Oral History of William Carrico Jr.
Part 2 of 2

Interviewed by:
David C. Brock
Marc Weber

Recorded July 17, 2018
Mountain View, CA

CHM Reference number: X8535.2018

Weber: So, I'm Marc Weber of the Computer History Museum. And my colleague, David Brock, and I are here doing round two with Bill Carrico, a major networking pioneer from several different important companies and efforts. And we're-- last time we got up through 3Com. And we were just on the cusp of moving to Network Computing Devices around 1988. We did, in the interim, get a couple of questions that go back to an earlier era. So, we'll start with-- so, how did-- in the 1984 to 1990 timeframe, how did you and your team regard wide area networking, basically the switch versus router argument?

Carrico: How did we regard it? So, originally, the company had been formed as Bridge Communications, which implied, by the way, switches. All right, it was just clear very early that you needed the network beforehand. You couldn't cut it out from whole cloth. And so, we went into providing networking for what we could, which was basically terminal servers is what we started out with. But we were well aware that Xerox had already done many of the things that would be later done at least in the Xerox Star environment with various kinds of gateways, routers, and so on. Although they never, as far I know, actually did switches the way we think of switches now. But in that period that you mentioned, we did start to get an interest in, first of all, bridges and/or switches from customers. I remember being in Israel talking to a military guy in Israel about what could we do for him. And he basically said, "Just put four Ethernet controllers in a box and make them look at the MAC level, and switch between them." Would that I had done that. Okay, it was a mistake because we-- it just didn't seem to make a lot of sense. I knew what he was trying to do, but four port switches for ten thousand dollars just seemed to be-- I couldn't believe it.

However, in the router area, we started very early. And we started building routers of various ilks even before 1985. Okay, probably didn't have them until 1985. And it took a while for people to pick up on them because, again, you really had to have some critical mass before they would start thinking about routers and interconnecting their LANs. You know we were selling LANs, if you will. And then they wanted to interconnect their LANs, and that leads you to routers. So, it wasn't-- there was no this versus that. It was more just what was the evolution as you went along.

And so, by the time we were about ready to sell to 3Com, we were selling X.25 routers in volume and other kinds of routers as well as bridges, for example, between broadband and Ethernet. Okay, we had products like that, which were to interconnect dissimilar MAC layers, data link layers. So, no, we were all there. I mean the irony of it is this was the argument that occurred at 3Com. 3Com really didn't want to take that from Bridge. They were all caught up in building essentially small servers. Okay? That was where they thought the future was going to be for them. And that was-- it didn't work out for them. If they would have followed the path that we had brought to the party, there would have been no Cisco. We were already selling way more routers than Cisco was in the early days. But what happened is, once particularly that Judy and I left, there was no-- no one was there to carry the torch. And you know it got folded into 3Com in a way that was consistent with whatever 3Com thought was the right thing to do. Now, ultimately, this got unwound. Down the road, a couple of years later, because they were struggling trying to sell these server things, Eric Banhamou, who'd been one of the vice presidents of engineering for Bridge, presented to the 3Com board a plan to resurrect 3Com. But his plan was nothing more than do what we had discussed earlier on. And that's how 3Com became more of a larger scale network player as opposed to just selling cards for PCs and small servers.

Weber: But they had missed the chance to be Cisco, in essence.

Carrico: Correct.

Weber: Which, as I think we talked about last time, Sandy Lerner said she thought something quite similar.

Carrico: Yeah, no, Sandy Lerner came and told Judy that-- thank you.

Weber: Yeah <laughs>.

Carrico: No, this really happened.

Weber: <laughs> No, I believe it. I'm just saying boy, what a double-edged--

Carrico: These are the things that happen in life, right?

Weber: And so, how did you view Cisco as a competitor during your Bridge days: ethical, fair, fierce, unscrupulous?

Carrico: It was not really any of those things because they were so small at the time. It was not really-- you know, we were vaguely aware they were selling them. We would see them at-- you know with their little booth and just the two of them at a show. We used shows a lot as a marketing mechanism in those days. And you know, everybody knows everybody. So, we knew pretty much what they were doing. They knew pretty much what we were doing. But they weren't-- you know, we had it, by that time, oh, I don't know, twenty-five salesmen. And she was trying to do it all for the Cisco of the time. What did happen, ultimately as Bridge failed to integrate properly at 3Com, many of the people who were Bridge went to Cisco, okay. So, the marketing manager went to Cisco. Many of the sales people went to Cisco, and so-- like the international sales guy went to Cisco. So, Cisco got the benefit of an awful lot of contacts and knowledge. I mean I'm not sure that they even did it on purpose. But those people moved to Cisco and, of course, did extremely well for themselves.

Weber: What are-- do you remember the names of some of the more-- the key people you're talking about?

Carrico: Well, like Cate Muther was my VP of marketing. And she ended up being the original VP of marketing for Cisco. All right? And that worked very well for her. Jean-Pierre Boespflug, who had been the hardware manager for Bridge, ended up being the internat-- maybe European sales manager for Cisco. And again, they were pre-trained, pre-knowledge, pre-aware of the customer base. It helps a lot.

Weber: So, then the next question is just almost the same period. How did you view Cisco when you were at 3Com? That's the period you're talking about actually.

Carrico: To be honest, there was so much going on in trying to resolve one way or another how to make Bridge integrate with 3Com, I'm not sure I ever gave it any thought. It was a very hard row to try to figure it out because, again, they agreed to do it one way and then didn't feel like they wanted to go through with that way in the end. And that really kind of made a mess of a lot of things.

Weber: So, you were not thinking about Cisco in any capacity?

Carrico: No.

Weber: And then his last question really we'll get to which is just to describe your time at Cisco. But that's ahead. All right, so then tell us about your decision to-- I think you did talk about the decision to leave 3Com last time. So, it's mo-- correct? It's mostly to talk about them-- your decision to join and help get going Network Computing Devices.

Carrico: Well, once we'd made the decision to leave, we didn't have any immediate plans. We were contacted by the founders of NCD, Network Computing Devices. And the founders consisted of Ed Basart, who had been-- I believe he was the founder of Ridge Computers. Okay, he had built at Ridge, which was kind of a high-performance computer in the vein of like Pyramid, and along with Doug Klein, who had been with him at Ridge, and then the other people were Martin Eberhard.

Weber: Oh, really?

Carrico: Okay, and Martin, as I think I probably told you if you didn't know, was the original founder of Tesla.

Weber: Yeah, Tesla and then Rocket Book.

Carrico: Rocket Book way before Tesla, right.

Weber: Yeah.

Carrico: Right yes, and but Martin, at the time, was focusing on being a hardware engineer. And that's what he did for us at NCD. And I went over there, and we talked. And they had tried to raise venture and had been unable to raise venture, not because they aren't technical. I mean they're really good technical guys. But they didn't have a CEO, if you know what I mean. They needed a-- you know, a face. So, we raised the money for them kind of quickly. And I ended up being president and CEO. Judy was executive vice president of I think it was sales and marketing. Ed became the engineering VP. Martin became head of engineering. And that's more or less how we rolled from there.

Weber: And how did you raise the money?

Carrico: I just called the guys I had talked to before. We raised the money in about one day. You know, it wasn't too hard. I had come off a couple of successes. And it did make some sense. And so, they said fine.

Weber: Do you remember who were the main investors?

Carrico: Do I? Well, one of them was Weiss, Peck, and Greer again. And I believe also Merrill, Pickard invested again. Those are the ones that are on the top of my head right now. There were others too, but I don't remember exactly who it was.

Weber: Okay. All right so, then you-- and they had-- how long had they been trying to get it going before you joined with Judy?

Carrico: I don't know exactly, but they did not have a prototype. You know, they were working on building the first instantiation of it. What made this possible is that the XCode had been developed at MIT. Are you familiar with what X is?

Weber: You mean the X Consortium?

Carrico: Yes.

Brock: X windowing.

Carrico: X Window System, right.

Weber: Michael Dertouzos--

Carrico: So, it-- and it was essentially an open system thing that you could, you know, download from MIT and go to town on if you wanted to use it yourself. So, that's what we did. We-- and our idea was to go ahead and build essentially very intelligent graphical terminals that would host the X terminal software then talk through TCP/IP to something else, which would provide the services to the X terminal. What we used to call it is vampiring of the Suns, okay, because the Suns -- Sun workstations in particular, but we did this with many different machines -- had a lot of extra power that couldn't really be used. And you could easily do even complex stuff and get essentially four users off a single Sun workstation without disturbing the primary user. Now, not always, but because we exported the graphics, that really helped. We were only sending the data sufficient to have the graphics painted by us.

Weber: Right, you're doing the main graphics processing on the local machine.

Carrico: Right.

Weber: Yeah.

Carrico: But that--

Weber: Client/server in essence.

Carrico: Exactly, and we did it in some clever way, so we could get good performance without having to resort to exotic graphics techniques.

Weber: And was this the vision of the founders, or did it change when you and Judy got involved?

Carrico: No, I would say it changed very little. I mean it was more-- I mean we might have changed the marketing stuff a little bit, but the basic technical ideas were all pretty much in place and was pretty clear and pretty much understandable. The way we sold this, once we had products, was not just leverage or workstations or your computers, we also sold it on the basis of you could put in front of users no user-accessible parts, if you will. All you could do was what you could do, which was talk to the workstation. You couldn't put your own software in. You couldn't download something out the front and so on. And this actually was a pretty easy sell then to people like banks. One of our big customers turned out to be Barclay's Bank. They put them in every bank in England. Okay? Where they were customer terminals to come up and check their balances and so on, long before, of course, there were smartphones and all that. But with the idea simply that the customer couldn't do anything that would disturb their mainframe or whatever they were using to keep track of their databases.

Weber: And so, the terminals were what type of machine?

Carrico: It varied. We made different terminals for different applications. So, the terminals, the smallest one we called the NCD-15, which was just a smallish black and white terminal. And all it looked like pretty much a terminal-- and ASCII terminal that you might have seen. So, it had a little base. It had an Ethernet port in the back. And by this time, it was generally an actual Ethernet port the way we think of it now, CAT connected, and then a black and white, again, in these days, CRT. Then we had a 15. We had a 16. We had a 17. These didn't all come out at once. The 17-inch was the first color one. Then we had a 19-inch color one. And surprisingly with this bus-- this business turned out to be fascinating. So, first of all, you-- we were trying to use as many components as possible that were consistent with the components being used in PCs. We didn't need to reinvent anything. But it turned out, it didn't work. It was too early still. And so, we ended up building our own keyboards, our own mice. The black and white monitors, we had to build ourselves in Taiwan. We did purchase the 17-inch color that we just put in our own enclosure. And then we-- the 19-inch color, which ended up being our most popular product, was a Hitachi 19-inch monitor. And each one had a slightly different base with slightly different performance capabilities. The smallest one had just a 68000. The biggest one had a RISC chip in it. All right? The smallest one had essentially no graphics support. The biggest one had a graphics chip that we designed and put in along with the RISC chip to get sufficient performance. And frankly, these things worked very well and, particularly for naïve users, was a godsend for people. It allowed them to get in there and do what they had to do without them having really the ability to mess things up very easily.

Weber: And why couldn't you have used cheap PCs of the era as a terminal?

Carrico: You could have. Okay, and some people, of course, brought that up. And so, we said, "Well, let's see what can we do about that." And what we did is we went and bought a company in Portland. And the company in Portland had already ported X, the X Window System, to the PC. We bought that. And for people who wanted to take that approach, we resold that software to them for a modest amount. So, you would basically take your PCs with some kind of Ethernet controller in them, and you would do-- we had integrated with the rest of our environment. And you could go to town that way. So, that was possible. Most people that we dealt with, though, wanted more performance. This tended to appeal to two primary audiences, at least at the time. One was the high-performance audience who was really doing graphical workstation kind of things, CAD, CAM, those kind of things. And then the other one was the people like the banks and the telephone companies who wanted untouchable locked down terminals. And that tended to be the bulk of our business, so while there were a few who could be satisfied by the PC X software, it wasn't really a big win for us.

Brock: May I ask a-- which operating system platforms could work with the X Windowing? So, was it tied to making sure whatever was connected to it through the Ethernet from the terminal was running a particular kind of operating system? I just don't know enough about the X Windowing system.

Carrico: Well--

Weber: I mean it's UNIX.

Carrico: It wasn't the operating system that was really the problem. All right, so these terminals basically downloaded their code from somewhere. And generally, we allowed the code to be downloaded from some kind of a Linux machine.

Weber: UNIX at the time, right?

Carrico: Yeah, UNIX at the time, yes, sorry.

Weber: Because X Windows is al-- always UNIX. I mean it's just--

Carrico: Well, nowadays, it isn't, but yes, historically.

Weber: Right, I mean the X Consortium, X Windows was-- I mean it only worked with UNIX as I understood it.

Carrico: Well, that was its bane, and we'll get to that.

Weber: Yes.

Carrico: So, that wasn't the issue. The issue was something completely different. The issue was there's no standard UNIX. All right? So, this is why, in the end, we couldn't make NCD work better than it did. I mean we got revenue, grew it fast, got it up to a run rate of, I forget exactly, maybe fifty, sixty million

dollars a year in terminals. But we then ran into a wall that customers would say to us, “Well, you know, I run this application on my Sun and this application on my HP and this application on my DEC,” or whatever it was. None of them would talk to each other. Okay? None of them had the same user interface for X. And we couldn’t fix that. Right? So, because there was UNIX wars among them, because they were all going for how do I get this to be more proprietary so you’ll buy more, by doing that, they basically severely restricted what we could sell, what we could participate in. And over and over, customers would come to us and say, “I’d really like to buy this if you can get this app to run on that UNIX that’ll talk to your terminal.” But we really couldn’t do those kind of things necessarily. Now, if it was really simple minded, maybe, and so on. But generally, we couldn’t do it.

Brock: So, the UNIX wars itself was a big impediment for you.

Carrico: Because those guys declined, as a group, to make a common applications programming interface, yes.

Brock: And that would have-- I wrote down on my notes like the Berkeley UNIX I would have thought would have been perfect for your terminal since it had the TCP/IP sort of stuff baked in, or--?

Carrico: Sure, I mean it wasn’t really UNIX that was the problem. It was the applications. We didn’t really have too much because people actually had their UNIX implementations reasonably--

Weber: But it was the interfaces on top, I mean Motif and Open Windows.

Carrico: Yes.

Weber: I mean there were-- it’s as if you had different version of DOS running-- well, or different versions of Windows running over DOS.

Carrico: Right. Well, or let’s say DOS and CP/M.

Weber: Yeah.

Carrico: All right? An app doesn’t run quite the same way on CP/M as it does on DOS assuming all the other stuff worked somehow, right? And it wasn’t our job or within our skill set to go and port those two.

Weber: And did you have many dealings with-- I know it was the LCS at MIT where the X Consortium was based, right? And Michael Dertouzos was very involved. Did you have many direct dealings with the X Consortium?

Carrico: Oh, yeah, a lot. We had one of the guys that worked for us was-- had been there and worked on the X Consortium. And he was our primary X guy. He was an engineer. And we went back there several times for the X Consortium meetings and tried to remain involved in that. But even that too was not really a big problem.

Weber: No, but I'm just-- you may not have had the-- you weren't in a position to try to force better agreement amongst flavors of UNIX, but the X Consortium, presumably-- were they trying hard-- they were trying to get more interoperability, right?

Carrico: Yes, but I believe at the X level, they wanted to make sure everybody was safe and sane. I don't know that they ever-- I mean I don't recall that they ever tried to knock heads together on the application stuff. Maybe, but I don't remember.

Weber: Okay.

Carrico: I just remember it being a real headache. It basically just stymied where we could take the company. And it was kind of unexpected. See, the company was very interesting in this way. When we first started doing the company and we first started raising the money, all the venture people said to us, "Well, I don't think you want to-- I don't think that makes any sense because Sun's going to have a workstation that costs thirty-nine dollars and ninety-five cents." I said, "No, they're not." "Yeah, I saw the board. And they told me it was going to be thirty-nine dollars and ninety-nine cents." And of course, this never happened. They never came--

Weber: They cannibalized their own--

Carrico: With a cheap product.

Weber: They'd kill their own SPARC stations.

Carrico: No, it didn't happen. So, they made higher performance smaller SPARCs and so on, but they were just as useful for us as any of the other ones they ever made. So, we never ran into the problems that the venture guys anticipated in that way. And I think, frankly, we should have done a better job anticipating the application thing. It was a little bit-- you get caught up in it though because we had gone a long way without getting-- having to worry about this. So, we were good if Sun was doing it. Okay? We weren't good if we ran into some kind of Oracle problem, right? That's the kind of problem you ran into. How do we port Oracle to SPARC OS and stuff like that?

Weber: And what were your main closest competitors?

Carrico: Well, there really weren't X terminal competitors early on.

Weber: But filling from let's say the point of view of a bank or-- who would-- if they didn't buy you guys, who would they be looking at, what sorts of things?

Carrico: I'm trying to think. So, later on, we ended up weaponizing a couple of competitors by accident. So, Tektronix came to us and wanted to do a relationship. And we said, "Sure, let's do a relationship." But then they turned around and eventually started competing with us. I mean there was no real way to stop from that. There was a company that did a serial X terminal. So, instead of going over the Internet-- the

Ethernet, they actually emulated the serial-- well, emulated the X to X over just a serial line, which was pretty slow. But it was nice because you could go over a modem or something, all right, so for like remote use. And we ended up doing that product also because people were asking for it. But not a lot of people who competed directly, not until much later.

Weber: But wouldn't you-- okay, for graphics, things like that, people presumably needed-- I mean you had a unique advantage, but if it was let's say the bank, wouldn't you be competing against traditional terminals on a--

Carrico: Terminals and there were PCs.

Weber: IDM or fax or something like that?

Carrico: PCs.

Weber: Okay.

Carrico: Yeah, I mean sure, we did. But it was pretty easy to show what you could do. I mean it was pretty seductive that it was locked down, particularly for that kind of application.

Weber: But with traditional terminals, it would be locked down, too.

Carrico: Yes, it would be, absolutely. But traditional terminals didn't look as cool. Seriously. You could do cooler things.

Weber: Yeah, no, not the good graphics and-- what were your price points for-- roughly?

Carrico: Oh, the price points for the X terminals varied. The least expensive ones were-- let me just think about this. It was probably about a thousand dollars for the lower monochrome ones, more like fifteen hundred dollars. And then the biggest ones were about two thousand dollars. This is the 19-inch monitor. Some-- those were the price points. One of the sad things is that "customers be" weird, as they say. And here, we're buying this monitor for a thousand dollars, paying Hitachi a thousand dollars for the monitor. And the customer could go buy the monitor from Hitachi for a thousand dollars. Hitachi had pretty good distribution. But they'd rather buy it all from us. But they wouldn't pay any mark up for buying it from us. So, I mean while it was a very big win for us, it was a very low margin product because we couldn't get-- we were lucky to get any margin on the monitor itself. The other things we had to do, too. I mean we had to end up going into manufacturing for ourselves for keyboards and mice just to get the price down. They were much more expensive then, than they are now. I mean now, they're just ridiculously low priced, but not then. We even had to design our own keyboards, put our own keyboard controllers in to keep the cost down. So, we built all that stuff in Thailand. And we managed to keep the costs under pretty good control except for the monitor thing. If we had done it some years later, assuming it was possible, it would have been much better because then we could have so easily used just the plethora of LCD monitors. That would have made our lives a lot easier.

Weber: And how many employees did you have? Where were the headquarters?

Carrico: It was in-- right in Mountain View off of Bernardo.

Weber: Do you remember the address?

Carrico: I don't remember the address offhand, no. And the-- I think we had, at the end, the number that sticks in my mind is about four hundred because we did manufacture them all in a facility in Mountain View. Now, manufacture meant bringing-- a lot of the parts were coming in done. We were assembling them.

Weber: Okay. And what was-- what kind of deal did you have with the founders?

Carrico: Well, I don't know what kind of deal. We apportioned the stock in whatever I thought was an equitable way at the time. I'm a big believer in having everybody have stock and never taking stock away from people or anything like that. And so, I forget exactly how we apportioned it volume-wise at the time. But so, Judy and I got some big chunk. The founders had appropriate large positions. And then we brought everybody else and tried to give them as much as we could always. But the deal was really I'm going to be CEO. And that's the way that's going to be, and if you want to do it on that basis-- and they were fine with it.

Weber: Did they remain actively involved, or--?

Carrico: Oh, yes, absolutely, all of them did. All of them did.

Weber: And how many founders were there?

Carrico: Technically, I'm not sure. So, it was Doug Klein, Basart, Martin, and I think Kevin Martin was one. And then Judy and I, I think, so seven.

Weber: Okay. And your main competitors were Sun, Apollo, HP, anyone else?

Carrico: Well, they were also our customers, so--

Weber: Well, yeah. I mean competitor is not quite, but the main players.

Carrico: Yes.

Weber: Any others that--?

Carrico: No, it was-- it tended to be the ones who had implemented X, right?

Weber: Makes sense. And so, some of the same investors were from Bridge, as well?

Carrico: Yes.

Weber: Right, the Weiss, Peck, and Greer.

Carrico: Yes, and Merrill, Pickard was at Bridge.

Weber: Okay.

Carrico: Other ones were brought in, but I just don't remember the names right now on the top of my head.

Weber: And the device separated display processing all the graphics from the applications processing. So, but it would do, obviously, all the graphics locally, or as much as possible, but then it would be doing mostly on the server would be where the application processing was.

Carrico: Right, on the device you're pirating from, right? So, they did the-- have the loading. So, I mean the Sun, for example, would really just pass along the commands to draw the-- make the drawings. But it had to calculate the drawings.

Weber: So, if you're doing 3D CAD or something, it would be--

Carrico: That's what you did, yes.

Weber: So, how would the apportioning work?

Carrico: Well, the actual calculations were virtually always done on the Sun or whatever, but then information would be sent through the X protocol. It would say we need you now. And by the way, we did later on have a full-- the 3D standard, what's it called?

Weber: Oh-- I mean the--

Carrico: I'm drawing a blank.

Weber: From AutoCAD, the-- DXF--

Carrico: Yeah, no, but before that, it was a Silicon Graphics thing, but anyway, whatever it was, we could take those commands and then draw that. We actually had the engine to draw all that built into the device.

Weber: On the terminal?

Carrico: Yes.

Weber: Oh, okay, right.

Carrico: It wasn't sending that down. It was just sending the instructions down.

Weber: So, let's say you rotate something complex on your terminal, it sends it to the Sun to say basically calculate what the new view will be, but then it sends back something really just the commands that get rendered, in essence, back on the terminal?

Carrico: Correct. And that, by the way, you had to get that right. And I don't mean just technically right, you had to figure out to make that work fast enough. So, there was a delicate design tradeoff between-- we were trying to keep this cheap, right? How much CPU performance, and how much graphical performance did you have to put in each device? So, for example, the higher end color ones had more exotic graphic stuff that we did plus a more exotic chipset in terms of CPUs. And we had to really work on the price. I mean we, for example, on the biggest one, we used Motorola's 88100 RISC chip and managed, through iterative discussions, got the price down to something that was affordable. On one of the chips, we used an LSI logic MIPS chip, their implementation of a MIPS chip. At the lowest end, I think I mentioned before, we used just a 68000. I mean so you had-- which by-- this isn't-- you don't really want to have to do this because having to support multiple chips and so on is a little overhead, but we had to get the price point.

Weber: And I presume the sensitive-- the system was sensitive to which terminal there was so that if you were on-- the customer was on the high end. The process could happen differently than if they were on the low end. I mean on the low end, more of the graphics stuff would have to happen on the SPARCstation or the side because it didn't have as much capacity?

Carrico: Right, but people didn't really have an interest in like doing 3D graphical rotation in black and white anyway. So--

Weber: But I mean the system was aware of which terminal they were using and adjusted. So, it makes it more complicated.

Brock: Would the customer have to load your software onto the workstation to accomplish this? Or it was baked into the UNIX already?

Carrico: No, they had to run X, which they were doing anyway. Okay? Some of them actually ran X on their own account to be able to split it inside their workstation. But then we had a server which could be multiple places, so we had no hard drive or anything. When you pressed start, the individual X terminal would ask for a download to load up the system and get on running. And that could either be somewhere on a Sun or a server we provided or something like that. But that server was really just to be a boot loader for the terminals at start time.

Weber: Okay, but you were provid-- the customer could have just their own Sun hardware, which would act as a server for the terminals, or they could buy a server from you?

Carrico: Yes.

Weber: And that server would be another Sun machine?

Carrico: Yes, and/or other things. There were a few other options.

Weber: Like what?

Carrico: I don't remember, to be honest.

Weber: But other UNIX machines.

Carrico: Yeah, yeah.

Weber: So, what would determine whether they had-- they bought a hardware server, or they just ran it all as software?

Carrico: Well, most of them would run it on what they had because that was easy for them. But customers are odd about what they want sometimes. They don't-- I don't want you to mess with my workstations kind of a thing.

Weber: So, I mean the main, as you described it earlier, the main proposition was to get more use out of existing Sun machines.

Carrico: That was the basic pitch.

Weber: So, it was kind of just to please them that you could also offer a configured Sun as a server? Okay.

Brock: Forgive my ignorance, but the UNIX based workstations were kind of already able to handle a situation where you had multiple users kind of wanting to use the same application at the same time? That was already baked into that workstation? Okay, got it.

Weber: But they generally weren't used that way, though.

Carrico: No, they were not because of people but not because of hardware. I mean that's my workstation. There was that issue. I don't want you-- I don't want you slowing down my workstation, that kind of stuff.

Brock: Got it.

Weber: But I mean in that era, people often would turn a Sun workstation into a server for various things. I mean it had the UNIX-- UNIX was built to handle at the--

Carrico: Well, yes, UNIX in itself was inherently multiprocessing, right, multitasking, multiprocessing, the multis, as we used to call them.

Weber: And the hardware was fast enough to handle quit a bit. Okay, so you were really just exploiting that spare capacity in essence?

Carrico: Yes, I mean and it was sort of an obvious thing to do. And by the way, Sun didn't love this because it cut down, theoretically, on the number Sun workstations.

Weber: Each terminal that you sold could have been a workstation.

Carrico: Exactly. But the customers got it. I mean-- and by the way, there was a lot of skepticism. They would absolutely want to try it out and see if this really worked because they'd heard it all before, which is always true of customers. Right?

Weber: But could they run pretty much the same app-- the same basic set of applications they would have run on their own workstation?

Carrico: Sure.

Weber: Okay. Plus custom ones, let's say the bank would write its own custom-- but, I mean, effectively, you had a virtual SPARC station on your desk?

Carrico: Yes.

Weber: Or you could also have it do these other function as a terminal for--

Carrico: By the way, it didn't have to be graphical stuff. Right? I mean, if you had a Sun that was just running a database, you could just export the database client and do that too. Right? I mean, it could be whatever you want. I mean, graphics tended to be what drove it, but it could be anything.

Weber: Very common. And I'm curious. At Bridge and then when you went to 3Com, you'd been-- you say that 3Com made the mistake of turning away from, really, the networking market. But then, you, in this company, went completely to the other end, to the thin client. I mean, why-- in some ways, you were-- 3Com was also trying to move toward thin client stuff. Right? But you ended up doing it in another--

Carrico: Sort of. Yes.

Weber: --completely different context.

Carrico: Yes. No. 3Com was trying to do client-server in the sense of shared disks on the network. We weren't trying to do that at all, but your point is true. I mean, we did go to a thin client approach to leveraging computing in the typical environment. But there was no focus at all on "Let's share this disk or

that disk over the network" in a production way, which is what 3Com aimed at. The problem is it's not that there wasn't a lot of desire for what 3Com was doing, and I think this is what got them excited to do it with their three-server product. The problem is is there were a lot of guys doing it already. All right? Microsoft was doing it and totally committed to it. Novell was doing it and eating everybody's lunch. Okay? Novell didn't require a three-server. You could put Novell's software in any PC on the network. There was its-- that was the Novell server. You didn't have to buy anything special and you were on your way. And as time went on, this just got more and more and more. So it was a 'too harder,' from my point of view.

Weber: But when you left 3Com, you had no interest in trying to do, essentially, Bridge again to do the niche that you saw 3Com missing and which Cisco then stepped into? You didn't want to get back into the fray?

Carrico: I can't say that we really ever thought about that. I mean, we got caught up in NCD when those guys called us.

Weber: Quickly--

Carrico: But I never really did think about that, although if we actually get to <laughs> the last thing, we'd kind of circle back to that.

Weber: Okay. All right. So for NCD, so talk-- take us up to the IPO and the growth of the business. Growth of the business after the IPO.

Carrico: So it-- did I write down when the IPO was?

Weber: '92.

Brock: '92, I think.

Carrico: Yeah. 1992 for NCD.

Weber: And sales-- there's a note. Sales growing past 100 million in the mid-nineties.

Carrico: Right. No. It did very, very well and basically-- and very quickly, by the way. I mean, because this came from about 1989 to 1992, was pretty Herculean. And what was interesting about it is when we got the first units running, which is probably about '90-- somewhere in '90 and '91, I can remember thinking "Oh my God, we're not selling any of these. We're selling one a week. What am I going to do?" Right? And we just kept plugging away at it and all of sudden, it just started taking off, the way it can, and, yeah, we started selling a lot of stuff to a lot of people worldwide. But the problem is-- the problem we ran into about-- in the middle nineties, was the problem I was describing before. With-- there was-- we were running out of options, running out of essentially room or market space, however you'd like to decide it-- describe it, for an inability to be-- cross-platform with the applications. If the Linux guys would have been willing to get together and make their applications cross-platform, just to-- their own instantiations of Unix,

it would have been a much bigger company. But they basically, more or less, shut us down by not agreeing to do that.

Weber: Unix, at the time, not Linux. Right?

Carrico: Yeah. I'm too used to saying that.

<laughter>

Carrico: Yes. And so, that's really what stalled that company out. And we couldn't-- we thought about it. I couldn't see any real way around that and we ended up giving the company to another guy to run. And Judy and I then went off to think about what to do next.

Weber: But you-- when did you see the handwriting on the wall in terms of reaching the limits?

Carrico: I don't know. I think it was probably about '94.

Weber: Okay. And in the period there, what was your life like outside of work?

Carrico: <laughs> In what respect?

Weber: If there was one? <laughs>

Carrico: In what respect?

Weber: What were you guys-- were you doing anything except work at this point?

Carrico: No. This was part of the problem. I mean, we had bought a house in Aspen in 1988, I think, and enjoyed that very much. And so, where we would go to get out of-- get away? It was go to Aspen to get away. And in fact, when we decided to leave NCD, we took a vacation for the first time since about 1981. Okay? And we spent five weeks in Aspen, which is the longest time I've ever been in Aspen, still.

<laughter>

Carrico: And trying to decide “Where do we go from here?” And I ran into a guy who was a friend of my realtor, who said, "Bill, you don't want to go and retire at your age and sit there and drink with those guys at Annie's restaurant over here. Those guys just sit around all day drinking." I said, "I probably don't want to do that." So we started thinking about what we might do next. And originally, I had gone and talked to a guy named John Davidson. Have you run across John Davidson? John Davidson had been the original-- he's Dr. John Davidson. The original-- I'm not sure what his title was. I think he was CTO at Ungermann-Bass.

Weber: Okay.

Carrico: All right? He had been at Zilog before Ungermann-Bass and I had gotten to know him pretty well. In fact, we had tried to recruit him into Bridge in the early days, but he didn't want to leave Ungermann-Bass. And very knowledgeable about TCP/IP protocols. Anyway, he had left Ungermann-Bass and had formed his own company, essentially provided implementations of TCP/IP. And I talked to him at some length about “Could we buy the company from him and incorporate some of the ideas we had in terms of some of the protocols that we might advance to the world through the auspices of his company?” And he thought about it a little bit and he just didn't want to give up control. I mean, that's okay. That happens. Right? So we finally decided to just sit down and I, once again, wrote a business plan. And the business plan basically focused on using some of the protocols that were coming into availability out there that might be able to make a big difference in terms of how video was done across the network, and that was the initial formation of the Precept Software.

Weber: Now, what did John Davidson have that you wanted to join with him rather than go out on your own?

Carrico: John Davidson was a smart guy. Okay? It would be nice to have had a smart protocol guy. And he had a TCP/IP implementation that we wouldn't have to do, then again, ourselves. And he had some people and so, it gave us some engineering critical mass. It had all of that, which can often be very useful. But I think he'd gotten used to having a small and--

Weber: Sure.

Carrico: --operation that he could control without being pushed on.

Weber: Yeah. I was just curious what the components were you saw there. And what were the protocols that were coming out that you saw as being interesting?

Carrico: Well, some we had in mind and some were already out there. So one of the people that I-- you really should talk to at some point is Van Jacobson.

Weber: That name, I've heard.

Carrico: And it's-- Jacobson with-- you know, spelled with an O, S-O-N. And Van is, in my view, probably the smartest guy in protocols alive today. And one of the things that he had promoted is multicast.

Weber: Right.

Carrico: Okay? And multicast was a way to basically send video only to those who've asked for it. But it does require some changes in how routers work, and so on. And as far as I know, <laughs> it's still not being used. Because people hate change in this business, in the network business. Right? But other things were coming together. One was RTP, which is-- stands for real-time protocol. And we also came up with something called RTCP, which was real-time control protocol. And together, these things provided some functionalities that we could use to, we thought, provide high-quality video over local area networks.

Weber: And these were protocols that were going through the IETF process?

Carrico: RTP, I believe, was a-- multicast had and I don't think RTCP had at the time.

Weber: But they wanted it too, right?

Carrico: Yeah.

Weber: Okay. But the multicast through Van Jacobson had not-- basically, had not been around?

Carrico: No. I didn't-- I think it was-- I don't know the details of this because I never followed that aspect of it too much, but I think that it was already being machinated by everybody.

Weber: Okay.

Carrico: So I know that Cisco had been interested in it and had purportedly implemented our multicast support in their routers, even at this time. Whether that really was there and really worked, I'm not sure.

Weber: But they were talking about it, whether it did or not.

Carrico: Right. So our idea, using more modern protocols, was can we build a video server and a video client that can send-- now, remember, this is the middle nineties, that can send full-on movies over TCP/IP, 10 megabit Ethernet, and, of course, higher, and have you show-- see it on your screen and be really thrilled with it, and in full synchronization, right, and full reliability? Which, by the way we don't get today.

Weber: Video on demand.

Carrico: Exactly. And that's what we decided to form a company to do and one of the things-- we got some help from Van on this. We hired some people that Judy's sister had worked with down at ISI.

Weber: Right.

Carrico: And talked them into coming up here. Couple of her students.

Weber: Who do you-- oh, okay.

Carrico: Okay? That-- one of them had a Ph.D. and one of them, a master's degree in this stuff.

Weber: Do you remember the names?

Carrico: Yeah. Steve Casner was the guy--

Weber: Oh, yeah. Sure.

Carrico: You know Steve?

Weber: Steve's the voiceover IP guy, along with Danny Cohen from ISI.

Carrico: Yeah.

Weber: He comes to the museum quite a bit.

Carrico: Yeah. He lives around here. He lives over in Sunnyville.

Weber: So Steve Casner and--

Carrico: And the other guy was Haobo Yu[1], but I'm not sure exactly how his name is spelled.

Weber: First name--

Carrico: H-A-O-B-O, I think, Y-U.

Weber: H- sorry. H what?

Carrico: H-A-O-B-O. And I think the last name is Y-U.

Weber: Okay.

Carrico: He had a Ph.D. in computer science from ISI and he, however, now, is in Beijing for reasons that are a little obscure to me, but that's where he is.

Weber: And have they worked at all with Bob Braden there or with-- do you know who they--

Carrico: I don't know who they worked with.

Weber: Okay.

Carrico: So we had a good team of people and we began implementing that and slowly, but surely, we got it to work and started going to shows demonstrating it and it was a pure software device. We weren't going to do any hardware anything. You know, it would have to require a server, but the server was just going to be another PC. The server, of course, was-- well, by this time, it was a Linux PC[2]. And of course, we're forced to run Windows as the client-- the basis for the client and we were forced to use some of

[1] William Carrico notes that Haobo Yu was hired at Packet Design, not Precept, in actuality.
[2] William Carrico notes that this was a Windows, not Linux, PC.

Microsoft's software. But we did a lot on our own. We did, among other things, things like phase lock loops in the software, and so on, to get this resynchronization to work. Again, I wanted to make sure if we're going to do this, we didn't want to screw around. I mean, when-- if Juliet is talking, it better look like her lips are synchronized to it, with no conditions, ever. And we got there. And it was pretty damn good. We showed it many times in many places. There was lots of interest in it, but it was fundamentally ahead of its time.

Weber: But this was with a dedicated client. I mean, what would your client be on the client end?

Carrico: What do you mean, what would it be?

Weber: What do you-- what software are you watching the video in?

Carrico: Yeah. It was our client. Yeah.

Weber: Right. So, I mean, it was, like, a media player for the PC?

Carrico: Exactly.

Weber: That was your proprietary media player?

Carrico: Exactly.

Weber: That you were going to sell that or give it away?

Carrico: And/or in combination with the server at the time.

Weber: Okay.

Carrico: Remember, nobody else was doing this at the time.

Weber: And this is before the Windows Media Player and all of that, obviously?

Carrico: Right. But also, the Windows Media Player, or even YouTube and so on, really don't do a wonderful job.

Weber: No, no, no.

Carrico: It's slowly getting better, but this-- you could go full screen and it looked wonderful, and this is 1995. It's not, you know, 2018. A lot of things have changed and a lot of people have seen a lot of code.

Weber: But the-- they would-- you're saying that there was a lot of interest, but was it tough to sell that proprietary player?

Carrico: Very. Not because of the proprietary-ness, but we would show at a show, so, like, say 10 PCs in a row all playing 10 different movies. People go, huh, that's pretty cool. They didn't really know where to go with it. Okay? And you could explain all kinds of-- you could use this for security. You can use this in entertainment environment. It's the way the world is going. Everything is going to be IP. I mean, you could talk until you're blue in the face, but it was just not primetime for this yet.

Weber: Hmm. How about--

Carrico: So we sold it, but it was a struggle.

Weber: How about all the people that have been trying to do the on-demand cable stuff since the eighties? Wouldn't they have eaten this up or seen it as a threat at least?

Carrico: You would think so, but we really had a hard time.

Weber: There was audio on demand actually starting over the Web by then.

Carrico: Mm-hmm. Audio is-- by the way, of course, lots easier. Right?

Weber: Of course. But I'm saying didn't-- because I remember in '95, Web pioneers saying, okay, audio is here now. Video is a little bit down the road. But I remember certainly awareness that this was coming, as a dream.

Carrico: Yes. But selling it-- we tended to-- and perhaps to our detriment, tended to try to sell things to the Fortune 500. All right? Maybe if we had had more imagination to try to sell it in a more-- in a Google kind of a way, if we'd started YouTube with it or something, it probably would have caught on better. All right? But even there, I mean, YouTube works because they figured out a mechanism. You give away the software for free in exchange for giving away your life for them to grab the data. Right? I mean, I'm not sure I would have thought of that personally. And--

Weber: Well, also--

Carrico: Go ahead.

Weber: No. But, I mean, thinking back, at the time, the ordinary person who might be just starting to explore the Web was still mostly dial-up. So that your--

Carrico: Yes. Absolutely. It's a very good point.

Weber: Even if you'd gotten the Web community interested--

Carrico: It was still slick interconnection, yeah.

Weber: I mean, that's why it actually did make sense to go for corporate customers who would have a high-speed connection.

Carrico: Right. You're absolutely right. But, for example, we talked to the people who do the cameras and-- the security cameras in the ceiling stuff, just couldn't really get it. You know, it was “wedded to their ways.” I mean, it was really tough row. I mean, again, we sold some and it started growing a little bit here and there, but it was probably the hardest thing I've ever had to actually sell to somebody. And I think just a lot of it is it's too early, sort of like-- I don't know. I think if I showed a starship out in the lobby here, people would go that's really cool, but I don't think they'd really get it. Right?

Weber: Did you have that realization at the time? Is that something that-- as you were working on the company, working on selling the technology, the product, were you-- did you at that time get these signals to lead you to the conclusion, uh-oh, we might be too early with this? Or is that something that you see only with the passage of time?

Carrico: No. I think I had a hint of it pretty early on, but I was-- I'm an optimist and I-- we kept banging away at it, trying to find-- I mean, there's a lot of ways you can after stuff. And a lot of different mechanisms to see-- to pursue to see if-- where they'll take you. But what happened here is in the midst of all of this, okay-- we were probably two or three years in. In the midst of all of this, the guy who was a CTO at Cisco retired.

Weber: Who was that?

Carrico: I can't remember his name. Whoever he was. He had run across Judy at various industry things. Judy always had done a lot of industry stuff so that the companies we had would have our hand-- we'd have our hand in those industry things, whether it be standards committees or whatever. Right? And-- I really can't remember his name. Anyway, he wanted to retire and John Chambers had told him, “Well, go find somebody else” for him. And he recommended Judy. All right? And we said okay, but you get to own us too. And they basically agreed. So we basically sold Precept to Cisco.

Weber: Talent acquisition.

Carrico: Pardon me?

Weber: A talent acquisition.

Carrico: Exactly.

Weber: That's what I was going to ask you. Yeah. I mean, did they have an organic interest in that before or that came from buying Precept?

Carrico: No. They always claimed to have lots of video stuff and so on. Cisco's like IBM. Right? “We got one of those.”

Brock: Yeah.

Carrico: I mean, not in a negative way.

Weber: Or Microsoft.

Carrico: In some little way they might and they-- but they could certainly use more of it and many of the guys were at Precept ended up staying at Cisco for a very long time. In fact, the guy who was the vice-president of engineering for Precept ran telepresence.

Weber: And what's his name?

Carrico: Guy named Phil Graham.

Weber: I think that's the-- no, no, no. I was thinking about something-- someone-- so that turned out, actually, to be-- I mean they were primarily looking at Judy initially, but it turned out to bring something that really was a market for them?

Carrico: Yes. And thus starts one of the funniest times in my life.

Weber: Before--

Carrico: <laughs>

Weber: A couple of-- so with Precept, how many employees did you have at the maximum?

Carrico: Oh, we didn't have a lot, because we weren't building anything. Right? So-- and we had only a small sales force. I would guess it was 60.

Weber: Okay. And where were you based?

Carrico: Palo Alto in one of the Stanford buildings, rent a Stanford building there off of Arastradero.

Weber: Arastradero. And those were mostly, what, sales and software developers?

Carrico: Yeah. We didn't need any-- we weren't building any product. Everything was going to use hardware from somewhere else. Right?

Weber: And did you-- this is more going back a bit, but you mentioned industry events. So Interop was important back in the Bridge days. Right? Did that remain an important-- I mean, presumably, when you at 3Com and even network-- no, I mean-- but, I mean, did Interop remain important into this era for you guys?

Carrico: Well, honestly, I don't remember which name shows did, but we went to a lot of name shows.

<laughter>

Carrico: I mean, I've been to--

Weber: Well, that was Dan Lynch's one, where you were preparing--

Carrico: Yes. No. I know. But I can't remember which were which. But I went to--

Weber: Okay.

Carrico: --Las Vegas many times.

<laughs>

Carrico: I went to Boston many times. I went to Chicago many times. Yeah. I believed in shows. I thought shows were a good-- as you-- there's a lot of looky-loos, but you occasionally find a gem. Right?

Weber: And this is when the Web was taking off, the Internet's exploding. I mean, had you thought about trying to do some sort of plug-in for Precept to the Web browser, anything like that? Did you talk to Netscape or any of the--

Carrico: No. We didn't. I think partly because we got so wrapped up in the Cisco thing so relatively fast, all of a sudden. It came out of nowhere because he really wanted a CTO replacement.

Weber: And this is '98?

Carrico: This was--

Weber: '97?

Carrico: --around '98. Yes.

Weber: Okay. So you had really-- you hadn't thought of yourself as moving into the Web at that point?

Carrico: No. We were looking at-- in our minds, we were looking at more, offering a broader thing, not trying to just be a, as you put it, a Web app or Web insert of some kind. I mean, we might well have gotten there, but we didn't focus on that at the time.

Weber: And by '98, video on demand was still mostly in the future. I've read that it was actually porn sites that pioneered some of that, but that's later in the Flash era. Right?

Carrico: Yes.

Weber: That would be in the 2000s.

Carrico: That's my understanding.

Weber: YouTube, I believe, yeah, got some benefit from what had been pioneered.

Carrico: Well, a lot-- there was a lot cross-pollinization between Precept and many other companies' video stuff. Let me say that.

<laughter>

Carrico: I can name names.

Weber: Please.

Carrico: No. I mean, like, the-- Apple's video that's part of iTunes.

Weber: QuickTime?

Carrico: What?

Weber: Oh, not QuickTime.

Carrico: QuickTime.

Weber: Yeah.

Carrico: Yeah. But that's part of iTunes, is how I think of it. That was done by one of the Precept guys.

Weber: Oh, really? What-- do you remember the name?

Carrico: I don't remember his name right now, no.

Weber: Because David and his colleague Hansen have done quite a bit with the history of QuickTime.

Brock: We had an event here about that.

Weber: So that can be an interesting--

Q2: That's interesting.

Weber: So that that person went from Precept to QuickTime. Any other cross-pollination?

Carrico: No. That's all I can think of off-hand.

Weber: And how about MacroMind and all of the multimedia companies? They were also-- there was Shockwave and, later, Flash, but were-- you knew those people, I presume, but--

Carrico: But we weren't doing any-- we were doing it in whole cloth. Right? And, again, maybe before it's time, I don't know.

Weber: Because you were only looking at-- what's the word? Not vibe, necessarily, but, in other words, the multimedia companies who were interested in embedding video in some CD-ROM or a larger experience, you were really focusing on the video itself, not a player for video within something else.

Carrico: Right. We were really focusing on almost the entertainment-level stuff. Right? I mean, we could do really high quality and-- but I think-- maybe what happened is sort of what you're kind of hinting around, is that that just wasn't where everybody was. They would have been happier with a YouTube plugin, just put a name on it, than this. You know, a little box that sits over here and gives you nice video here just to do this, that, or the other thing. We were giving you full screen, full motion, full synchronization video with no drop-outs, buzzes, any of that stuff.

Weber: So did-- on the other extreme, though, did you think about becoming Netflix, streaming Netflix, or who-- running the service?

Carrico: We actually talked to Mark Cuban. Before Mark Cuban sold whatever he had to Yahoo!, Mark Cuban came by and we talked a little bit about that. Right? Because he was trying to pull in the sources of supply of entertainment and so on. And we explained what we did and so on and we explained what we did to several other people who had a similar idea. But it just never really went anywhere. It would have been a good idea-- I'd never-- I don't think I ever thought of it at the time. So I knew Barksdale [James L. Barksdale] real well. Okay? Barksdale had been on the board of Bridge.

Weber: Oh, really?

Carrico: Yes.

Weber: Okay.

Carrico: Okay? Because Judy had been on the board of FedEx. So-- and that's how they knew each other. We put them on the board of Bridge and then, ultimately, he ended up going-- being CEO of Netscape and we—it would have made sense to go and talk to him about that later on. But that really did get stopped-- not really stopped, but it never came to fruition because of the whole Cisco thing.

Weber: Makes sense. And to finish that, television-- real broadcasters weren't interested either? They had their own system?

Carrico: Yeah. They were-- I mean, because-- they were sort of luddites, right, in the sense-- only in the sense that, as you say, they had their own system. They didn't want to, “Hmm, I don't want to-- don't even tell me.” Right?

Weber: Okay. So tell the Cisco story.

Carrico: So the Cisco thing, so we-- so Judy is going to go be CTO of Cisco, which was interesting, because Cisco, if you remember, at the time, was going just beyond gangbusters. It was doing like this. You know, growth like this. Everybody's expectation is it was going to be a trillion-dollar company, the first one. I remember all this pretty clearly. And consequently, everybody wanted to talk to her. So we go over there. There is a-- the remains of Precept are set up in a building and so with actually the CTO-- CFO and this Phil Graham guy managing it. And I'm-- I had been the chairman of Precept, not the CEO. Judy had been the CEO. But I was the chairman and so, in order to exercise fully the stock as a part of the purchase, I had to stay at Cisco for two years, which is not uncommon, right, at all. And so, I didn't have a role, so I used-- I sat out in front of Judy's office in a cube. <laughs> This is one of the funniest things that ever happened to me. So nobody knew who I was and I really didn't care. And so, Judy's going off and doing Judy stuff with whatever. And I'd just sit there talking to the Internet. And various humorous things happened. One of financial people came up to me, one of them that had used to work for me at Bridge, and she said, "Bill, could you come and take a look at this tab run and, see, these costs don't make any sense to me." I went and looked at it and I said, "Yeah. That's kind of a problem. You should talk to somebody about that." Right? I mean, it was kind of weird, some of the things that happened. And then, what's surprising is John didn't know who I was, at all. He knew who Judy was because the guy had promoted Judy to him.

Weber: Because you were in the-- I mean, Sandy Lerner and Len Bosack [Leonard Bosack] knew very well who you were, but John--

Carrico: But they were all long-gone. Right?

Weber: I mean, Morgridge [John P. Morgridge] knew who you were?

Carrico: No. He didn't either. They were all long-gone. Well, Morgridge should have known because Morgridge tried to get me to go on the board of Cisco at one point. But he didn't remember. Anyway, the-- eventually, Howard Charney-- now, do you remember who Howard--

Weber: I know the name.

Carrico: So Howard Charney had been the guy who was in charge of three servers at 3Com. Okay? And I actually was-- had a good relationship with Howard. And Howard Charney had another company, which he'd also sold to 3Com, and he was running--

Weber: To Cisco?

Carrico: To Cisco, I'm sorry. He was running the Cisco business, which was small switches and routers. Okay?

Weber: But connected with Mario Mazzola.

Carrico: Yeah. The way it was broken up is Mario ran the big routers-- I'm sorry, the big switches, primarily, and lots of other miscellaneous stuff. Then, there was Kevin Kennedy, who ran the routers pretty much alone and all other ISP products. Okay? So that-- those are two pieces. The third piece was Howard's piece, which was small routers and switches, what's called SMB, small-medium business. Those were the three product groups at Cisco at the time. Howard didn't want to continue being an operational executive. He'd done it for several years. And so, he told John that I should take over. John said, "Who is he?" <laughs> It was really funny. So John asked me to interview, so I went and interviewed. So I interviewed-- well, Howard knew me. I didn't need to interview with Howard. I interviewed with the guy who was head of sales. I interviewed with Don Listwin, who was kind of executive vice-president of Cisco. I interviewed with the woman who was head of HR, Barbara, and-- this was the course of maybe a week. And I talked to John, of course, too, because I would have-- I was going to report to John. And so, finally, they said, "That looks good, Bill. When can you start?" So all of a sudden, I'm running SMB and--

Weber: Which is-- right.

Carrico: So that was approximately, oh, let's see. At the time, it was probably about a $3 billion business. Okay? Yeah. So Mario had probably about a $10 billion business and then, probably another $8 to 10 billion that Kevin Kennedy had, per year. Right? Something like that. I might not have the numbers exactly right. And so, it was different because the salesmen liked to sell, as salesmen do, the big stuff that costs lots of money. Right? So it was-- SMB always was a little bit the backwards thing because while--

Weber: Only 3 billion, yeah.

Carrico: Well, yes. They're only going to buy eight switches. It's that kind of stuff. Right? But there were things that mitigated that. For one, we had the 2500 router, and I don't know if you're familiar with the 2500 router. So the 2500 router had been around for a long time. It's 1U router box that had been-- essentially been blessed as the router for 99 percent of all routing in the world.

Weber: And it was the AGS successor, right?

Carrico: Yes. But it was-- everybody-- it was the go-to router for the low-end, and they were used everywhere and they-- we made them for a very modest price and sold them for a very large price. Okay? So that was sort of fun. That's always fun to make a lot of money on something.

Weber: Do you remember the prices?

Carrico: Of course I do. So--

Weber: But can you say? <laughs>

Carrico: I don't know. Can I?

Weber: I don't know.

Carrico: So there-- that business was about $600 million a year, just in those routers.

Brock: Wow.

Carrico: And so, it was-- so there were fun aspects of it and Cisco was matrixed. So that was interesting. I mean, I-- in addition, I had two vice-presidents who reported to me. One was in charge of the small routers and one was in charge of the small switches. Then, I had a marketing guy vice-president who reported to me. Okay? And then, a bunch of support people. And then, I had the distribution guy for the United States reported to me. Okay? And the person who was service and support for the United States reported to me. But again, those people were all matrixed. They reported to somebody else too.

Weber: So dotted line reporting kind of thing.

Carrico: Yes. The organization was a little bit odd to deal with in terms of how all of this worked. So I did as well as I could with it. It's a big company. It's got a lot of inertia is probably the best word I can come up with. It's very hard to get them to do anything different. The individuals will do well. And they were very, very driven by John. Now, John is not a technical guy. John is a great sales guy.

Weber: Motivator.

Carrico: And you know, the phones. Right?

Weber: Well, this is what led towards the phone. Ike Nassi involved…

Carrico: I don't know who Ike Nassi is.

Weber: The competitor-- anyway.

Carrico: Mario and I got along really well.

Weber: Yeah, I've interviewed him.

Carrico: I'm not sure Kevin got along with anybody really well. Kevin Kennedy. Have you interviewed him?

Weber: No. I think Chuck may have.

Carrico: He's very smart. Very smart. But my experience, hard to get along with. No. It was an experience for me to come back to a situation where you could use the power of Cisco. And by that, I mean, the power of its product breadth, the power of its sales breadth and so on to do things that you just couldn't do at a small company. It was really interesting to be reminded of that. Right? So I did that for about two years. It paid a very well. I was-- what did they call me? I guess it was a senior vice president. And the pay scale at Cisco what like this. Okay. So it motivated people because it wasn't always that much fun because some of it was a slog.

Weber: Well, the scaling must've been stressful. I mean this is when it was just growing and growing and growing.

Carrico: Yeah, but at the same time John did know how to manage the sales guys pretty well. So he could scale the sales guys pretty well. We had a pretty good handle on scaling the manufacturing. The hardest thing was to get products right. One of the biggest issues they faced which was one of my hobby horses is that they had too much overlap in products. One time we looked into it and we had 1000 different cables for power cables. We had like 97 different RAM chips, stuff like that. Because everybody would argue why they needed their own to be this way. And John's attitude was, "I don't care if there's overlap. As long as I'm making big money I don't care if there's overlap." Because he didn't want dissension in the engineering ranks.

Weber: Have you fighting over things.

Carrico: Yes. And by the way, he didn't care what you did. So if I could go to Mario and say “Mario, I want you to give me this long end product so it will fill out my product line better and I'll give you this higher end thing I'm working on here.” If we agreed, nobody cared. Nobody cared. John would go, "I don't care." He just didn't care about that kind of stuff as long as we were both happy. If it upset Mario or if upset me or if it upset Kevin Kennedy that was a problem because he wanted those guys, the line guys, to keep it together which makes a certain amount of sense.

Weber: And so Judy was where-- these sort of things she wasn't…

Carrico: Judy is not involved in that.

Weber: Okay. Looking far ahead at the prior…

Carrico: Judy is basically, I don't want to say ivory tower but she was just being bombarded with people who wanted to understand Cisco's direction and product direction and what was Cisco going to do with this and that and so on. It was overwhelming the amount of contact she got from everybody you can imagine including the federal government, the military, the security agencies. She had a STU phone in her office which is the secure phone. It was all a consequence of that time. Right? It was really a very big deal where Cisco was at. It was like Google today.

Weber: Yeah. It was the company for the infrastructure of the whole thing.

Carrico: So finally after about the two years were up we went through the process of trying to make sure we had our products working for Y2K, by the way. That was kind of exciting. But I think we did a good job. We basically, we being Judy and I at the time, decided this is not what we want to do.

Weber: This is by 2000 roughly?

Carrico: It wasn't so much Cisco it's just that at Cisco you're a cog even if you're a high-level cog. And so much of it is other stuff not maybe doing what you really enjoy doing. How many times can you go and meet with distributors and stuff like that? Right?

Weber: And with the 2500 because it was selling to so many different people you were dealing with-- I mean the customer base was huge and varied. Right? But that didn't necessarily-- how much of that affected your…

Carrico: You have to understand, though, that I think sold-- you didn't have to do anything. Just ship a good product. People -- they knew what they wanted. They'd call up and say, "I want a 2500 with these interfaces." You didn't have to tell them. You didn't have to do anything. It was rare to see a customer on many of the products. They knew what they needed. Now, as you went up the complexity line that changed. But I was at the low end of the complexity line.

Weber: So it's really a commodity whereas, it's the bigger ones that they're selling to the telco's that might have very specific requirements of governance.

Carrico: Yes. For example, the GSR, the big giant routers those were very much more complicated and there was a lot of discussion to be had and so on. The same thing with the very big switches. But that really wasn't what I was doing. I was just trying to shepherd along selling as many as we could of these little ones. Right?

Weber: So you were talking about your decision to leave Cisco at the height of the boom.

Carrico: Yes. So, again, really more motivated by the day-to-day than anything else. And we had started to develop an idea that certainly appealed to me which idea was that it would be nice to go out and have a company that was sort of like Xerox PARC in its heyday. That was really the idea behind the concept in that we would put together smart people and we would identify a collection of investigations and hopefully turn some of those investigations into products. Now, we were consciously not trying to build what they call an incubator. Now, that's in my view, a completely different thing. And incubator is you bring people in and you help them along and then you send them back out with their ideas. We weren't doing that. That wasn't what we wanted to do. We were going to create some ideas, not competitive but different ideas about what might be done on the Internet and raise the money for this and then when we got a company or a product idea or whatever it might be to the right point we would turn that over to the venture guys and let them take care of making it into a company. Now, I went and talked to several venture people the first

one was Foundation Capital and I said this is what I want to do and they said, "Oh, that sounds wonderful. We love this." And along the way-- I should back up slightly.

While we were at Cisco Van Jacobson had contacted Judy and offered to come to work at Cisco as a Cisco Fellow. Now the Fellows at Cisco were the very highest level engineers being paid like vice presidents and so on. It was to try to keep them there and keep the ideas and juices flowing and so on. And he also brought along with him, his wife, Kathy Nichols who is a PhD in computer science. And so Van came and worked for Judy. And the Fellows essentially worked for Judy at Cisco. And Van is a fountain of knowledge when it comes to things like this. And so we knew we could generate a lot of ideas and we did. We raised some money and it was a time when the bubble had not burst yet. And we were paying $14 a square foot for a building-- an old building in Menlo Park. But that's where we started. And we also hired Martin, again, and this time, also, Marc Tarpenning. Marc Tarpenning was the guy who went on to become the VP of engineering for Tesla later on. And so I had known Martin for a long time now because he had been at NCD the entire time. And then he had done that Rocket Book. And then he came to work for us at Packet Design. And so we came up with a lot of possibilities. We came up with the possibility of, for example, is there something we can do to the Internet to make it better per se. In one respect, for example, now, we should probably talk about you're familiar with what BGP is?

Weber: I know the name but…

Carrico: Okay. So BGP is the Border Gateway Protocol.

Weber: Oh, yeah. The one on the napkin at Cisco.

Carrico: It's the one that actually talks for a router where you connect it to the real Internet. And it routes to the routers on the Internet. So if you're a big company you have a router which has the BGP table in it. It talks to the Internet.

Weber: And I'll give you, actually, they reprinted the napkin that they drew the initial sketch for for that.

Carrico: So, for example, one of our ideas was to enhance BGP. There are some issues in BGP. We came up with something called BST which was a backwards compatible enhancement. So that was one idea we had. One of the things that Van was very interested about was could optical routers be done differently? And we still have a bunch of optical router ideas that are sitting around that we're mulling over as a consequence of this. Basically what we call color routers. Route based on colors. We talked about the fact that there was a desire among-- now, this is in 2000, remember, there was a desire still among the bulk of the ISPs to think about the Internet as strings because that's how they were used to it. And by strings I mean every-- a line goes to everywhere. Right? The idea that the Internet could float your packets through any number of routers and God knows how it gets there but it gets there really made them uncomfortable. I think, actually, probably to this day still makes them uncomfortable. I noticed when my modem went down at home, my ATM modem, which stands for asynchronous transfer mode, they're still talking about ATM as a way to connect back into their systems. Right? What it is is a string back. We're not using the Internet in that way. Right? It's an Internet bypass. Similarly everywhere you look at

big networks they'll talk about MPLS. MPLS stands for multiprotocol label switch switching. And it's another way to put another layer on top of the Internet to hide the bad things from you.

Weber: It's a virtual switching-- virtual circuits in some form.

Carrico: Yes, it is. It exactly is that. So instead of using the Internet the way it was designed to be let's hide that Internet stuff from you. And there's actually an article about this about this time that came out. I think it was called “The Bell Busters.” And it was about Judy and I talking about this matter relative to particularly the phone guys, the AT&T's of the world and how they really didn't want to look at the Internet. They wanted to keep pretending that it was not what it is. Another thing we looked at is can we build virtual wires? Not by MPLS but by doing a variety of things to basically make sure if you put in something here it gets here no matter how it gets there but it gets there completely synchronous and in the timeframe that you think it should.

Weber: Related to the Precept work presumably.

Carrico: Yes.

Weber: You would solve that within the limited domain for video.

Carrico: Right. In fact I've got a company I'm invested in now that's still trying to do this effectively and finally, I think, it's going to have done it. So we had that idea. And we actually started testing that idea and we got that to work. So we had a lot of ideas. And we had to kind of shrink them down to something that was manageable. I have to say here too Van was just absolutely inspirational in all of this. Van is a hard guy to talk to because he's kind of a low bandwidth guy. I mean his personal bandwidth-- his personal I/O is slow but back here is a giant computer. And if you can say the right words to him to get it out of him gems fall from his mouth. He's that kind of a guy. I mean he really, really gets this. But that's not easy. It's not an easy task. And he doesn't suffer fools even remotely gladly. So what did we do? So that's kind of as a background. Right? So we started doing some specific companies. The first one we did, this isn’t exactly the right order but we did something called Vernier. Now, Vernier came out of the idea of having-- do you know what a vernier knob is?

Weber: Sure, yeah.

Carrico: You two are the only two I have ever told this to who knew what a vernier knob…

Weber: I’ve taken machine shop courses.

Carrico: Exactly. It's a knob that you turn where it turns really slowly and it has a leverage in it so you can get a very fine-grained control of a distance.

Weber: Like for calipers and stuff.

Weber: Yes, exactly. So that was where the name came from. And the idea was to give you vernier control over Wi-Fi. And when we talk about control we're talking about security. So this came out of the fact that the initial Wi-Fi was all based on so-called WEP security, W-E-P, which basically didn't work really well. It wasn't really very secure at all. And so we were going to add the ability to give you a better security plus also allow you to dial in the security.

Weber: And what were the trade-offs though? If you dial in too much security it slows down or it's less compatible with other things.

Carrico: It doesn't really but what it did do is you could basically put people into categories. So, for example, the classic example was you walk in, like this building, and I don't know what you guys do but you provide Wi-Fi and you have guest Wi-Fi. But the guest Wi-Fi is absolutely firewalled off from the mainline Wi-Fi that the employees use. So that's an example of the kind of thing Vernier was doing back in the day.

Weber: Okay. But it's not so much about the level but it's about separating zones.

Carrico: Right. But you could do anything with it. It was set up so you could arrange groups that only the group-- one group could talk to this machine or talk to that other group. But this group couldn't talk to that group. You could just do it however you wanted. And there was a lot of interest in this. And so that was a company we put and got the venture guys to put the money in and so on. And it was sent on its way.

Weber: And specifically over Wi-Fi?

Carrico: Yes, this was very Wi-Fi oriented.

Weber: And this is right when Wi-Fi is taking off. Were you dealing with any of the Wi-Fi companies?

Carrico: Oh, yes. Absolutely. Other people, by the way, went and did this about the same time.

Weber: But who were the main companies you were dealing with on the Wi-Fi end?

Carrico: I don't remember the names, actually. It's been a while.

Weber: And at what level were you doing-- this wasn't in the chip. This was software.

Carrico: No, this would've been whoever actually was shipping Wi-Fi equipment. This was a software thing. It wasn't a hardware thing again. There was a little box that ultimately did all of this. Any Wi-Fi would hook up to it. Any access point would hook up to it and so on.

Weber: So the people that were selling the access points and the Wi-Fi routers you would be dealing with them?

Carrico: Yes. And we had the guys on the standards committee, again too, to try to make sure we knew where that was going to go. And there was opportunity there. People were coming to us and saying, “Yeah, I really like that.” There was a real mixed list, though. For example, a lot of people would like to be able to have just one access points 15 miles away that you know you can't get into but only you two guys can get into like that. And so you could really easily do something like that with this. Okay.

Another company that we started developing was a company we called PIO for precision I/O. These came out of the fact that we wanted to solve a problem that is still, I think, basically unsolved which is here we are sitting here with first one gigabit per second Ethernet and then ten gigabits per second Ethernet. And then probably only 40 gigabits per second Ethernet. It's not clear how you do it really much faster than that other than doing handwaving stuff. And if you think about it the packets are coming in. How in God's name does the computer that has to see them-- forget about the switch. If they’re being handed to the computer how in God's name is a computer going to deal with all the interrupts? Interesting, huh? Most people go, “Uhm.. Uhm..” Well, they can’t. So there's various mechanisms that are now kind of cobbled together and slap dashed on to try to manage this issue. Some of it is pre-sorters and so on so that they can at a more granular level make sure that you, if you're processing database, you only see those where you, if you're doing just slow transactions, only get those. So it's a box that somebody sells. And the idea of this was not to try to force yet another box, another layer, but allow it to be done in the actual interface of your machine and your machine by having a more intelligent card that could pass the interrupts and the data specifically to the processes that needed it without going through the operating system.

Weber: And how would it know which ones belong to which without doing a lot of analysis of the packets?

Carrico: Yes, there was a way.

<group laughter>

Weber: And that's the secret sauce.

Carrico: So this is still-- this got patented. And so I'm not totally sure who owns this patent at this point. But it looked like it was a good way. And we initially simulated it on software only. One of the ways we could do it is Van-- software is now written in a very layered way -- particularly protocols -- because everybody has been taught in college layered software, defined interfaces. Well, what does that really inherently do? It slows it all down. It makes it easier to service but it slows it all down. So I said Van, go home and rewrite that and I want it all one big podge of code. But I want it faster than lightning. The next day he walks in and he's got it. And so we were able to get a TCP/IP stack that would, in a very fast way, be able to deal with the packets so then we had time to start working on how we would then pass them out around appropriately. If we didn't do that the TCP/IP test stack took so long that it just didn't work.

Weber: But with that once you've done the fast sort of glommed together version it would be hard to upgrade or anything. Right?

Carrico: Oh, no it's a problem. This isn't necessarily how you want to do it in real life. But it was a prototyping tool.

Weber: Yeah, okay.

Carrico: So, again, the idea ultimately was get directly to the process and not through the OS. Martin was working on this. Martin Eberhard was working on the hardware of this. After we did sort of a software prototype we embarked on a hardware chip. And we figured we could make it pretty inexpensively, about seven million gates. And we raised money for PIO. And this is right around everything bad is starting to happen and the venture guys pulled the money out just as we were about to get started. So that kind of died on the vine.

Then the other thing we did-- I'm kind of skipping some of it because we did a lot of these things. The other thing we did is Packet Design itself. Now, Packet Design itself eventually got sold to a private equity company about 2010, I think. But what they did is-- and by the way Van kind of stayed as a contributor to all of them up until some point. But what they did is they wanted to do two basic things. One is traffic analysis on the Internet. And they built a system that allowed people to do -- ISPs primarily -- traffic analysis. Which packets are going where? How is that working? Are there anything weird things as a consequence of this and this? And they basically built small routers of their own but which were essentially tooled routers. The idea was that they're not really routing things but they behave as a router, gather the data as a router and then tell you information about what they see as other people are routing around them.

Weber: They’re more of a measuring instrument.

Carrico: Yes. And the goal was once we understood that really well-- and by the way people really did like this because we found that we could find problems that were not even visible to them otherwise because remember nowadays it's pretty sophisticated. People have lots of tools. But they couldn't always tell about subtleties in routing and so on and it also somewhat scared them, I think. And this would allow them to say it looks like this thing is only spitting out every other packet as it routes to over here. That's pretty hard to find if you don't have something that's actually looking at things like that.

Weber: Because it was a real-- it wasn't just a tool trying to analyze at a metalevel. It was in there as a router you found things you couldn’t find otherwise.

Carrico: Right. And what the goal is as we gathered data about usage we then wanted to eventually move to traffic engineering and really simply because people want it. This is really the goal of MPLS, again, and so on. ATM they want traffic-- they want to be able to say all the traffic for the banks in New York is going here. All the color camera stuff for the Super Bowl is going to Louisiana and stuff like that. That's what they really want. And so that was the goal was ultimately to get the ability to dial that in. And they got a good start on it. Now where they are now, I don't know. But they took all of that intellectual property and they took a couple of really good guys and have moved forward with it.

Weber: Which group was that that purchased it?

Carrico: The private equity group? I can't remember their name. If you want to send me an email I'll be able to find that, though. I can ask my guy. But I don't remember.

Weber: You didn't have a lot to do with them at that point.

Carrico: No, I was gone by then. I left Packet Design in 2005. And this happened after that.

Weber: Okay. And then you got some investment from Jim Barksdale there. Right?

Carrico: Yes. Early on he did invest in its. Yeah. But there were other people investing…

Weber: And Bill Joy.

Carrico: Yeah, a number of people invested in it. So the real problem with Packet Design is that we hadn't intended, as I said at the beginning, to be the instigators of actual companies. We wanted to be the developers of ideas and concepts. And let the venture guys go put the companies together. But in the end the venture guys really don't want to do that either. It's too much work. And we quickly realized that this was going to be a problem. And in the end it was a mistake. We should have cut back, recognized what it was going to be, built the resources to take say three companies only and spin them out and actually take care of it ourselves. But by the time we realized that the venture guys were going to be no help it was too late to do all that. The structure of the company's was not going to work.

Weber: And you couldn’t work with an existing incubator that does, as you said, they bring in someone with their own idea and develop it. But they are used to helping them grow. Right?

Carrico: It might’ve worked. It wasn't done. Now, bear in mind, at this point in time I was, again, the chairman, not the CEO. Judy was CEO. And this was about the time that we divorced. So things could've been better. Right? So I kind of was not involved in the rolling down of it into that final situation. I was always interested, though, in the original idea a lot because I think we had access to a set of people who were really, really capable. Again, just think about it what, for example, Martin has done. Right? And Martin, again, in my experience was always an absolutely first-rate hardware engineer.

Weber: I have a note about to ask you about Nouveau Media which was the Rocket Book. You were on the board. But that was before he came back to this. That was the late nineties. Right?

Carrico: Yes.

Weber: So that was when you were at Cisco, Martin was doing that.

Carrico: Yes. In fact, I got to Cisco investment for Nouveau Media while I was at Cisco and he was doing Nouveau Media.

Weber: Okay. Because I will circle back a little bit to some Cisco stuff. Okay. So go on. You were saying Martin is a great hardware engineer.

Carrico: Yes. And we hired another guy from L.A. who I'm not sure whose student he was. What's his name? I had it right on the tip of my tongue. He had worked-- I can't remember right now. He had worked on high-speed computer networking-- very high-speed computer networking for supercomputers. Networking supercomputers and using, I think it's called MCP, to bring them together and make them do really, really fast stuff. So he's another kind of a guy that we had working at Packet Design to work on some of these issues. And, he in fact, worked on this PIO also to try to get the performance up. And he since going to Google as a-- I believe he's actually managing the architecture for their mainline networking. God, it's right on the tip of my tongue.

Weber: It's almost like what was missing in the model where sort of the more junior people to work with these experts who could have been parts of the teams that the venture capitalists would put together.

Carrico: Well, we had the engineers. I don't think that. But what we didn't do because that wasn't what we were thinking about doing we didn't have the business side of that. Right? Our idea was that they would provide the business side of that equation. So no, those people really weren't hired.

Weber: The VCs were meant to provide…

Carrico: But on our part we viewed that as a conscious decision.

Weber: Right. So, I mean in essence, you were setting up similar to a corporate research lab, a PARC or whatever, but without a clear pathway from there to the market which is true of a lot of corporate research labs, too.

Carrico: Bob Felderman, that's his name. Bob Felderman was the—Dr. Bob Felderman was the guy who was the MCP guy. And I think he's at Google running their high-speed Internet infrastructure.

Weber: So you and Judy got divorced. You sold your interest in Packet Design. Is there anything more on Packet Design?

Carrico: No, I think that summarizes it pretty well.

Weber: I mean we have a little bit of time if you want to talk about some of the other-- you said there are number of other-- but Wi-Fi, you talked a little bit about Wi-Fi but Wi-Fi was a main interest of Packet Design. Right? Or just that one?

Carrico: Inasmuch as the Vernier thing was. Yes.

Weber: Okay. But not beyond that? That was the one Wi-Fi venture?

Carrico: No, not really. The idea was to try to improve the security of Wi-Fi.

Weber: And what are the others that you didn't mention that you guys were mulling over?

Carrico: We had lots of other ideas. For example, I mentioned briefly the idea of a virtual wire where you're using techniques to reduce jitter and so on that you would be able to really not see a difference between-- as if you had actually hooked a wire up from here to here and we would still get exactly the same way with packets. And that turns out to be pretty hard. But we thought we had some really good ways to go on that. I've got an investment now in a company called InSpeed which is finally doing a version of that. And they were founded on the idea-- this by the way is Ed Basart's company who worked at NCD. And the idea is that if you listen to particularly like Cisco phones that you have on the table let alone cellphones and the quality is just nothing like it used to be.

Weber: Awful. Yes.

Carrico: If you remember in the old days the quality of a telephone call you never had any garbage on it or anything or it was extremely rare. And now, they're just terrible.

Weber: That's why I keep the old RadioShack phone.

Carrico: Well, it's because the packetization is not the problem, per se. It's that there are so many buffers in between. And the buffer management is done so poorly because all they're trying to do is get it there that you're constantly running into trouble. It's why you see the problems even on YouTube. So YouTube will run really good and then it won't. All right. So he has built a system that does a variety of things, some of which we've all talked about before, that allow you to make a connection and never have it go down and it's-- people are pretty excited about it, right? He's starting out just trying to give you a very good audio connection, but people are already trying it on video, and it does the same thing. See, the thing is if you think about it-- do you know about Cisco TelePresence?

Weber: Oh yeah, yeah. My wife contracted for Cisco.

Carrico: Okay, so Cisco TelePresence looks wonderful, right? I think, anyway, pretty wonderful.

Weber: Yeah, pretty good.

Carrico: But that ain't no Internet it's going on. Those are dedicated lines with conditioning to get that quality of look.

Weber: Back to the Bells, yeah.

Carrico: So yeah, it looks good and if you can afford it, it's fine but that doesn't work for the average company, right?

Weber: You have-- it only works at specific locations, too. Even Cisco can't just set it up in a new field office instantly, right?

Carrico: Right, but the goal has to be that the Internet can do this for you, and so what he's got is we don't count on anything. You put it in here. It comes out here and you're happy and so far it's working. I think it's going to be a big winner.

Brock: Are you doing that investment on your own or as part of a group?

Carrico: Oh no, no, as a bunch of other people that I generally invest in have invested in.

Brock: Okay. You're part of kind of a group of people that you've worked with in the past-- is it formal or...?

Carrico: No, no, no, completely informal.

Brock: No, it's just-- okay.

Carrico: I work with a bunch of guys that I've just worked with before, and that's what I do now. So for example, some friends of mine that I've worked with many times, I'm now-- I just invested in their company, which is going a specialized kind of camera. Essentially, it's a 360 camera, 360-degree camera, and it's pretty impressive.

Weber: So for virtual reality?

Carrico: Yes, virtual reality but also more profound things. Let's say you got your camera out and I'm looking at my grandkids and the grandkid runs away so, "Sister, can you move your camera so I can see little Johnny?" Right? This, you don't have to do it. The camera on his end has this software in it so...

Weber: So they can zoom-- I mean they can pan and zoom.

Carrico: ...it's all transparent and I can just sit here and go, "There he is. He's over there. That's nice."

Weber: You point to see that...?

Carrico: I just am really moving around like this just to see-- have it look in but at his end the camera sees a full 360.

Weber: Taking memory. So I mean the-- changing the perspective is done on the user end, the client end because you're already getting the whole signal. You're just choosing which portion of it to look at.

Carrico: Right. It's really pretty damned impressive.

Brock: But what about-- doesn't that make the bandwidth go through the roof?

Weber: Okay. Let's go back to Cisco a little bit. So the deal when you sold Precept was $84 million and-- but that was obviously for the whole company. Was-- that was when Cisco was acquiring everything.

Carrico: A lot, yes.

Weber: That was, for them, a fairly medium-size... how-- looking totally aside kind of from your story within Cisco, Judy's story within Cisco, how successful was the integration of Precept into Cisco?

Carrico: Well, remarkably, I didn't have high hopes, but it actually did work okay because Phil Graham and Jack Bradley went and ran that part and they initially kept selling the Precept as it was but the whole thing got re-oriented towards Cisco TelePresence and so in terms of a integration, I think it did pretty well. Moreover, from a Cisco value point of view, they got two executives, so that's not too bad. So while there was a lot of integration of startups that didn't really do too well, some did do okay, and some of it was just, I think, accepted as, "Well, we got two more engineers on." Now, they were really expensive engineers sometimes or maybe it was 4 or 8 or 10 or whatever but there was some value in that, in getting them now. So I think that worked out okay for them, in that sense.

Weber: And why-- I mean Precept, the whole premise was to be able to do the high-quality video over the internet with complete synchronization, et cetera, so why did they need to move away from that with TelePresence into just a dedicated line?

Carrico: Because the TelePresence was in Cisco's wheelhouse, right, I mean a big, expensive thing that relied on selling you big, expensive stuff. I think it's no more profound than that because it was very, very impressive and there were people who were going to pay for it and so why not? It's harder to sell Precept as itself.

Weber: So could they have done TelePresence over the internet using some of the things you developed for Precept?

Carrico: I don't think then, and I don't think their mindset was that. They jumped right to conditioned lines on Telepresence immediately. I think they'd have a hard time going back. Remember, this isn't really a Cisco problem, per se, it's that if you look from here to here in terms or if you're in New York talking to San Francisco, you have no idea how things you're going through and how many of them have got buffer problems, right? It is a real issue, let alone many other possible problems, okay?

Weber: But you-- with Precept you solved that enough for relatively small video. I guess Telepresence, though, it's a much higher bandwidth, right?

Carrico: So here's what did happen, though. The guy who was the server designer for Precept stated a company called ViVu.

Weber: Vi--

Carrico: ViVu. V-I-V-U. ViVu. The guy's name is Sudha Valluru-- and we-- I had invested in that company, also, and he had worked for me at Precept and he brought in another really smart engineering guy from India and they came up with the next path, the next instantiation, where they were able to do pretty good, pretty high-quality, continuous-on video over the standard Internet. So they kind of took it the next way and then after about four years of working on that they got bought by Polycom and Polycom invested in integrating that into their system So I don't know where exactly that is, and it's those two guys who are now doing this 360-degree TV I mentioned. So they went to-- then they did another company where they did an AI thing on video and Google bought them for that and kind of hid them and then they stayed at Google for three or four years and now they're off doing their own thing again.

Weber: And you had mentioned Nouveau Media, but were you and Judy involved in-- in the Cisco era, involved in other companies as advisors, investors, board members?

Carrico: You mean as part of Cisco?

Weber: No. When you were at Cisco, you had been on the Board of Nouveau Media simultaneously, right?

Carrico: Yes.

Weber: And you got Cisco to invest. Were there other companies you guys were involved in, in that late '90s timeframe?

Carrico: I don't think in that way. Judy was doing a lot of board seats at that time, so Judy ended up being on the board of Sun, FedEx, and Rockwell. So she was kind of pretty full up, and no, I don't think we did any-- it was kind of a coincidence that I got involved with Nouveau Media.

Weber: There was a lot going on.

Carrico: So I don't think so.

Weber: And you were-- when you were first at Cisco, you were-- internet security was your actual focus or...?

Carrico: No, my actual focus was play with the Internet. No really, I was actually helping Internet security, but I don't think I had the title. The woman who ran Internet security and I spent time talking together and focusing, but it wasn't really a formal thing.

Weber: And-- but you were interested, at least. That was something of particular interest to you?

Carrico: Yes.

Weber: Describe.

Carrico: No, just that it's clearly an area, as we know even today, and I'm still-- my personal view of this is I am still mystified why we're having so much trouble as a society with this because we were pretty sure at Cisco back then that if you properly install the tools, properly use the tools, it was remarkably hard to break through those kind of tools and that it means just to me that a lot of this stuff just isn't used correctly, thoroughly, monitored, and so on. We really had very complex stuff and I never saw the really complex capability be broken but I saw slipshod be broken.

Weber: So it's a human problem, not a technical problem.

Carrico: I think it is, yes, but I don't really know. I haven't looked at this in a long time, but it was-- I thought we had done a good job.

Weber: And security was one issue. This was when Cisco was doing a lot with the U.S. government, too, right? Any particular-- were you-- well, the Clipper Chip stuff was earlier on. That was all settled by then, but what-- were you advising to government agencies or-- Judy might have been.

Carrico: Judy did talk to government about this, that, and the other thing, but I don't remember exactly what it was about.

Weber: And during that period, Judy was involved in a number of the acquisitions, right?

Carrico: Yes. Judy actually-- Acquisitions reported to Judy. There was a guy there. What's his name? He went on to run Hulu. You know who I mean?

Weber: I know the-- I've heard about the Hulu founder.

Carrico: Anyway, he was responsible for all acquisitions, and he reported to Judy.

Weber: Were there any stand out...?

Carrico: No. There were so many acquisitions. Some of the acquisitions that had really made a difference, I think, pretty much had happened, so hiring Mario was brilliant. Acquiring the ATM guys, as much as I dislike ATM, was brilliant because it got them ATM overnight. Hiring Howard's company or acquiring Howard's company got them intermediate switches overnight, so those, in my mind, stick out as the ones that were the really big wins for Cisco. The biggest problem that Cisco faced-- and I'm not really sure where this is at now-- was IOS, which is their operating system. I'm not talking about Macintosh operating system.

Weber: I know, I know, the original IOS.

Carrico: Right, and IOS was a gigantic piece of code that was very difficult to maintain and very difficult to develop around millions of lines of code and-- but that wasn't the worst of it. The worst of it is there was never going to be the time to go fix it because we need this new feature for this order. So you couldn't get off, if you will, the train, so I'm not sure what finally happened. So some of it was that the code was a little on the curmudgeonly side and it wasn't really designed to be modular as it should have been and so on but until they actually bit the bullet and started over on top of say, a UNIX platform, Linux platform, they were in trouble. It was just-- that's the thing. They could afford it. That's the good news but they had a thousand guys working on it but it was a problem. For my little divisions, I had to go and take the code and rip all the stuff out of it so I could make it fit on the little routers and switches and to make them performance-wise and so on because we didn't promise every feature on every box but even doing that was dangerous because it was always a risk that we'd mess something up. So it was this-- big, giant entities have their own little problems.

Weber: Yeah, the momentum, turning around a oil tanker. And did you see that period, all the acquisitions, as part of another kind of major wave of consolidation of the networking industry, I guess, similar to in the '80s or...?

Carrico: Look, beyond a few really big acquisitions, Cisco didn't really make anything but smaller acquisitions that I don't think were probably earth-shattering in any real way. So for example, they did make some acquisitions when they started doing the telephony more, some telephony things here and there but those were really more like going and getting a feature and I can't say-- I may be completely wrong about this-- that I can think of anything that really made a huge difference. Certainly, at an industry level Cisco did make a huge impact on the industry by going into digital PBXs, voice over IP phones. There were no voice over IP phones, and then you saw them in every movie you ever watched. They now are ubiquitous.

Weber: I know. Well, I know there were ISDN before that but not the-- that's different. Yeah. Juniper, though, was another-- and that's going the other way.

Carrico: They were the big competitor. So in small switches, it was 3Com, and that's who I competed with as the SMB guy.

Weber: Which had a certain irony when you...

Carrico: Yeah. It does, doesn't it? And to some degree small routers but more switches is what came up. The medium switches, well, there were more and more of those. Juniper was one and Juniper also, of course, competed in routers but there was also the-- oh God, what's their names now? Extreme was a big competitor and the bigger switches and Foundry, so those guys all competed. It was never much of a problem, though. They got the dribs and drabs. I would say that Juniper-- from my experience, Juniper did a better job of getting router business than anybody else did in getting switch business is my perspective on this.

Weber: Taking more from Cisco, you're saying. Yeah.

Carrico: Yeah. Now, that doesn't mean still that it was that much but more. Cisco did a really good job on continuously putting out new products that people liked, and the IOS, as much as it was curmudgeonly, had lots of features and you ended up with the priests of IOS and so they didn't want the management to buy something else because that took away their priesthood. It was actually easier to program a Juniper box. "I don't want that."

Weber: Well, and do you think Cisco having all those training courses and certification, it probably helped perpetuate that?

Carrico: Absolutely, and by the way, there was a lot of effort put into that stuff. That woman worked for me who did all that stuff.

Weber: Oh really? Interesting. Yeah. That was one of the early programs like that, right? I mean I know a number of companies have copied it since then, so that was seen as a real marketing strategy. Get in the trench. Get it...

Carrico: Yeah. There is no question that-- but ultimately, the bulk of the stuff sold either because it was kind of pre-certified, like when we talked about the 2600, or our salesmen were selling it. I remember visiting the big giant distributors in the U.S. who supposedly were going sell all this stuff for us. They could take orders just fine. They could not sell anything on their own. You had to give them business, pretty much.

Weber: And Juniper, I mean they were already a major competitor by the time you were there? Yeah.

Carrico: Yes.

Weber: Yeah. Oh, the-- they made such a big deal out of VLSI. That's more for the router market, right? I've interviewed Pradeep Sindhu from Juniper, and other people have said that, you know, it's sort of-- it was an arms race between Cisco and them, that you were both doing pretty well with that. It's not that Juniper had such a huge advantage, but tell me your thoughts.

Carrico: No. I can only see it from the Cisco point of view. Cisco, my perspective on this is their lead in the midrange switches, Mario switches, was beyond titanic. In small routers, we dominated absolutely. The only place there was really a fight left was in the highest-end routers, and when the GSR came out it just swept, from everything I could see and I think that has to keep getting rejuvenated and I haven't been paying attention but I assume it is.

Weber: And you've talked quite a bit about virtual circuits in different forms throughout the era, but were you-- one of the-- much earlier on but Tymnet was a quite major commercial network that was circuit-based into the '80s. How did they even make that work? I guess I'm asking-- you're obviously coming from the Internet side, but I mean you hear so much that it's only packet switching that is practical, but they managed to have this quite large network using not virtual circuits but real circuits.

Carrico: Yeah, and I don't know the answer to that. The problem is, even today I think that there are people who wish that Tymnet still did everything. It really makes some people uncomfortable when you tell them that I don't know where your packet is. Is it okay if it gets there? Don't worry about it, and literally, packets can do this. There's really nothing to prevent that. Now, you might want to try to prevent that, and there's some things you could do but the whole idea is it's multiply redundant.

Weber: But people don't worry about when they put the letter in the envelope-- I mean the letter in the mailbox, they don't care.

Carrico: Exactly, and we used that analogy at times.

Weber: But LaRoy Tymes of Tymnet became a Wi-Fi pioneer. Are you familiar with his work? No. I think pretty much up to-- I mean Rocket Book, there's a question to tell the story, but I mean is that-- are you the-- I've met Martin. We should probably do an oral history with him, but...

Carrico: You should probably do an oral history with Martin for Tesla.

Weber: By the way, yeah, just sort of an aside.

Carrico: No, it's a sad thing. Marc and Martin brought me the Tesla "mule." Did I tell you this story already?

Weber: No.

Carrico: Marc and Martin left Packet Design in-- I don't know exactly-- maybe 2004.

Weber: Marc who?

Carrico: Marc Tarpenning.

Weber: Okay. You mentioned him.

Carrico: With Marc Tarpenning, he was the engineering guy. Martin was the more CEO guy, and I went up and looked at the original Tesla prototype and drove it around and we talked about it and he'd already hired a number of people who had worked for me over the years just because he knew them. They were the engineers working on it, and so on. One of my marketing and sales people was there working on it, and they wanted me to go on the board and I said, "Martin, I just don't think this is the right thing for me to do. I just know nothing about this stuff. I wish you well," and then about six months later, maybe not even that long, I get a call from Elon Musk asking me what I think of Martin as CEO. So this is when he was doing his due diligence to invest in the company. So we had a little chat about that, but all in all, I think I'm glad I missed that bullet.

Brock: Yeah. I would just be interested maybe, in the few minutes that we still have available, just to-- I'd be interested to hear you connecting your-- this long experience with computing and networking and Silicon Valley and entrepreneurship, just to kind of look at that and ask you about what do you see as the big changes, any thoughts about where you see it heading in the future on, any of these dimensions.

Carrico: Yeah, I think that it is true that entrepreneur opportunities are alive and well and will continue to be so for a long time to come but I think the character of them is changing in that it's getting more and more complicated. To be successful with new idea requires more of a foundation than it did, perhaps, beforehand. If you think back to Fairchild making its first transistors, you pretty much can just about make it in a room like this with a couple of diffusion tubes and couple of vials of chemicals and so on and maybe you wouldn't get it right but you could experiment with it. When you're starting to talk about almost any of these modern things, it's a lot of commitment, and the cost is high. It's hard to do anything on a shoestring even if you're trying, and so I think it's only going to get worse. There's a stratification of you need better and better people to get it going so that you can get it going faster and get it off the ground faster. You can't make as many mistakes as you might have done early on, but I think it really is just that, essentially, innovation layers on what's below it. We're getting pretty high up. How many things are going on underneath there? So yeah, I think it's going to continue just fine, but for example, this company I described to you with the 360-degree camera in talking to them about their software, this is some heavy-duty stuff. It would be very hard for somebody else to come up with this because they just happened to have all that experience in their head and they know how to do it because somebody had to help done it 15 years ago at another company. To have to start from scratch to figure that out would be almost impossible.

Brock: That's interesting. So that kind of regional accumulation of relevant experience also is a kind of path-dependent factor.

Carrico: Well, but think about it. When the switches were being made at one point in time in the middle '90s, there were a bunch of companies building kind of medium-performance Ethernet switches, and most, if not all of them, got sold to somebody and had some kind of an outcome. There's no hope to go do that now, and switches were relatively easy to do. Routers are even relatively easy to do, but there's no hope to do that. I think that there is a-- how would you describe it? There are increments of time when you can get away with success, and then there's going to be passages of time where it doesn't work very well. One of the big increments where it worked was when PCs came along. PCs utterly destroyed the minicomputer business. First of all, who would have thought of that? I mean, not that PCs came along but that it would just utterly destroy that business? Before that, when Xerox really showed us all what local area networks were going to be, that created a dislocation that could be taken advantage of and now lots of people have done lots of different networking things but there's not more that's obvious that can be done there, really, other than around the edges. Cisco is another example. What has Cisco done new in the last 20 years? Well, bigger routers and so on is not necessarily new. They may all fit in the marketplace, but there's no dislocation. I would argue Apple's got some of the same problems.

Brock: Intel?

Carrico: Intel's got the problem, but Intel is even worse because Intel is running down into, are we processed out here. From my understanding, they're having a hard time making 10-nanomter products, and if they can't make 10 nanometer it's going to be pretty hard to go below that. By the way, this Felderman and I talked about making a company to deal with that, at one point, but I think picking what you do is harder. A lot's been done. Picking what you do is harder. I think if anything that strikes me as high possibility is things that do involve some kind of AI, and by AI I don't mean monster brains attacking Chicago. I mean simple AI. I was involved with this one company that got sold to Google that had a-- it used the power of the masses of people looking at things to rate outcomes. So that's not really AI but it sort of is. It's using the-- well, sort of a way to think of it is the way the Google search engine works-- page ranking. It's the power of the individuals making the page rank, so we used the power of the individuals to make the selection on what is the item you're looking for in a video, where is Tom Cruise, and instead of trying to analyze or something we let the people kind of do it for us. I'm simplifying here a little bit, but I think that kind of stuff, AI approaches to things, is another probably dislocation and again, I don't mean in the sense of I'm not worried about the grey goo problem. I'm not worried about them turning into Terminators or anything like that. I think it's more how can we get something really useful out of what this is AI is starting to show.

Brock: Right, almost in the same way of-- with the local area networking. It was like all these experiments that created like an infrastructure that's still there. You know, these examples that you gave of these dislocations are kind of, you know, veins in technology that get opened up and then they become an infrastructure that things are built on top of. So it sounds like that's what you're saying about some of these things.

Carrico: But here's another problem we have. Where are we going with the cell phone at this point? Unfortunately, Steve Jobs isn't around to tell us, but from perspective, I don't really see a big difference between a cell phone he announced back in whenever it was, 2005 and the iPhone X. I don't really care about emojis and crap like this, so there's no real other difference. How much further can this go, other than it's become kind of a jewelry item? So yeah, you have to admit that, but I've always wondered about this. You can buy in China a smart Android phone for, I think it's $29.00. Probably works just fine for most things, including WhatsApp and to look at Facebook. $29.00 I always had a joke about things. In electronics, everything costs $5.00 in the end.

Brock: And just-- but to close, I'd just love to hear your thoughts about networks in particular. You know, do-- I don't know. It just seems like over the course of your career, you've seen it go from essentially some to internetworked networks for communications of all kinds and computations of all kinds that, are in certain geographies, absolutely ubiquitous. Where do you-- I'd just be fascinated to hear where you see that going. Is there any chance it would lessen in importance?

Carrico: No, but I still think it's not very seamless. I have two Internet connections to my house, and I have two because one doesn't work half the time. There's a lot of just very simple things that still don't work very well. One of my constant questions is, how does anybody who doesn't have a technical background ever have an Internet connection? I don't know. I don't really know. I'm able to make my Internet work by myself, but I don't think most people can, and I do all kinds of things to protect it and so

on. It's still very clumsy, in my view. I think this can go a long ways to less clumsy. Again, in the old days, you picked up the phone. You dialed the number, and it always worked. We need to get to that point. It's still pretty archaic. How many times do you lose a cell phone call?

Brock: Frequently.

Carrico: Yes, but I hardly get cell phone calls at my house at all. It's 50/50, best case. So I think there is a polish and a refinement that is maybe the best thing that could be done, and it's slowly happening. I had both of my network connections go out recently. I had an AT&T guy out there, and I had a Comcast guy out there. They were both actually not bad but I could tell that both of them are kind of just fumbling around and in the end I had to fix it. The Comcast guy just wasn't getting anywhere, and I said, "Let me think about it a little bit," and I changed around the configuration and got it to work. I couldn't do it on the AT&T one, but eventually we got the AT&T connection to work, so all of this stuff is just too hard for the average person. I'll give you an example of what that means. It doesn't mean that it doesn't always work for them, but I know multiple people who get a wireless router from their provider and never put a password on it. It's too hard. Practically, it's probably not too much of a problem because they don't go that far and so on and somebody standing at the front of your house would be pretty suspicious anyway but...

Brock: Yeah, and then it goes back to what you were saying about the Internet security issues. If the existing tools were made more user friendly, much more polish, much more ease, they'd be deployed properly. It's interesting, an interesting observation.

Carrico: No, these are all things that the level of polish needs to be improved. We've got to the level of more or less functionality for a smart person, but it's not really for the average person at all. If you're really concerned, I run four different programs to make sure I'm protected in four different ways, and I've been lucky. It's worked. I trap things all the time where one of the other of them will say, "Rogue program. Violation. You don't want to go to this page," stuff like that all the time, but that's too much for most people. They would go crazy. I've seen it. They can't deal with it.

Brock: Well, I don't want to go over too much, so maybe we will just take a break there, then. Thank you very much, Bill.

Carrico: Thank you.

END OF THE INTERVIEW

