

December 16, 2014 | By Tiffany Fox

## CWC 5G Wireless Forum: The Promise and the Potential of a New User Experience

**What's certain is that 5G is coming. What's less certain is what 5G will look like once it arrives.**

It's a testament to the excitement building around emerging fifth-generation (5G) wireless technologies that with only one month's notice, 130 key experts from academia, government and industry met at the University of California, San Diego for the recent CWC 5G Forum on Next-Generation Wireless Systems – an opportunity to share insights, best practices and remaining research questions about the emerging systems and applications that are expected to drive 5G user experience.

“First- and second-generation wireless was all about voice technology, and 3G and 4G were all about data,” explained Sujit Dey, a professor of Electrical and Computer Engineering (ECE) at UC San Diego and the incoming director of the university's Center for Wireless Communication (CWC), which organized and hosted the event. “Different people working in wireless technologies have different views about the direction 5G is headed, and we in academia are working with our partner companies to define it. We expect, for example, that 5G networks will have 1,000 times more capacity and other such quantitative parameters, but I believe it will be much more than that.”



*Sujit Dey, Director of UC San Diego's Center for Wireless Communications*

Added CWC Outgoing Director and ECE Professor Alon Orlitsky: “In a decade, even the much anticipated iPhone Air will be as obsolete as flip phones are today and as anachronistic as rotary phones were 10 years ago. Our mission at CWC is to prepare for the next decade and

help define and design the next generation of wireless systems – from the ubiquitous network infrastructure, to the powerful wireless interface, to the yet unthinkable applications that the next consumer generation will take for granted.”

Judging by the comments made during the more than two dozen presentations at the 5G forum – which featured speakers from UC San Diego, Qualcomm, Viasat, Nokia, Intel, Mitsubishi, Samsung, InterDigital, Brocade, Ericsson, Keysight, Yahoo!, China Mobile and NTT DOCOMO – expectations are high for 5G, which will likely involve new apps for multimedia, mobile health, mobile education, energy, transportation and emergency/disaster relief.

According to Takehiro Nakamura, Vice President and head of 5G Research for NTT DOCOMO, to achieve such technological feats, 5G will require higher data rates, massive device connectivity, higher system capacity, reduced latency, energy savings and cost reduction – especially for scenarios like stadium sporting events where millions of people are generating and sharing massive amounts of data (a scenario that was repeatedly cited by presenters at the forum).



*Takehiro Nakamura, Vice President and head of 5G Research for NTT DOCOMO*

Phil Fleming, Chief Technology Officer for North America Nokia and one of the event’s keynote speakers, was clear in his assessment of 5G: “Every 10 years there’s another ‘G’, and 5G will prove even more exciting than LTE. 5G is going to blow that out of the water.”

“The reason why,” he continued, “is this experience we have come to love will just get stronger and stronger. Even with 10,000 times more traffic we’re moving toward zero latency apps and a 10 gigabit per second data rate, and we’re going from audio to visual to tactile. We are here for the long term and the long term is 5G.”

Fleming also noted the many technological components that will be required to make 5G a reality, from antenna arrays to new beam-forming technologies, total system virtualization and advanced control and optimization.

“The architectures that you see in the cellular domain will completely change in the next five to 10 years,” said Fleming, adding that key drivers for 5G will include low-latency services required to facilitate the growing Internet of Things, a world where common objects like refrigerators

and home lighting systems – even medically implanted devices – are connected to the Internet.

“Everyone has been talking about digitizing everything,” he added. “In the next 10 years we will cognitize everything.”

And most everything will also be shared and stored in the cloud, said Byung K. Yi, Executive Vice President and Chief Technology Officer of Interdigital Lab. Li noted that there are currently 7 billion connected mobile devices (more than one for every human on earth), with 10.2 billion expected in 2018. Mobile cloud traffic, meanwhile, is now around 13 percent and will be 70 percent in 2020.

Yi also noted that this traffic is originating and terminating predominantly indoors (86 percent) vs. outdoors (14 percent).

“When we were designing the cellular system, we were always concerned about the traffic outdoors. Now we have to pay attention to our customers who are using their cell phones more indoors than outdoors. At the same time, we used to talk about QOS (quality of service) but now we talk about QOE (quality of experience). It doesn’t matter how the data is delivered to you. What matters is the quality of experience.”

Satellites might increasingly become a means for providing this quality of experience, added keynote speaker Mark Dankberg, the Chief Executive Officer of San Diego-based satellite company ViaSat.

“Why satellites?” asked Dankberg, “The first answer is geographic coverage. Satellites can reach places that other technologies can’t. India, for example, represents 25 percent of unconnected people in world but is less than 1 percent of geographic footprint of the world. The other is bandwidth.”

The trouble, noted Dankberg, is that “satellites that provide a lot of coverage don’t provide a lot of bandwidth.

“People think of them as slow, congested, and that’s because people today are still building satellites largely like they did 30 years ago. They could be 100 times more efficient than predecessors but they’re made out of the same parts. If we can deliver lots of bandwidth through satellites it will transform how people see it.”

One example of the potential of satellite technology comes from ViaSat's own business portfolio: It has partnered with JetBlue to offer free WiFi and recently provided 150 people with 10-15 gigs of bandwidth, in-flight.

Another element of 5G that remains to be determined is the level of standardization that will be required to foster the Internet of Things (IoT).

"That's another fascinating aspect of 5G," remarked Dey, "how can we establish wireless standards that will enable the Internet of Things, such as low power, reliability of transmission, security, etc., but still allow IoT products to remain diverse?"

3GPP (3rd Generation Partnership Project), a collaboration between groups of telecommunications associations that specifies standards for mobile communications, is expected to establish the standards for 5G by 2020. This is why, Dey added, it's increasingly important to "pull together stakeholders to brainstorm and make conscious decisions."

"Up until 4G came about, it was all about having a fat pipe or increased bandwidth," Dey noted. "We have to move away from a pipe mentality and understand things like user experience, trust concerns and security concerns for different application areas. As incoming director of the CWC, I envision us creating opportunities, both large and small, for dialogue with and among industry partners, and for pursuing multiple verticals involved in 5G technology."

Qualcomm Senior Director of Engineering (and project lead for 5G at Qualcomm) John Smee, agreed in his remarks that 5G "is not going to be a one-size-fits-all solution."

"When we're designing 5G it's getting beyond what we designed 4G for," he added, "At the same time, all this work on 5G is going to be in the presence of a continually evolving 4G, with new features added and improved. We need to look at how legacy spectrum will be re-farmed, and how 4G and 5G are going to work together in terms of evolution of what we call dual-connectivity and moving toward multi-connectivity on 4G, 5G and WiFi."

"Something that can't be overemphasized," added Smee, "is looking for ways to drive down the cost of operating that network. We have to look at bits per second, per hertz and per joule, as well as looking at the cost factor for these networks. Techniques that are going to help have a more sustainable, energy-efficient network are going to be very important."

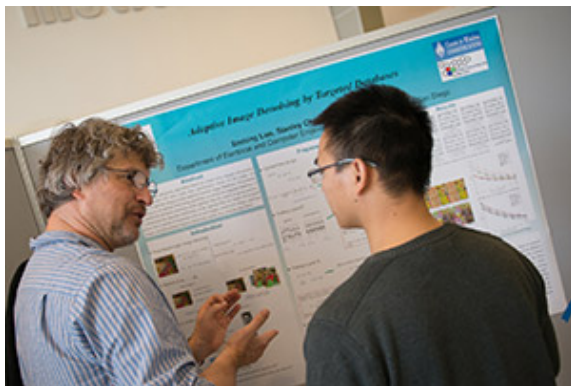
Farooq Khan, President of Samsung Research USA, also underscored the importance of developing a low-cost 5G network. Khan's presentation, titled "Connecting Every Being and Every Thing," cast the role of 5G in humanitarian terms, noting that the world's top 10 problems

(from energy to environment to poverty) could potentially be solved with “5G as the backbone of a networked wisdom or ‘network sapience’ enabled by the cloud.”

“We’ve heard a lot about connecting ‘every thing’, but first we need to connect every being to solve the top problems that humanity is facing,” said Khan. “We cannot connect everybody in the world if the cost is very high.”



*Farooq Khan, President of Samsung Research USA*



*Benoit Schillings (at left), research fellow at Yahoo!*

Cost is also important in the software world, noted Benoit Schillings, a research fellow at Yahoo!, who gave a detailed description of the pain points related to 5G from the perspective of an app developer.

“My job is very simple: I make black boxes that will stimulate the pleasure center of the user,” he said, only half-jokingly. “Looking at the mobile industry as a black box, and thinking about what we provide

the end user is really a fundamental view that I’m trying to bring. And for me, the dimension that’s really important is the revenue I’m going to generate per user. When I look at applications, this is really the place where we hit the line.”

Someone who understood the power of wireless from an early start was Qualcomm founder Irwin Jacobs, who was honored at a dinner following the 5G forum with the CWC Wireless Leadership Award. UC San Diego Chancellor Pradeep Khosla presented the award, and former and current Jacobs School of Engineering Deans Bob Conn and Al Pisano gave remarks.

Reiterating UC San Diego’s commitment to and impact on wireless engineering, JSOE Dean Al Pisano noted at the forum that its students are especially poised to lead the world into 5G and beyond.

“I hope that you view UC San Diego as a destination where you can connect with the top minds in this field and other fields,” Pisano told the participants during his opening remarks. “In turn, we strive to ensure our students receive the training that will be the most relevant for them in the field.”

For Rajesh Pankaj, Senior Vice President for Qualcomm, the best training a student could receive might be in how to use his or her imagination. He described a time around 2003 when he and his colleagues tried to predict what cell phones would look like a decade later.

“We were low by an order of magnitude on the number of things our phones can now do,” admitted Pankaj.

“The world has changed quite a bit since the time we started working on 4G, but at this point there is no doubt that the biggest platform in the world is mobile phones,” he added. “We have to be bold in thinking about how these devices will look in 10-11 years. We are limited by our imagination, so at least we should imagine crazy stuff.”

The Forum ended with a planning session, where industry participants shared the 5G research challenges most likely to be solved by active collaboration with CWC faculty. Dey said the planning session, and follow-up discussions, will help determine future CWC research collaboration plans. He intends to broaden the dialogue in a follow-up forum by involving more companies in application domains, which can help better guide 5G requirements and the CWC 5G research projects.



*Irwin Jacobs (at left), founder of Qualcomm, with UC San Diego Chancellor Pradeep Khosla*

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## MEDIA CONTACT

**Tiffany Fox**, 858-246-0353, [tfox@ucsd.edu](mailto:tfox@ucsd.edu)

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