



Interview of Robert William “Bob” Taylor

Interviewed by:
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James Pelkey: I want to go back to where you first got involved in communications, but this issue of when the Arpanet project really -- if there was a seminal meeting or if there was a build-up, and the meeting that is referred to as the Michigan Meeting, which no one has remarked on other than what's in this book. A number of other people -- Kleinrock and Baran -- remember this meeting that they were in with Uncapher and Shapiro, that they thought was a critical two-day meeting, which happened in Washington, D.C., in the spring of 1967.

Bob Taylor: The Michigan meeting was, I think, earlier than the spring. The IMP notion that was proposed by Wes Clark was not proposed at the meeting, it was proposed in a car on the way to the airport.

Pelkey: Who was in the car?

Taylor: In the car was, I believe, Wes and Larry Roberts and myself and possibly Licklider. I can't remember if Licklider was there then or not. The thing that triggered this particular proposal was that prior to this time, Larry, who I finally was able to hire as program manager for the Arpanet activity -- and there are some things wrong, by the way, back up here that I'll have to come back to in a minute -- Larry, prior to this ride to the airport, was thinking of a network controller in a centralized sense; something in the center of the country, a large machine, that would control the network, and I was nervous about that. I talked to Licklider and to Wes about it, separately, Larry wasn't irrevocably wedded to the idea, but that was his tentative model at the time. I got Licklider and Wes to think about it, and in the ride to the airport after this meeting, I got Wes talking about it. Whether he had done -- he had sorted it all out prior to that ride or whether he sorted it out based spontaneously on the conversation in that car, I don't know. You'd have to ask him, but he said: "Why have a central control. Why not have small machines?" He was a small machine advocate.

Pelkey: Right, from his TX-2 and LINC?

Taylor: Well, the LINC was, in some sense, the first personal computer. Do you know about the LINC?

Pelkey: No.

Taylor: Well, you'll have to find out about that. Anyway, Wes Clark is a fine machine designer, systems designer, who believed more in small computers than in large ones. He was interested in small machines, so he proposed essentially what came to be the IMP scheme, which Larry then later adopted, and that's how the IMP was born. Of course, BBN developed the idea from a set of specs that was given them; not a detailed set of specs. BBN designed the detailed specs, and Frank Heart can tell you a lot about that. Now, the thing that's wrong with this up here is just some dates and facts about the origins. Prior to February of 1966, there was no network project in ARPA's Information Process Techniques Office, which I was then the director of. What we had done, up until that time, primarily through Licklider's genius initially, was to sponsor a few groups whose work resulted in the first timesharing systems that were built in a research context. Not all of the first timesharing systems, but many of the first general purpose timesharing systems -- the Dartmouth system precede some of it, Licklider himself, when he was at BBN in 1960, '61, had a group that put a timesharing system on a PDP-1, but the Project MAC timesharing system was an ARPA supported effort, as was Project Genie at UC Berkeley and another effort at Systems Development Corp. in Santa Monica.

Pelkey: Although Project MAC preceded ARPA in terms of its origins, it had been funded by other groups and was underway and ARPA just put more money into it?

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Taylor: No. Licklider, again, was the idea force behind Project MAC. He may have helped bring together study groups or discussion groups about this project that he'd like to see come into existence before he went to ARPA, but it wasn't until he got to ARPA that it could be funded in any significant way, and that, I think, all happened in '62. In any case, by late '65, early '66, there were a number of ARPA sponsored research groups that had built for themselves, and were using in their own work, some of the first timesharing systems. So, it occurred to me, sort of taking off from this tongue and cheek

'intergalactic network' phrase of Licklider's, that the next thing to do was obvious, and that is -- if we had singular communities who could interactively communicate through a timesharing system that they were all members of, why couldn't we have clusters of communities, groups of communities, where members of one community could interact with members of another community, as though they might be sharing a single timesharing system, and so I decided, in early '66, that that's what I was going to do as the next big ARPA push. I went to Charles Herzfeld, who was then Director of ARPA, in February of '66, and I said: "I want to start a new project. I don't have any funding for it, so I want to get some funding from you. Here's what the project is about. The project is essentially to link the interactive communities that we have now, one to another, in an interactive way. There are a number of advantages to doing that, other than the obvious advantages of building a large community, and one of the advantages is that, in facing up to this problem, we'll have to figure out how to make heterogeneous systems communicate with one another. We'll also be able to share a specialized nervous system resource in a broader way than we can now. There are certain experts in certain fields who sit in California and there are other experts in that same field who sit in Massachusetts or someplace else, and if we can make this work, we can have medium through which they can work cooperatively, and so we get amplification of ideas. Another advantage of tackling this problem is that we might be able to achieve some fail-soft characteristics in any collection of computing that the Defense Department would especially be interested in." So, that discussion probably lasted 15 minutes, and he immediately was excited about it and he said: "You've got the money. How much do you need to get started?" I gave him a number, and he pulled it out of another one of his ARPA projects, and said: "Go." So, the Arpanet began.

Pelkey: Is that a classified amount, how much money, at that point in time?

Taylor: No, it's probably not classified, but I don't remember what the initial sum was.

Pelkey: Was it less than a million dollars?

Taylor: No, it was probably about that. I also needed a billet from him to go hire a program manager. He gave me everything I needed, and soon thereafter, I began to try to recruit Larry Roberts. Now, I had asked -- Larry Roberts was a principal investigator on ARPA supported work out of my office at Lincoln Lab at the time. I had talked with him about some -- asked him questions about some problems of using the US telephone network for interactive digital communications and that sort of thing -- prior to my meeting with Herzfeld.

Pelkey: Larry, at this point in time, had built this link over the network, with modems?

Taylor: I can't remember whether he had done it by then or did it about that time, but I asked him if he would run an experiment between an ARPA supported activity at Lincoln Lab and an ARPA supported activity at System Development Corporation in Santa Monica, and he agreed to run the experiment. He set up and designed the experiment, set it up and asked CCA to run it, and I can't remember if I asked him to do that before I saw Herzfeld or after, but it would either be '65 or '66.

Tape Side Ends

Taylor: After obtaining Herzfeld's approval, in February, 1966, for the network project, I got in touch with Larry Roberts and said: "Ok, the ARPA networking project is a 'go.' I want you to come down and be the program manager for it." He said: "No, I want to stay at Lincoln Lab and stay close to doing research and technical work. I don't want to become a program manager and I don't want to move to Washington." So, I didn't give up. I kept trying to persuade him, and he kept saying no. I thought very hard about other people to come do this job, and I just couldn't think of anyone that I thought was as well qualified as he was. Then, one day, in about -- I think September or October of '66, it dawned on me that ARPA support 51%, or thereabouts, of Lincoln Lab's budget. So I went to see Herzfeld, the same fellow that had so readily said: "Yeah, go do it," and I said: "Charley, is it still true that ARPA supports 51% or more of Lincoln Lab," and he said: "Yeah." I said: "Well, you know this network project that I'm trying to get off the ground?" He said: "Yeah." I said: "Well, there's a guy at Lincoln Lab that I want to be the program manager for it and I can't get him to come down here. His name is Larry Roberts. I'd like for you to call

the Director of Lincoln Lab and tell him that it would be in Lincoln Lab's best interest and Larry Roberts' best interest if the Director of Lincoln Lab encouraged Larry Roberts to come down to Washington and be the program manger for this project." Charley said: "Sure," and he picked up the phone with me in his office, and he called the Director of Lincoln Lab and had a short conversation and he hung up the phone, and about a month later Larry accepted the job.

Pelkey: Good for you.

Taylor: And in Christmas of 1966, Larry came down. His family was down there and they stayed at my house over the holidays because they didn't have a place to live yet. So, I have those dates, like the time that he was with us Christmas, to remember how all of this developed.

Pelkey: A couple of questions –

Taylor: I blackmailed him into fame, is what I claimed.

Pelkey: Let me ask you questions. You were talking about this issue of where the idea came from and your recruiting of Larry. It wasn't quite clear -- were you involved in the selecting of the four universities that were selected as the original sites?

Taylor: Yes.

Pelkey: Why those four.

Taylor: First of all, let's see if I can remember which ones they were. A lot of it has to do with the nature of the talent that was at that site. Different sites had different kinds of talent. Different sites had different kinds of motivation. Let's see if I can remember the first four; UCLA was one, because Kleinrock wanted to do measurement of the network as part of his research; I think MIT -- no Lincoln? Let's see.

Pelkey: UCSB, SRI and Utah.

Taylor: Utah, right. SRI, because Engelbart wanted to be involved in developing a network information facility. UCSB was one of the first four? Why was that?

Pelkey: It was obviously because of Glen Culler.

Taylor: Yeah.

Pelkey: My opinion is that UCSB was thrown in there because you picked the other three, and you needed to create a network, and UCSB was convenient.

Taylor: Yeah, and we wanted something, initially, I guess, first four nodes not too far apart, for reasons that I can't remember.

Pelkey: So by default UCSB got thrown in?

Taylor: Probably.

Pelkey: Because Utah was on (unintelligible)?

Taylor: Yes.

Pelkey: That was strictly because you wanted to access that graphics technology site at Utah, because you thought that could be shared.

Taylor: I doubt that. It turned out the Arpanet never really addressed graphics.

Pelkey: Was it because Southerland was there or because Evans was there?

Taylor: No, I think it was because Evans was eager to throw in some of his resources to building -- each of these sites had to do some programming. Think of the IMP as a two-faced head.

Pelkey: They had to program the host-to-IMP.

Taylor: That's right, their own local host-to-IMP. So, one of the factors was which sites had the manpower to throw into that early on, and Utah did.

Pelkey: So it's really Engelbart and Kleinrock and Evans.

Taylor: They all had distinct roles.

Pelkey: And they were willing to devote resources --

Taylor: They were willing to devote resources to it right then and there, in our time frame. That must have been true about Santa Barbara too. You see, systems programming --

Pelkey: Why didn't you do it on the east coast, where you had MIT and you had Harvard?

Taylor: Well, Harvard was not a strong node.

Pelkey: But why did you go out west--just because those were the people willing to commit resources?

Taylor: A lot of the question has to do with timing. Let me try to clarify this. All of these places need to have staff programmers who are not just graduate students or who are not faculty people, and different ones of these places had different levels of that kind of support, for different reasons. Now, MIT clearly had a lot of staff programmers, but then you get into questions of how overloaded is that staff at that point in time, and what other things, maybe ARPA things, things that matter to ARPA, are going on that those sets of people are now devoted to, and you don't want to shake it up or pull them off or weaken it in any way. Of course, BBN was a node.

Pelkey: But it wasn't one of the first four.

Taylor: Yeah, I guess that's right.

Pelkey: Which is strange.

Taylor: They were the fifth one?

Pelkey: No.

Taylor: Did you talk to Frank Hart yet?

Pelkey: No, but he has agreed to sit with me.

Taylor: Well, verify that with Frank.

Pelkey: They were not the fifth. They were in the first ten, but they weren't the fifth. I think it was either SDC or Rand or --

Taylor: My recollection is it had a lot to do with the kinds of talent that was needed right then and there without weakening some other part of what they were doing.

Pelkey: Now, going back to early '66, you proposed this project to Herzfeld. You proposed to him this idea -- you described a kind, since you had all these different centers, maybe connecting them together was of value and had these benefits you talked about earlier. Was there anything more profound than that? Were you impacted by conversations with Licklider who, if I understand correctly, was proposing his 'intergalactic computer system' in '65 that struck Larry Roberts?

Taylor: The phrase -- Licklider didn't actually lay down an intergalactic network proposal to anyone. He threw the phrase out in a memo that he wrote while he was in ARPA, and it was in the ARPA files, this memo, but he never laid down a proposal for such a thing. You don't know his sense of humor yet. He's got a very dry, effective sense of humor, so the phrase 'intergalactic network,' when we had just brought up a few limping timesharing systems, was very funny.

Pelkey: I'm sure it was. When I first saw that expression, I really had a good laugh, to tell you the truth. So, in early '66 -- it was really 'a good idea has many mothers,' but you just felt that the need was there --

Taylor: The time was right.

Pelkey: It was in the background, you just took it up yourself to find the initiative to go do something about it?

Taylor: That's right, and I had talked with Licklider about it, and he was very supportive, very enthusiastic. I talked with some other people about it who weren't very supportive.

Pelkey: Then you got Larry Roberts aboard, Christmas of '66. How did -- this process of the Wes Clark meeting, which happened in early '67, I gather, which was the issue of the IMP in that ride to the airport, that happened in early '67?

Taylor: That sounds right.

Pelkey: And Wes Clark had worked with Larry at Lincoln Labs as well, or Larry had worked for Wes?

Taylor: They overlapped some, yes.

Pelkey: Do you remember any other seminal meetings in '67? I mentioned this meeting about Uncapher, Shapiro and Baran and Kleinrock. Does that meeting --

Taylor: Where was that meeting?

Pelkey: In Washington, D.C. in the spring.

Taylor: I remember meeting with Uncapher and Baran. Kleinrock could well have been there, but I don't remember any -- I don't remember what the issues were that were decided at that meeting. What have you been told the issues were?

Pelkey: They were issues of the design of the network; the kind of things that led to what appeared in the RFQ.

Taylor: That's plausible.

Pelkey: Were there any other particularly important events during that period of time? By this point in time, you had kind of left it to Larry and Larry was now starting to run with the ball.

Taylor: What I did between the time that I got the go-ahead from Herzfeld and the time that Larry finally said yes, which was from February to October or November, something like that, was to visit various projects that we were funding and tell them what I was up to. I didn't have a program manager yet, but I was going to find one.

Pelkey: So you were getting people interested?

Taylor: Well, I'm telling various ARPA contractors what I'm up to, sort of on an individual basis, and I'm getting a wide variety of reactions. Some people's initial reaction was: "Oh, that means that I'm going to have to give up some of my cycles to somebody outside my community?" Some people got very provincial about it, and others didn't.

Pelkey: Had you initiated this annual get-together of principal researchers at this point?

Taylor: Licklider initiated that.

Pelkey: And at this meeting, you would surface this idea about this network.

Taylor: Yeah, that was surfaced at that Michigan meeting in that the ride to the airport.

Pelkey: So that was one of those principal get-togethers, the Michigan meeting?

Taylor: That's right -- an ARPA contractors' meeting.

Pelkey: And you initiated the one of the graduate students getting together, without the principals being there?

Taylor: Right.

Pelkey: Was that in '67, the first time that was done?

Taylor: Could have been. Barry Wessler would know the answer to that. He was my representative, because he was the only person in the office under 30.

Pelkey: So, once you got Larry, your primary thrust was starting to put the seeds out there and getting ideas --

Taylor: Getting people ready for it, finding out their reaction and getting Larry in.

Pelkey: Then when Larry came aboard --

Taylor: It was his baby.

Pelkey: His baby, and you let him run with the ball.

Taylor: And the actual ARPA order that formally established the program on paper wasn't done until after Larry came aboard.

Pelkey: Were you involved in the selection process at all?

Taylor: You mean the BBN? Oh, yeah. Larry and I had long talks about the criteria for selection before we ever sent out the RFQ.

Pelkey: Was it close?

Taylor: No. The reason -- the fundamental difference between BBN and all the other bidders -- was that BBN could work with our contractors an order of magnitude more effectively than any of the other bidders. Compared to the other bidders, BBN had a stronger history of computer systems research. This gave them an advantage in working effectively with the ARPA IPT contractors.

Pelkey: Then, after '69, you went and formed Xerox PARC?

Taylor: No, I went for a little less than a year, in late '69, to the University of Utah, to decompress from the Pentagon and Vietnam. Vietnam had a very depressing effect on me. While I was at Utah, I got contacted by Xerox PARC to come -- first of all, give them advice on building Xerox PARC. The guy that was going to start it asked me to come and talk to him about getting it started. I did, and then went back to Utah, and then later he asked me to come and head up a part of it.

Pelkey: Hooking the laser printer up to devices which drove, I guess, the Ethernet -- the need for this network -- was a very, very important part of bringing forth local area networking.

Taylor: Yeah. If you wanted a local area network for your computer-to-computer communication, but you also wanted something to print what you could put on your screen, because the rest of the world --

Pelkey: Doesn't have a screen. And that simple need was what really, at the systems level, drove the need to connecting these things together in some kind of way. Metcalfe was there and had some knowledge and expertise, from having been --

Taylor: on the networking side.

Pelkey: on the networking side.

Taylor: There was a competitive networking idea in our lab at the time, and Metcalfe was worried about it, thinking that his idea wasn't going to get a complete enough test. He came to see me, and I guaranteed him that it was, and his won out.

Pelkey: There was also this Data General thing that was running around.

Taylor: That's right, and we started with Data General machines before we had Altos, but there were a lot of pieces there that had to fit together. The first prototype laser printer was called EARS, after the abbreviations of the elements that were required to make it work: E for Ethernet; A for Alto; R for Research Character Generator, which was the electronics, that was more complicated than an Alto, necessary to generate the characters in those days; and S for Scanning Laser Output Terminal, which was simply a Xerox copier with a laser head on it, driven by the Alto.

Pelkey: It must have been a particularly enjoyable period of your life.

Taylor: It was a lot of fun, although Xerox didn't appreciate it very much. That part of it was no fun!

Pelkey: That issue about not opening up the Altos and the language and putting it out there, and the protocols of PUP --

Taylor: Well, we had a lot of blood on the floor just to get them to agree to open up Ethernet.

Pelkey: Yeah, it was a really tragic set of management decisions, not opening those things up at that point in time.

Taylor: It's because Xerox, even PARC, was not managed by computer people. It was managed by physicists -- and PARC, even after the time I left . . .

END OF THE INTERVIEW BECAUSE INTERRUPTED BY VISITORS