



## **Celebrating 40 years of Ethernet! – from 2.94 Mbps to 800 Gbps ...**

**30 September 2020**

### **Transcript**

#### **Featured Speakers:**

**Analyst Chair:** Tam Dell'Oro, Founder & CEO, Dell'Oro Group  
Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship  
Brad Booth, Chair, Ethernet Technology Consortium  
David Law, Chair, IEEE 802.3 Ethernet Working Group  
Nan Chen, President, MEF

#### **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Thank you, Mark. I very exciting to be sitting here with all of you. First of all I want to say what a true blue Ethernet gal Ethernet fan I am. This is a multi gig Ethernet chipset with a diamond. Thanks to the NDP Alliance, Chair, Mr. Peter Jones, we turned it into some bling. I. So, I, I want to just say Bob you've made possible, a wonderful opportunity for you and all the others that have built this industry, change the world. It's remarkable, remarkable wouldn't have Dell'Oro group had it not been for Ethernet. So what I'd like to do is shift over and chat a little bit about what Ethernet has brought to each one of the panel members. Okay, so perhaps we can kick off with David law, you share with us what Ethernet has brought to you and your, IEEE 802.3 forum that would be great.

#### **David Law, Chair, IEEE 802.3 Ethernet Working Group**

So, if I may, I'd like to start off with a quote from Bob, Bob, I believe it's from a blog so I hope I have it correct, my apologies if I don't, but if the quote is at its heart, Ethernet is a brand and innovation brand. Brands make promises so it's entirely appropriate to ask what promises Ethernet makes such as the promise for openness interoperability at higher speeds at lower cost. Ethernet to promise also comes in the form of open standards and fierce competition. But interoperability. Among competing products. It also means preservation and backward compatibility with install base and the rapid evolution of I triple E standards on the market. Engagement long live ethernet. Yes, long live ethernet,

- 1 -



**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yeah, sure.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

So, I just I mean that I always remember that. I mean there's key parts there the key parts about standardization in there which is the interoperability of standards, etc. From an organizational basis, because for a two to three years we've just heard from Bob. You know the blue book, what, what we're celebrating the 40th anniversary of today. It was the foundation of the 802.3 standard. Earlier this year were tweaked it was a v2 version that actually became the of the blue book that became the 802,3 1985, which was the first IEEE standard, and that that was based on the blue book and of course by then. We're starting to get established in the marketplace. And 802.3 was already working on additions to the standard as well. 10 base 2 10 broad 36. So personally asking about you personally and Tam you covered. Of course the thousands of people, hundreds of thousands of people whose careers are based on Ethernet and I'm one of them I've had a 31 year career based on Ethernet. And actually I wanted to touch that touches on something else Bob mentioned, which was the fact that he co-founded 3Com, I was 18. I was employee for 18 years with 3Com was, of course, required now. Yes. So, 3Com is also very important to me personally, of course, but more importantly 3Com and the companies that were founded based on the commercialization of Ethernet. Built this massive ecosystem that is still growing, because more and more areas are wanting to use Ethernet. So to me it's not just the innovation in the blue book but it's very important what we're celebrating today, but it's also how, Bob, and his entrepreneurialism brought that invention and commercialized it. That's an important step that is an incredibly important step.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Very, very. Thank you. Thank you David and I would say, 3Com, was one of the very first customers of Dell'Oro group. What do you think of that.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Again, all part of this wonderful ecosystem that Ethernet has built.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yeah. Yes, so we shift over to you and. Go ahead.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Say so Tam we paid you to tell us how many Ethernet, we were selling.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

That's right, the ports, how many ports

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

So thank you Bob

- 2 -



## **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Nan why don't you tell us about Ethernet into the telecom infrastructure. What y'all been doing there.

## **Nan Chen, President, MEF**

Yeah. Yeah. Happy to, you know, when we started MEF in 2001 and Ethernet at the time is more of an enterprise technology, not more, all the enterprise technology, and for carriers, like AT&T, you know, the Verizon doesn't exist and, you know, SBC bows out the France Telecom, they all using something called SONET SDH I think a lot of people in this particular group may not necessarily remember that. But, either as nowhere near what is it today obviously. And so the idea there is really simple. At the time enterprise already building a gigabit backbones and we starting developing I was involved in, I triple E with them a lot and companies doing 10 gigabit ethernet standardization and up to nine, like a 1999 and 2000 timeframe. And I personally just thought that was really ridiculous to have a gigabit backbone of Ethernet and then you have something called T one, you know, which connecting offices together. First of all, a different protocol. Secondly, is, you know, 1.54 megabit per second versus a gig. It just doesn't seem to make sense. And we want to build beside the building a startup around that concept, but also really is a building industry platform to for two reasons. One is to building standards extend Ethernet capabilities into a carrier space and you need a, you know, really perfecting making Ethernet more of a carrier class. Secondly, is really building a marketing platform to do that. And I think is a, you know, if I looking back and to see the success of MEF from, you know, zero to one, if you would, is really because I think three things. One of them is clearly have a bunch of visionary, who actually come together really helping to get the forum off the ground. People in the first group of people, not only from company perspective but a organization perspective but also individual perspective, they'll really drill in and you innovators and wanted to get internet becoming, you know, predominantly carrier technology. That's one second one is we focusing on that kind of Ethernet services because that's where make money, you know get like Bob said earlier today. You got to follow the money. Well you can sell the technology, unless the, there's money associated with it. So from carrier so if they sell Ethernet services, that's actually a money. He made. And number three reason I think we, we, that that was a reasonable kind of united the industry together. And that is so that you don't have to say, initially we all knew at the time you know Ethernet is going to win out as a transport technology but there are a lot of SONET bigots there out there say, Hey, you know, we should do Ethernet over SONET that's the infrastructure we already have, we should deliver Ethernet services, but nevertheless we use that as a way to really kind of a united the industry together move forward and eventually, you know, SONET SDH as well now today, nowhere to be found. Also Ethernet. And in the carrier space, but number three the most significant reason personally is Bobby Bachman he really kind of mentored me, myself and also guide the MEF, through the, you know, thick and thins, in terms of being able to give us an advice and be able to have be the spokesperson for us. Through the years, and obviously I'm, I have learned so much just be around with Bob, to be able to leverage the experience as well as it's his ability to be able to, you know, cutting through the bullshit you know you just say what you need to do to get things done and move things forward. So I'm personally grateful and I build MEF, as it is today. Obviously we do a lot of different things but Ethernet itself is fundamental technology, and really move forward, make a MEF, as, as it is today. So Bob Thank you, that was a it was awesome right and, you know, awesome, awesome conversations as awesome experience and an awesome wines along the way. So,

- 3 -



### **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

yeah, very good Nan. Let's shift over to Brad, Brad. Why don't you share with us what has Ethernet allows you to do where, how has it affected your world.

### **Brad Booth, Chair, Ethernet Technology Consortium**

Yeah, so it's been it's have a pretty major impact so my background actually started in the telecom industry, predominantly in Canada. I work for Bell northern research out in Ottawa for a number of years working on things like T one, E one, J one all the base level telecom specs, based on copper, then this crazy thing wrong came along called fiber world where we were going to suddenly do fiber communications. And then I shifted, I was looking at the telecom market and I was like, you know, this is really cool and then I went to work for a startup, which was PMC Sierra eventually that when they got to a point they were like, We own 90% of the ATM market, but it's still not worth as much as 10% of the Ethernet market. And that was sort of a little alarm that went off in my head and I'm like, okay, obviously the Ethernet market is gonna far surpass ATM, I need to move over into the Ethernet market and so for me that actually caused me to transition from living in Canada to living in the United States and I actually moved to Austin Texas where, where Bob is now located and went to work there for a startup, and what I saw when I got there was you know I was just an IC an a sec designer. And I got sent to a standards meeting. The first standards meeting I got sent to was in Hawaii so I'm like hey, this isn't too bad. I get to go to a standards meeting in Hawaii. And I went there and it was, it was interesting, it was. To me it suddenly made me realize you know all this tech that I've been working on where we're so focused on trying to drive something to what your marketing people have told you this is what we need built to suddenly seeing all these other engineers with different opinions and different ideas and but collaborating, like literally sharing, you know, at the time we I saw some of these guys literally sharing RTL code you know literally telling the others no you've designed that wrong. This is how you need to design it, and I'm like, This is strange. These are two competitors and yet they're working in a collaborative environment and I think that comes back to what Bob was saying right there was by that point in time, you know, there was an understanding that interoperability was absolutely key the ability to have multiple players. Build interoperable parts, was a very much a foundation of what drove Ethernet forward. I think the other aspect that Bob touched on, is we stuck with where we were the best at, you know, we didn't say oh we're gonna go in and write a new TCP IP protocol or we're going to go write some other upper layer protocol we said, you know, this is, this is the Ethernet spot this is where this group is going to exist in work. And that allowed me to, you know, move forward to actually chair. Eventually edit a standard so I was the editor in chief for the 10 gig Ethernet standard, and then went on to chair the 10 G base T standard. And at that point in time when we were looking at the industry, I was like, we need a group that exists in perpetuity to support Ethernet. So at that point in time, as Dave and I and various others in the industry talked and we decided to form the Ethernet Alliance. So the Ethernet Alliance got kicked off to be a marketing arm, which allowed me to meet with people like Mark Fox and various others in the world and travel throughout the world to talk to press about hey, this is the Ethernet technology and see what people were coming back with saying and what they wanted from Ethernet technology. It was interesting at the time when we created the Ethernet Alliance the tagline was from consumer to carrier.

- 4 -



And that's actually become very much true i mean if you look at where Ethernet is gone. The beauty is is that it's just a fundamentally a transport protocol which allows us to go just about anywhere with this thing. And then eventually, you know, moved away from eaten alive because I realized, one of the gaps existing in our industry, which is what we call the Ethernet technology Consortium, was that IEEE has a process that works extremely well for collaboration and consensus building, but sometimes there's these little one offs, that we need to be able to do. And the timeframe for it is actually more urgent. So, the Ethernet technology consortium uses the IEEE standards to build off to build these little one off nuances to help the industry because our industry has changed. You know, the enterprise industry that we grew up with. In the 90s in the early 2000s is really changed to be, you know, a hyperscale market, and we've seen, Ethernet, you know progress into cars and into IoT and into powering devices and stuff so these massive changes allow us to be able to implement or drive new innovation on a, on a slightly faster pace, but in a collaborative effort with 802.3 so for me it's, it's been an amazing ride. I've had the pleasure of meeting Bob at various circumstances throughout our careers. And it's always interesting to see in this industry how someone with an innovative idea and innovative concept can actually with Ethernet developed some pretty interesting technologies.

#### **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Terrific thanks for summarizing that Brad. Okay, now I'm going to shift the conversation to some of the issues that we're, we're dealing with 800 gig is coming into the market coming on to all of the design. We have two separate camps. We've got one here that says, hey, the most efficient, effective way to drive 800 gig is with 50 gig lanes. And then we have the other guy saying, No way. It's going to be hundred gig lanes. That's the most efficient. So now we have a little bit of discord, which is not exactly bad. So, tell me what you think, what do you think about this discord is that gonna blow things up or you think healthy competition. Brad you want to kick that off where Bob, what have you jumped in.

#### **Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

So that's nothing new. I mean, we were arguing about 10 meg versus 20 meg, we were up one Meg, you know, 20, 30, 40, years ago. And so arguing between 50 gig lanes and hundred gig lanes that's just par for the course. The trick is to be sure, of course, for that process to converge. By the way, I ran into Brad at a bunch of ethernet parties. And one of the secrets of Ethernet success was we is parties, having lots of parties. Of course it's gotten harder now at this COVID thing. So this is an Ethernet party that we're having right now. And it's to celebrate these guys, it's a celebrate the successful working out of controversies like this 50 hundred controversy, you know, over the last 40 years, 802, and its related activities have managed to work this stuff out and look what we got. As a result of that, so I'm, so at this party my goal and coming to this party was to thank all the people who made this standardization effort, which say we began on September 30 1980 to thank them for seeing it through and I'm sure the 50, 100 controversy will get worked out somehow. Probably by using 25 instead.

#### **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

We've got some absolutely brilliant minds on this I mean, Andy Bechtolsheim is a is a legend in his own, but all the guys over at Broadcom too got some Smart Cookies over there.

- 5 -



### **Brad Booth, Chair, Ethernet Technology Consortium**

Well, I mean, it is interesting time because if you look at the technology right, we, we try to progress the technology at a pace that allows innovation and return on investment. It was you know interesting listen to Bob talk about you and Jensen talk about startups right when you're trying to do, innovation, you know it's very hard to go and invest in these technologies because it's a massive cost nowadays like doing a wafer run, today is, is, you know, it's for a lot of these companies, it's what used to be the investment that they used to get 10 -15 years ago from a VC, that's the total investment now has to go to a wafer run. Um, so what we're seeing is yes there is this debate going on I mean, we're working. We're 50 gigs is out there electrical is out there and that's what we're using today to drive 400 gig hundred gig is coming, you know, the IEEE hasn't finished its specification The IAF is still working on that specification. But now we're even talking about 200 gig. And, but this is all these progressions are going to change and their timeline of adoption is going to be based upon you know what can I get when, and in, you know, do I have to do extra circuitry so for example when we look at when I'm working at Microsoft and we look at building these things. Yeah, I could do if I'm trying to do a 400 gig link, which uses 100 gig per lambda optically. I don't want to drive it with 50 gig electrical lanes I want to drive it with 100 gig electrical lanes so I don't have to put this gearbox re timer in there because that's a power cost for me I actually have to burn more power to be able to do that. So, you know, I think things will trend to match we've seen that with one gig we've seen it with 10 gig we've seen it with 25. Eventually, what happens is your electrical line and your optical lane will match, and that gives us your lowest cost lowest cost denominator of being able to build these things lowest power lowest cost and then eventually, that's what the market drives forward with in volume. And then you move to the next technology, another three to four years

### **David Law, Chair, IEEE 802.3 Ethernet Working Group**

Yes kind of wash, wash and repeat, but just, just to add into this discussion, kind of late breaking news. So just a couple of days ago 802.3 announced that we were the Beyond 400 Gigabit Ethernet call for interest so that's kind of our. The first step in our standardization process and Brad's already touched on it because I was going to mention 200 gigabits per second, as well as also, you know, part of some of the initial discussions that were leading up to that call for interest because I'll know if it's beyond 400 gigs so 800 gig is in scope, one gig is in scope, sorry I always do this one, terabit is in scope. 1.6 terabit is in scope so they're not just the 800, but anyway more to the point is as Brad's already mentioned you know 200 is also might also be an option for eventually, certainly eventually 300 gig and, yes, it tends to the endpoint usually is when the, the Ethernet rate and the serial rate and the electrical rate are all the same. And then that's it that's the complete move on to the next. But, but there's also what's happening because as you know when you was nobody got 800 gigabit 800 gigabit serial technology right now, you have to start with multiple lanes. And you may end up with generations that 800 gig one that's 16 lanes and you do an eight then you do a four and some people believe four is a particular sweet spot but then if you wait for that you're not going to get the early technology. So, lots of interesting discussions I'm sure on this.

### **Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

- 6 -



How about getting to one terabit per lambda, when's that going to happen.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Oh, that's a good question.

**Brad Booth, Chair, Ethernet Technology Consortium**

Yeah that's that one's really interesting. I mean we're at 400 gig per lambda now right that that's being worked on that one t per lambda that's gonna be fun. I'm hoping to be retired by then Bob.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

I can't imagine you'd be retired

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

that gets me to the next point. All right, we're talking about, you've got different folks here in the standards body, trying to get some kind of cooperation. Well, how is a vendor let me I got this written down. How do vendors drive innovation. If the standards bodies are forcing, some sort of commoditization.

**Brad Booth, Chair, Ethernet Technology Consortium**

That's always a tough question. Go ahead, Dave.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Oh well I was gonna say, it took to me the key point with all of that and I guess with Bob mentioned that earlier on when he was talking about the whole approach to Ethernet is his standards should only specify what it what is necessary to specify. So, back, back to the back to the, the quote I get from Bob earlier on, you know, what are the key what are the what are the key components and again, picking out you know the brand what's the brand interoperability, is the key and backward compatibility as well. But there's only so much you need you need to define what the signal is at the interoperability interface standard shouldn't be specifying how you implement that standard should also not over constrain that you shouldn't you shouldn't put anything in extra, and that's where the innovation happens. And that's also important to allow technology to change because what today we think is feasible and the best way of implementing something may not be in 5, 10, 20 years time and again the standard shouldn't constrain that so key to me is specifying only what is necessary to provide the interoperability that's required.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Is that, So, it sounds to me like differentiation could be that SNA software dust that IBM sprinkles on the token ring. So how do you stay away from that software dust that impedes others. But still, get, get the cooperation.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

- 7 -



I have a great example of this that at 3Com we were building some of the early Ethernet NICs, and they had to conform to the standard and they were commoditized to use the word, but one of our geniuses Ron Crane may rest in peace. He delayed the handoff of the card to manufacturing for a month. While he developed a lightning, a lightning protector for the card. Now the standard doesn't mention lightning protectors and we had no requirements document. But Ron Crane had a hunch that lightning was going to strike and we sold 1000 cards to this bank in New York, and they bought 1000 other cards from our competitor, whose cards were cheaper than ours they were you know going down the commodity cost curve and we weren't lightning struck, fried all of our competitors cards, and our cards kept working so we were able to, we were able to get more than the commodity pricing on our cards, our cards were always more expensive than everybody else's.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Wow. That's a great story

**Brad Booth, Chair, Ethernet Technology Consortium**

And I think that's an excellent point.

You know, so this is where innovation comes in. I don't. The foundation of using Ethernet is being able to use something that's interoperable. If you create too many what we in my industry call a snowflake these too many single level variances. It's hard to put it into a massive deployment. If you're deploying, you know, millions of servers like Microsoft has millions, you know, a couple millions of servers out there, and you don't want the snowflakes. The single little snowflakes existing out there because that becomes a management nightmare. So, what we look for where I'm seeing the innovation come is not in trying to make Ethernet better so much you know the innovation that the speeds and feeds and progressions are Yes, but that needs to be like said commoditized is, is the term that we like to use, but I think where the innovation is now coming from is in the packaging and in the manufacturing of these technologies, especially as we move from using a lot of copper technology into optics, because now that is becoming, especially in the, in the hyperscale data centers optics are becoming more relevant. And as that starts to happen. That's where we're looking for innovation and that innovation is not applied directly to the Ethernet technology per se because Ethernet has done a fantastic job of what it was set out to do. And, and keeping that as a base level technology that becomes the foundation technology, this is what I'm going to use I'm going to build, you know everything else upon that, then it becomes, where do I innovate and it could be in software although a lot of hyperscalers user own software so it's hard to innovate there, but it's a lot of it now that we're seeing is packaging and manufacturing which is where a lot of the value is being being gripped.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Okay, thanks Brad, you know I'm looking at the time and I think we have about 20 minutes left, approximately, we want to leave some time for Q&A with the press. But I there. I think a very important aspect that we want to address here is a greener planet. Okay. Because we are we are blowing through a tremendous amount of power. Tech. These data center folks are building their data centers, mix to power sources. Right. And we're mostly at giggy, 10 giggy. We got a little bit 100 giggy, and now

- 8 -





we're talking about going to 400, 800 gig. Bab boom with the power, right. So, tell us how are we going to address the power issues and Bob, I think you've been involved with some of this green regenerating of power. So, you we're going to kick off.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Yes, I'd like to begin by attacking the question. You know all this, these power being consumed by all these little transistors shifting on and off all day. Just think of all the energy that we have saved by the couple of hundred of us attending this event. And we're attending this event without going to the airport without flying in a plane without staying at a hotel. So we are saving energy we're green by virtue of the substitution of connectivity for transportation we're already saying, oh not that's not the end of it but we're already cutting energy consumption and. But now, getting the getting the. I think the other half of the motivation is that cutting power is comes with speed. So we're already motivated to cut power because we want speed and we want size and we want all the other features which. Thank goodness, are highly correlated with energy consumption I think inversely.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yes, yes.

**Brad Booth, Chair, Ethernet Technology Consortium**

Yeah, a lot of times, unfortunately, I was gonna say a lot of times you know it's interesting when you build a data center. You know, it's not like, Oh, I'm going to put a new technology in and I'm just going to turn up and get more power for my utility nearby, our data centers actually usually are power constrained. So that means for me to, you know, for us to innovate and to be able to build into this we have to figure out ways to advance the technology, but also get that power back, or put it into our users, you know, our end users are not looking at Microsoft and saying, Oh, I'm on Microsoft because of their network no they're on Microsoft because of the applications they can run in our servers. And so for us, you know, the more power I can put into the servers and stuff and make that available for my end users, the better. Which means I have to figure out how to be efficient I need to eliminate things like gearboxes and re timers, I need to figure out, innovative ways of cooling instead of cooling with, you know, air. Do I look at doing liquid cooling Do I look at liquid immersion cooling. So there is a very strong focus you're seeing that. Thankfully from, you know, Amazon you're seeing it from Microsoft you're seeing it from some of the others in the industry that are saying we want to be energy efficient we want to move to a greener we want to use wind power solar power. you know, you know, methane gas from a cow farm nearby to power our data centers. So, there, there is innovation that that goes on there. And that I think is going to help us because we know we don't have an unlimited supply of power to make use of we either have to figure out a way to generate it ourselves. or we have to be more efficient in what in what we're given, you know, because this is taking away from others in in our communities, you know we have to be very cognizant of we're kind of given a special token to be able to do this and build these data center

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

David, which is the more energy efficient using 50 gig lanes or hundred gig lanes.

- 9 -



**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yeah, good question.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Good question. So depends where you are in the technology cycle. So what we, what we have been doing we have done energy efficient Ethernet we've tried at lower speeds to reduce energy consumption when the link is idle we've also provided an ability to signal in band to the far end device. When the near end device has no more data to send and therefore making the, allowing the far end device to potentially go and save some energy, but of course Bob actually I think you've got the really key point is. Think how many times when we transport mass, when we actually all we want to do is transport information. I mean we used to go to a store and get a DVD and play it. And now we just do it online and you were transporting mass and when actually all you wanted was the information. So I think example to the call today is another example we would have transported all our masses around the planet to eat somewhere and now we're doing it online. So I actually think there is that the networking has provided a huge benefit.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Thank you

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Carry bits not atoms.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Absolutely yes carry bits not atoms

**Nan Chen, President, MEF**

One of the things I think is the green technology, you know, from my perspective, I think we may want to stepping back to look at the, you know, building that network differently. The network has been doubled every since Bobby mentioned Ethernet, the same thing for every enterprise, the building, exactly same way. Sometimes a question could ask and given the ability right now. A lot of things are hosting the cloud is actually, is this actually necessary for every enterprise builder network, is that actually necessary. So, if you think that things are slightly differently, it may potentially could have, you know, shipped out the how the networking, you know, as we know it today, to a different paradigm, you know, sense of may or may not be necessary for every single enterprise to, to build a network. That's a huge saving of energy, you know, it basically paradigm, how that thing's gonna work out.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Good point. Man, what a nice way to wrap up the call here. Let's now open the line to the press. For Q&A, and I'm going to come over to this little Q&A icon and see about asking some of these questions. So, our.



**George Rickman, NetEvents**

Should we start with Guy Matthews, Tam?

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

You know we got, oh yeah, There we go. All right. Here is from ai, ai business guy Matthews. How do you so called intelligent, Ethernet services shipped in the era of artificial intelligence and adaptive networks.

**Nan Chen, President, MEF**

I can take that I think, Oh from, you know, we were not into like Brad or Dave is doing on the on the bid side we, you know, take advantage of what they have built. We're building, we're trying to make money out of that so we're really building a services on top of on top of what Ethernet has provide. And, to that extent, giving today's industry is a much more diverse and also you innovation happen a lot a lot of places and standards becoming really, really actually really important to be able to connecting different industry together, to actually deliver services and the customer looking for one of the example of that is the, you know, we, we have this initially we have the camp of carriers who actually want to build something that have people like cloud guys, Google, Amazon and Microsoft that were wanting to do something. Now we actually see Ethernet being that under, under link, and the new services like SDWAN, being defined and unite the people together unite those two camps together into working together, in a sense, I mean, in competition obviously but still the example of that is that you know Microsoft recently joined join MEF, simply because they want to have universal SDWAN to actually be able to deliver you know over a transport like Ethernet, and in fact it's specifically Brad is Azure, you know joined join the MEF to do exactly that. So, what we the intelligence, the more and more moving towards the network edge as well as the, the computing edge. It, all the intelligence that would be getting closer to the customers that's where they really the AI's and all the analytics is happening, but and then that that analytics and as well as the security as well as the overall quality control zone at the edge of the network where you deliver to the end user. So it's really important to have that cohesive end to end, not only QS perspective but also security view of on a per user per application basis, and to be able to.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Thank you Nan, I'm gonna cut you off, only because I think you made a very good point and I want to get to a bunch of these other questions. Okay,

**George Rickman, NetEvents**

so the next question we have from Hector Pizarro from Diario TI, I'm gonna allow Hector to actually ask this question over his audio so I'm just going to unmute his microphone.

**Hector Pizarro, Diario TI**

Thank you Hello, can you hear me. Yes. Thank you. Congratulations Bob on your great invention. My question for you is regarding automotive Ethernet. So with all the infotainment high resolution cameras Raiders etc. We're talking about a future need for multi gigabit bandwidth in cars. So somebody actually said that cars will become data centers on wheels. So the question is, do you think that

- 11 -



Ethernet is up to the job even considering the physical limitations like the weight of the wires, and particularly the bandwidth that is going to be needed in cars

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

our cars are gonna need many networks, I need to talk to each other they need to talk to the road they need to talk to the internet, they. There's not going to be one solution so it's not as if automotive Ethernet will be the, there's this other standard what's it called ICANN. The car area network. And it. I think what I'm hearing is that the can. The CAN bus and the Ethernet are going to coexist inside of cars. Yeah, I've run out of things to say about it it's it was very exciting when I ran into a bunch of car people arguing over the relative merits of Ethernet and which standard to adopt so it was again it was a standard. We're celebrating standards today that that was also a standards discussion the CAN bus is a standard, Ethernet standard How will they be used in some combination. That's it the right.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

sure you're turn them just make it quick so we can go to the next one. Okay, Dave.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Okay, I was just gonna say so. As far as what we've been doing in 802.3 on, automotive, I mean automotive Ethernet first was using cars as a diagnostic port wasn't even used that 100 megabits per second wasn't even used when the car was running but now it's very different. So we've done everything from 10 megabits per second, up to the most recent standard added two and a half, five and 10 gigabits per second, and we're currently working on a greater than 10 gigabits per second. Ethernet automotive Ethernet standard, although I will always point out is, it's actually applicable in aircraft trains trams trucks. So automotive Ethernet is kind of a marketing term but it's more transportation Ethernet. I call it. And so those speeds are on single twisted pair, so it's not the four pair cabling the you know the patch cords you would not normally be used to that. I got a yellow one to celebrate the course, the yellow cables. So the single payer is to reduce the weight and exactly as the gentleman mentioned, and also there's plastic optical fiber as well standards on Ethernet we've done one already for gigabit, and we're working on multi gigabit optical fiber. There you go. Hopefully that wasn't too quick.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Very cool. I like your yellow cable.

**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Oh yeah well that was that was good to be why demonstrate many people think this is Ethernet. In fact, many people think this is the internet was gonna be my point. When I was talking about the various other things we do with Ethernet these days like automotive Ethernet which is no longer an rG 45, but I thought in celebration of the bluebook code have a yellow one.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Whatever you do, or whatever you do don't call it wired Wi Fi

- 12 -



**George Rickman, NetEvents**

the next question. Yes sure that the next question is from Simon Bisson from ZDnet. Despite the success of leaving the appropriate things to higher layers in Ethernet and given how many systems now rely on having the right security at the hardware layer. Is there a need to now have security down in Ethernet, that the higher layers can build on. And that's to everyone.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Yeah, so you're right when we designed Ethernet we assume that security would be handled at higher layer layers and our understanding at that time was very cryptography oriented encryption all was going to have encryption and it'll be at a higher level. And I'm not sure I'm ready to change that position that is the moving it down into the hardware may not get us where we want to go I think it's almost the reverse is getting it up into the applications. Someone once said that optical fibers were a security problem because you could bend them and then the light would leak out, and then you can report, what's going by on the fiber because of the light leaking out from the cladding. So, see some insecurity down to the fiber doesn't work because it'll the light will leak out.

**Brad Booth, Chair, Ethernet Technology Consortium**

I think the other aspect to that people need to remember is Ethernet is a point to point technology. So, you know, well we have Mac sec, which is available to do encryption on a point to point basis. Most people are looking for end to end, you know, data in flight or data at rest security and that's a whole different level of security so Ethernet I think has done a good job of saying, point to point will do will give you a level of security but if you need something to go and you need to add something on top of that, to be able to.

**Nan Chen, President MEF,**

Yeah, today I think it's a, the old flexibilities. While we see it, and on a per application per user level has to be done on a higher level, I don't think Bobby you need to change your position is completely correct you build, build a highway and people will do a lot of things on top of it and make it more efficient. You don't need to every layer have a security. So that's that that's what we see and being implemented by the customers.

**George Rickman, NetEvents**

So the next question we have is from Anthony Caruana, who I believe is from Australia so it's incredibly early for Anthony, and he's from Computer Weekly, and he's got a question for Bob, he says. Many of the changes we've seen over the years with Ethernet have been linear faster smaller next thinner cables etc. Where do the nonlinear leaps that have seen Ethernet leap ahead, and not just incrementally change.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Well, there's a judgment call in there so for example the move from coax to twisted pair was a huge Lee important leap in the mid 80s, but you've relegated it to a minor improvement. That felt really big at the

- 13 -



time and of course going to fiber, and then eventually going back to radio is we've now done with Wi Fi. So, so, from a plumbers point of view, those are big changes, but the pop up a level, the really big changes have to do with the uses of Ethernet. As I mentioned earlier, the, the way we, the killer app for the first Ethernet was PFMTS - print file mail terminal service and it has stubs or API's, so they were the first Ethernet we sold did printer sharing and disk sharing basically, but then this multi user accounting came along, thanks to Novell and others. And that immediately transformed Ethernet from being a PFMTS thing to a multi user accounting thing, and then the internet came along and now people buy Ethernet for none of, they don't use it to do multi user accounting that much it's all internet access now. So, those are transformations of the uses of Ethernet and the creation of dramatically larger markets for connectivity. So the, the Wi Fi leap I want to touch on you know we used the speaking of Hawaii. You know Ethernet borrowed a low, high net randomize retransmissions in the early csma CD version of Ethernet. And people have asked why didn't you just use radio in 1973. And we knew all about radio because we had gone to Hawaii and we could see their modem, their modem for at 4800 bits per second wireless was as big as the Alto, personal computer. So it was slow and it was big and it was expensive, we had to wait 20 years for the semiconductors to make Wi Fi practical. 20 years waiting for the semiconductors. And so, and then when it came in the 90s that was another one of these big leaps that I think you're talking about Anthony. Yeah, that was a that was a huge leap. And whatever you do don't call it wired Wi Fi, that would be annoyed by that.

#### **George Rickman, NetEvents**

So, the, the next question, I have to the whole panel it's from Jim Carroll of Converge, Network, Digest. And he, he says, are the new generation of smart NICs powered by DPUs, really, the third socket for data centers after CPUs and GPUs. That's to everyone.

#### **Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

I wish Baron Fung on our team was listening in because he is the smart NIC guru. But I can't, I can't. Jim you got me stumped.

#### **Brad Booth, Chair, Ethernet Technology Consortium**

I think you need to understand why, why are people starting to build the smart NICs and the primary reason behind using a smart NIC is that you have to use cores to manage the network in a standard GPU or CPU system right. And so by pulling those cores out and putting them into a NIC and making it a smart NIC, you actually enable that device to manage the network Connect connectivity. Well the CPU and GPU can go and perform all the operations, you can literally sell all the cores that you have existing in those devices to be able to run the applications for your end users.

#### **Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

You know, earlier we were talking about the commoditization of standards, and we talked about Ethernet well one of the early ways that you could sell an Ethernet compatible product was with a smart NIC. So we put I forget what they were called at 80, 86s or something we put them on our NICs to do TCP IP. So to offload TCP IP protocol processing from the CPU. This is in the 80s that we're doing this. Also,

- 14 -



what's that what's the new insight, other than offloading the offloading the processing load of protocols, or is there something else going on here I'm missing.

**Brad Booth, Chair, Ethernet Technology Consortium**

Some of them are actually using, for example in some of the data centers right we're using it to run security protocols we're using it to check whether or not because now you've got, not a single CPE, well, not a single core CPU you've got multi core CPUs multiple VMs. So you actually have to be able to analyze some of the traffic to some degree, to be able to determine whether or not it's allowed access into that or whether it needs an exception processing to handle it. So yeah i agree with you we used to do that. TCP IP offload engines were kind of prevalent in the, in the late 90s early 2000s but that got kind of bumped into the way the smart mixer now, we're actually not running necessarily a lot of TCP IP, you know it could be RDMA protocols, it could be other type of protocols that we have on top of this

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

smart NICs could be the answer to that earlier question is, you know, we're used security we're going to do security and smart NICs.

**Brad Booth, Chair, Ethernet Technology Consortium**

Exactly. Exactly. That's where you're starting to see some of that potentially show up. But it's still an upper layer protocol it's not existing in the Ethernet layer it's actually existing above it.

**George Rickman, NetEvents**

Okay. So, our penultimate question is from David Heath from IT Wire. Sure we can keep increased speeds along with the technology improvements required to achieve those changes. But where is the left turn. Where is the big change.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

I think we failed to answer that questions previously.

**Nan Chen, President, MEF**

Well I am always thinking of the big changes. It really is the part to me I mentioned that earlier it's a paradigm shift, how network have been built and to do actually be able to leverage a universally. You know how the network's supposed to be built, instead of a built individual that decision made individually so I felt that there's a there, potentially, time is getting right to rethink the network paradigm shift here.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

So just the virtualization of networking like the virtualization of processing and storage.

**Nan Chen, President, MEF**

Yeah, similar to exactly similar to that and also, you're absolutely right about also the fact that you can, you can think of to the every single business and needed network to be successful. Is that a necessary

- 15 -



evil, is actually necessary tool. I think if you think along something along that line you can think of, you know, how the network can be, you know, potentially centralized or potentially distributed, but not necessarily built by every single business that's out there. And today, that seemed to be the things you need to do for every business.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

I would agree with you Nan, I would say that the big the big change is you don't have to own and operate your network someone can do it remotely you can put your infrastructure some run your one run your app somewhere else.

**Nan Chen, President, MEF**

Just like Bob always says he's a plumber, I guess Jensen said it right you're probably the most highly qualified plumber there is in the world. But we don't need a plumber, for every house.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Well we do actually, I got, I got two hot water heaters installed yesterday and I assure you that was done by plumbers,

**Nan Chen, President, MEF**

but not yourself. You get someone do that for you.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

That's right. Well, they wouldn't let me, I'm not allowed in the basement.

**Nan Chen, President, MEF**

Exactly.

**George Rickman, NetEvents**

Um, okay. So our final question is from Nathan Brookwood and, and it's in the, the first years there were many network architectures contending for the standard, notably IBM's token ring and data points database. What is, what is it about Ethernet that allowed it to prevail over the all the others. Then, and now.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Well, I have a story about data point, which has a lesson in it, the data point came out in the Arc net came out in around 76, 77, and it was sort of an early, early network to achieve success. And when we formed IEEE 802. I was deputized to go get Arc net to be submitted to the IEEE. So I spoke to the VP of engineering there Victor poor was his name, I believe. I said, the IEEE would like you to submit Arc net as a standard candidate. And he said, I'll call you back after my board meeting in two weeks and two weeks later he had his board meeting and he called back and said at the board level we've decided to keep arc net proprietary and not submitted to the IEEE. So that answers the question what happened to arc net for the next. The customers wanted standards they didn't want proprietary networks from

- 16 -





individual companies, of course, Arc net persisted for another 20 years in fact I think you can probably still buy Arc net. But that's what happened to that one. So Ethernet was open interoperable It was. It was too fast, 10 megabits per second was too fast initially. So a lot of the competition like Omninet. And there were 10, others ran slower and were a lot cheaper. So we had a hard, as selling 10 meg was hard we were selling the future that someday, you're going to need 10 megabits per second so you should by the standard not one of these all like Apple talk ran at, I think 250 kilobits per second. And that was an apple proprietary network. Very much like Ethernet just nonstandard and slow, and eventually we got Steve Jobs to put Ethernet in his computers but it took a long time to talk him out of apple talk.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yeah, I want to say

**Nan Chen, President, MEF**

I'm a simple answer to that question, Bob, I'm not as eloquent as you are. I think the Ethernet success. The reason he said success is because is the cheapest good enough technology. That's how I see why ethernet is success.

**Brad Booth, Chair, Ethernet Technology Consortium**

And we have good parts

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Looking at data, looking at the data from the 1990s. I can tell you a token ring, IBM kept the price high and like 200 bucks at four and Ethernet pricing was dropping below, 100, or towards 100. Everybody and their dog was creating Ethernet shocks. Right. Remember Daisy networks. Ungermann-Bass, chip com, [Inaudible] all these guys were coming up with Ethernet dropping the price. And then, IBM had some, or was it Texas Instruments, IBM had problems with their chipset. The next token ring chipset had jitter. So there was a, like a year delay. And by then, pricing on Ethernet, the vendors, the plethora of bab boom

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Can we quote you on that Bab boom.

**Tam Dell'Oro, Founder & CEO, Dell'Oro Group**

Yeah, it just exploded is that very exciting, very exciting ride, and thanks to you, Bob.

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

Thanks to our, our, the current troops on the front lines of standardization of networking, we are lucky enough to have them attend this panel thank you very much for attending and you're the guys we're celebrating today. And don't kill each other, trying to sort out the standards.

**Nan Chen, President, MEF**

Thanks for. Thanks.



**David Law, Chair, IEEE 802.3 Ethernet Working Group**

Thank you.

**Brad Booth, Chair, Ethernet Technology Consortium**

Good. Seeing you

**Bob Metcalfe, Co-Inventor of Ethernet & UT Austin Professor of Innovation & Entrepreneurship**

See you.

**Mark Fox, CEO, NetEvents**

Thanks very much Bob provided the industry of the great legacy and you should be very proud. A lot of the people here on this call, are all actively involved in Ethernet now so Ethernet continues to go from strength to strength so you've provided a gift that carries on giving. So thanks very much to you, Bob from the industry. And thanks everybody for participating today,

**Nan Chen, President, MEF**

well said Mark.

- 18 -

