# S1 EP28 - Read Channel Innovations

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Join Mats Oberg, Associate Vice President, DSP Architecture and podcast host Chris Banuelos on this week's episode, discussing the heart of hard disk drive (HDD) controller design -- Marvell's read channel technology. Learn about the challenges of data storage as data continues its explosive growth, future technologies shaping HDD controller design, and what is next for HDDs. Be sure to check out our other recent podcast episode 24 "Scaling HDD Capacity in the Data Center" to learn more: http://bit.ly/3FdapmX


**Speakers**

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**Christopher Banuelos 00:04**
Welcome to the Marvell Essential Technology Podcast. I'm your host, Chris Banuelos. Today join me and Mats Oberg discussing what is READ Channel? What are some of the challenges, the future technologies, as well as what's next for hard disk drives? To stay up to date on future episodes, please be sure to subscribe to the Marvell Essential Technology Podcast. Mats it's great to have you on today's episode. I'm really looking forward to our discussion today. I'd like to start off with just establishing what is read channel.

**Mats Oberg 00:39**
Well, the READ channel is really at the heart of Marvell's hard disk drive controllers. Marvell has been selling over 5 billion hard disk drive controllers, since the company was founded over 25 years ago. The Marvell READ IP incorporates efficient error correction schemes, in addition to advanced signal processing, and digital filtering, and data protection techniques. Marvell's advanced architecture really allows the customers to achieve best in class areal density, data reliability, and power consumption in order to effectively meet the growing demand for storing more and more data. And always data stored on the on the hard disk drive what's really stored on magnetic disks, that's kind of mini magnets that really points up or down from the disk. And basically, magnet pointing up representative one and magnets pointing down represents a zero. And the writing process goes to have a right hand that tries to magnetize the media in this direction. So basically, if we want to write one by one it point up. And if you want to write a zero, maybe it point down. And then we come back and read this data. And then it's a READ sensor that passes over the data and senses the magnetic fields on these magnets and basically returns in electrical signals, this electro signals goes through a preamplifier and then into the READ Channel of and then the purpose will read channels to accurately decode this data and return it to the user.

**Christopher Banuelos 02:22**
Mats, what are some of the challenges?

**Mats Oberg 02:25**
Well, one major challenge is kind of the ability to, to say retransmits. If you write data, and then you come back a year later, and you want to read the data, well, if it's up there, tough luck, you may not be able to retake and a wedding pictures or something. So data needs to be written reliably. And to keep the costs down. There's also ways to really store data as dense as possible. And today, we have hard disk drives with a capacitance of 22 terabytes, that's shipped to data centers. And this is really expected to grow to over 40 terabytes by the end of the decade, if not before them. So basically, what we have to do is we have the squeeze in more data per desk. And if possible, more disks per drive. Getting more disk drive, you're limited by the form factor of the drive. Drive is roughly one inch high in the data centers. And how many disks can you squeeze into that. Right now, It's about 10, trying to squeeze in maybe 12. But seems like that may be a limit. But of course, you can't really make the disks and the bigger because once again, the form factor of three and a half inch disks if you want to make them bigger, you will actually need to change the form factor in the data centers. But the other thing, of course, to add additional capacity is to increase the areal density. That's basically number of beds you fit to desk or to give an area of the desk. Of course, when you do that, it makes it a little bit harder to reliably read back during the day. So the main challenge for the READ Channel is to really continue to improve the performance year after year. And one of the interesting aspects of the READ Channel is also that it's a closed system to the best of the READ Channel both write the data to the disk and reads back the data from the same disk. So there's no standards limits innovation for us.

**Christopher Banuelos 04:46**
And what are some of the future technologies and READ Channel?

**Mats Oberg 04:52**
Well, there are a lot of interesting signal processing challenges for signal processing architecture to be working on and the READ chanel. And we have already kind of pushed the envelope or the basket of signal processing solutions. And so we're trying to go beyond that. And obviously, machine learning, [has] this significant interest in academic community, but also inside more wealth region development. For example, at Marvell, we utilize machine learning techniques several years ago, that was prohibitively complex to implement and utilize that mainly for kind of guiding development, what can we do? Recently, we've utilized machine learning techniques to provide additional gains with, for example, nonlinear equalization. You know Chris, one of our engineers won the "Best poster presentation award", at the recent Magnetic Recording Conference, or also known as TMRC, back in August. And in addition, we're also looking to kind of develop better air control code such as LDPC codes and aura codes, to bring us to the next capacity gains. So machine learning is a big thing in the future. And we're also looking to develop better error control codes such as PC codes, and we're looking into polar codes as well. Well, there's a lot of lot of interesting challenges going on.

**Christopher Banuelos 06:23**
One of my last questions for you Mats is what's next for hard disk drives?

**Mats Oberg 06:28**
Well, the industry has, like I mentioned, they're looking for more and more capacity. And the big thing now is actually medical energy assisted magnetic recording. And that's basically where you use laser to add heat to the disk. Or you use microwaves to add energy so that it makes easier to flip the bits. And this actually allows us to use bits that are hard to flip and room temperature. But then when you heat them up, or excited with a microwaves, they get easier to flip to do this in the right process example, you have a laser spot, you heat up the spot where you want to write, and then you can write a bit of the bits there. And then when the laser passes by, the media cools down and immediately stable. So this is what kind of the companies are looking at now and in the future. And trying to really make this into markets, which will help us achieve this 40 a terabyte and talking about even 50 terabyte drives in the future. So this is kind of an exciting time in this area.

**Christopher Banuelos 07:39**
Matz wanted to take a quick second and just say thank you for your participation today. It was a great conversation, and I look forward to continuing our discussion in the new year.

**Mats Oberg 07:47**

Thanks, Chris. It was a real pleasure for me to take part in this conversation, and I'm looking forward to future discussions. Thank you. 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.

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