Interview of Judith (Judy) Estrin and William (Bill) Carrico

Interviewed by:
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Judith Estrin: My interaction with networking actually started, to a small degree, when I was at UCLA, because UCLA was one of the original nodes on the Arpanet, and I guess you've spoken to Len Kleinrock; he was at UCLA at the time. I did a lot of reading. At the time I didn't know whether I was going to continue at UCLA for my graduate work or go to Stanford, so I started reading about Arpanet. I wasn't directly involved, as much as I just began to get interested in that. Then, when I went to Stanford, I worked for Vint Cerf on the original TCP/IP program.

James Pelkey: Now this was 1974?

Estrin: This was 1975, and Carl Sunshine and Yogen Dalal had already, with Vint Cerf, done the initial TCP/IP specifications, and was part of Carl Sunshine's doctoral thesis, and they were -- they had the protocol specified, and there were some initial implementations done and they were at the point of actually doing testing with it. The main thing I was involved in was actually writing test tools and actually exercising the TCP/IP protocols. I did a lot of work with the guys at the University of London, testing back and forth between Stanford and there and BBN. So that was kind of at the tail end of the specification. At that time, TCP/IP was viewed as a vehicle for Arpanet. No one had any idea that it would ever be used in local area networks. It was kind of designed to be an improvement over what was used at the time. So I did that for a year --

Pelkey: It was really just TCP at that point?

Estrin: Right, IP was -- the real focus was on a reliable end-to-end protocol, as opposed to internetworking architectures, and actually still, today, IP exists, but there's a lot of work going on in the research community to come up with the right internet architecture.

Pelkey: Were you aware, at this point in time, of what Robert Metcalfe was doing with PUP?

Estrin: When I was at Stanford I took -- actually, I forgot that -- one of the classes I took was in distributed computing from Metcalfe. He was a lecturer at that time, and that's when I first heard about Ethernet, because he had just done some initial Ethernet research at Xerox, and a lot of the work was beginning on Altos, so yes, I was aware of that through taking a class from Metcalfe, and through many of the people that I associated with, other students. John Shoch was doing his PhD at that time, and he ended up being a key player in Xerox's effort. So there was -- Yogen Dalal then went to Xerox and actually was the author of the XNS protocols, and he was my officemate, so there was a lot of interaction with those guys.

Pelkey: Do you recall anyone else from Metcalfe's lectures who is in the communications business?

Estrin: No. Actually, the two people that I vaguely remember, and I can't even remember the name of one of them, I think ended up not being in the communications business. They ended up just going into software, but not the communications business.

Pelkey: Now, I understand there was a small office in which these meetings of the Vint Cerf group and you and other people would meet. Were the French, Louis Pouzin and so on, were they there at that time, or did they precede this?

Estrin: No, they were not there. They preceded. The key people that are still in -- they weren't at Metcalfe's seminar -- but part of that group, working with Vint, was Yogen Dalal, as I said; Ron Crane, who ended up being one of the founders of 3Com and is really the guy who invented the whole concepts of Thin Ethernet, and he did some of the original Ethernet transceivers, he was part of that research group; and a guy named Jim Mathis, who is now at Apple leading Apple's TCP/IP efforts, was also part of that group.

Bill Carrico: What about the --

Estrin: No, don't say it on tape . . . [Tape is shut off, then turned back on] . . . and then there was a guy named Darryl Rubin, who is now up at Microsoft, but he's not doing networking. Oh, yes, sorry. He's responsible for LAN Manager.

Carrico: He's the Engineering Manager for LAN Manager.

Estrin: Right, right, he's managing LAN Manager. He wasn't for a time, so he also was part of that group.

Pelkey: And that group was working --

Estrin: People that had research assistantships with Vint Cerf. So I got my masters and went to Zilog.

Pelkey: And what year was this?

Estrin: 1976, and at the time -- it's interesting -- the two places -- I interviewed seriously at three places: Hewlett-Packard, which would have been nothing in the networking area now; Zilog, which wasn't in networking, my original job there at Zilog was doing microprocessors and computer systems; and at Xerox, and I interviewed with the group that was doing the Star System. I chose to go to Zilog because it was the smallest of the companies. I was person number 51, and thought it was a good opportunity to join a small organization. For a couple of years, I worked on chip architecture and software -- different operating system software. Then, a couple of years into being there, we decided to start a networking project, and actually, the first impetus for it came from a guy named Bruce Hunt, who had been at SLAC, and had done something called Ariel, and he had joined Zilog and thought it was a good way to implement, to hook together microprocessors, and since Zilog was in the microprocessor business and in the computer business, he thought this was a good idea to start a network project. I became the -- since I had an earlier interest in networks, this became very interesting to me, and Bruce Hunt and I worked on it, and then I became the project leader for Ariel; the product name was ZNet. It started out as not a general-purpose network; it started out as a way to connect some microcomputers to a disk, and then we began to grow the concept. Right in the middle of it, Ralph Ungermann left Zilog, and then six months later Charlie Bass. Essentially, Ungermann-Bass was formed with my boss, my boss's boss, and seven of my engineers, so that was kind of a shift time for Zilog. A lot of people from the Ariel program ended up starting Ungermann-Bass.

Pelkey: Do you recall when this was?

Estrin: Yeah, this was June of '79. Now, I'm going to back up a minute just to talk about -- when you talk about how things are first started. A couple of months earlier was when Bill came on the scene, then, because he had joined Zilog -- and he can backtrack in a minute -- but he had joined Zilog in a strategic planning capacity, spent his first time there looking at semiconductor stuff, and Manny said to him: "I have trouble with the systems group," and he kind of came in and started looking at it; got very interested in the networking and the systems part, and when Ralph and Charlie left and Zilog was reorganized, Bill became the business unit manager for that systems group, and I became the engineering manager for it. So we really then completed -- took ZNet from kind of a project into the product stage over the next year. It was introduced at NCC in 1980, and that was three weeks after Xerox made their announcement about -- when Xerox, DEC and Intel made their announcement about Ethernet, so it was really the product, LAN-based product.

Pelkey: Do you recall the time frame of this?

Estrin: It was June.

Carrico: End of June, in Anaheim.

Estrin: So it was really the first LAN product to hit the marketplace, and DEC, Xerox and Intel had announced the specification, and our product was Ethernet-like, in terms of its technology. We basically

take the whole concept of Ariel, and then ZNet was looking at the technology that had been done at PARC or at Xerox, and scaling it down at that time to be cost effective for the microcomputers we were working with, in terms of lower speed. Now, one of the interesting parts about -- talking about how companies start and, in this case, industries -- was that in the couple of months before Charlie Bass and Joe Kennedy left Zilog to start U-B with Ralph, we were in this intense strategic planning phase of what to do with systems. Here we had this Ariel program, what should we do with this? Should we build a multi-user system? Should we build a LAN? There was no such thing as the LAN business in those days. There were people working on networking technology, but there was not a general purpose LAN business.

Pelkey: Although certain manufacturers like Data General and Prime - -

Estrin: They used networking to interconnect their machines, but there was not the concept for using networks for multi-vendor connectivity. It was not yet a concept, and one of the ideas that was floated around in that strategy planning at Zilog in the April/May time frame was the notion of an intelligent wire. There's a guy named Dave Folger who was part of that program, and John Davidson who had joined Zilog six months earlier, had been from BBN, and myself, and we were all kicking around this memo. There were various proposals. What do we do with Ariel? What do we do with this program? One of the proposals was to sell it, not as just a way to connect Zilog systems, but sell it as an intelligent wire to hook other systems. One, it never really flew at Zilog, initially because Zilog was focused on selling computer systems. The interesting thing is that Ungermann-Bass then went off and started a company to do just that, and because Ungermann-Bass started their company nine months before the DEC/Intel/Xerox thing announced, their first product actually was a four megabit Ethernet-like, but it wasn't Ethernet either, and they ended up having, when the specification came out, to shift to a second generation product line. So it was very much formed out of that Ariel ZNet concept.

Carrico: It's an interesting point. They basically took a concept that nobody wanted to pursue internally, and went and did something with it.

Pelkey: That story is repeated many times.

Estrin: My prediction is that they forgot that that concept was kicked around. My prediction is Ralph Ungermann will tell you that they created this marketplace and it was kind of their idea.

Pelkey: More people hold your view.

Estrin: Right, the same he'll tell you I came to Ungermann-Bass in order to learn that business so that I could start Bridge. He, to this day, thinks I joined Ungermann-Bass to take his business way.

Carrico: There is no love lost between us and Ralph Ungermann.

Estrin: I'll get to that. This is more background than you'd probably want to put in your book, but -- so we brought the product, finished the product, actually turned the product into not just a connectivity for Zilog systems but we added in a little bit of this concept, towards the end, in that we had a product called the 'Universal Controller' that allowed -- but Zilog, about -- actually, in the three or four months after these guys all left to start Ungermann-Bass, just stopped funding the project at the level that it needed to be funded, meaning it was funded at barely enough to bring the product to market. There was new management. Zilog didn't understand the networking business, didn't want to be in the networking business necessarily, and so there was a competing project started, which was actually a Unix machine, and this Unix minicomputer was competing for resources with this distributed microcomputer architecture. I can still remember -- I had one hardware guy on this whole project.

Carrico: We were before out time. There was the competition between this minicomputer, which is just a standard, no kidding, regular Unix minicomputer built with a Z8000, which, of course, was very much the essence of Zilog, versus this distributed architecture. Again, we were before our time, at Zilog, so the minicomputer won. Everybody could see more clearly how to do the minicomputer -- what to do with it,

who might buy it? -- and the distributed architecture, most people just glazed over when you started talking about it.

Estrin: But we did bring the product to market, and we sold some. The main thing is that, I think we learned -- I spent a lot of time talking to customers because the marketing didn't understand what this LAN was. The irony is that I can remember arguing with the marketing guy that reported to Bill, he didn't want to call it a local area network. He said: "Judy, people out there aren't going to know what a local area network is. Let's make up a new name," and I'd say: "I'm telling you, this is what you need to call it. It's going to be -- " you know: "Don't do this." We had argument after argument, and we ended up calling it a local area network, but it was just before its time. What I learned was that we had basically built a product in a company without the right marketing input and the right distribution channels to sell the product, and so it was a good experience in how not to do it, from a total package point of view, in terms of product development. I personally also learned the lesson that I never wanted to just go for some technology again. That was my shift from being an engineer to being interested in business and marketing and management and sales, because I just hated developing something and putting in all this energy, and then not selling it because it was not in tune to the marketplace. So the end of 1980, the product was out. We were marketing it. It had been announced in June. The writing was on the wall that Zilog was moving away from a focus on networking, not towards. Exxon Office Systems was becoming more and more of a force at Zilog at the time. We spend infinite amount of time, and Bill can probably add to this when he's talking, about trying to deal with Exxon Office Systems -- trying to get them to use the ZNet technology. It was just, politically, very difficult. At the end of 1980, actually January 1981, I left. I thought about doing a lot of things, and ended up going to Ungermann-Bass in a marketing role.

Pelkey: When did you arrive and Ungermann-Bass?

Estrin: Beginning of February, I think, and within two weeks, sensed that I had made a mistake, in that I was in a role that just wasn't fulfilling to me. I had come in in a role without enough responsibility, and I had to spend a lot of time trying to sense whether they had learned some lessons from Zilog about business focus, and after I got there, sensed they hadn't really learned some of those lessons. I was there for five months and the main thing I did was negotiated their OEM contract with Xerox. They had -- one of the things that was very good for U-B in the early days is they had a handshake, when I came in, to do some joint development with Xerox, and Xerox OEM the products, but they had no idea how to develop what was actually done, so I, from a program management point of view, put that together, negotiated the OEM contract, and by May again, throughout the whole time, sensed that I'd either stick it out and be bored or try to do something else. That was about the time when Bill was saying he had had it with Zilog also, and what was he going to do, so in June, left to start Bridge. When we left, the reason, obviously, there's no love lost is that I was there a very short time, and because they had hired me into Zilog, they really viewed me as their protege, in some sense, but they forgot that when they left, I continued to grow, and then when I came into Ungermann-Bass, it was like a slap in the face. "How could you not like it here?" So it was a very hostile type of thing in the early days. They went and told all the venture capitalists that I stole the business plan. It was a pretty heated thing, that actually, to this day, I'm shocked at that animosity that still exists.

Pelkey: That's unfortunate.

Estrin: Why don't I stop there and let Bill catch up to that point.

Pelkey: Let me just ask you one important question, at Zilog, what were Ralph Ungermann's and Charlie Bass's roles, relative to yours?

Estrin: Ralph was COO of the whole company. Charlie Bass was General Manager of the Systems Division, so Charlie worked for Ralph, and at the time that they left, Joe Kennedy worked for Charlie as Software Manager -- no, Engineering Manager, and I worked for Joe, running his project.

Pelkey: What was Bruce Hunt?

Estrin: Bruce Hunt left. Bruce Hunt went and started Ariel. He was involved, technically. He was still going to school and didn't want to work full-time, so he was put as a person on the project. He wasn't -- he also is better technically than he is managerially, so I was kind of leading it, and he was a technical person. Then, a couple of months into it, he was mad that somebody else was kind of leading his project, so ended up kind of fading out of Zilog, and he ended up starting Metapath, which took some of the same concepts that he --

Pelkey: The datagram orientation --

Carrico: They're not around anymore, are they?

Pelkey: Actually, they are, in that it was merged into Prentice.

Estrin: I should tell you, another interesting thing, a link that you may not have gotten to, was that one of my software engineers on Ariel, on ZNet, was a guy named Phil Belanger, who we hired straight out of school, and we put him to work developing some of the protocols. Well, about a year later -- I don't remember when -- he went to Corvus, and was the engineer who designed OmniNet --

Pelkey: I was not aware of that.

Estrin: -- for Corvus, so he went to work with Mark Hahn, who was the VP of Engineering at Corvus, and he was really the networking expertise at Corvus, behind Omninet.

Pelkey: That's a link I hadn't heard.

Carrico: It's clear now, so Ungermann-Bass came out of Zilog; Bridge came out of Zilog; Corvus, at least the technology came out of Zilog; in a way Metapath came out of Zilog; and Excelan came out of Zilog.

Estrin: Because Inder Singh --

Carrico: -- Took over the Ariel project after Judy and I left.

Estrin: He took over that, and Navindra Jain, who is now the VP of Engineering, was one of their key technical people, when they started, was one of the software engineers on ZNet. So there's really a lot of -- if you look at, in LANs, everything either started at PARC or Zilog, and in some ways there's a link there between Xerox PARC and Zilog, in that Bruce Hunt at SLAC had looked at the PARC stuff; I had taken a class from Metcalfe; there was a woman named Carol Hankins who had worked at Xerox on the Star System and came to Zilog. I happened to share a house with a woman who was working at Xerox at the time, and the social circles of Zilog and Xerox, at least in the systems things, were very closely linked.

Pelkey: During this period of time, did you go see what they were doing there?

Estrin: We talked to them, and we knew what they were doing.

Carrico: They had published a fair amount of it, what they had done.

Estrin: I knew all about the Star stuff, again because this woman, Barbara Culkin, who I shared a house with at the time, was very involved in all of that. So our social circle was David Liddle and Shoch and Metcalfe and all the people who were working in that --

Pelkey: Obviously all of you were hard workers and social life is not a high priority, but during this period of time, did people get together from Xerox and -- did they go to parties or --

Estrin: Actually, the reason there was is that Barbara and I used to have parties. I think we had parties almost every month, and the parties were always Zilog/Xerox parties, because I was working at Zilog and

it would be the people I was working with, and she was working at Xerox. So there was social interacting in that respect.

Pelkey: At Zilog, that planning session of: "What are we going to do with this?" that was a seminal meeting. If that meeting had gone in a different direction, in terms of where the insight came --

Estrin: Right, it wasn't just one meeting, it was a process of meetings, and if Zilog had decided to be serious about the networking business --

Carrico: It would have been a different world.

Estrin: It would have been a different world. Now, the U-B guys didn't leave because of that meeting, because, remember, Ungermann left in January because of the board fight battle, and -- I don't know this for a fact -- my belief is that it was already agreed -- he said he was going to go do nothing for six months and decided what he wanted to start. Independent of what he had done, I think Charlie Bass would have gone with him. I think that was kind of agreed from the beginning, and I think it was an issue of 'what'll we do?' Well, I think once we, through this planning process, the idea had come up, that that was then the idea that they started to form. There is nothing inherent -- Ralph also could have started a computer company or some other kind of company.

Pelkey: In that planning process, who was leading that process?

Estrin: Were you or was Boris? Bill was responsible for strategic planning; there was a guy named Boris Petrov who was responsible for financial planning; Charlie was kind of involved because he was the general manager. Who were the key players?

Carrico: John Davidson --

Estrin: John Davidson and myself and Joe Kennedy. John Davidson and I reported to Joe Kennedy. Dave Bolger who --

Carrico: I think it was relatively freeform. Was Manny there?

Estrin: Yeah Manny was there. He brought you in. Of course he was there.

Carrico: But was he at that meeting?

Pelkey: But Ralph wasn't there?

Carrico: No, Ralph was gone before then.

Estrin: No, Ralph was not there, but Charlie and -- the key there actually is not Joe or Charlie --

Carrico: It's John Davidson.

Estrin: It is John Davidson.

Carrico: John Davidson is responsible for the success of Ungermann-Bass. It is not Charlie Bass; it is not Ralph Ungermann -- from the technology perspective --

Estrin: From the technology point of view, no question about it. Now, Joe Kennedy, from implementing that technology in some sense, or probably from the hardware perspective, but John was really the only person in that founding team who really had networking experience.

Carrico: Who knew anything about networking.

Estrin: Yet, since then they've painted a picture because Charlie was at the University of Hawaii, and therefore brings in the Aloha Network stuff. Ralph happened to work at Collins Radio years ago, so he now sells himself as a communications expert in some sense, but it really was John Davidson who really understood --

Pelkey: And John and you were kind of peers?

Estrin: We were peers at Zilog. The way it was is I was responsible -- before they all left, I was the project manager, John had the software resources, and there was another guy that had the hardware resources, because the software resources were being -- ZNet was only one of the projects they worked on. Now, when they all left, I then became the engineering manager.

Pelkey: Were other networking projects going on?

Estrin: There was one other long-term project called Summit, which later was spun off as a special R&D effort for Exxon --

Carrico: Exxon subsidiary.

Estrin: -- as an Exxon subsidiary that was going to be the long term distributed computing architecture, and Dave Folger was the guy who spearheaded that. It was he that got frustrated. He went and started Ridge Computers and he now is off on his own. So there was another computer networking effort going on.

Pelkey: That planning fuss -- if I could ask the two of you to recall that session, this planning process, was there a general consensus among everyone about this local area network?

Estrin: No. Actually, I just remember (unintelligible) the planning process and why none of this ever --

Carrico: Bill Sweet.

Estrin: Zilog had brought in a new marketing team: Bill Sweet from National, a guy named Bill Hesley, and Larry Badagliacco was still on the scene for some reason, so there was a group of people that knew nothing about this technology.

Carrico: They had a very minicomputer outlook.

Estrin: They were very minicomputer -- our sales guy at the time was a minicomputer sales guy, the head of sales -- so there were two parts of Zilog. There was this old -- the original part, which was very semiconductor, microprocessor oriented; there was this new contingency that were thinking computers; and then there was kind of this group that had done this technology, of which I was part, and said: "This is a great technology," but none of these guys knew what to do with it.

Pelkey: Understand it.

Estrin: Right, and it wasn't until, actually, those guys left, and they left partly because they didn't like all this new management, and Bill then took over the division, or this business unit, that we then were able to say: "This is what -- let's try to define what we're trying to do here."

Pelkey: Coming back to this series of sessions, which lasted, what, two or three months?

Estrin: Probably a couple of months.

Pelkey: There were these people involved in the process who knew nothing about this technology --

Estrin: Nothing.

Pelkey: -- and who came with a different mind set, of minicomputers and so on, so this planning process wasn't just an institutionalization of what was already pre-ordained or commonly shared, even among the group of you?

Carrico: No, it was a situation where the whole company was in a great state of flux, because it had too many technologies and not enough focus, and I think the purpose of the process was to try to straighten that out. We had the ability to go take a Z-8000 chip and build a Unix machine; we already had this Ariel project well under way; there was this Summit project which, still, was so far sighted it still hasn't been implemented in the world -- the product was amazingly complex and about ten years ahead of its time, maybe 20. All these things were competing for resources and direction and so on. It was the process of trying to resolve that that brought about the meeting.

Estrin: Remember, in whole sense, the whole systems business was weird for Zilog. Zilog was a semiconductor company.

Carrico: And probably 80% of the sales came from semiconductors.

Estrin: So there's a certain amount of: "Who are these guys in Building Three anyway? They walk around barefoot. They had beanbag chairs in their office."

Carrico: Did Manny tell you the story about the first time we walked through the systems building? I knew Manny very well, because I had worked for him for years at Fairchild. I remember coming over there and Manny came over one day and was obviously very upset. In fact, he was so upset he went home for the day, and I asked him later: "What was the problem?" He says: "I walked over there and there were guys without shirts and without shoes on."

Estrin: And what's worse, the guy without a shirt on was the engineering manager, because it was probably Joe Kennedy. I'll never forget, one day when Exxon was there visiting and Manny brings them into the building to give him a tour, and they go by one office and they see these legs sticking out from under a table. It was one of my software engineers that had worked all night, so then he crawled under his desk to go to sleep for a couple of hours, because he lived in Santa Cruz and he didn't want to drive back. So, in some ways, what we had, there was just -- it was more like Xerox PARC than Zilog. Zilog was a semiconductor mentality a little bit more.

Pelkey: Yes.

Estrin: So there was that going on. Zilog was also trying to compete with Intel on all fronts, and it was this little company.

Carrico: A factor of 100 to one in size or something --

Estrin: And then Exxon just kind of got confusing. It just confused things more with all of the Exxon Office Systems Companies --

Carrico: Also, Exxon didn't know what Exxon wanted. Exxon flip flopped from day to day whether they wanted profit or whether they wanted glory from Zilog.

Estrin: And Zilog had too much money. It didn't have to be profitable. In some ways we were like a little kid in candy store with too much money. What did we do? Eat a lot of candy and get sick, in some sense. So all of this was going on --

Electronic Beep sounds

Carrico: 12:45.

Estrin: Before we stopped working full time, we never knew that our alarm beeps at 12:45 each day. So, the first time it happened we thought something was wrong. It wasn't a normal set of -- well, maybe it is normal, but it's not like a company that is successful, know what its market is, and is trying to decide whether to fund a new project or not -- there were just so many constraints and so much going on, that when somebody brought up this idea of this intelligent wire at this meeting, there was mostly blank faces. I think there was a group of us who said: "This is a good idea. Let's talk about it," but for the most part, there was just kind of --

Carrico: But it is absolutely true that at Zilog, Ariel -- there's all these stories about where you want to be on the maturity curve when you get a company going, and Ariel was just ahead of its time. It was too far ahead of its time at the time -- the actual Ariel project.

Estrin: Yeah, and then what happened is a guy was brought in -- what was his title -- Rolando Esteferino was brought into the company from DEC, and he was really a minicomputer guy, and that's when the minicomputer project started --

Carrico: The minicomputer won.

Estrin: -- and ZNet began to decrease. An interesting thing I can remember with -- one of the things I remember doing at Zilog was flying back to General Motors in the snow, it was freezing, and I was the only vendor who, at that time, was allowed to address a small group at General Motors that was called the Manufacturing Automation Protocol group.

Pelkey: When was this?

Estrin: This was in 19 -- we announced in '80. It was probably the end of '80. All it was then was this group from different General Motors -- technical people from different General Motors divisions -- that were trying to figure out how they were going to have connectivity between different systems. I came in and presented ZNet to them, and a guy named Sam Smith, who then became a salesman for Sytek years later, at that time was kind of heading this group. We came in and told them about ZNet, and then I kind of forgot about it. It was just a sales call, like another sales call, until, obviously, it grew into much more.

Pelkey: But out of this planning process where the intelligent wire was postulated, do I understand that something came out of that process that lead in the direction of doing something with it?

Estrin: No, we decided -- well, it's interesting, because I kind of remember -- I have a memo that was written to me, one by Dave Folger and one by John Davidson, talking about this concept. It was just about the time that Charlie Bass was leaving, he knew he was leaving, I don't know yet whether he had signed -- here you start getting into legal implications, so -- I don't know if he had signed up Davidson before he left, or whatever. Even if he did, he'd say he didn't. I think that it stopped getting escalated because these guys decided to go do it themselves.

Pelkey: Sort of forced that when they left.

Estrin: Right.

Pelkey: And the process of Ariel first came in first to be this project of maybe hooking up some microprocessors up to a disk or something as a way of interconnecting things, grew to be a little bit more than that. You were doing one of these experiments prior to this planning process?

Estrin: Ariel started as just playing around with the technology, and Bruce Hunt kind of brought that in. Then there was an actual product plan done, probably December of '79, first time we got a marketing guy involved, that talked about something called ZNet, which was microcomputers, Z-80 based microcomputers talking to a disk using ZNet technology, so ZNet was this whole thing. It was a little mini version --

Carrico: The concept was identical to the current concept of PCs sharing access to a server. It was identical.

Estrin: In essence it was a PC LAN. Now, what did we do? We went and did, and as part of ZNet -- the network was just one part of the technology -- we developed the network; we developed our own transceivers; we wrote our own protocols; and we also had our own operating system called RIO.

Carrico: This is where we learned the lesson of standards.

Estrin: This was in the days of CP/M, but RIO was probably --

Pelkey: R E A L?

Carrico: R I O.

Estrin: Realtime Operating -- no, I don't remember. Joe Kennedy would remember, but I don't remember. It was probably on a capability level of OS/2 --

Carrico: Right.

Estrin: Meaning, it's feature content is more like OS/2 than MS-DOS. It was way ahead of its time, because I remember the sales guys were always accusing me of having RIO as a mechanism to sell 4K RAMs. Meaning, because it took so much memory -- and you know we were in these little-memory systems -- and we also did a new file system, so there was a lot of parts to this program. Now, in -- the product plan was in December of '78, because you weren't there yet. You came in '79. We were developing it when this planning process was going on. We probably had some prototypes working in the lab.

Pelkey: So this Ariel to ZNet was in '78, not '79.

Estrin: Right. And the first product plan said it was going to be a six-month program, because we weren't going to do all these new things. We were just going to take this RIO operating system and plug some network on it and make it a network. When we got into it, we realized you can't do that. You needed protocols, you needed a file system, you needed all these things, so it became more like an 18 months program instead of a six-month program.

Pelkey: When was the two or three-month planning cycle?

Estrin: It was at the end of that six months.

Carrico: No, no, it was absolutely in the April/May time frame of '79.

Pelkey: Now, by this point in time, Metcalfe had formed -- no, in June '79, he formed 3Com.

Carrico: In fact, sometime later on here, it was probably in late '79 or perhaps early '80, we actually -- Metcalfe came over, and we had him give us a lecture on Ethernet at Zilog.

Estrin: Because he was --

Carrico: What he was really forming was a consulting company.

Pelkey: Absolutely.

Estrin: And we also -- remember he had all these dinners with Ethernet backers. Were we already at Bridge when we went to that dinner? I can't remember when that dinner was, now. Bob would remember.

Pelkey: He didn't mention it.

Estrin: He had a dinner at some trade show where he invited people - -

Carrico: It was probably in '81 at –

Estrin: No, I remember. No, no. I was at Ungermann-Bass. I went on behalf of Charlie.

Carrico: Yeah, it was '81 at NCC.

Estrin: Right. Right. It was right before I left U-B, and he was thrilled. He got 25 people at this dinner, all companies who were interested in Ethernet.

Pelkey: This April/May, in the background, Apple had been formed, the group of you must have been really prone to leave, because of the commingling with Xerox and then what was happening and the microprocessor technology --

Carrico: Oh yeah, we were believers.

Estrin: And Joe Kennedy and Charlie Bass were from Berkeley, and there was a lot of -- Zilog, in its early days, in that first couple of years, had an incredible combination of people and technology, so it was the case that we all saw something was going to happen, and knew it was going to happen. In my case, I was too naive to know what the process was to get there. I still had a lot of growing to do in that respect, but I knew that the technology was something that was going to happen, and was still not in control enough of my destiny, meaning it was really more a result of how Zilog wanted to position it.

Pelkey: Yes. So that period was very active. A lot of you were coming in contact with ideas that appeared revolutionary in terms of where things are going, and here you had this technology and you had this organization which was confused and all over the place, people were leaving and starting companies, or about to. All this was happening around you. It must have been an incredible period of time, in terms of trying to sort things out.

Carrico: It was, however, this lack of our ability to convince Zilog, Exxon and so on, that caused us to decide to then, after Judy's brief sojourn at Ungermann-Bass, to form Bridge.

Estrin: But after Ralph and Charlie and those guys left, we really did, for a year, really were convinced we were going to really try to make this happen. Even though the other project got funded, we put everything into 'productizing' it, trying to sell Exxon Office Systems, and it wasn't until -- announcing at NCC was the high-point, and there was a lot of interest in the concept, and then from there it went like this, as things kind of -- not fell apart, but it just was clear nothing was going to happen.

Pelkey: Now, during this period of time, Xerox was publishing, as you mentioned. There were lots of things going on. Was everybody aware -- were the two of you reading these kind of things that were being written and published by IEEE and ACM about all of this technology.

Carrico: Actually, realize there wasn't all that much being published at the time about networking. It's amazing. I can remember when we first started Bridge, subscribing to Data Communications magazine, and there was never an article about local area networking in it. I guess until maybe 1984 or something, it was like once a year when you'd see any article about local area networking, because Data Communications magazine in particular was just completely steeped in modems and multiplexers. Now, there was some stuff clearly being published in the more technical journals, the ones you described, but even that was relatively limited. By far the best stuff that was published was published out of Xerox, which was descriptions of the original Xerox system in one form or another.

Pelkey: Maybe you could relate how you came to all this from --

Carrico: Well, I got an engineering degree in 1972 from the University of Santa Clara, and then, at the time, business was tough. I couldn't get a job as an engineer, so I went to work at Fairchild Semiconductor in marketing, and spent seven years at Fairchild in various marketing and operational roles, and then during that time I met Manny Fernandez, and I worked for Manny Fernandez as his marketing director for a couple of years during all this, and after seven years just became kind of tired of Fairchild and tired of the ultra-commodity nature of the semiconductors business, although at the time I had no great vision that I was going to be interested in systems. I went to Zilog more because of the microprocessor content of Zilog than anything else. So I went to Zilog working for Manny, as Judy described earlier, as the strategic planning manager with a charter of trying to sort out what was going on there. As Judy has described, Zilog was very interesting because, at the time, it probably had more smart people per square foot than anyplace I've ever been before or since, and they did an incredible job of just bringing together some terrifically smart people. It was, as you suggest, an exciting time. The problem with that, though, is that everybody was -- there was lots of egos; lots of ideas; as Judy said, lots of money; and sorting that out was a continuous and extremely difficult problem. Again, as Judy suggested, was it supposed to be a PARC or was it supposed to be a real company. It was never a real company. There were a few good products that came out, but it would probably have been better off picking the five super product ideas and go with those, just letting the other ones fall where they may.

Pelkey: It seems to me, at Xerox, there was this kind of overriding vision about a systems project, connecting laser printers to these desktop workstations and so on, that was a driving force at some level, that marshaled people and got something accomplished. It sounds like Zilog just had too many projects. It didn't have a big vision.

Carrico: Right. The problem with Zilog . . .

Tape Side Ends

Carrico: . . . and you needed some amount of systems to out-Intel Intel. The way the Zilog Systems Division came to be is as a software development system support group for the semiconductors, and it expanded, somewhat out of control, from there. The temptation was too much to take those development systems and turn them into computers. That's what happened. Originally, it was just the development system support arm for the microprocessors, and if they had stuck with that, they might have been more successful, but again, it was an exciting time.

Pelkey: How did it get out of control?

Carrico: I don't know. That was before my time. I think it was just because it was kind of there, and as Judy said, there was so much money, nobody seemed to care much about profit, so they just kept spending more and Exxon just kept sending them checks.

Pelkey: What about this network? How did it end up --

Carrico: I think they just managed to get good people, and those good people attract good people. So, there was tremendous talent there. I was trying to make another point. We were talking about the two visions. So the one vision was the semiconductor vision, and the other vision ended up being: "Let's build a super-strong system company, too" vision, and that was all way too much for a company whose sales were $25 million.

Estrin: They also had a board business.

Carrico: Well, yeah, in fact, they were even thinking of building not only boards, component boards to plug in systems, but also automatic test equipment, because they had built some of their own testers, IC testers, large scale IC testers. This was typical Ralph. I don't know if I should say this. The guy is a megalomaniac and he just doesn't -- he can't focus. All these were good ideas, but you just can't run a company that way.

Estrin: Remember when I said one of the key things at U-B was had they learned lessons from Zilog? One of the things I felt at Zilog is they were doing too many things, trying to be too much, and I even remember sitting with Ralph before I accepted the offer and saying: "You did this at Zilog. Are you going to do this again?" "Absolutely, positively, not. We're going to focus, we're going to do this," and I got to U-B, and they had their first product out, and they were going in a million directions. It was like -- some of it was because they had a lot of political interaction at the top. Some of it was, Jim Jordan is the ultimate sales guy, he's one of the best sales guys, but he was running sales and marketing and he's not a marketing guy. Whatever customer you talked to, he'd come in and that project was put on the product planning list. It was like the company was all over the place, and that was one of my issues with U-B. "Are you going to try to do too much too soon again?" It ended up being true, for Ungermann-Bass. Things like INI and --

Pelkey: Clearly, Ungermann-Bass was trying to be a little bit of everything to everybody. So you were saying that you joined --

Carrico: So I joined because of Manny. I tried to start unraveling the strategy, and I think we got -- we made some progress in getting the semiconductor side of it a little less confused, so I started working on the systems side, and I got just very enamored with systems in general. It was my first exposure to it, so I basically lobbied with Manny to become part of the systems thing. I ended up, in August of '79 becoming, becoming the business unit manager for the microcomputer -- the Z-80 based systems, and Judy was my engineering manager. The Ariel project had already been underway, so that's what started us. As Judy suggested, we put emphasis on that for about 18 months before we finally left.

Estrin: Now, when I left, you, because the Ariel project was kind of folded because of reorganization, you then went back to the semiconductor side --

Carrico: Yeah, I went over and did the marketing for the semiconductor side for about six months, but I had already done that --

Estrin: So while I was at U-B, he was --

Carrico: So I did that as a place-holder until I could decide what to do.

Pelkey: What caused you to decide about Bridge?

Carrico: Well, it's a little unclear. I think that we thought that there was an opportunity. It was clear we had seen the opportunity. We had seen the initial reaction. There was no competition of a material nature.

Estrin: It started with Bill looking to do something else and starting to think about either joining a new company or starting a new company, and I think, in those days, what you used to say is, he was tired of working for people that he felt he could to a better job than they could. So he was ready to go start something, and if I had been happy at Ungermann-Bass, I predict what would have happened is he probably would have started something, maybe in a different field, but because I wasn't happy, we started saying: "Well, why don't I leave, and why don't we do something together?" Given that, networking was the obvious thing, because I was bringing the technology side, and that was really my field.

Carrico: The irony of it, by the way, is that, while I was trying to decide what to do with myself, and while Judy was at Ungermann-Bass I even talked to Ralph about coming over and working with Ungermann-Bass, and he just kind of dismissed me out of hand.

Estrin: Then the other irony is that Ungermann-Bass was going through a hard time, and John Davidson is one of my good friends, and he thought it was great idea that I was going to go start a company. He said: "You have more courage than I do," because he at the time wasn't real happy --

Carrico: At the time, he was very dissatisfied with Ungermann-Bass.

Estrin: So it's real funny. Now, when we started Bridge, we were not going to compete -- we didn't have the intention to compete against Ungermann-Bass. Our first business plan was very focused on bridges and gateways, but as internetwork, connecting networks, as opposed to the networks themselves.

Pelkey: What would have prompted that, given that there weren't a lot of networks around.

Estrin: Well, as we were writing our plan, we said: "This isn't going to work, because there's not enough networks yet," but when we first started, we said: "Let's go build a product that will -- " What there was at that time was a lot of different technologies out there. What we said is we're going to go build some products that will tie together these technologies. As we started doing it, we said: "This is very important stuff. It's ahead of its time, so why don't we do a complete LAN company? We'll design in the internetworking from the beginning," which was one of our advantages over Ungermann-Bass, but we're going to do these communications servers, because that's where the bread and butter is. So over the couple of months after I left, our plan evolved to be more competitive with Ungermann-Bass than it was --

Pelkey: 'Communication servers' meaning in terms of terminals.

Estrin: Terminal servers, host servers. Right. During that six month period when we were raising money, an interesting side note is I went to consult for Xerox, and what I did for Xerox was help document their XNS protocols, which then were put in the public domain.

Pelkey: Ah, because that was -- your being -- the XNS gurus were really helpful to you as well.

Estrin: Right.

Carrico: There's some real high irony here. The whole thing is just fraught with this, but in any case, what we did do though, is that the whole architecture, at a hardware level of the product, which we conceived of from day one, which was this multi-bus one architecture, enabled us to do anything we wanted; I mean, we could build communications servers, bridges, gateways, and it was very flexible to that extent, so we didn't have to restart the company in any significant way. It was more a matter of emphasis than it was a matter of architecture.

Pelkey: And you did that consciously.

Carrico: Oh, yeah.

Estrin: And if you look at the hot companies, hot start-ups over the past two years in networking, they've all been bridge companies. Wells leaped in, and Vitalink, and so actually, in the last two years, the internetworking products, Bridge really started to take off. Again, we had a reputation, because early on that was a key focus of our product line.

Carrico: It was the whole -- one of the primary bases for competition for Ungermann-Bass later on. As kind of an aside, thought, what's funny is we did do XNS early on. We did Ethernet and XNS because those were the things that were closest to being a standard. We had no interest in doing an OmniNet-like thing, or anything like that. In XNS, by the way, it's clearly the best local area network protocol ever written, and is dramatically superior to TCP/IP, and most superior to OSI. It is, there's no question about it, and you know it, but the funny thing is, here we did XNS and we did not do TCP/IP, because we knew that it had a lot of warts in a local area network situation, and so we did XNS and it was reasonably easy to sell XNS early on because at least it was in the public domain.

Estrin: And we had more -- one of our early selling things was our XNS was a true XNS, whereas Ungermann-Bass's wasn't. They didn't really --

Carrico: It was quasi-XNS.

Estrin: -- they had done something proprietary, and it was like XNS, whereas we really, from day one, felt that standards were going to be the key to our business.

Pelkey: But when Xerox, while they opened XNS up a little bit, then they decided half-way through --

Estrin: They kind of stopped.

Carrico: They crippled their --

Pelkey: "Wait a minute, this isn't a good idea. We're not going to tell you anymore." What was that like?

Carrico: There was only one reason they did that, right? The only reason Xerox did that was because they were frightened of losing the laser printer business, and what they did is they never published the session layer, I believe, and they never published the print protocol --

Estrin: They stopped, but then they did it two years later --

Carrico: -- their PostScript equivalent.

Estrin: -- but then they did that.

Carrico: Right, but it was too late.

Estrin: And what stopped them was the printing stuff, so then they stopped, and then a year later they decided to do it, but it was too late, because TCP had started to slip in.

Pelkey: Because of --

Estrin: Because it was in the public domain; Bill Joy, Berkeley --

Carrico: It was mostly because it was there, because protocols were then, and are still now, a little bit on the arcane side, and so what they Unix Berkeley release did was it just made it easy. You didn't have to know much about it if you kind of just used them and didn't look.

Estrin: One of the things we did is we did a deal with Xerox where we got their specification for their terminal protocol, and that's what we implemented. We just weren't allowed to tell anybody it was theirs. Actually, one of the things we did early on with Xerox was, we had something called a Xerox Certification Service. Xerox put in money and Bridge put in staffing, and we kind of gave a party and nobody came, so we stopped it, meaning the two of us put out this press release, and we developed these test tools, and then, by then, XNS had kind of lost its momentum as a standard because, in the middle of doing this certification service, Xerox decided to stop publishing the protocol.

Pelkey: This was about '83?

Estrin: Yeah, probably.

Carrico: Around this time frame, it was probably '84 that TCP/IP started to creep up to higher visibility in the marketplace, and people were starting to use TCP/IP more visibly, and that's what prompted us then to go implement TCP/IP, and put it in the terminal servers and gateways and so on. TCP/IP then just slowly, completely encroached on XNS because it was standard, even though, with our very best implementation, it's still half the performance of XNS on the network.

Estrin: And we actually still sell a reasonable amount of XNS to people who just want terminal-to-host connectivity, and don't care about interoperability, because it's got better performance.

Pelkey: I notice there was a bit of a difference of opinion relative to OSI.

Carrico: Judy is just trying to be -- I won't get into this. Judy just doesn't want to be on record as saying that OSI is a committee-designed protocol.

Estrin: That's not true. I think OSI is better than Bill thinks OSI is. On the other hand, XNS has some things that are -- it's better performance, it's more finely tuned for a LAN environment. OSI is written for wide area networks and local area networks, and when you have generality -- now, OSI is actually better than -- in many ways OSI is better than TCP, because there are some things to learn. In some ways its worse because there was so much consensus involved.

Carrico: It's a compromise set of protocols. That doesn't mean it's not going to be important and isn't going to sweep the industry over the long haul, it's just amusing that -- I guess the thing that bothers me, because I am completely supportive of OSI and Bridge went and invested in OSI and announced OSI nine months ago, but the problem was that it's frustrating that we still end up with a lower performance protocol. If Xerox had pushed XNS harder, the industry could have had a standard protocol that was also really designed for a local net.

Estrin: Actually, OSI's strength is also its weakness. Its strength is it's got an incredible amount of generality and flexibility in it, but what happens is, when you sit down to implement that, it's just confusing and a mess.

Pelkey: Because performance testing was obviously an issue.

Carrico: And that's why -- TCP/IP is unbelievably successful out there and TCP/IP's success is pushing out OSI's acceptance, because there's a lot of people who say: "What do I need OSI for? I can talk to 250 companies who have got TCP/IP implementations and know it works." So even though it's not high performance, and even though it does some strange things, as Judy say, it works. It works fine. It's pretty workman-like.

Estrin: On the other hand, TCP will benefit OSI, because what TCP is doing is it's teaching users to understand the issues of multi-vendor connectivity, and in some ways, if there had been no TCP and we went straight from proprietary protocols to OSI, users would have been much more afraid of interoperability and what it means to buy from multiple vendors. What can happen is today, and actually we've sold this concept a lot, people install TCP, they get through the learning curve of what it means to chose vendors, to do interoperability testing, to do network management in a multi-vendor arena, and the vendors and users are learning a lot by that, so by the time OSI comes out, the acceptance curve, in one way might be delayed because they have TCP that works, on the other hand, it'll be easier to switch, because they will have learned all of these lessons.

Pelkey: Did Bridge participate in the NBS workshops?

Estrin: Yes, absolutely.

Pelkey: Could you comment on those? Were they important?

Estrin: Critical. Of all of the groups that people talk about, that was the one that got the least visibility and made the most difference in implementation of OSI, because that's where the real work was done. I mean, the COS, everybody sends their management or marketing people and you talk about certification testing. The users group is very PR oriented; also very manufacturing oriented. The NBS workshops were where you sent your software engineers, and those guys sat down and said: “This is -- ”

Carrico: So they could arrive at a detailed compromise.

Estrin: They started. Here is the standards document and it has all this generality, so they sat down and said: "Ok, we're going to have an implementation agreement," which is what they did, which said: "We're

going to do this here. We're not going to do this. We're going to do this," and then what happened is, after all of the other things, the COS documents or the GOSIP documents or RFP all said: "this standard, as modified, or as sub-setted by the implementation agreement out of the NBS workshops." In some sense that did more, that workshop did more for ultimate interoperability than anything else, because of its agreeing on those subsets that are key.

Pelkey: Did either of you participate in the early days of the 802 committee --

Estrin: I did.

Carrico: She was in 802.3. Her name's in the book.

Estrin: I was very active in 802.

Pelkey: Could you comment a little bit about that process? There were three committees -- data, physical, everything else. I'm led to believe that there was one particular vote in which everybody's trying to agree to one standard, and there was one vote in which the required margin was two thirds to adopt a standard, and token ring got over 50% of the vote, but didn't get two-thirds. At that point, there was a recognition that they were going to have to support more than one standard here. Then it got changed from the three committees, to the CSMACD and Token Ring and then eventually bus.

Estrin: God, I don't remember -- I got most active -- I was kind of peripherally active during those days, but very active -- see, remember when I was consulting at Xerox doing the XNS specs, but the guy I was consulting for was Bob Prentice, who was Xerox's key person in the 802.3, so I had a lot of conversations with him about Xerox's politics going into this. There was a guy named Clancy who was the Honeywell guy I think.

Pelkey: Right.

Estrin: He created all sorts of trouble, from an Ethernet perspective, obviously.

Pelkey: He was for tokens?

Estrin: Yes, he was the reason token bus happened.

Carrico: Would you like to hear our opinion on token bus?

Estrin: You know why token bus happened? It was because there was a smart engineer from Concord Data Systems, and I just drew a blank on his name --

Pelkey: Not Ken Miller?

Estrin: No, his engineer from Arizona --

Pelkey: He was the guy from Phoenix.

Estrin: Right. He came up with this token bus and he managed to sell Clancy on the fact that this was a good idea, and they managed to get a standard based on something no one had ever built, and it wasn't true of Token Ring and Ethernet. At least there were big companies behind them kind of developing stuff.

Carrico: You realize that token bus is like combining the worst elements of token ring and the worst elements of Ethernet and throwing in just some non-linearities of its own. It is like a complete abomination, and I do not believe it will ever really work. It doesn't work now, and I don't think it ever really will. There's nothing wrong with TOP, because TOP is just OSI over Ethernet. It makes a lot of sense, and to this extent DEC's right. It's just that General Motors, Kaminsky just needs to save face. That's the bottom line. He can't afford to throw in the towel. I mean Ungermann-Bass threw in the towel.

Estrin: The dynamics -- I got very, very involved once 802.3 was spun out, so I spent a lot of time on the 802.3 portion of that. I'm trying to remember --

Pelkey: 802.3 --

Estrin: -- is the Ethernet lower layer, and I used to go to the LLC meetings, which was the common link layer that goes above Ethernet, Token Bus and Token Ring. Those dynamics in the Ethernet meetings were interesting, because the big players were obviously DEC and Xerox. Xerox never knew how to deal with standards committees in my opinion. DEC does an excellent job. They have a Manager of Standards Activities. He manages hundreds of people that go to these meetings, but HP, although they weren't part of the DEC/Intel/Xerox, really, the guy -- Don Loughry led that group -- so a big, big force in this was -- no way were they just going to take the Blue Book and adopt it. They just couldn't, because then it was --

Carrico: You realize part of this was just political. The Blue Book was perfectly fine. They just didn't want to accept it as it is because that would be caving.

Estrin: So in some ways, HP had to put their stamp of approval on it; not just HP but all of the other vendors. So there were all of these discussions of -- but often people would know this concept was the right concept, but how do you change it while still keeping the benefit of that concept? There was a lot of those politics. Then there were the politics of the Ethernet was moving faster than Token Ring, so how could IBM slow down the whole effort. Just the incredible --

Carrico: See, it's very interesting. If you look at the marketplace after the fact, it's just fascinating what happened. DEC, Intel, Xerox, HP, blah blah blah; all the little vendors such as Bridge and U-B, what they at least managed to do was create an industry, and a lot of things happened because of that. One thing that happened is that there are five or maybe six Ethernet chip sets you can buy to implement Ethernet if you're putting it in whatever your putting it in. So an industry was created, and one of the ways you create an industry in a systems business is you damned well better have the VLSI backup for that industry. It's critically important. You can see it in all aspects of what you're writing about. New modems, right? You can't implement V.32 without LSI. Well, the same thing is absolutely true of the networks, okay? So the Ethernet chip sets and then the number of them and the proliferation of them, they -- first of all it gave you lots of choices and second of all it pulled the price down. So, when we implemented our first Ethernet controller, it was on two multi-bus cards, and it probably cost us $300. Right now it costs us $100, and with more functionality than we ever had in the first one, so that Ethernet chip set just really crashed the price. It got the whole thing -- made it a lot more successful in the marketplace too. It just opened up everything. What happened with Token Ring that was fascinating -- because IBM never got a consensus on Token Ring if you think about it from an industry perspective -- it's IBM and you have to pay attention and you have to worry and so on, but there's no industry consensus. They signed up TI with the TI Token Ring chip set, but there's only TI who has a Token Ring chip set. IBM doesn't sell their Token Ring chip set. TI's is not 100% compatible with IBM's, so it is almost impossible to compete, really, in the Token Ring business with IBM.

Estrin: So IBM did exactly what they wanted to do.

Carrico: Exactly.

Estrin: They achieved exactly what they wanted to do. They have the illusion of a standard. It is a standard, but it theirs. They have cost advantage, they have technology advantage, and it's just hard enough that other people can build products but, --

Carrico: It's difficult and messy, and the users are nervous as hell, because the users are -- if you go buy an IBM Token Ring card for your PC to put it on a PC Network on Token Ring, and you pick any random IBM software, of course it runs on it. If you put in a 3Com Token Ring card in your PC, it's absolutely compatible on the network side, but IBM is constantly fiddling with the interface to the PC. At

the chip set level, not the AT level or anything, and we don't know whether it'll run or not. They're constantly changing it.

Estrin: And throw in a little Söderblom in there so people have to pay a royalty –

Carrico: It just turned out to be a complete mess. While I think it's inevitable that Token Ring will continue to be important --

Estrin: And we, at Bridge, have Token Ring products --

Carrico: And so did 3Com, right? They really did another job on the industry with Token Ring. I mean, Judy's right. It was a magnificent job of creating the proper illusion without creating the industry per se.

Estrin: If you really want to get some detailed insight into the -- into those meetings, there's a guy named Phil Arst, who was Intel's representative. I don't know where he is now.

Carrico: I have no idea where he is. I think he lives in the Bay Area, I'm pretty sure.

Estrin: I have a feeling he will remember that intensely, because he was really a star during those periods, so it was a real important period of his career and his life, and I --

Pelkey: Do you have any idea of how I can track him down?

Estrin: I know he lives around here. The other thing is that it is possible that John Davidson will remember where he is. John Davidson's at U-B.

Pelkey: Maris Graube, I'm interviewing him.

Estrin: He'll have a different perspective. He will try to make it sound much better than it was. He is a very mellow -- the whole time --

Pelkey: He was also instrumental in getting the NBS workshops going.

Estrin: Yes, he probably did a much better job there than he did with 802.3. I always thought that 802 --

Pelkey: And Don has agreed to sit with me. I'll be interviewing him.

Estrin: Don is more level headed than probably Phil Arst will be. From Phil Arst you'll get the DEC/Intel/Xerox perspective: "This is what these jerks did." Don is just a mature, levelheaded guy, and from Graube you'll get the kind of top management perspective. I always felt he was never tough enough on what was going on, although it wasn't a company. It was a voluntary type of thing.

Pelkey: And it was individuals voting, not companies.

Estrin: It was BOLD.

Carrico: It was BOLD.

Pelkey: I've heard about packing the house --

Estrin: Oh, yeah, that's such --

Carrico: But at the end, it was fine. Again, the Ethernet thing -- it was a shining example, as far as I'm concerned, but Token Ring and Token Bus, what --it's just off in left field. Political constructs, right?

Pelkey: Yes, but in terms of culture. I have asked this of a number of people. It seems to me that fundamental technology, and in a certain way, IBM came out of the sort of polled modems, that led to synchronous protocols, and it all came back to the very beginning because they built a certain kind of terminal in the 1960s, which said: "I've got to do everything here locally," as opposed to getting acknowledgments at the other end, because they wanted to build something. The thing just kept cascading on itself. They built a front-end processor, which I forget the name of, that was in fact a Token Ring orientation in the early '70s.

Estrin: 8100 Loop System.

Carrico: It's more than that. The real thing comes from IBM is just always into master/slave. Everything has to go back up to the mainframe.

Pelkey: Right. That's a better way of saying it. So what happened, you get this perpetuation, so the Token Ring was just a logical - -

Carrico: Oh, yeah, I'm not saying it wasn't consistent with IBM's technology --

Pelkey: Jerry Saltzer at MIT got involved in consulting with them and --

Estrin: You know that my sister did her PhD with Jerry Saltzer.

Pelkey: You told me that. I've interviewed Jerry and I've interviewed Dave Clark. I guess Dave Clark's view is that it was not only the Berkeley Unix version of TCP, but it was also the PC version that was created at MIT that --

Carrico: No. It was Berkeley Unix. The PC thing came much later. I'm sure he'd promote that, but it is really true that it was Berkeley Unix that did it. The PC thing just wasn't interesting in the early days, because the PCs --

Estrin: In universities only.

Carrico: - the networking of PCs didn't do anything that was promotional.

Estrin: It impacted academia. It didn't impact commercial types of things. There's nothing -- it's not that there is something wrong with Token Ring technology. Actually, Token Ring is fine technology. It is the process of standardizing Token Ring; it would have been better if it was simplified some, as opposed to made more complicated during that process, so that chip vendors would get on board and would build. So it's just that the standards process for Token Ring was slowed down enough to give IBM the advantage. They really know how to play that game, and - -

Pelkey: Does it say anything about de facto versus du jour, in a sense of how standards come into being?

Estrin: I have this seminar I give and in one of them, I talk about there being two, really three types of standards. There are de facto standards, of which there are two types, and one of them is industry standards, and Ethernet is an example of an industry standard. So, in some sense, are the XNS protocols. The second part of de facto standards is when it's IBM's strategic direction, and that's what the Token Ring is. The third type is consensus standards. Bob Metcalfe then took what I said, and said that there are de facto standards, du jour standards, de IBMO standards.

Pelkey: I hadn't heard that.

Estrin: My sense is that the industry standards have often have a greater chance of succeeding. For a consensus standard to succeed, it takes a much longer time. Industry standards have more success in the short term, but consensus standards will win out in the end IF they have the right standards bodies

behind them, and if there was enough consensus going into it, meaning if everybody participated, like in the 802 -- there's so many companies participating in it. You can also get IEEE standards that -- two or three companies get the IEEE to decide, or some academic institution decides this would be nice to standardize but there's not a lot of people involved -- those types of consensus standards don't go very far.

Pelkey: Could one or both of you comment on this period of time back when the issues were broadband/baseband, Star, distributed, bus? Trade rags, everything --

Carrico: Well, it was one of those things where everybody just --

Estrin: Were focusing on the wrong issues.

Carrico: Right, they focused completely on the wrong issues, and we kept telling people it doesn't really mater. "Let's focus on what you can do with a network," and then also stick with where the industry is going from a cost perspective; this discussion of the chip sets driving Ethernet.

Estrin: And if you look at where we ended up, that's what people -- now everybody's not arguing about it, and the reason they aren't is everybody's into hybrid systems. Everybody has now agreed that there are different technologies that are good for different applications -- and sometimes twisted pair is better, sometimes fiber, sometimes broadband -- and that all the vendors are now building their systems independent of that technology so that you don't have to argue about it.

Carrico: The vendors, in the early days, couldn't afford to build all that into it, so they were a little stuck and had to argue for what they were good for. It's funny, too, because one of the ways that Bridge got beat up in the early years was Ungermann-Bass had broadband; again a non-standard broadband. We got beat up because Ungermann-Bass would use that to beat us up because that was the best lever they had. Our product, overall, was superior, but we didn't have broadband, so they emphasized broadband, which is pretty typical. All that kind of went away when we introduced broadband, and the main thing broadband's good for, the main place we've always sold broadband, is where people just wanted the long distance. In the end, broadband is probably five to ten percent of Bridge's business, and it probably never is going to grow above that because, what people are doing is they put in these broadband backbones and then Ethernet ribs, so the dollars involved in that backbone and the bridges between the broadband and Ethernet is not very much money. So it's still Ethernet dollars that dominate.

Pelkey: Data PBX -- terminal multiplexers was a very important part of your product. That was a data PBX domain.

Estrin: That's who we really competed against when we started.

Carrico: Micom, Gandalf, you know.

Pelkey: Was that a difficult positioning, in terms of the user's mind when you went in to sell them?

Carrico: No, we competed with them, but we were always able to make the differentiation, that the local area network was distributed, less inherently failure-prone, that it was the wave of the future. It was very easy to do that. We had a five to one cost differential.

Estrin: Yeah, but the main issue was in the first two years, we had like a five to one price differential, so there you sold to the people who were not bottom line conscious but who were productivity, making decisions based on productivity. We had features and sex appeal galore in the product against those. It wasn't until --

Pelkey: Just inherently?

Estrin: Modularity of growth; the software features; the distribution; we had a whole list of things that you could do with this product that you couldn't do with a data PBX, even though the function, the black box function, was the same. It wasn't until three years into the company, as costs came down, that we were really able to go in and not only compete on a productivity, but on a price.

Carrico: When you talk about industry formation, one of the real interesting things is that when you look at what the venture guys push back on Bridge during the formation? First of all, they pushed back on whether Ethernet was going to make it. It was pretty obvious to us, but I can remember one consultant that we were asked to go talk to by one of the venture firms, and he just reported back to him that there was no way we were going to be successful, that Ethernet wasn't even going to live beyond Thursday, and that this was the dumbest thing he had ever heard. That was kind of where it was at. People had no vision. They were really looking backwards and not forwards. So there was that aspect of it. Ethernet was one thing. The other thing is that everybody just couldn't believe that the minicomputer companies and the existing data communications companies weren't just going to slap network interfaces into their products and we weren't going to last a year. They fundamentally didn't understand what a big hurdle this was technologically, but even more importantly, visionarily. In many ways Bridge succeeded on the basis of its vision more than on the basis of its technology. In fact, I met a guy the other day who founded a company that failed the same time we did.

Estrin: Failed --

Carrico: Let me tell the story.

Estrin: You said "failed the same time we did."

Carrico: His company was founded the same time we were, they failed after about $20 million of venture. He said: "We used to laugh at you guys. We couldn't believe anybody could just slap six multi-bus boards into a box and make a company out of it," which, at a hardware level is what we did. Again, it was not so much technology as vision that kind of made us successful. What happened is that everybody thought that the Micoms and the Gandalfs and so on were going to put network controllers into their data PBX's and kill us. They couldn't do it. They just didn't even --

Estrin: They couldn't make the leap.

Pelkey: You didn't really compete against Interlan that much, because they were an OEM --

Estrin: Yeah, we did. They had a terminal server.

Carrico: They had a terminal server that competed strongly with us, and then Micom acquired them and killed them.

Estrin: They started out in the board business. When they saw, I believe, our success in some sense in the com server business --

Carrico: Except Severino did it again with Wellfleet.

Estrin: Made them think that they ought to move into that business, and they came out with a cute little box, and it was starting to be competitive when Micom bought them, and then they just kind of --

Pelkey: They implemented TCP before you.

Estrin: No. Oh, they had TCP on their board-level products, not in their terminal server.

Pelkey: Right.

Estrin: We were the first company to have TCP in a terminal server product, but Excelan and Interlan had it. They allowed file transfer between hosts, because the initial application of TCP was more for file transfer.

Pelkey: Now, given that you had been going after the data PBX guys, there was this background, there was concern that those guys were going to wisen up in the channels of distribution, and they were bigger companies, and Interlan was just starting to become competitive with you. When Micom bought Interlan, what was the reaction in your organization?

Carrico: Well, because we already knew Micom was just --

Estrin: We had talked to Micom.

Carrico: Micom had such a box-level mentality and no system mentality that I knew it. I knew that that was the end of Interlan. We had eliminated a competitor.

Pelkey: So there was no doubt in your mind.

Carrico: No, because we had talked to the Micom guys. They come to us and said: "Maybe we should buy you," and we said: "No thank you."

Estrin: And the one guy who I think had a real vision there left about that time, which was Steve Frankel. He's a sharp guy, and he might have been able to do a little bit more with it, but we were already, we had more momentum than Interlan. We were doing better than Interlan, so it wasn't a question of a competitor up here was purchased. We also -- I mean, it was true of Micom, Develcon -- they have a box mentality and a hardware mentality, and the LAN business, the general purpose LAN business, was a system business; software system sell.

Carrico: You realize we had at Bridge -- and I think it's still true -- we outnumbered software engineers to hardware engineers like ten to one. It was a software business, and these guys -- it was probably the inverse.

Estrin: The data PBX guys focus on very high-speed buses and moving bits around in that box at very high speed. It's a different focus and it's a different mentality -- of their management, of their manufacturing, of their engineering organizations --

Carrico: But it never ceases to amaze me how much vision counts. I almost think that vision in management makes far more difference to the success of a company than technology ever does, and I can think of many examples in the data communications business. One that just floors me is Telebit. Here Telebit -- this product is a nothing product. There's no technology there. I scratched out the design on the back of the envelope when I saw the data sheet, but they had the vision to go take a chance on something that nobody else had ever thought about, exactly the way to do it, and boom! It was more the vision than it was the technology.

Estrin: That's why Paul Baran is all --

Carrico: It was his ideas, right?

Estrin: You know Paul Baran did his masters with my father, so it's funny, all of these --

Pelkey: The modem guys, the traditional datacom industry, other than Concord and Racal-Milgo's early attempt with the PLANET, the stuff that became the Cambridge Ring, none of them did anything in local area networks until --

Estrin: Codex OEMed to U-B.

Carrico: Codex tried to. Codex OEMed U-B for a year and a half --

Estrin: And that was a failure, and then they tried to develop their own box, and they were talking about it, and they finally killed that.

Pelkey: Right, I stand corrected.

Carrico: But they didn't succeed.

Pelkey: Right.

Estrin: Develcon bought our technology and put it in their PBX and have never been able to really make it work. They bought a board design and some software from us, still they'll probably make it work. Infotron bought Applitek.

Carrico: But I think that's all history. I don't think that exists. By the way, Applitek, not on this subject but another interesting one. Here's a guy who came out with a technology that tried to outdo the standard at a technology level, right? Applitek's claim to fame was that you got more efficiency of the bits on the cable. They had this thing called UniLAN which looked token oriented at one level or performance, and CSMA/CD on another level of, not performance, but of load on the network. It was a clever idea; not bad, but nobody cared.

Estrin: The standards already existed.

Carrico: You can always get a few people interested in a tweaky thing, but in the end, and it might have been a terrific idea, but it was -- nobody cared.

Pelkey: The process of standards are what uniquely differentiates a communications business, because you don't know what's at the other end that your going to talk to, so that influence of it being not only a market technology but its the standards that are really critical.

Estrin: You know that's starting to happen in the computer business with Unix and OS/2.

Pelkey: That's because communications --

Estrin: And application interfaces.

Pelkey: Interconnectivity and communications is driving its way back into the computer business right now.

Estrin: Right, but the whole application interface is, everybody is standardizing on these API's, and there are things like OS/2; there's things like Unix; there's things like the X-Window standard that has come out of MIT, which is a windowing, so there are more and more -- I think a lot of people in the computer business have seen the success of what the standardization has brought -- and in the communication business, the standards in the communications business have created more and more multi-vendor environments, which drives the need for standards in the application interfaces.

Tape shut off, then turned on.

Pelkey: Why did the traditional datacom guys miss this?

Carrico: Well a couple of things; again, one is vision. They just didn't know what to think about it. If you don't have somebody who is a visionary about a new technology or a new direction, how are you going to figure out what to do, right? The second thing is they didn't have the technology -- not the vision -- but they didn't have the expertise. These guys were, as Judy suggested, hardware guys. There whole deal was circuit switching buses, and this was a packet switching technology, and packet switching is intensely

software oriented. So, again, they were completely reversed in the expertise that they had internally. I think they just never figured it out.

Estrin: This may be partly what you mean by vision, but they refused to acknowledge to themselves that this was an important technology. I remember talking to many of these people in the early days, and they'd say: "But that's the wrong way to do it. This is the way you should connect terminals to computers," and they did that for long enough that, by the time -- they thought all these LAN guys would go away. It's similar to Ungermann-Bass when Bridge started: they refused to acknowledge that we were going to be a serious competitor. For two and a half years after we started they didn't come out with a new software release. We had all these more advanced features. They thought: "We don't need to worry about Bridge." They kind of went about their own way, and by the time they stopped and said: "Uh, oh," it was too late. That's what happened with the data PBX guys.

Carrico: Our software was overwhelming more powerful.

Estrin: By the time they realized that this was replacing -- take away from their sales -- this was creeping into their market, it was too late.

Pelkey: Why did you put yourselves together with 3Com?

Carrico: Well, a number of things. I think, probably, we were convinced that we had covered the one segment of the marketplace very well, what we call 'the general purpose LAN segment.' There was another segment of the LAN market, which we called 'the system vendor segment,' which is DEC with its networking equipment, which is primarily focused on DEC's solutions, not multi-vendor, and the third piece was the PC networking, which was really very distinct, because the PC networking was focused on application sharing over the network, where the general purpose was focused much more on communications and connectivity -- very distinct. If you think about 3Com, 3Com still doesn't know that much, as an entity without Bridge. It doesn't understand things like X.25 and SNA and so on. They understand file sharing and electronic mail, but much less knowledgeable about the protocols and that kind of stuff.

Estrin: And they're PC centric.

Carrico: Exactly. And it's much more aimed at replacing the departmental minicomputer with PC's and a server than 'how do we get a global network village?'

Estrin: That enterprise network.

Carrico: Exactly. But it was clear . . .

Tape Side Ends

Carrico: . . . because the customers saw both of these things being on the network, so they were both on the same physical cable, so the customer said: "Wait a minute. I've got these PC networks and I've got these general-purpose multi-vendor networks. I want these all in one piece. I don't want to have to buy this from two vendors -- "

Pelkey: Were you hearing that from your customers?

Estrin: Absolutely.

Carrico: Oh, you bet! Absolutely.

Estrin: And, I want my PC to talk to that host and I want network management to be common throughout the whole thing.

Carrico: So, it was clear that that's where the industry was going, and it was primarily because they were hooked to that same wire. We were convinced of the inevitability of that requirement, and we were convinced that the market was maturing rapidly and that sheer mass, size, was going to make a big difference. We thought about a lot of different combinations. We actually talked to Novel extensively; we talked to 3Com; we thought about growing by acquiring companies ourselves and we investigated that. In fact we did make two small acquisitions. We acquired a company in Dallas, which provided the RF technology for our broadband local area networking. We also acquired this spin-out of Ungermann-Bass which was working on encrypted local area networking, but those were really more technology acquisitions than mass acquisitions. We decided for that set of strategic reasons that we should do the deal, and that's what prompted it.

Estrin: Strategically, financially, customer reaction, it was absolutely the right thing to do.

Pelkey: Who initiated the conversations.

Carrico: You know, I'm not really sure. I can't remember whether Krause called me or I called him.

Estrin: We had been talking off and on for years, because we had done some -- first, we did joint development with them, and I knew Bob Metcalfe, and we were located very close. Then we had a reference sell arrangement with them, and then we OEMed their product. Metcalfe, Krause, Bill and I used to get together for lunch every couple of months, just to talk about the relationship -- you know, how was the OEM relationship? How can we do these things? Every once in a while it came up, and it was never the right time and no one wanted to talk about it. This time, it was kind of the right time for both companies, and I think Krause called Bill.

Carrico: I think he did, actually. I think it's true. It was also, though -- we were kind of rough because we had just disengaged from Novel.

Pelkey: They had disengaged from Convergent?

Estrin: That disengagement had been earlier.

Carrico: That had been earlier, like a year earlier. Convergent was not the right thing for them to do. Convergent was just because Krause wants to run a computer company. It was not -- it made no strategic sense at all, and Metcalfe wanted to do it too, desperately, and for reasons that are still totally obscure to me. I don't think there was any issue in our minds about the strategic benefit. From that perspective, we'd do it again. What was the big surprise was the culture clash was much more than I ever imagined it would be. I certainly knew that there were culture differences. I knew what I was getting into, but it was just real hard. Also it was hard because Judy and I had gotten very used to running a company more directly, where I was, at Bridge, more involved in the day-to-day activities, and overnight, I was managing through six general managers.

Pelkey: Right.

Carrico: It wasn't as much fun. Judy, on the other hand, went the opposite direction, in that Judy had been second in command at Bridge, and now was just another general manager at 3Com, and because Judy had been the visionary at Bridge and now Metcalfe demanded to be the visionary at 3Com. He's got a larger ego than all of us in this room put together.

Pelkey: Yes. I agree, and on some level, it required that on the part of anybody who is a visionary. I'm not trying to defend that. I just know that there's a lot of people who are detractors of Judy, for example, and some of it is because if your going to be a visionary, you're going to hold out, here's what you think is going to have to be done, you have to be willing to get up and beat the Pom-Poms and -- anyway, T-1.

Carrico: What about it?

Pelkey: The T-1 guys, they came out of the X.25 and that had obviously been, in terms of data communications, a successful market event. T-1 came on like a storm here, post-deregulation. Was that something that Bridge should have been --

Estrin: Yeah, well we did a T-1 --

Carrico: We did T-1 bridges.

Pelkey: Right.

Estrin: -- and so we hooked to T-1. The T-1 business, like NET, is very voice oriented. They do data, but if you look at their systems, they'll tell you that 70 to 80% of the decisions made are driven by the voice capability, so the sale is different --

Carrico: The technology is different. It's circuit switching again.

Estrin: So it wasn't --

Pelkey: So that fact that you investigated T-1 is understandable.

Estrin: Right, because we were a data company. Now, if we had stayed -- one option we had, in terms of broadening out, would have been to merge with a T-1 company, moving into the voice/data world, and that's why NET and , for instance, was an example of that type of combination.

Carrico: It's going to be rough for the -- Judy's right. It's going to be rough for the T-1 multiplexer companies to get into the packet-switching business. It's always tough to merge --

Pelkey: Are we setting ourselves up for -- the fast-packet technology is going to be yet new companies, and the guys who are out there now aren't going to be --

Estrin: There's a chance that that's true.

Pelkey: -- they're either going to be circuit-oriented or packet- oriented and there's going to be --

Estrin: Well, there's a chance that that's true, because there's a chance that the current stars in the T-1 telecommunications arena -- one, they've got a lot to do just to continue to make their products work and support and enhancements, rather than focusing more on data. Now, my sense is if they are different companies, then they'll end up merging. I don't think in the long term they'll be different companies --

Pelkey: Because the channels of distribution and customer are going to force that --

Estrin: Right, but in the short term, you could see some new technologies being the winners.

Pelkey: In terms of where we come up with these ideas, the issue of research, and at some level maybe even systems research, the kind of stuff that the Arpanet represented; that Xerox represented; and at some level what happened at Zilog, which is one of the few examples of an almost academic oriented business situation -- do you see those kind of things happening today? Are those things important for economic growth?

Estrin: I think they're very important, but are they happening? DEC has their --

Carrico: Yeah, DEC and Xerox still do some --

Pelkey: DEC and Xerox still do it. Universities are doing it -- the Project Athena stuff at MIT has been an impetus for a lot of things going on. I think that, yes it is still going on. I think that it shifts around, depending on which industry those centers are in different places.

Carrico: Let me tell you, though, it is my perspective that while we are going through some maturity curves in some of the businesses, like LANs and even T-1 multiplexers -- they peaked pretty fast, faster than LANs did -- we are still embryonic in networking.

Estrin: In total networking.

Carrico: in the concept of where total networking is and where it's going. Judy and I have been thinking about this, and we're off thinking about what we should do for our next company, and I think that we're just very far away from where we'll eventually be, before networking becomes as pervasive as the telephone system. You really would like to be able to sit at your terminal anywhere -- Judy and I are about to embark on a trip to Israel, and I'd like to be sitting in the Tel Aviv Hilton and be able to check my electronic mail without a lot of muss and fuss, right? Or go get that latest reference out of the University of London that Joe Whipple published, right?

Estrin: And this is what NRI is all about, actually.

Carrico: Right. This is pretty important stuff, and we're light-years from that yet, so it's kind of -- at least we know where we want to go, but we're a long ways from there. Some of that is ISDN, some of it is some other new thoughts about networking more in a way: how do you use networking and how does networking really fit? I don't think, by the way, PC LANs are the last answer, by any stretch of the imagination, because PC LANs are currently marching through all the problems that the minicomputer companies went through, so they're just repeating all of that, so all the lessons that the minicomputer guys learned from a software perspective, are still embryonic. I mean, OS/2 is like VMS 20 years ago. That's too long, but 10 years ago, and it'll take ten years before OS/2 is as stable and as feature rich as VMS is. Trust me on this.

Pelkey: I agree.

Carrico: So, I mean, PC LANs are useful and are going to be used and are going to replace some of the minicomputers and so on, but that whole thing has got to do an immense amount of maturing, and an immense amount of opportunities for businesses yet to come out.

Pelkey: I agree. Thank you both for your time. I appreciate it.

END OF THE INTERVIEW

