



Interview of Maris Graube

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James Pelkey: You've been involved with a number of events that are of great interest to me. Maybe you might begin by, since you and I don't know each other, I don't know where you've come from and where your thinking about these issues, where it came from, and how you came disposed more towards the 802 and the NBS experiences, and now your role in IEEE and 802.

Maris Graube: Well, it's -- like I said before, I don't think it's anything that was premeditated. I think there was kind of a random sequence of events that happened that brought me to a particular place, and it wasn't that I had planned to be there or anything. It just happened to be at the right place at the right time. I can give you a personal view, in the sense of what happened. I went to school at the University of Michigan. Had a friend that I had been friends with in high school --

Pelkey: What year was this now?

Graube: This is in the '60s. He graduated -- he was a couple of years older -- he graduated and went to California and subsequently, I took a Christmas break and went to California and kind of liked it, so when I graduated, I went to California. We kind of palled around and, anyway, by and by he got married and moved to Oregon. I had some vacation coming, so I went to Oregon to visit him and his wife, and I looked at this place and I said: "Hey, this is really wonderful. This is God's country." It was beautiful weather, it was clean, it wasn't like Los Angeles. I said: "Gee, I'd really kind of like to live there." He happened to be working for Tektronix, so I applied to Tektronix and they sent for me, and I interviewed with them and all that, and it just didn't work out. For some reason, they didn't want me. Then, maybe a year later or so, I was still wanting to get a job up there and move to that part of the country, and a year later, again, I had an interview with them, and saw a bunch of people, and again it didn't work out. We couldn't come to something, so it was one of these things. It was something I wanted to do, but it wasn't anything urgent. Then, one day, my friend calls me up and he says: "Well, there's this job here that no one seems to want, and it has to do with this instrumentation interface. Do you know anything about it?" I said: "No, I don't know a thing about it." I was working for a semiconductor company at the time, and he said: "Well, if you want the job, it's probably yours." So I went up, and I didn't understand what it was all about, but I thought: "Gee, here's an opportunity to go to Oregon," and so that's how I happened to go to Oregon.

Pelkey: What year was this?

Graube: This was in 1976.

Pelkey: So I got thrown cold into this area. This was basically the standard that Don Loughry had developed for instrumentation interface; the 488 interface, IEEE standard. At that time, Hewlett-Packard already had a large number of instruments that they were producing with this interface and Tektronix, at that time at least, considered themselves to be a rival in that instrumentation game, and so they hired me to see what Tektronix could do with this standard, or what is the standard about and how can we answer the Hewlett-Packard challenge? What can we do in this field? I am a reasonably fast study, so I kind of came up to speed on what was going on with this interface, and organized the company, to some extent at least, that we were going to be adopting this as a company standard, that any programmable instrumentation we're going to do at Tektronix will have this interface on it. Then I went on to postulate some further standards, which we called codes and formats at the time, which were basically higher-level protocols; how you send data over this interface. So at that time, I got involved with the 488 Committee which Don -- I don't think he was leading it as such, but he was very instrumental in guiding its direction. We started this work on this codes and formats, or higher-

level protocol, and so I got acquainted with Don and some of the standards processes of how one goes about making standards. This was all new stuff to me. I have an engineering background, but I didn't specifically study this kind of thing. I knew very little about it. I still do, but at any rate, as this whole process was going on, and as I was working within Tektronix to organize the company in some way to bring coherence to the product line, in terms of this communications capability, it occurred to me that there are some severe limitations to the 488 interface, the specification. The distance can only be 20 meters between instruments; if you need to automate the larger laboratory, this is not appropriate anymore; various techniques for extending the distance of that particular technology were inadequate; so I was thinking: "Gee, there must be something that has a little bit longer length to it that operates in the megabit per second kind of data rate." You don't need to go extremely fast. I didn't know exactly what it was. The term LAN had not been invented. I had never read anything about LANs. I knew nothing about data communications, zero, zip, I mean absolutely nothing.

Pelkey: And what year would you guess this was?

Graube: This was about '67 or so.

Pelkey: '76?

Graube: Yeah, '76. So one day I happened to be talking to --

Pelkey: Relatively shortly, then, after you joined Tektronix?

Graube: Right. So, I happened to be talking, one day, to a writer for some electronics magazine, and I was very much involved in promoting this codes and formats standard and saying that Tektronix has something more than HP does, and I was saying: "Well, it's a wonderful standard, but it's lacking in its distance and its really not made for automating bigger kinds of projects or what have you," and I said: "It sure would be nice if there were something that was roughly a megabit per second and one kilometer in distance," and this lady said: "Well, there's a group at Purdue University, and it's called the something Industrial Process Control Workshop, and here's the name of the professor that runs this. Ted Williams heads it up," so I called up professor Williams, and I said: "I understand you have some workshop, and they are talking about data communications for something that's a little bit longer distance." He says: "Oh, yes, that's process control people. They have a working group, working on something called Data Highway for Process Control, and why don't you come to our workshops?" So I did; I started going to these workshops. What these people were doing, basically, was defining a local area network standard.

Pelkey: How about that. This is still '76?

Graube: This was about '76, '77, I think, is when I started participating in that effort.

Pelkey: And they did refer to it as a 'data highway?'

Graube: Yeah, data highway, and there had been data highways used for process control. If you think about it, it really makes sense, because in process control, you have a chemical plant, or a refinery, and it's spread over some area, and what they need to do is to get information from sensors which were all over the place, up and down cracking towers, and they need to turn pumps on and open valves, or close valves, and control temperature, and various things like that, and they really need something that ties a larger system together. So what they were

looking for is some sort of what they called a data highway, and it looked like the kind of thing I was interested in. So I went there and I participated. I eventually became chairman of that group and headed that up for a couple of years. As we got more and more into defining this particular standard for process control, it really seemed to me that these guys, while they were serving the process control industry very well, this was going to be not really quite adequate for the kinds of applications I saw, more of computers controlling instrumentation, a much more benign environment -- you're not out in an outdoor environment, you're not into hydrogen sulfide and all kinds of nasty gases, you don't have to worry about intrinsic safety, of things exploding on you if the cable ever breaks, and this PROWAY, this process control data highway effort, really seemed to be a narrow little niche, so I thought: "Gee, it would be nice to have a standards committee for something that was more applicable towards computers, instrumentation and more of a commercial environment, certainly, but not a process control environment." So, I started poking around to see if anyone else was doing anything like that in standards bodies. So I called the people up at what was called ANSI X3 at the time, and asked various people there whether they were doing something like this, and they said they weren't, and I asked them if they were interested in doing something like this, and they said no. It's one of these background tasks. It wasn't something I was working on full time, but it was basically my job to kind of keep Tektronix on top of this kind of technology. As time went by, I think in about '79 or so, I ran across a fellow named Bob Stuart. He's down in your area, the Bay Area, Los Altos, and he's with the IEEE, and he's been very instrumental in starting up many of these standards efforts for microprocessors within the IEEE. So I just happened to be talking to him and told him about my interests, and he said: "Well, why don't you just form a little standards group under the microprocessor standards umbrella." I didn't know anything about how one goes about starting standards or about getting project authorizations or anything, so he helped me a little bit and told me about what to do and what forms to fill out, and so in about '79, basically, the effort to get -- I still didn't know what a local area network was. The term hadn't been invented yet. We were going to do this data highway, communications scheme, for more commercial type environments.

Pelkey: Do you remember around when in 1979?

Graube: I think the project was approved in something like October. We could look that up in the IEEE records if necessary, but that's when the project was approved, and it started out under the microprocessor standards activities efforts. We held our first meeting -- I sent word around to everybody I knew, press people and things like that, and I think at the first meeting we had something like 70 people show up. That was in San Francisco in February --

Pelkey: Jack Tar Hotel, February of 1980.

Graube: Right. February, I think 28th, or something of that nature, 1980. It was a very good turnout, I thought. I kind of put together some thoughts on --

Pelkey: Now, when you say 70, are you being modest at 70, or do you pretty much know it was 70? Other people's estimates were that there were 150.

Graube: No, no, it wasn't nearly that much. It was around 70.

Pelkey: What was it like?

Graube: Well, it was total confusion because we really didn't know what we were doing. People came because they were interested. No one really knew what local area networks were.

Pelkey: But you didn't even call it 'local area network' at that time.

Graube: No, didn't call it local area network. I'm not sure what we called it at that time, but it would be interesting to look it up and see what we did call it.

Pelkey: Do you think you have in your files any of the fliers or whatever you sent around?

Graube: I might.

Pelkey: I'd love to see one of those.

Graube: When I left Tektronix, a lot of that stuff, I think, was tossed away. Now, I look back at it. It might have been interesting to save it, but I'm sure we could reconstitute some of this by going back to the IEEE records and things like that. Unfortunately, one of our secretaries in 802 that we had passed away while he was secretary, and he had a lot of material, and then when he passed on, there was total chaos. Some of the stuff was saved, and I'm sure other stuff was just jettisoned.

Pelkey: Who attended this first meeting? Do you recall?

Graube: Well, I think Don Loughry did, I think -- I'm not sure all the people were. I remember Ken Sumner was there. He was our first secretary and kind of kept us on an even keel. He knew more about organization than I did, and about Robert's Rules. I had a lot of help in that area. There was a fellow named Jerry Clancy; you may have come across his name before, but he was one of the movers and shakers, a very dynamic fellow, that was one of the early instigators of this whole thing. At any rate, we kind of put together a committee and we thought what we'd do is one thing, whatever it was, that would be roughly a megabit per second and roughly a kilometer long, and connect some 100 devices or so, and made for the commercial environment. We were not going to do things for the process control field, because somebody was already doing that work. So that's where it started.

Pelkey: How long did this meeting last?

Graube: I believe it was just a one-day meeting, as I recall.

Pelkey: Do you know if Bob Metcalfe was at the meeting?

Graube: He might have been. I've met those people along the way, but whether they were at the first meeting or not, I don't know.

Pelkey: Do you have an attendance list?

Graube: I don't think so. That might be, again, possible to reconstruct that from minutes someplace or whatever.

Pelkey: So, as a group, you decided to come up with and work towards this one megabit --

Graube: Well, that was the initial proposal. At least I wanted to set some -- what I went in with was, I had a model in my head as to what the PROWAY was doing, and what success they were having and what problems they were encountering, so what I wanted to get away from

was any kind of vendor coming in and saying: "This is my product. Let's standardize on that," because in the process arena, in that forum, that wasn't working, because there was Honeywell, and there was Fisher-Porter, and there was Foxborough, and they each had their proprietary thing, and what the PROWAY people had done that was good was they had set up some functional requirements; what did they want the process control data highway to look like, the standard to look like, as far as characteristics, so they had a set of function requirements. That, I think, was very good, but what they were doing wrong, I felt, and what I was trying to turn around within that group, was that vendors were coming up and saying: "Here's my product, and this is how the product fits the function requirements," and then at the end, the thought was that there would be one product that was more outstanding than the others, and that would be selected as the standard, but I knew that it wouldn't work, because no vendor in his right mind would vote for a competitor's product. So what I wanted to do was, first of all, put down the function requirements as what we wanted to achieve, but keep any commercial products out of it, because we could never come to consensus otherwise. So that was the kind of flavor I wanted to start the committee out with. As to what the technology should be, I really didn't have any particularly strong feelings on that. Tektronix didn't have any products along those lines, and I just wasn't interested in making something proprietary in any way.

Pelkey: Then you decided to have additional meetings?

Graube: Well, then after that, that's where it started. There was quite a bit of enthusiasm. People really wanted to get moving on this thing. We did kind of a 'back of the envelope' market studies, and saying: "If we had something like this in the commercial area, how many nodes would be one the network?" And we came up with some astronomical numbers, and that got people very excited. I think our numbers were a little bit optimistic, in that they're coming around, but not as fast as we thought they would. At any rate, that's where it basically started. Organizationally, I thought that we would have three sub-groups: one group would deal with the physical media kinds of issues, whether it's coaxial cable or what type of signaling, things of that nature; then we'd have a group that dealt with more of the protocol frame format kinds of issues and access to the media, however that was to be done, whether it was supposed to be polled or some sort of a token passing scheme -- those technologies had been fairly well worked out already, many people had those in their, at least, process control highways; and then I thought there would be a group that would look into the interfacing issues. At that time, interface to me meant a hardware interface -- how does a chip, a semiconductor part, interact with a microprocessor. That's the interface I thought about, so we had this group we called HILI, which is still called HILI, which is higher-level interface. As it turned out, it's more of a logical interface than a hardware one, and we have very little to say about how the microprocessors work, but at least that was the idea. So, we basically started out with great enthusiasm. There were many meetings held. I think we held a meeting every two months or so, and they grew very quickly from three-day meetings to a full-week meeting, and a lot of times we'd start on Sunday and work all through the week. So that went --

Pelkey: At this point in time, what was the microprocessor standards? It was a 'T' something, or a 'TX.' I was looking for my notes -- the auspices under which you would have --

Graube: Oh, I should back up a little bit, as soon as we got the committee started, the Technical Committee on Computer Communications within the IEEE got wind of the fact that here had been a group started under the microprocessor technical committee in the IEEE, and they thought that: "Gee, this is an effort that really belongs under their auspices," so right away there was a little bit of a turf issue. Personally, I didn't care where it was going to take place, so we switched out affiliations from the microprocessor group to this Technical Committee on

Computer Communications, which is still today our parent group within the IEEE, under whose auspices we operate.

Pelkey: And was it called 802 at that point?

Graube: Yeah, 802 is the project number that is assigned by the standards office. When you get a project approved, they just simply pull another number out of the sequence, and that was 802.

Pelkey: So you were defined as 802 at that point in time?

Graube: Right.

Pelkey: Ok. Now, when did the process about these local area networking companies that were in existence at that point in time, when did they start to come into effect? Given that you started in February of '80, the whole process about the Blue Book and all those efforts, when did those start to come into your view?

Graube: Well, it was, I think in, roughly, as I recall, around June or so, when Xerox, DEC and Intel announced that they had this Ethernet standard that they were supporting.

Pelkey: Were you aware of it before that?

Graube: No, I was not. By that time, I knew what Ethernet was. Some of the people at Tektronix' research labs had educated me enough to give me Metcalfe's initial paper and things like that, so I knew that things like that existed. I wasn't aware of any commercial product, per se, other than the process control industry, that was anything like this. I think, at that time, the Xerox, Intel and DEC people came in and they gave presentation as to what Ethernet was all about, how it worked, and how we should adopt what it is that they have already as a standard.

Pelkey: Now, this was a meeting in Washington?

Graube: I'd have to go back and take a look. I don't recall. There was a whole bunch of meetings all at once there. I think we're on our 28th meeting, and I don't have them down.

Pelkey: My understanding is that there was a meeting in Washington in which they came in and kind of presented this to you.

Graube: That could very well be. Robbie Rosenthal probably has a better idea, because it was held at his --

Pelkey: And that went over big when they came in and presented this to you?

Graube: Well, it went over big in that people were interested in the technology, but what always happens in these committees -- I'm not sure how much you're aware of this but --

Pelkey: I'm learning a lot.

Graube: There are a lot of good engineers, and somebody stands up with a good proposal, which is basically sound, but then they say: "Well, what happens if..." We started picking Ethernet apart pretty badly, so it wasn't long afterwards where they had to put out version two of

Ethernet, because, obviously, someone had uncovered some major difficulties with it. So, at that time, we had positioned ourselves with the IEEE version of Ethernet one place. The Ethernet Blue Book started out here, Blue Book number two came closer to it, but still with differences.

Pelkey: The Blue Book came out in September of '80.

Graube: The first one, right.

Pelkey: Then, you say, there was a subsequent one.

Graube: There is a subsequent, second version to it, which is different than the first one, which was never officially published, as such, but obviously everybody in the industry that wanted to build Ethernets got copies of it somehow. So we were closer, as far as technical approaches to this kind of a scheme. Then, what happened then was there was quite a bit of interaction with people in Europe in the ECMA organization, European Computer Equipment Manufacturers, and they were widely interested in this particular scheme also. So the Europeans were trying to decide what are they going to do, so they came up with a position that was more or less mid-point, or at least close enough to mid-point between what Ethernet version two was and what we were formulating in the IEEE, and basically simply bit the bullet and said: "Ok, let's move over to the ECMA position," and that's the kind of technology that was incorporated in the IEEE 802.3 standard. It's basically as a result of this process of accommodating these different views. In my opinion, I think we did things which could have been done differently, which could have been done better. Of course, I'm an engineer, so I don't know what's better, but there were things done which were a compromise position, and if you look back at them now, they are somewhat silly, I think. On the other hand, it did galvanize the standards effort and bring us to a single position.

Pelkey: During this period of time, even through the end of '80, there was still the process of your three subcommittee structure?

Graube: Not yet. What was going on at the time was --

Pelkey: Didn't you say that the Jack Tar Hotel --

Graube: Yeah, we set up the structure --

Pelkey: -- the data link, and the HILI, and that structure was persisting through this process?

Graube: Right, that was persisting.

Pelkey: And increasingly, as I understand, this contention over whether it was Ethernet or was some kind of a token scheme, that your meetings, which were now becoming a week in length, were really starting to become, not fractious, but this debate, because there was this presumption of one standard -- you were being driven toward having one standard.

Graube: Well, my view at that particular time was that it would be very nice to have a single standard, and I felt that even if the standard doesn't cover all areas of interest, if one had a standard, then we would have some semiconductor chips, and the chips would make the implementation inexpensive, and that people would use their ingenuity to adapt this to many, many things that we hadn't even thought about, and if it wasn't perfect for everything, it was

better than having two or three or hundreds of different kinds of schemes of doing this. So I was trying to drive it as a single standard at the time.

Pelkey: Then you had some meeting in Phoenix?

Graube: Was it Phoenix or was it Denver? It was Denver, as I recall. It became obvious, as we went through this thing, that there were these big fights going on between the people that were the CSMA/CD, or Ethernet, type technology proponents, and the people that came from more the process control background, or from other backgrounds, that wanted to do more of a token, more deterministic kind of network. I think if you had recorded some of these meetings, they would be very humorous to look at today, because at one meeting, you'd have the Xerox people come in, from PARC, and they were very knowledgeable and very well educated people and very articulate and they would prove and show us that Ethernet worked beautifully. It was just what you'd want. Then, the next meeting, IBM would bring in their people from the Zurich research labs, which proved that Ethernet doesn't work, never has worked, never will work, and it's an absolute disaster. It was inclusive, again, where there wasn't any -- it became a religious issue, basically, that you could always -- people run simulations, and you know how simulations go. Depending on the assumptions you start off with, the results you get. So, if you chose the proper assumptions on your network model, you can get anything you want, and that was exactly what was happening. So, it was becoming clear to me that things were not going to converge into anything. What I did in about 1981, after our -- I think we had a meeting in Seattle -- I simply asked each of the people that were working on documents to give me what they had. I took them all back to Tektronix and I put together a composite document, our first Draft A, and it was a total mess. You could see that it was a total mess, because we had this big tree kind of structure, where you could start out and you could choose this media or that media, and you could choose the access method and you could choose this and choose that, and at the end, there just wasn't any standard whatsoever, in the sense that you could choose so many options, all we were doing was listing a catalog of the way you could do thing, rather than the way you should do things, but it was a catalyst in trying to get our thinking going. First of all, there was a document, now, that people could throw stones at, that we could either improve or abandon the project or whatever, but at least we had something on paper, and so that's where it became obvious then that there really couldn't be a single local area networking scheme, and that we would have to do something to accommodate these different kinds of interests. I forget when it was, '82, '83, somewhere in there, we had a meeting, and I simply went in and -- before the meeting, I wrote a letter to the committee people, saying that we're going to reorganize, and it was pretty much a unilateral decision. I took a lot of flak for it, but I think, in the end, it really did work out, in the sense that you could separate out these warring factions, where the CSMA/CD people could go out and do their standard, and the token bus people could go do their standard. From token bus, there was this second division where the token ring people came and separated out.

Pelkey: How did that happen?

Graube: I think kind of slowly, over time. I don't recall how it was, but it was, again, one of those obvious things where people were not going to be accommodated, and IBM expressed a great deal of interest in the token ring technology, and so, of course, that had a natural following, for better or worse, whether it had the technical merit to it or not. So it kind of broke up into these three groups. Initially, the way we were approaching it was yes, we'd have separate sections of the standard, but everything would have to be put out at the same time. That was one of the agreements we reached at one of the meetings, and everything would have to be in the same document. Well, I just didn't see that that was tenable. One group would be

ahead of the other one; the second group would be slowing things down so they could catch up; so the idea was, gee, let's cut these guys apart and let each one go at their own pace. They can attract their own following and do their own thing, so if we have a small set of standards, hopefully then, that's better than having no standard at all. So that's how we got to where we are.

Pelkey: During this period of time, were you influenced by what was happening in ISO?

Graube: Well, as we were going along, I think we were all learning. I think I had not heard of the ISO work, or the seven-layer model, at all. As we started out learning about it, I think, we all had wildly different ideas of what this model was all about and how things would work. I don't think the ISO people knew that much as to what they were doing, because at times, we would ask for their guidance, in terms of how we described these standards, the reference model, and how these little arrows go in and out of layers and so forth, and we had a model that used three arrows, and then, when we got through with our standard, they changed their minds and went to a two and four arrow model thing, so we went -- it was a mess, trying to track what they were doing, use them as guidance, but at the same time, trying to -- knowing that they didn't always have the right answers either.

Pelkey: Now, my understanding is that . . .

Tape Side Ends

Pelkey: One critical meeting was a meeting that I'm led to believe took place in Phoenix in which there was a late night session in which the people who were supporting CSMA/CD finally -- it was clear that the issue of CSMA/CD wasn't going to get beat back. There was enough support for it that it was real, in contrast to earlier, it may not have been totally token, but there was more token support than CSMA/CD. I'm also under the impression that there was a meeting in which a vote was taken, in which the requirement was to get two-thirds of the people to vote for something, and while token got more than half the vote, it didn't get two-thirds, and there were some events like that which also were events that were happening that you were responding to and taking a leadership role around -- of breaking up into first the two and then the three committees. Do you recall any of that?

Graube: Now that you mention it, I think there may have been something like that. It doesn't stick out in my mind as -- I guess I have more of a Gestalt impression of these whole things. I didn't look at discrete events necessarily. There was a series of small things that kind of came together that -- you might want to talk to my wife about some of this stuff. I'd toss and turn at night and go to these meetings like going off to wars.

Pelkey: Well, from the end of '80, until you broke up into the three separate committees -- do you recall when that was?

Graube: I'd have to look it up, but I recall it being in Denver in 1983. That's what sticks in my mind. I can visualize the place. I can remember having heart to heart talks with some of the opponents of this particular scheme of doing things, because they were losing their jobs as chairmen of these groups, which was not something they liked to do, nor was it easy for me to disenfranchise them, but it was something that needed to be done.

Pelkey: Do you recall what time of year the Denver meeting was?

Graube: August, I believe.

Pelkey: This period of time, from the end of '80 until your decision in August of '83 -- in '81 and '82 and when '83 was coming on, there must have been an incredible amount of pressure because of the desire to get something created and something done, both in the external world and internal felt pressure on your part and the executive committee, of trying to get a standard out, something that could be useful, yet there was all this debilitating debate. It must have been a very troublesome, difficult period of time.

Graube: I call it interesting now, I think, but there were lots of moments of anxiety. This role that I found myself in is not something that I had been particularly trained for or --

Pelkey: You started out innocently, just trying to do something, and all of a sudden now you find yourself sitting on these volcanos - -

Graube: That, I think, was very much a maturing experience for me, in terms of leading people who are very much my superiors in terms of knowing the technology, and education levels and so forth. I knew very little about Parliamentary Procedures, I knew very little about organizational matters, or any of those kinds of things. I didn't have an MBA or anything like that, so it was all on-the-job training. I was very fortunate, though, in that when we did break up into these three groups --

Pelkey: So then, at that point in time, you had four. You had Data Link --

Graube: Data Link Group -- well actually five. Well, at that time, it was four, yes, it was Data Link, CSMA/CD, Token Bus, and the HILI. I was very fortunate that Don Loughry volunteered to -- or I asked him to head up the CSMA/CD, because I knew, from my previous contacts with him, that he was very capable of leading a standards effort. Then Dave Carlson, who I didn't know at that time, he was the father of HDLC, he volunteered, or I asked him to become the leader in the Logical Link arena, because I thought he knew what he was doing, and indeed he did.

Pelkey: He turned out to be a very critical person, in terms of -- other people see his competence on that committee -- other people see that was very astute choice on your part.

Graube: Again, it wasn't by design, it just happened to --

Pelkey: He was very professional, in terms of knowing how to hold his ground, yet compromise and get something accomplished, because it was at that layer, at some level -- it's knowing how to differentiate and divorce --

Graube: Well, he also knew the standards process. He had worked with the ISO and the CCITT people. He knew that process very well. He knew how to lead a meeting very professionally. He was a professional standards man, basically. So was Don Loughry. In the token bus arena, we went through a number of chairmen who were very good, but they were basically young guys that were doing technology, rather than, necessarily, leaders coming in that had already done this kind of thing before, so we had some changes of chairman in that arena. Again, I was very fortunate when the token broke into two parts, that Bob Donnan emerged, who is the father of SDLC. So he just kind of found a place. It wasn't anything that was particularly planned, or anything, it just happened, and these were competent people, and they kind of ran the show. I think my own -- like I say, I got into this by accident. I'm not sure

that I've really contributed that much to this process, except that I happened to be at the right place at the right time, and things fell into place.

Pelkey: Well, you're very modest. The 802 is clearly now seen as a very professional standards body. It has evolved a long way in this period of time.

Graube: Well, I can tell you some of the issues we had to face and are still facing today. One was -- first, historically, for the background, was that as soon as we got established as a local area network/communications technology group, suddenly it came to the attention of the ANSI -- what do they call it -- SSSM? The board that manages information standards, they look over all the standards that are going on in the United States, and checking for duplication, are there people doing the same kinds of standards under different auspices. As you may know, in the US, all the standards activities are strictly voluntary. You have trade organizations of various kinds, professional groups, and they all make standards, and it's all a helter-skelter kind of thing. To a large extent, as far as planning as to what should be standardized and so forth, the groups themselves may operate in varying degrees of professionalism, but as far as saying what should be standardized and what shouldn't, it's not a government function. There isn't any other organization that does that. So, at any rate, there were a number of efforts identified which were potentially conflicting, so we had a meeting in New York and the ANSI headquarters.

Pelkey: What time frame was this?

Graube: It was pretty early. It must have been either '80 or '81. We got together -- I remember a fellow named Pat Lannan, who used to work for AMP, was the chairman of the group, and he had each of us explain what we were doing and show him how it was that we were different from what everybody else is doing. So 802 was different than the 488 bus, so that was, by virtue of distance and the kinds of things we were doing there; it was different from the PROWAY effort, which was under the auspices of instrumentation society of America, because of our non-process control interest. That was part of our project authorization, that we would not do something for the heavy-duty industry. It was different from what X3 was doing, which is basically the HYPERchannel, they were looking at the HYPERchannel things; 50 megabits per second type of standard. We and the HYPERchannel folks and the X3 folks were probably the closest in terms of the scope and the kind of thing we were trying to standardize. The difference was in the data rates, and the agreement that was achieved at that time was that 802 would stay at data rates of 20 megabits per second and less, and then the X3 people would do things which were higher speed. Basically, we resolved the standards issue as to who is going to operate on what turf. That kind of kept us within a confined area here, where we haven't flown off in too many directions at least. As it happened later, the process control people joined up with us, in that they held joint meetings with us as we held 802 meetings, and so what's in the process control standard is very much modeled after the 802, which is a very symbiotic relationship. I admit freely to stealing their function requirements, knocking out the words 'process control,' and putting in, as a straw man for the very first function requirements, so we borrowed liberally from them, and I'm sure they borrowed liberally from us as this thing has gone on here.

Pelkey: And the X3 -- DDI is in X3?

Graube: FDDI is in X3. They grew out of the LDDI, the HYPERchannel kind of standardization that moved onto fiber.

Pelkey: Now, when did you come to know Robert Rosenthal?

Graube: Well, Robert Rosenthal was very active right from practically day one, I think. He may have been at the very first meeting.

Pelkey: He was.

Graube: Ok. So I got to know him, and as a matter of fact, he volunteered his facilities for one of the very next meetings, at NBS, that was held, and I think we've been back there perhaps a couple of times, at NBS. He has been one of the movers and shakers. He is very bright, he knew the technology, he had vision of what he wanted to do for the government, in terms of government standards and procurement practices and such, in this arena. Again, this NBS workshop business kind of came by Rob by accident.

Pelkey: How did that happen?

Graube: Well, we had an 802 meeting in Boston. I forget when the date was. I recall it was cloudy and it wasn't very hot, so it must have been springtime.

Pelkey: I was told it was toward the end of the year.

Graube: Maybe it was the fall. Whatever. So there was a meeting in Boston and somehow during the meeting --

Pelkey: This is the end of 1980?

Graube: No, it was quite a bit later than that. I was starting to see some light at the end of the tunnel, in terms of us getting out some local area network standards. They weren't done, by any means, but I could see that we had --

Pelkey: What year was it, do you recall?

Graube: Well, it was six months before the first NBS workshop, so we could probably --

Pelkey: Which was when?

Graube: I don't recall.

Pelkey: I don't have my notes with me.

Graube: I would guess it was in the '83 time frame. At any rate, during the meeting, I had some discussions with people, saying: "Well, now that we have this LAN sort of in hand -- it looks like things will happen -- what do we do for these higher-layer protocols?" Obviously, it was just like with the 488 standard business, where we had the transport mechanism, but the instruments still couldn't communicate because there was no data format specified, so I wanted to see what we could do in terms of getting some agreements, what have you, for these higher-layer protocols; what was really needed. I'm kind of a minimalist thinker, in the sense that I don't like big, fancy structures. I say: "What's the minimum that we can use and get away with it?" Robert Rosenthal and the NBS folks were very much on top of what was going on in ISO with the protocol standardization, very much on top of things as far as the ARPA network and the TCP/IP protocols and so forth. So what we got together -- after a meeting, there must have been six of us. I think there was Robert Rosenthal and I, and Tony Lauk from DEC, and Alan

Rockhein from Intel -- I think he was at Intel -- he was either at Intel or Spectra-Physics at the time. So we just got together informally after the meeting at DEC in Tewksbury, and just sat around a table and kicked around some ideas as to what we could do. There was nothing definite that was decided on at all, but at any rate, I got back to Tektronix, I wrote my trip report, passed it back to my boss saying: "I had met with some people at DEC, and we were thinking about what to do as an industry, as this common way of what do we adopt as protocols." Well, somehow this got to the company lawyers, and just a week before, they had gone through a big hassle with another standards group for Tektronix. Tektronix is a leader in the graphics kinds of things, and has been very active in graphics standardization, and somehow the people at Tektronix that were involved with graphics standards, there had been some questions from the antitrust department of the Department of Commerce, saying: "What are you doing? Is this preventing trade? Is this a monopolistic kind of thing? Are these standards breaching some monopoly of some kind or another?" So the lawyers have been very much sensitized to these people getting together and deciding to do things. Well, we hadn't decided to do anything, we just kicked around some ideas about what to do. At any rate, the lightning bolt came down from the lawyers, through my boss, to me, and: zap! "Thou shalt not do things like that anymore!" So, I happened to be talking to Robbie Rosenthal, and said: "Gee, I got my fingers slapped here for a little meeting in Tewksbury," and Robbie says: "Well, no problem. We hold these workshops at NBS all the time on various topics. Why don't we hold an NBS workshop on implementors of local area networks?" That's where it started, basically. It works nicely because the National Bureau of Standards works under the Department of Commerce, where the antitrust division is also located, so you have the same people --

Pelkey: Threw it over to their side of the fence.

Graube: Right. Let them worry about how they're going to thrash out. Let them fight it out in the Federal Trade Commission, between NBS and the Federal Trade Commission. At any rate, that's how the workshops started, and we got that going.

Pelkey: Now were you, at this point in time, in terms of organizational form, was the fact that DEC and Xerox and Intel had formed collaborated, did that impact your thinking?

Graube: Well, I think there was a lot of anxiety, in the sense of whether we were going to have a de facto standard, where these companies come and produce enough products --

Pelkey: No, that's not what I'm referring to. It seems to me, intellectually, that the NBS workshops are a successor, a more institutional form, of what Xerox, Intel and DEC did -- that is, the three of them getting together in a way that gets -- the way they got around antitrust was to make a standard of it, to say that they're working towards putting this in the public domain, so they didn't have legal problems.

Graube: Well, if you talk to some of those people, I think they were very closely watched by their lawyers to make sure they stayed out of trouble. There was a lot of consideration given by them, at least from what I've heard, of how they approached all of this Ethernet standardization, to make sure there wasn't antitrust elements in it.

Pelkey: Exactly. In fact, they were successful in doing that. This NBS workshop was the same sort of a vehicle, that is, allowing competitors to get together and work something through. Was there any conscious connection of that effort with this?

Graube: Not on my part, no.

Pelkey: Given that you had been at DEC, was there any thinking or discussion about that?

Graube: No, it was purely technical discussions, really. It was more a question of now that we have these LANs in sight, what do we use for higher-level protocols. I think that was the discussion. The discussion came up with TCP/IP; it's already there. Robbie Rosenthal saying: "No, that stuff is not going to fly over in Europe." I think most of us had the vision that we needed international standards in this arena; that US standards by themselves are not the end goal, and it was better to stay with ISO kinds of standards. So we didn't talk about products. We didn't talk about market shares, any of that kind of stuff.

Pelkey: Was that a difficult discussion at that point? TCP/IP had been government funded, in contrast to ISO, which was coming, but wasn't -- at that point in time, TCP/IP was shipping. One could argue what state it was in, and it wasn't standardized, but --

Graube: I think my vision -- probably Robert Rosenthal was in the same mindset -- that we needed international standards, and while TCP/IP is a fine protocol, it has a lot of functionality that's necessary and so forth, that it wasn't going to be internationally acceptable because of its DOD start. The Europeans weren't going to adopt something from the United States Department of Defense, lock, stock and barrel, and my feeling was, and still is, that we need international standards that we can all subscribe to, and it's going to be more painful to get there, but that's where we have to go. In my recollection, there was not much connection with the prior DEC/Intel/Xerox kind of agreement of any kind. It was purely a convenient way to avoid the antitrust issues and my company lawyers, to get something done. It was a convenient vehicle for that.

Pelkey: Could you talk a little bit about those first workshops? I presume you attended the first ones.

Graube: I was the moderator for the next couple of years, until I left Tektronix, so up until '85 I -

Pelkey: When you say moderator, what is --

Graube: Basically, stand up and chair the session.

Pelkey: So you created the agenda, in conjunction with Robbie, as to what the sessions were going to cover?

Graube: Yeah, we worked pretty closely together on this. They take care of the logistics, obviously, in arranging for the hotel rooms for all of us and things of that nature. It was a pretty loose organization. I know that after we talked for a couple of meetings, I had to suggest to them that we should put it together as the Implementors' Agreements and put it on paper and have a document that we can carry from time to time. NBS, of course, is a government organization. They view the world a little bit differently than people coming from a commercial company who want to see products coming out, so maybe I was bringing more of that view into the NBS workshops. If it had been all NBS people, they would probably have had a little bit different flavor to it.

Pelkey: Did you interact with John Heafner during this period?

Graube: Oh yeah. John Heafner was there, Bob Blanc, those were other people that were instrumental in this whole thing.

Pelkey: Were you involve, at all, in the concept of creating the GOSIP profile?

Graube: No, not really. I knew that was their end goal, as far as coming up with standards for government procurement. That was their whole reason for existence.

Pelkey: What about MAP and TOP?

Graube: I'm not sure where MAP and TOP were born, but we've always had very good relationship with those people, as far as 802 versus -- not versus, but -- in working with MAP and TOP. A lot of the MAP/TOP people came to the 802 meetings, they participated, contributed, and basically MAP and TOP are adoptions of our standards as they are. They just make some choices, in terms of parameters in some cases, but other than that, MAP and TOP didn't come up with their own thing and then take it back into 802 and get it passed. A lot of people came and contributed very good material and real practical experience, in some cases. For example with the carrier band network, one of the standards in 802.4, the token bus, there was this technique defined called 'carrier band', and it was basically dreamed up in committee, and designed in committee, and then it was Kodak, as part of their MAP effort, who actually went an built something and tested it found it to be lacking in some areas, so that provided some very valuable feedback for us in 802, but it's always been a cooperative effort. It hasn't been them against us or anything. It's been a give-and-take.

Pelkey: Did you have any involvement in the creation of COS?

Graube: No, John Heafner, I think, and Bob Blanc are probably very much involved with that. I'm not sure what really happened. They had this idea -- Reagan came into power in '80, and there was all this decentralization, or privatization, I should say, of government functions, and I think at one time, John Heafner and Bob Blanc had the idea that they were going to pull away a section of NBS and set it up as a separate for-profit kind of organization that would do testing and all the things that were needed to really bring this networking about, and I'm not sure what happened as to how it all came about, but in the end they were out of the picture, and somebody else came in and took that kind of concept over and brought it forward. I'm not sure what happened there. I have a feeling that John Heafner and Bob Blanc got screwed. While they were probably instrumental in the initial thinking of this, and perhaps the concepts and development, that somebody else went and got the credit for it.

Pelkey: The concept of profiles, do you subscribe to the concept of profiles?

Graube: Yeah, pretty much. I think it's part of the, as I see it, the standardization process.

Pelkey: Do you think they are needed?

Graube: As steps towards interoperability. What happens in these standards groups is -- it's always the same. You have a bunch of people get together, and they have different ideas, and they finally come up with something which looks pretty good, but you have one guy that won't go along because he's got his pet project, or maybe he has to justify to his company why he is going to meetings and he has to get his idea in or protect his company's position, or what have you. Basically, you'll have a standard, and then somewhere you have a little option; "This is the way to do things, but optionally you can do that," and this is to get somebody's vote, and these

things are worked out at the bar late at night, or whatever. That's the way things move forward, so the end result is that every standard is full of options. You can do it this way, you can do it that way, and at the end, that does not lead, really, to interoperability. It narrows the choices down considerably, but if the uninitiated person is to pick up a standard and build something to it, whether it is hardware or software, they'd be hard pressed to figure out what it is they are to build, to be able to interoperate with their competitor down the street, or somebody else. So, after the basic standards are set, you need another level of agreement, like the MAP people who say: "Ok, for the industrial automation things, this is what we're going to choose. We're going to choose token bus, and we're going to choose these parameters in a token bus, and we're going to choose these protocols, and these other parameters within those protocols," and you narrow it down. Even in MAP, if you look at things, there's things you can do this way, you can do it that way. Again, they had to -- but it's a narrower set. So as time goes by, I think the marketplace itself will thrash these differences out, where some things will survive and some things won't survive, but as we work on these standards that are not de facto standards but things that we try to agree in some sort of an organized group decision process, we need to go through these several steps in order to refine the standard.

Pelkey: The ISO process, leading to OSI, was one of the first examples of a model -- creating a model first -- as opposed to getting into the specifics and allowing things to be thrashed out within the model, did that process of approach to creating standards have much of an impact?

Graube: Oh, definitely. I think it has been very, very useful, in that if you look at some of the data communications things that had been done before that model came into thinking in the industry, is that people mixed all kinds of functions together, again for the 488 interface kind of thing. It's a fine interface, it does a good job, I'm not trying to pick at it, but it was developed at a time when people didn't have this thinking, so what you have is physical lines going up and down that signify various things, like end of a message. We wouldn't do that today. We would have some sort of a character, or some sort of data stream, which signified that the message now has ended, that you can do some parsing and make some sense out of this. There, there was an actual physical line that was to do that. So what you had in data communications prior to the model is, in many cases, you had this mixture of functionality, that you'd have physical lines signifying what today would be considered higher-level protocol functionality. I think the model -- I'm guessing, but -- I think the model didn't come by itself. I'm sure the model came out of a lot of work that was done with IBM and SNA and getting data communications more codified as to the functionality that has to be done, and how the functionalities related to each other in some sort of coherent way. As far as standards setting, I think the model was a real boon, in that we in 802, it was one of our first resolutions was that we were going to stay with layers one and two of the model. That was Robbie Rosenthal's resolution, and none of us really knew what the model was, but it sounded like a good idea.

Pelkey: It was sympathetic with your view of keeping it simple too.

Graube: Yeah, and we're not going to worry about all this other stuff. We're just going to work on a piece of it, and get that done, and then the other stuff can come later, or somebody else can do the other things, and I think the model has helped to put together these committees in the structure where their work has been pretty well segregated. Now, that's, perhaps, the idealistic view of it. Every committee, like any other organization, tries to expand the scope of its work, so instead of having nice clean layers like this, what you really have is a little bit of that, and so, if you're looking from a purist point of view at data communications, you say: "Well, we have this functionality which is duplicated from layer to layer. We really don't need this complexity, necessarily. We could cut things down." That's, again, another place where these

functional standards, the profiles, come in handy, because you pick and choose something that is appropriate to a particular application and you don't have to have the whole wealth of capability. Anyway --

Pelkey: The process of -- I don't have any other specific questions relative to this period of time. You have subsequently added .6, .7, .8, .9, so the work within 802 continues, but now on metropolitan area networks and so on. The NBS workshops, of course, are a surviving entity that is going on. You mentioned you're no longer with Tektronix. What are you doing?

Graube: I have my own company. I formed a small company. I was trying to get Tektronix to move into this area of having some of their products be networked, perhaps make more of an active business out of networking; I could see that as something of real business advantage, and I, frankly, couldn't raise any interest in this. I had a small group of people that were doing some protocol development, but I came to the conclusion that this really was going nowhere, that I was not only wasting the company's money, which was a considerable amount, but also my own time, and I thought: "Well, I have a choice. I'm not old enough to retire on the job, and I think I'm still young enough to do something, and if I really believe this stuff, why don't I do something along those lines?"

Pelkey: Good for you. When did you do that?

Graube: It's been three years now -- '85. I left Tektronix in '85 and started a small company. It's been very much a -- same way around 802. I had no one working for me, and everything is done on a farm-out basis by pure persuasion . . .

Tape Side Ends

Graube: . . . so anyway, I had some contacts with your industry, that is, venture capital people, and I'm not much of a seller or promoter, and I couldn't --

Pelkey: No, you're not. You'd have a hard time raising venture capital, being low key, the way you are.

Graube: I wasn't successful in convincing people that there was a market in local area networking, that there was anything to be done, so I just decided to do some consulting, and do a little bootstrapping, and it's working, little by little.

Pelkey: I mentioned that the larger issues I'm dealing with in this effort of mine is to say that organizations are going to behave differently, operate differently, when everybody can talk to anybody, and you have these networks and so on, and that this traditional hierarchical organization is going to change. It strikes me that the process you've gone through, in terms of committees; how you get these special interest groups, analogous to the functional parts of a parent organization, who have very different perspectives and they have their own turf and they have their own viewpoints; and how you get consensus building and decisions made resulting in action; that as you have less of this hierarchical, authoritative organizations, this committee work represents an emerging way of organizational thinking, how they organize themselves and how they do business. Do you see anything in that?

Graube: Oh, yeah, absolutely. I don't have any hard and fast ideas in this, I just have this gut feeling that we're on the verge of something really significant in the way that we work together, as companies, as a nation, perhaps even as a whole world, and that is that as the

communication breaks down between people, they don't have to go to the top. They can work with each other directly. I think the personal computer has done a lot to help that along; that is, today, I work by myself -- not by myself totally -- but I'm by myself. I don't have a whole bunch of staff around or people that I work for or that work for me, and I do a lot of my work on a PC; I do all my writing on a PC; it's my secretary that basically types; it's my spelling checker; it's my grammar checker; all those things that the secretaries used to have to do. I'm on three electronic mail systems. I communicate with people pretty freely. I get faxes, I get telexes, in many cases I never see the people I do business with. One consulting kind of a job that I had was when somebody from LA called me up. We talked a little bit. He had something for me to do. I did it. He put me on his electronic mail system. I'd write for him. He'd review what I was writing, putting comments in. We worked for a couple of weeks like that. He was satisfied. The check came in the mail, and it was very nice. I deal now with -- I've written a book on this carrier band network. That's a specialty that my company is producing products for, and basically, I send this book out. It educates the end-user as to what the technology is and how they can use it, and what products they need, and in the back of this book are my products, and other products that I sell that other people make. So this book goes out, it educates the people; they're my little salesmen out there, and then I get telex messages come in from all over the world, and people want either more information, or they want pricing, and orders come in over the telex. I fill the order and the bank notifies me that money has arrived, and again, we didn't have to go through this whole hierarchy of things at all. Things just simply get done. You go to the people that have the knowledge, that have the products, what have you, that have the needs, and you can do this one to one correspondence, pretty much, without having to have a big, wide organization on top of it all.

Pelkey: I agree with that view.

Graube: And I think we'll start to see more of that. I've been -- the trade press I read, at least, is this X12 standard for --

Pelkey: E-mail.

Graube: I think that's going to change how businesses work, a lot. Why cut paper for all this routine stuff. It's silly. Why don't we work together? Let's agree on how we're going to do invoices and purchase orders, and when you want something, I know who you are, right? Why do I have to run a credit check on you every time, right? You're an approved vendor, and this stuff comes into my computer. Well, why do I need a person to look at this? Why doesn't this go directly to the production control department, to tell them to churn out so many widgets?

Pelkey: What is there about, specifically, the standards making process? You've gone from a period in your organization, the 802, from being a nascent organization to one that was floundering for a period of time, and not lost its way, but wasn't being very successful, in your view and lots of other people's minds, and reorganized. Clearly you had some competent people, but other things happened. You started to develop processes. You started to develop a way of approaching that problem, of getting these things accomplished, I presume. Is there anything to be learned in that, where you have gotten a strong-willed group of people to work together where they have differences of opinion?

Graube: Well, I think that gets back, in my view, to classic business philosophy. If you show people what it is that has to be done and are pretty clear about what has to be done, people take up the banner and go with it. I guess the example I always use that I think is very insightful is this book, or the movie, "Bridge on the River Kwai." It's one of these things where somebody

shows: "Hey, we have to build a bridge," and everybody gets enthused about building a bridge, and even if it's for the enemy, you're building a bridge, and I think it takes people with some vision, and some way to explain that vision to other people, saying: "Here's what we need to do, and you can either come along or you can stay behind." Once the momentum starts, then it kind of builds by itself.

Pelkey: You've been incredibly kind with your time, and this has been very, very helpful and enjoyable.

END OF INTERVIEW