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Advancing the 5G Wireless Standard at Convida Wireless: An Insider Look

Convida Wireless is a joint venture between Sony Corporation of America and InterDigital that focuses on Internet of Things technologies and advancing the specifications and standards for 5G wireless technology. Three InterDigital engineers – Lakshmi Iyer; Paul Russell, Jr.; and Allan Yingming Tsai – describe their work on behalf of Convida with two 3rd Generation Partnership Project (3GPP) working groups and explain the instrumental role that MATLAB plays in those efforts.

With all the interest 5G is generating in the industry, what aspects of the technology is your team most excited about?

Lakshmi Iyer (LI): One of the big changes in 5G over LTE is that we are targeting ultra-reliable, low-latency communications. We are talking about end-to-end latency of less than a millisecond and highly reliable links. To achieve this, we are aiming for a PHY layer BER of about 100-1000 times lower than the LTE rate of 10 percent.

Paul Russell, Jr. (PR): Ultra-reliable, low-latency requirements and techniques will make numerous innovations possible, including mass vehicle-to-vehicle communications, new applications for handling emergency situations, and high-definition streaming video, to name a few.

Allan Yingming Tsai (AT): And 5G will support wider bandwidth and higher capacity than 4G by leveraging a beam-centric architecture to enable higher concentrations of mobile users in a given area.

What role does Convida play in the 5G standards working groups? And from a business perspective, what are the benefits of participating in these working groups?

PR: Convida is a contributing and active member in 3GPP Radio Access Networks working groups, RAN1 and RAN2, which involves collaborating with other delegates on defining robust 5G solutions and specifications. We collaborate with InterDigital and Sony as well as delegates from Huawei, Qualcomm, and other companies on standards contributions that help advance the 5G standard.

We benefit by being fully engaged with the standards as they are being developed, understanding other delegates' concerns, and identifying agreeable robust solutions.

How do the working groups operate? What types of challenges do you face?

PR: At the RAN1 and RAN2 working group meetings, participants share the technology they have developed for the standard. Between meetings, each group reviews and evaluates the shared contributions – typically by running simulations – so they can provide feedback at the next meeting.

With LTE, meetings were typically held about every other month. With 5G the pace has increased significantly, and we are meeting eight to ten times a year. On top of that, we've seen record attendance at the meetings – a recent RAN 1 meeting attracted more than 600 delegates.

The Convida team sees hundreds of contributions that we need to review, in addition to developing our own. So, we are facing a heavy workload and an aggressive schedule.

What aspects of the standard were important to implement early?

LI: One challenge our working group had to tackle early on was developing a clustered delay line (CDL) channel model for millimeter wave frequencies. These channel models incorporate spatial modeling in link-level simulations and extend beyond the tapped delay line (TDL) models frequently used in earlier releases. These channel models required calibration so that companies could compare apples to apples and regenerate others' results.

Why is simulation such an important part of your work?

LI: In general, simulations are a large part of the evaluation process for proposed contributions in RAN1. For example, if a company develops a PHY layer design with certain signal characteristics and submits it as a contribution, other working group members may not simply accept the conclusions reached by the company. We may want to evaluate the design, and for that, we rely on simulations.

How does MATLAB help you evaluate contributions and develop your own?

LI: For our simulations, we use MATLAB. Many of the companies we collaborate with also use MATLAB either for simulation or for data analysis and visualization – or like us, for both.

The ability to run simulations in MATLAB enables us to better engage with the various members of our working group. In order to have an informed discussion with another member about a standards contribution, we need to be able to compare our assumptions and our results – and much of that discussion relies on simulations. Our MATLAB simulations make it possible to move the dialogue forward.

LI: Not all simulation environments are suitable for the work we are doing. We need to be able to quickly build and evaluate algorithms; we don't need a great deal of hardware detail. Fixed-point operations, for example, tend to break the algorithm into smaller steps and make it more difficult to understand. Readability is very important when you have multiple people working on a common simulation platform. From that standpoint as well, MATLAB is a great tool.

AT: In addition to the link-level simulation that Lakshmi talked about, our simulation activities also include system-level simulations, which help us analyze capacity, throughput, and other network-level performance criteria. The ability to perform both link-level and system-level simulation in MATLAB helps accelerate the development of our own 5G technology.

How does development for standards contributions differ from product development?

PR: When we're doing standards development, we're primarily focused on the transmitter side, whereas with product development, the major focus is on the receiver side. Usually floating-point analysis with some high-level quantization is sufficient for standards development, but product development requires fixed-point and bit-accurate simulations to support final product validation.

LI: Our work with 3GPP does not require bit-accurate or cycle-accurate simulations. Instead, we're focused mainly on quickly modeling signals and transmissions. The time needed to create and simulate these models in MATLAB is very short.

AT: To provide an example: for certain fundamental 5G features, we need to support different FFT sizes and different subcarrier spacings; this was not a requirement for 4G. MATLAB made it easy for us to prototype these features because we could start with fundamental transmitter functions in LTE System Toolbox that have already been validated, customize them with our own enhancements, and rapidly produce a prototype for simulating the new capabilities.

How can companies that are not participating in the 5G standards work jumpstart their own 5G development efforts?

LI: For these companies, I think there is significant value in using MATLAB and LTE System Toolbox. It is not trivial to read and understand the standards and then directly build to the specifications. Having the 5G Library for LTE System Toolbox will help companies come up to speed quickly because the engineers can first verify their understanding of transmission. Then, if they want to build a receiver, for example, they have the complete transmitter chain available for simulation so they can focus on the receiver side.

PR: InterDigital works on a number of projects that are leveraging commercial wireless technology. The 5G Library for LTE System Toolbox is used on those projects to better understand the performance and capacity gains that stem from 5G, which helps with planning future product lines.

Now that the 5G standard is ratified, will your work continue?

LI: Our efforts on 5G will continue to progress. In the next phase, we will begin evaluating additional technologies, including non-orthogonal multiple access (NOMA) schemes. We will also be working on evolving the standard for non-terrestrial links that rely on satellite communication. Operating in unlicensed spectrum is another area that we will explore. For our team, simulations in MATLAB will play a vital role in these continued efforts. So while there is still a great deal of work to do, at the same time there is significant momentum behind evolving the standards.

Learn More

Overview: *5G Wireless Technology Development with MATLAB and Simulink*

Ebook: *5G Development with MATLAB*