area licenses in this spectrum. The FCC expects mobile operations in this band to provide mobile broadband access in dense population centers and along highway corridors.

37 GHz licensed band for terrestrial mobile operations, barring a few federal uses that remain protected. A portion of the newly-opened spectrum will be available on a co-equal basis to federal and non-federal uses, and will be monitored as a “proving ground” for federal and non-federal sharing in high-frequency millimeter-wave bands.

39 GHz licensed band with co-allocation for fixed, fixed satellite, and mobile services; however, the FCC has always declined to permit mobile operations in this band pending resolution of potential interference issues. In the Order, the Commission authorized terrestrial mobile operations and adopted service rules to minimize the risk of interference between terrestrial and satellite uses, and a “protection zone” free from terrestrial operations in the 39 GHz band.

64-71 GHz unlicensed band available for use by unlicensed RF devices under the FCC’s Part 15 rules. This band will serve as a place to test and deploy wireless devices, contributing to the development of new unlicensed applications.

While the FCC focus is for now spectrum below the 71 GHz band, UK regulator Ofcom also moved seek comments on spectrum used with fixed wireless but noted that the European Union plans are to look at spectrum up to the 175 GHz band.

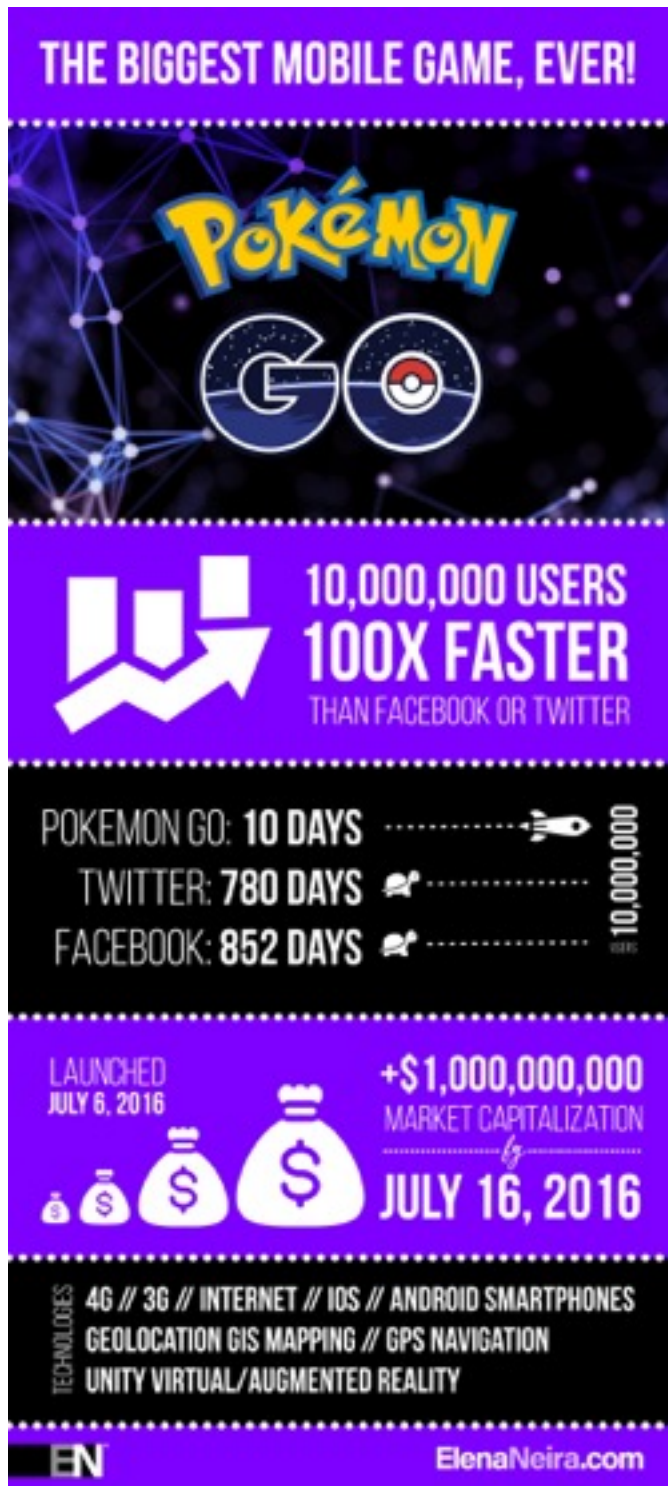
Pokemon Go is the Largest Mobile App, Ever

With more daily users than Twitter and bigger engagement than Facebook in under one month, Pokémon GO is a viral phenomenon with unprecedented growth at global scale. It launched in the

US and just 10 days after this augmented-reality multi-player mobile game app reached the same active users that Twitter reached in 10 years. Let's look at this and record-breaking numbers -users, engagement, market cap- as well as companies and technologies behind it, and the impact in the future of mobile and 5G.

The mobile app 20+ million daily active users has already surpassed that of Twitter and other major top-rated games like Candy Crush which are also available via mobile app stores. Players go out to the world with their smartphones to capture exotic creatures and/or to interact with other app users, and in doing that they are spending far more time daily in the app than in some other popular apps, including Instagram, Snapchat, and WhatsApp with latest reports indicating that the engagement has surpassed all other social networks because the time playing Pokémon Go is more than the time on other social media app including Facebook.

Active users and engagement are not the only records that Pokémon GO is breaking. In the world of finance and investment, the app has been producing for its parent company, Nintendo, record-breaking increases in market cap valuation. The July 16 data point had the firm's shares up by over 50% since the game's release, adding \$11 billion to its valuation. Unity Technologies, maker of the app's core engine technology has also been surging in value since the launch.



Global mobile connectivity, augmented reality, GIS, and geolocation technologies power Pokemon Go. Behind the scenes is a global connectivity platform with Android/iOS smartphones on the device side and 3GPP-based global mobile communications on the infrastructure side. Unity makes the game engine that runs Pokemon Go. This is the same technology that its software is used in about 90% of the content created for virtual reality platforms including Samsung Gear VR and Facebook Oculus. And with the recent events. Probably Unity, and the rest of the industry will put more attention on the futures to support the augmented reality aspects of their products. Then, using GPS (Global Positioning System) and mapping technologies including GIS (Geographic Information Systems), the app developer Niantic Labs put it all together into a user experience that has gained the hearts of millions around the world.

The game shows the potential of mixing mobile, geolocation, augmented reality and social; it shows that users' appetite for combining real and digital worlds to create new realms is big. Soon we will see these capabilities applied to not only games but also finance, transportation, healthcare, education, manufacturing, retail and many more in 5G.

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