Bob Metcalfe Part 2

Derick: Connectivity, more than ever, drives how we live, work and play. Join us. As we engage the people who create, shape, and use the technology that connects us. I'm Derek and I've spent most of my life building and operating networks of every kind.

Brandon: I'm Brandon, and I've spent most of my life building software to empower network engineers like Derick. This is Seeking Truth in Networking.

Intro

Brandon: Thanks for joining us. If you're coming in fresh, take a moment to check out part one, which covers the origins of ethernet and Bob' stories from early Silicon Valley. With that said - let's get started with Part Two.

The Real 3 Contributions of Ethernet

Brandon: So let's, let's zoom out for a second. There was one question that you brought up earlier that I wanted to kind of get back to; question was: what were the three big technology inventions of internet? and you mentioned before that they weren't what people think they are. Dive into that.

Bob: Well more importantly, they weren't what I thought they were. That is, for the longest time I thought Ethernet was a combination of Manchester encoding of on-off signals on a coaxial cable, a vampire tap that would allow you to puncture the cable and install a PC connection without bringing the network down and randomized retransmissions as a method of taking turns for putting your packets on this shared cable.

So - Manchester encoding, Gerald vampire taps, and ALOHAnet randomized retransmissions - to me, that was Ethernet. But if you look at Ethernet today, those are all gone. No one uses any of those, but they still call it Ethernet! So there's the mystery. What is Ethernet now?

I realized it was a different list of three things that Ethernet introduced in 1973.

The first one was bringing packets to the desktop. The previous generation of computing, interactive timesharing - use dumb terminals that were all character-oriented. And the early internet was packet-oriented to the minicomputer and then character-oriented to the dumb terminals. Ethernet fixed that. Ethernet had brought the packets all the way to the desktop. You could have software that was sending and receiving packets running on your PC. Not - sending and receiving characters and typing things out. So that means you could send pictures, for example, pictures aren't characters, but they're bits and these packets contain bits. So, bringing packets to the desktop.

The second contribution was the factor of 10,000 that I talked about. Bandwidth was scarce - until Ethernet arrived - and then it became abundant. Then it went up a factor of 10,000. So you could, you could send the ultimately voice and video over it.

And then the third is that Ethernet joined the movement for open standards. So TCP/IP became an open standard through the Department of Defense, uh, processes.

Ethernet became a standard to the IEEE 802 project. And so the, the standard plumbing of the Ethernet was open and anyone could - 3Com was the first to offer a commercial version of TCP/IP, but we were not the only ones because they were open standards.

So, those are the three things of enduring importance that Ethernet had introduced: packets to the desktop, abundant bandwidth ,and industry-standard protocols.

Exporting culture, and how things have changed

Brandon: So we've been talking a lot about technology and I think it would be equally interesting to talk about culture and changing it and what it is. And so you were in the Valley earlier, but you're no longer in the Valley. And you can tell our listeners about where you live most of the time there there.

Bob: Well, we left the Valley in '94. Our family, which formed over that period left in '94 and we moved to Maine. And then we moved from Maine to Boston and from Boston to Austin. So now we're all in Austin. I'm not sure this is a generalizable truth or advice for people. We didn't leave Silicon Valley 'cause we didn't like Silicon Valley. We just wanted a change .

The Silicon Valley of today is probably quite a bit different from 1994. The scale of things is certainly different. I mean, 3Com was a very successful company, but we were never a unicorn.

When we went public, our valuation was close to a hundred million. And we were profitable. As you may know, a unicorn is not public and it's generally not profitable. So my company never got to be a unicorn. It just went to be a public company and yes, it peaked at 5.7. This is all funny money, but anyway, it peaked at 5.7 billion in revenue in 1999 with a market cap, inflation-adjusted: 52 billion dollars.

And as I like to tell my students, I didn't even get half of it. That sort of a joke.

Brandon: Nice. So tell us what you're doing in Austin to enhance tech and to develop it and connect back to your roots.

Bob: So I've been in Austin for almost 10 years as of December. And my mission there has been to help Austin become a better Silicon Valley. Not better than Silicon Valley, but a better Silicon Valley. And that boils down to, since I'm a professor at the University of Texas at Austin, boils down to helping professors start companies and taking general responsibility more broadly for the startup ecosystem in Texas.

Brandon: How do you do that? How do you help professors start companies?

Bob: While you learn about what the professors are doing and talking to them looking for things that look like they might be a company. You have to, you know, sort of the first question is, is this a, you look for successful research, it has to be successful research. And

then you ask, can this research lead to features or products or companies? Is the idea of big enough to be a company or not? And if you conclude that as big enough to be a company, can you figure out how to get it going without venture capitalists? But eventually you cave, and a lot of them do choose venture capital as the route, and then you help them raise venture capital and generally move them forward. It involves a lot of, speaking and attending part at throwing parties, attending parties. I throw a thing called, uh, studios, starting a company as an art. So therefore you should learn how to do it in a studio, and a studio is basically three professors, each of whom present their first deck.

Their first ever deck to about 50 people who are entrepreneurs and scientists and so on. And then from there, they get some training. if they want and with them, we do a mentoring and then we do networking and we try to provide adult supervision. Adult supervision is a, is a key feature of Silicon Valley success. And so providing adult supervision for startups is something we do .

Brandon: So I wanted to ask about kind of the nature of innovation a bit. It felt like, I mean, it feels like we have some massive tech giants now that aren't just big in terms of market cap, but they're affecting popular culture quite a bit. And I'm curious if the nature of innovation is changing as these companies get bigger and get access to more data. We've had congressional hearings around this stuff recently. What are your thoughts there for where the innovation's coming

Connectivity is a thing?

Bob: Well the general, my general view of that is that, connectivity is a thing. Connectivity has its own, disruptions, pathologies, dimensions, laws, and the internet has in 50 years reached more than half the human race. 50 years is really a short time in the grand scheme of things. And we've gotten so much connectivity. We don't know how to handle it. And all these pathologies, some of what you just mentioned are a consequence of our, not really knowing how to manage the connectivity that we've created

The first pathology of the internet was pornography.

The internet was almost shut down by ignorant congresspeople who believed that the internet was being, it was a tool for the distribution of pornography. Well, as you know, we've eliminated pornography on the internet and fixed that problem. It's the next, the next pathology was advertising. That the people who built the internet were offended that anyone would send an ad on the internet and they wanted to make it illegal and shut it down, and there were these two jerks in Arizona, both lawyers who started advertising furiously and, the internet intelligentsia hated them for this. Of course, Google arrived and advertising became the principal monetizer of the internet. Uh, much to the unanticipated chagrin of the intelligentsia of the internet.

uh, so going back to your question where we're dealing with a very powerful resource, connectivity that we don't really know how to handle, and we're still learning how to handle it. And this, for example, this fake news thing, we made a mistake. We asked. Facebook Google Twitter to filter news, and then they made a mistake.

They agreed to do it. So now we have this mess where these very few, monopolies are attempting to. rise above their biases and, and failing miserably. So we're going to have to figure out how to filter information in a different way... the current solution is clearly not working.

Derick: That's a sort of a future looking statement. So the Internet's here and it's everywhere, right, and we got everyone on board. The next step is, is up the OSI stack. A challenge is managing all this data and connectivity or harnessing it for better outcomes. What do you think those outcomes could be and how do you think we could get there?

Bob's Next Big Startup Idea

Bob: I have an idea for a startup. I liked that you brought in the stack just then. Cause I think that that's a good model to stick with. You know, the plumbing got put in that was able to deliver packets. Then the World Wide Web got put in that was able to deliver information with links and stuff, and then search was able to harness that - Google. And then social media, Twitter and Facebook were able to harness that. And so we were marching up like this, but anyway, here's the startup idea instead of relying on Facebook and Google and Twitter to filter our information, let's have a bunch of startups that create filter composers, an app.

That you go to, to choose how your information is going to be filtered. and some of the filters will be brand- name like New York times. So you could click on New York times and add that to your, your filter. Or you could say not, daily news or not. CNBC. So - composable filters - and then you can make your own filter out of the component and you could brand it yourself and offer it to other people.

How many people want to add Bob Metcalfe's filter. So they're composable filters. So I'm imagining a bunch of startups offering this - different ways of composing filters and relieving Facebook, Google, Twitter, et al. from being our filters. We just have this composable branded set of information filter.

That's my startup idea.

Brandon: So in this define-your-own-filter-bubble world, you would need standards for what a filter is and how to access the filters and how to apply them to your view of the internet.

Bob: You would. Yeah, just like you have standard Ethernets you would have a standard for how you code a filter and how you make it composable and how you would connect it. How would you connect to the Twitter stream? There must be a standard for that. So you could connect to the Twitter stream and apply your filter, your composable filters to the Twitter stream.

Brandon: So this, this sounds like one area that you're encouraging others in your Austin community to take on as a startup. I'm curious about what other problems you encourage people to solve.

Bob takes on energy

Bob: Well, a few months ago, I made a big leap in that direction. I am now the principal investigator of a Department of Energy program to enhance the startup ecosystem surrounding the development of - you ready for this? - deep geothermal energy. Which is a solution once and for all, for the energy problem, Deep geothermal is the ultimate solution. So we just have to, in our particular strategy, and by the way, I'm a follower of a woman named Jamie Beard who brought this idea to Texas. Let's get the oil and gas companies to be our partners in this and have them pivot from drilling for hydrocarbons to drilling for heat.

And then the heat becomes our source of energy, clean, safe, cheap energy, deep geothermal closed loop energy. So that's my new project. Connectivity is sort of my ongoing continuing project.

Starting your next company

Brandon: So what would your personal algorithm be for evaluating value here? Right. So connectivity - . you wanted to connect the world? You've got geothermal as well. How would you look at an idea someone comes to you with, and go, is this worth doing, is this worth investing? Is this worth contributing to? What are the things that make it pop?

Bob: Well, I guess the first thing I look at is size. How big an idea is it? Because if you're about, you know, building a startup takes a long time, it's a lot of hard work and it can destroy you. So you want to choose your startups carefully. Your startup has to be worthy of you. And too many of our students and professors propose startups that aren't worth doing.

Every semester one or two student teams want to do it - an app for finding each other on Sixth Street in downtown Austin and where the free booze is . And I say, you know, we've done this six times before. Why would you want to waste your time on that app? Of course their, their answer back is well: "We've been advised that we should do what we know. And we know how to go to Sixth Street and how to drink there. So is the idea big enough? Is it worthy of starting your company, and worthy, meaning, impact. And so geothermal? It certainly has a scale to it.

it can solve energy period and you know, climate change and all that other stuff, or sub-problems of harnessing the Earth's naturally occurring heat - so size. And then there's the people. Do the people know anything? Ideas are a dime- a-dozen - do these people know enough about this idea in order to implement it, or are they just, you know, they have a good idea, but as I say, ideas are a dime a dozen of course, people hate to hear that! I'm not a very popular mentor to give advice like that. You know, your idea isn't worthy of doing and, uh, and you don't know anything. So that's one of the reasons I focus on professors, rather than undergraduates, is undergraduates don't know enough to start companies. Of course, right after I say that, they say, wait a minute, Steve Jobs, Bill Gates, Michael Dell, Mark Zuckerberg.

You know, the list goes on, are people who dropped out of, they were undergraduates when they started these monstrous companies. And I say, well, does the list really go on - name five more? And of course they can't, no, they can't name more than five of these college, dropouts, who you started companies. So you gotta know something.

And, and, uh, there are exceptional people who know special things very early in life, but there aren't very many of them. And I generally don't advise people to start companies when I was 33, when I started my company and I had a PhD, I finished school. I did not drop out. And then I went to graduate school, so to speak, at Xerox and Stanford.

And then I started my company. So I had a claim to know - I knew something.

So that's the next - so is the idea worthy and is the team, does the team know enough to pull the idea off after that considerations become smaller.

Brandon: So you're not encouraging them to solve any particular area, but you're applying a criteria and encouraging within that. Are there any ideas that just really - like the one you just mentioned, the filter bubble one - that pop out as that would be really cool if someone did it - or the world needs this now sorts of things or both?

Bob: Well, there was a time when it was unimaginable that there would be any computer companies other than IBM. They built the chips, they built the computers, they built the databases. They built the software. It's unimaginable that anyone would, and guess what happened? IBM got unseated approximately 1985. I like to say Ethernet was their downfall, but in '85, they got taken over. They got beaten by the vertically disintegrated. You know, the chip maker was different from the soft, the database maker was different from the computer maker. And then it became Microsoft, Intel, Oracle, and then it become unimaginable that that would ever change. And of course then along came Google and the current batch. So. So that's the question. it's unimaginable that anything's going to change. Google is forever going to dominate and Twitter and Facebook are forever to get larger and larger and larger.

No one can beat them, but someone is, we just haven't, we just haven't figured it out how it's going to happen yet. And so, uh, I've skipped over the hard question you asked, which is what, what is the world crying out for?

Brandon: Well, what excites

you

is really the question...

Bob: Geothermal excites me. Yeah. I'm pretty interested in that because it's a hugely impactful question. You know, there are 10 million oil wells in the United States and four or 5 million of them are no longer in use. So there's big potential, in just going back to those several million oil wells and just taking heat out of them instead of hydrocarbons. So that's an exciting prospect because it has major scale and it solves important problems.

The composable filter thing is a smaller idea, but it's closer to my field of expertise. and then there's, what's happening in biotech and biology. That's interesting. Oh, have I mentioned, the internet is not done yet! The internet is getting faster and getting bigger and getting more complicated.

And in the talk that I gave on complexity, I point out that there is a paradox, which gives us hope that there's a bright future for the internet. And the paradox is this. The human brain is made of neurons and computers are made of transistors. Well, if you compare the transistor to the neuron, the transistor wins - it's ten to the 10th times faster than neurons.

And yet the things you can build with neurons are way smarter than the things that we currently built with transistors. And the reason is we haven't figured out the connectivity of transistors. Our transistors are not properly connected. So the Internet has a lot of headroom. There's a lot of growth ahead along the dimensions of speed and mobility.

So there's going to be a next-generation internet. And in fact, the very next generation, is the, uh, I call it the augmented video, mobile gigabit, internet of things. It's coming right now, 5G is part of the, of that wave. And then there'll be another generation after that. And so the, the networks are getting more complicated, a lot of the, the algorithms of the internet that work at small scale begin to break down with larger and larger scale. So I guess I would have to add to the list, the internet-after-next is another worthy one that we're not done with the internet yet.

Predicting the Future

Brandon: So making predictions of the future is really tough. If one goes to your Wikipedia page, there are some examples where you made predictions and then literally had to eat your words.

Bob: I'd like to point out at that juncture that the people who do Wikipedia don't like me and my Wikipedia page is not fair.

Brandon: So I won't ask you to make another prediction.

Bob: I'm happy to talk about the prediction, but I wanted to blurt out that - Wikipedia is a great example, where, it's not a perfect process and those bastards, they won't let me modify my entry in Wikipedia. I've tried to modify it and they undo my edits. So I'm very frustrated by Wikipedia, but yes, you're right. If you go to my Wikipedia page, you'll see early and frequent mention of my failed predictions. So you want to talk about those?

Brandon: No. I want to say, what is it that makes the future so hard to predict? You were just describing that IBM, no one would have thought in the seventies and eighties, the changes that came to the world through desktop computers, networking, and all the things that followed.

I'm curious about your perspective on this, having been there and having been able to look back at 40 plus years?

Bob: Complexity is the reason why it's hard to make predictions. It's too complicated to figure out. Ethernet didn't come to market alone. Ethernet came to market with the personal computer. And both of those were enabled by the 1103 one, memory chip from Intel, but then the internet was coming along at the same time.

So what you saw, there was a confluence of a wave of technologies, all arriving all with their own biology, timeframes and so on, and that was way too complicated to figure out. So for example, Bill Gates is approximately the richest guy in the world because he figured out the exact instant in which the computer world would move from eight bit to 16 bit computers. And the software that Microsoft developed was for 16 bit, not eight bit. And he was right. And that's why he's the richest guy in the world. But just think about that, that simple fact, the eight to 16 transition and all the implications of going from eight to 16 bits, it's just leads to, a great deal of complexity.

So we started developing Ethernet for PCs and we had the problem of how we were going to sell them. And then a new industry was created called computer retail and ComputerLand and Businessland, and Entré Computer all blossomed in the early 1980s. Exactly when 3Com needed them to blossom.

And that was unpredictable. Suddenly they came along and provided us. I don't know how we would have predicted that, but we didn't predict it. We just took advantage of it when it happened.

Wired WiFi?

Brandon: And then a question, that you had suggested, - Ethernet descends from ALOHAnet. So why not just go straight to WiFi?

Bob: Well, you know, today, they, they talk as if there's Ethernet and there's WiFi. And Ethernet has the cable and WiFi is wireless. And by the way, I will be distraught the day, someone calls Ethernet "Wired WiFi", that would just be devastating to me if they ever started doing that.

But, the ALOHAnet, I spent a month in Hawaii and I recommended studying the ALOHA network and we took from it for Ethernet, the randomized retransmission method of sharing so it was natural to think about having a radio network. And in fact, in the Ethernet memo, there's mention of the radio ether using zero wires. We got as close as we could, one wire, the shared cable, but we couldn't get to zero. And the reason we couldn't get to zero, is radio modems in those days in particular, the ALOHA network modem was bigger than the personal computer that we were building. And it cost $30,000, tens of thousands of dollars. And it only ran at 4,800 bits per second, or maybe 9,600, but I'm not sure it ever made that. We needed megabits per second. So we couldn't use radio. Oh, and we couldn't fit it on the card.

Remember I mentioned it has to fit on that card that plugs into the PC. So with all those constraints, we had to go on cable - coax cable. It took 25 years for the industry to create a chip, to make a radio that you could put on this card to make what was later called WiFi - it

was called Wireless Ethernet in the IEEE. And then in 1999, they changed its name, wisely I think, to WiFi.

But over that 25 years, think of all the cables that got installed, They started out yellow, but then they turned blue along the route. So there are virtually buildings being held together by the Ethernet cables in their cable trays. And a lot of people have complained over the years.

My customers: you know, why do we have all these damn wires? And the answer is we're waiting for the chips. You know, Ethernet's progress has always been paced by the availability of semiconductors. And that's certainly true of wireless. So in around the mid nineties, the WiFi chip started to arrive and WiFi took off and, there's still a lot of cable Ethernet shipped but, Wireless Ethernet, also known as WiFi taking over.

Documentation or Writing?

Derick: Some of the people listening to this podcast will be, or a lot of them will be network engineers. I've been a network engineer, my whole career. One very sensitive topic in the network engineering community is documentation. And I read somewhere that, when the Internet was first publicly demo'ed to the world in 1972 at a Washington Hilton hotel - that you were in charge of documentation. Uh, what are your feelings about documentation?

Bob: I call it writing. High on my list of, you know, what skills should you have to be successful? There's of course selling. But part of that is writing. So when we were preparing to debut the ARPANET, soon to be called the Internet, in 1972, I was given the job of producing a book whose title was scenarios for using the ARPA computer network. Think of it as "The Internet for Dummies", circa 1972. And what it was is ,page by page, is how you could log into one site after another, around the United States. And play with it. And so then people came to the Hilton and we gave them terminals and then they would to open this book and they would then move around the Internet.

And, and so I was responsible for writing, I guess editing would be better editing that book, but it was part of my belief that writing was so important. So I wrote a column, for example, in InfoWorld for eight years and had a million readers. And so I recommend that people learn how to write.

I once took a course from the inventor of core memory. Of course you don't remember what core memory is, but it was a big thing. And he used to invite us to his offices at MIT every Friday afternoon for a writing workshop. And he had us this - one year - write the same essay 19 times. And what I learned, I learned a little bit about writing from Jay Forrester, but what I learned was Jay Forrester believed that writing was important.

And so I think writing is important now you call the documentation. Is that the same topic?

Derick: Yeah, that was very good.

Bob:

You know, 3Com spent a lot of money on documentation, but no one does anymore. You expect it to be easy to use, you know, or in the, bowels of the network or do you still rely on documents?

Derick: Oh yeah. Documentation is, one of those things that it causes different feelings of different people. Some people love creating documentation, explaining how the the design choices were made when they built their network. And then some people. .. documentation is a constant source of pain. It's never accurate. It's missing. It's, difficult to read, you know, it's, if you want to throw a bomb into a discussion of, network engineers, just bring up the topic of documentation. You'll see varied emotional responses to it.

Bob: Well, last night, I was in my boat making about 10 knocks across the Penobscot Bay and thick fog. The sun went down and as soon as the sun went down, my electronics, including my radar display and everything switched to night mode.

Because the sun had set, I just put these electronics in the boat, so I don't really know how to use them yet, but I couldn't read the screens because they were too dim. So here I am in the fog, in the middle of the ocean with rocks all over the place. And I couldn't read the screens. So I, you need to know how to turn up the brightness on this display and I couldn't find it, and finally I found the manual by clicking this, I found the manual, but I couldn't read the manual because it wasn't bright e the brightness was too low. I guess that was the last time that I failed to find the appropriate documentation. We eventually found the mooring and, uh, The boat was safe, but there was, you know, an hour or so there where I really wish I had the documentation available.

It turns out really easy to brighten the display. You just have to push the right sequence of buttons, which is carefully documented in the documentation. I know it doesn't sound like a great story right now, but last night it was a major event in my life.

Derick: That must have been frustrating. You can't read the documentation cause the brightness is too low. And that's what you're trying to figure out is how to turn off the brightness.

Bob: Very self referential problem.

One-liners

Brandon: So Bob, I want to be really sensitive of your time. We're getting towards the end. We have a few, one liners we want to ask you. First off, whose story would you like to hear next?

Bob: Marc Andreessen.

Brandon: Great idea.

Bob: Danny Hillis,

Grace Hopper. Interview somebody who knows her story. We don't know her story. I mean, she allegedly invented the bug. I'm a recipient of the Grace Murray Hopper award. And so I found out a lot about her, in 1980, when I got the thing . Who is this person - Grace Murray Hopper? .

Brandon: If you think of anyone else, let us know. One other question I wanted to ask is that you've done the Boston Marathon , you've hiked to some interesting places - what haven't you done that you still want to do?

Bob: Well, I want to go to the South Pole. I've been to Antarctica, but I was on the peninsula, not the South Pole itself.

I'd like to visit, Vietnam, because I grew up at a time when going to Vietnam was not something anybody wanted to do. There was a war going on. And I think it's time that I overcame that and go visit Vietnam, 'cause I've heard so many good things about it.

I'd like to go to the bottom of the ocean, 37,000 feet. It's not much to see there , but I haven't been there .

I do not want to go to space. I don't know why; I just have no interest in going to space. I'd much rather go down into the ocean than up, plus Marcia McNutt who heads the National Academy of Sciences once told me that, you know, going to space is hard. You have to overcome gravity, you need the rockets, the fuel and everything, but going to the bottom of the ocean is easy. You just push it over the side and it sinks.

Brandon: That's a pretty good answer. And I don't know too many people who have done that.

Bob: Gone to the bottom, a few...

Brandon: What's the craziest thing you've seen in a network, craziest network design - or most Most

Bob: Well, I know that they've installed Ethernet in the F-16 and I'm really happy about that. I'd like to see it in the F -16. I haven't seen it yet, but I understand it's in there somewhere.

Brandon: Would you like to ride in see it?

Bob: You know, I get motion sickness too easily. I think I would probably not like to fly in an F- 16. Although I have a boat, I was just in my boat today. The trick is, keep your eyes on the horizon. and never go below decks. Anyway, so that keeps me out of the F- 16.

Brandon: Well, I think we're over time at this point. Bob, on behalf of everyone here, I want to thank you for sharing your stories and your insights. This was a ton of fun. And, and my takeaway is this you questioned conventional wisdom, you made a big bet on what the future might look like and you made it happen. So I hope others find this conversation equally motivating because we have no shortage of problems left to solve.

Outro

Derick: Thanks for listening. Just a quick reminder, check out the show notes, at seekingtruthinnetworking.com. We have links to some of the stuff we talked about, including some of those early papers, as well as some pictures of Bob, at work, inventing Ethernet.