S1 EP25 - Evolution of Optical Connectivity to 3.2T

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Xi Wang, Vice President of Optical DSP Business Unit, and podcast host Chris Banuelos discuss optical connectivity – the foundation of today's internet infrastructure, enabling the emergence of hyperscale data centers and the new era of wireless communication. Cloud-based services continuously drive the need for data center hardware with high bandwidth capacity along with low power consumption. Just as data centers begin their transition to 400G and 800G, the bar is rising towards the next evolution of 1.6T and 3.2T, with the same demands for high performance and low power with minimal financial impact. Tune in to hear what is driving the transition and learn more about the advancements needed to enable data centers to advance capacity for future generations to come.

Speakers

Xi Wang
Vice President, Optical DSP

Host

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Christopher Banuelos 00:04
Welcome to the Marvell Essential Technology Podcast. I'm your host, Chris Banuelos. On today's episode, join me and Xi Wang, Vice President of Optical DSP, discussing the evolution of optical connectivity to 3.2T. Join our conversation today and find out what is driving the evolution to 3.2 T. Why this transition is important for optical connectivity in the data center, what are some of the technologies required to enable 1.6T to 3.2T, and what will be the lasting impact for data centers for future generations of optical connectivity. To stay up to date on future episodes, please be sure to subscribe to the Marvell Essential Technology Podcast. Hey Xi, it's great to have you on today's episode. I'm really looking forward to our discussion today. Before we get started, I wanted to talk about a recent event you attended ECOC, How was your time at the show?

Xi Wang 01:04
It was great. Chris, the EEOC is the European Conference Optical Communication. This conference has a long history. At Marvell, we go to this conference on a yearly basis, it has been more than a decade tradition for us, it's a great place for us to meet with customers, industry partners and vendors, and alike. So it helps us to showcase our latest technology, as well as meeting the customer [to] understand their requirements and also the industry trends. And what's more important is, it gives everybody a chance to share their idea, right and then communicate and hopefully push the industry forward together at this show. So I was really excited to be a participant at the EEOC this year.

Christopher Banuelos 02:01
Absolutely. And glad you had a great show. Why don't we dive into our conversation today and what you touched on a moment ago about technology. And this being a big mind share event. One of my first questions is what is driving the evolution to 3.2T?

Xi Wang 02:18
And what you said a moment ago, that is a very interesting trend you mentioned, the need for faster optical connectivity and that the next generation transition could happen faster than we think. That is a great question, Chris. So the 3.2T what we are referring to is the optical connectivity that goes into the data center. Today, the mainstream application of the optical connectivity is the pluggble optical transceiver module. Today the state of the art is at 800G per module and that has been driven by the rapid expansion of a data center business in our daily lives, right. So the data centers start from just some regular compute that the customer do the industry do in the cloud to more areas like even on this podcast, when they broadcast that it's probably hosted somewhere inside a data center. So the data center is expanding and also there is a consolidation at the data center in the cloud computing space. Because of that, the expansion and evolution of the data center is faster and faster. When their demand increases the compute, the amount of compute increases, there will be more and more demand on the bandwidth to connect all the computer nodes, you need faster optical connectivity that is driving the need from 800G to the next 1.6T module to the 3.2T module afterwards. And that cadence has been faster and faster. In old days, it usually takes four to five years for each generation to evolve. Now is narrowed to two to three years cadence and the history right the history in that there is an optical connectivity evolution definitely showed that right from 10G to 40G to 100G to 400G a few years ago to 800G today and what we believe in the next three to four years, we will see 1.6T being massively deployed. And also with the arrival of a 3.2T technology in the optical connectivity space. Correct. If you look if you look back in the last decade, there has been five transitions inside the data center space rate from 10G all the way to 800G and at Marvell we are proud to be the main supplier, right, to enable all these transitions over the last three, four generations. And we see that by providing the bandwidth by enabling the bandwidth upgrade, we can massively change how the data center is being constructed, being used and being deployed. So we were very excited to be part of this ongoing evolution.

Christopher Banuelos 05:32
And why is this transition so important for optical connectivity? In the data center?

Xi Wang 05:38
Yeah, I think there's two aspects of that, right. So one thing is for the data center itself, right? When you look at connectivity, we all say, Okay, it's a 40G, 100G to 400G, what does that mean right? So what I mean, there's not only the optical connectivity, bandwidth increases, but also the switch ASICs, the switch systems, when all the bandwidth increases, you want to remain the same redex, right. And also, to reuse the same fiber topology, that network topology, you don't want to change those fiber plans that are already in place, you want to double the bandwidth together with a switch ASICs, and then that is what we do here is to increase the bandwidth at the switch level, as well as at the optical connectivity level. And then that will be the minimum impact or a minimum changes that is required on the topology side. So in the past a few generations, right, so we were able to maintain the same topology at the network level, and then keep the redex. Same, this is why it's so important for this transition to be moving forward at the same rate, or even faster rate as before. So that is the importance for the data center itself. And also the importance is for the connectivity, right? The optical transceiver module, if you look at it as is slightly bigger than a finger, right, and then for that space, you need to pack in today 800G of bandwidth. Typically, inside the optical transceiver module, you have the DSP, the driver and the TIA components, and also the optical components, there's a lot of electronics and optical components to put in, when we upgrade the network, when we upgrade bandwidth over the switch box, the physical dimension of the module doesn't change the physical dimension of the box doesn't change, you need to pack in more and more bandwidth with the same number of counts of components. So that is why they call we need to go faster, but now go wider. Maybe or need to go faster, right, you need to increase the baud rate of the components, the analog bandwidth of the CMOS components, the driver NTI components and optical components, there will be a lot of technology breakthrough that is needed to change the baud rate, change the speed of the component. Not only that, we need newer modulation format that will enable all these transmissions that will be another technology breakthrough, in addition to the raw bandwidth increases for those technology breakthrough will play a long term role to increase the bandwidth not only not only in the optical domain, but also in your electronics to the switch as access to the server side. So that benefit is really important for the optical connectivity to go beyond these network architectures, to go beyond that connectivity, but it also goes into the compute. Those are the two things I see why this is so important for us to continue this evolution of the connectivity.

Christopher Banuelos 09:22
Xi what are the technologies required to enable 1.6T and 3.2 T? What's the status? Is it ready? And what is needed to get to these higher speeds?

Xi Wang 09:34
That's a great question, so at the ECOC this year, I gave a presentation at the market our focus forum. So that is actually the main topic of my talk. Again, if you look at the optical transceiver module as I mentioned earlier, there are the CMOS components, the driver and ti components and optics. So historically The bandwidth between the amount of these components are similar at 800G which we use as a benchmark for the industry, the same as front end is about 30 gigahertz bandwidth, the driver TIA is the same, the optics also around 30 gigahertz bandwidth. So, you just need to match these components together and then bring them together and to build the module. Moving towards to the 1.6T right. So, we see advancement in optical domain with the arrival and the maturity of silicon photonics technology on the optical transmitter side, we have made progress on the bandwidth for the optics from 30 gigahertz to about 55 to 60 gigahertz. Similarly, for the driver and the TI components with the breakthrough in compound semiconductor technology, we are also able to increase the bandwidth to 60 gigahertz so, those technologies are ready. And on the CMOS side will may shrink the technology no the from 7nm to 5nm and also there is a benefit to increase the CMOS front end bandwidth as well. So that technology is also available. So today, if you look at the whole chain right we have the CMOS technology, the driver and a TI technology an optics technology or 60 gigahertz to enable the 1.6T optical module. So all the fundamental technology is mature and is up to the ecosystem to bring this technology into the actual device to to make month 16T a reality.

Christopher Banuelos 11:57
Could we dive deeper into 3.2T?

Xi Wang 12:00
Well, there [are] challenges, right? Because what we see is additional breakthrough is being made to make the optical component have higher bandwidth, they can increase the bandwidth from 60 gigahertz to 80 gigahertz on the optical side. On the driver and TIA side, similar advancements [are] being made. However, the bandwidth and on the same as front end is unlimited. They need to have the new ideas, we need to introduce more advanced modulation technology in addition to the baud rate increase to make 3.2T happen. So again, for the 3.2T generation, even though the fundamental technology is available, but we need to put the more processing power into the CMOS space, into a DSP space to allow a higher modulation format. To enable this yet another two arcs of a bandwidth increase.

Christopher Banuelos 13:09
Xi what will be the lasting impact for data centers for future generations of optical connectivity?

Xi Wang 13:16
So the lasting impact for data centers with the optical connectivity technology, I would say we are building the foundation for the future, right here, right now. The technology breakthrough that we bring to the table to enable 1.6T and 3.2T paves the way for higher bandwidth components across the board, those components can be redesigned and reused to not only connect the data center together, but all the compute nodes. One trend and we are seeing is that AI, the artificial intelligence and machine learning (ML) play a bigger and bigger role in our daily lives. The connectivity between AI and ML today is based on copper connectivity, but they are on the transition to more and more optical. That's just one example the optical connectivity can also [be] in your cars, your homes. We are very excited that this foundational technology we are building can expand to our daily lives [within] the next decade or so.

Christopher Banuelos 14:29
Xi thank you for joining the podcast today. Looking forward to continue our discussion in the future and really excited for you and your team.

Xi Wang 14:36
Thank you, Chris. Our team is excited to work on this technology really looking forward to what is next. Thank you for having me on today's episode.

Christopher Banuelos 14:47
Thank you for listening to the Marvell essential Technology Podcast. As always, please feel free to visit our website to learn more. And we'll see you on the next episode.