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Oral History
Interviewer: Leonard Kleinrock
Date: 11/18/2014

What you have. So you already know where to start. I came to networking. Oh. I'm Barbara Eden. I came into. Networking sort of accidentally. I was working at U.C.L.A.. As manager of this system programming for what was an I.B.M. supercomputer. On a lady one with a four million bytes of memory. It was one of the passes and the largest machine outside a hidden basement in Washington D.C.. And. Around one hundred seventy I can't get a fact they my boss called me in the office and said. Arpa. Once is to connect the three hundred sixty ninety one to the ARP it and which I said was in our Panetta. And that so began a a rapid learning process. As measure programming I was responsible for the. The software the technology. Technological part of of hooking and I.B.M. system. Into this new fangled our packet switching network. We what our role on the our present was so rather unique. Most of the sites on the ARPANET that point. Were computer science researchers using tech systems. Timesharing systems. Writing everything and C. and. And they they were funded by taught by arpa. To do research on that work. We were funded by ARPA to provide a service. On the network. The original purpose of the Arpanet was to be resource sharing. And we were to be a resource to be shared and to be accessed. Remotely. And as it was a big I.B.M. ugly by I.B.M. mainframe. It was be basically a batch processing system. So was another thing that sense aside from everybody else was. We did batch processing when everyone else was doing timesharing. And so we had to invent a protocol for that. For the first things I did do. For doing remote job actually when the work will do. Please. Oh yeah. Oh we need the money. U.C.L.A. had stuck their neck out. Getting a twice the memory of any ninety one. Four million bytes. And the the belief that scale. Are scaling arguments said you needed that much memory. To go with that Sansa C.P.U.. But it was expensive. And that there were the I guess Nix was in the White House. Anyway. And I B M was cutting back on their educational grants. And we were some of them parents been from funds. And so when ARPA came along and said we will buy computer time from you. We were. Yeah. We're here to please. We've a pathway think your money. It was. What did this true I know it's true. We were not alone. We found ourselves in competition with Santa Barbara. They had three sixty seventy five. And that later on U.C. San Diego. Borrows system. And. I think that's true and I was I can think of. Calgary. Anyway so so I was told I needed to solve the software problem which was was not well known. Certainly not known in the I.B.M. circles. I had to start by inventing in ever enterprises communication the I.B.M. system because it has some what sort of fundamental building block. And. But we we did it and became a the host of the Arpanet. And in the famous. I teach seventy two. Demo. Arco were in Washington. Big and what we demonstrated successfully really submitting jobs remotely Krusty was a country. Getting back printed results. So. So you started by asking me about the culture. So I know I was. I was in the early stages my career course I I sort of was in the foxhole being away and Sir pure of the site is. I didn't have much to direct contact with with the movers and shakers. About cons are the likely rug for the people who are. Larry Roberts. People who made it go. But let's generally understood that our position. Was to find the best

people and. Get to put in the work. You know that that that was that was there at their. Their goal and. And in order to do that. You didn't write a proposal to Arpan generally you waited for them to come to you and say here please do this and that fact as happened with with the music. Anyone. And they came to us and said we would like you to do this it will pay you. So that was. That was one was huge difference in in mission. It wasn't so must the product they wanted as as the people saying that. That's my impression when I read it. When I heard the time. Now that all changed when Congress passed a lot of law. To. Which is intended to. Limit the production of ten thousand dollar hammers. Was big there's a big to do Washington. Big controversial hearing in which they told harsh stories about ridiculous prices the government was paying for for common objects. And so the Congress passed a law which required. Bidding basically. For contracts that are proposed forward proposals that and and. Fair bit ng. Valuation. Poses. And so are could no longer. Just go and pick people. And that that may have made a big difference. With other factor of course is a really deep problem. Me I had the idea of computer communication was new and had even though its best with little imagination. Who couldn't. For example for fee the web. Realize that Hokie computers together. Must have some important consequences. And a lot of a lot of low hanging fruit that the in the European sorts most sense. And. So it attracted the the brightest people. To to work and attracted the best program managers in the part of people. Oh by the common people. And later on twenty years on. ARPA stops funding internet research. But by that time the general level of savvy of the program managers had fallen sharply. From what we had known. And the so Another difference was operationally the program managers in the early days. Cut out were actively involved in the program. Invent serve. Paid major technical inputs to T.C.P. IP. And he really he shaped protocol to a large extent. The details as political and. Today's program managers. I don't know if I can't do that but I certainly don't do that and most of the probably are cable. So. So I don't think that Harper has a choice of returning to the way things were at one hundred sixty nine. Because of the cut contest of rules. They have to follow strict strict rules. Oh interesting. So life continued to be interesting. And maybe a year or two after connecting the ARPANET. Arpan was funding climate dynamics research at RAND Corporation. And what. What our program tend to do with climate I am excited no idea that they thought. This is a weapon or something. But anyway they are finding climate than actually search and. Although Rand is only what ten miles from U.C.L.A.. They use the ARPANET they use the ARPANET to to to access. Our machine. They each year of the hydrodynamic calculations that they do for climate that I mix. Is that they need huge memory. Very large remember e. Big big big arrays and it's of the four million bytes in our machine was retracted. And that that's basically so ARPA came to us against it we'd like you to. Continue doing what you're doing and and. We will give random big pot of money to it for them to spend on your computer. And again we're because of. Well Bob Carr appeared to get us caught with a bill calles office in their pockets code there. And it was a problem that the church did. The rate we were charging was too much. We had developed. Actually I developed a a a resource based charging scheme which charged. Independently for C.P.U. time. And memory and. With. I remember the exact argument but I he was. It was intellectually defensible. Scheme of allocating resources and keeping the people from from hogging resources. Properly. But because

memory costs increase linearly like C.P.U. and. I O. that. When you started to use a four million bytes. The talk quite expensive. And we were told that that would not do. So we. We changed. That the charging formula for all of our users. We had to be. Say very mighty. To meet the requirement of artisans in the upper. What upper limit. Was low enough to to equal a pot of money there are perhaps. So people sense I would ask is Why did that funny re the curve. And what that that was that was the reason that was negotiated between Bob and. My boss Bill kale. So just yes. You would go. I was right you was. And it was a P.R. stunt. You. Right you. Well I'm good friends with Steve Crocker. And who was the league Rogers to wear it for you I guess. And he told. Told me and. That the graduate students were given a computer and then work. But a. I guess a working network from B.B.N. and told to make it work or in fact they weren't waiting to hear it is do something. And Steve remarked about the fact that they take practice to skeptics pectin grown ups to come and Tom what to do. But the local An observer showed up. So they just did what they should thought they should do and that with of course quite quite brilliant. But. As matter of fact my wife heard a story. And she always to Hugh also tells the story people. I don't know what it is about as it did that triggers it. To light it or part of it is this image of graduates to speaking a wandering in the water and as we know with a guide to sports. It was purposeful. Yes. You mean you didn't know what to do either. Didn't you guys direct and goals. Because you. Yes absolutely. What was the. People working for Steve was Job hostile to has become famous over the years. Because it is a remarkable. Terminations and it's writing things down. Your own everything then. And eventually here. They were given numbers. And then they called them. Requests for comments in the R.F.C.'s R.C.C. eries and he then serves as. And these are the R.C.C. a reason to lose. Untimely death. I think of that I published some early. I guess my first R.C. was number one hundred. Just sort of thought. And in fact. John. John came to I thought I and was my boss here at his office. To the next to her. For number of years. And I had not really been involved at all with John's activities including the R.C. editor and the act of the function. But when John passed away. The battle sort of naturally fell on my shoulders and I took. Took up the task of editing are seasoned. By into the air at a thing that. But those that. An organization having to go to bed at times to do but I started out as our C.N.N. or for thirteen years. They define the john. Explicitly to do. R C. No action. Now actually now so you know now that was John's. John was the. He was those affectionately as the protocols are the he used his position. Of as are combined with his deep knowledge of of of the so that you to try to prevent silly things should be published. And with General History. Successful. But the little sigh the dictatorial but the it. But it got away with it for years and and worked. So that this is in fact the past now office in honor John we. We have this this office which is used by visitors and. We have a lab which is awesome lab. Or is it. It did. Period in which I was involved with the R.C.S. or are they are just you. Well my my first direct money from ARPA was in two thousand nine hundred seventy four. And I think we got a contract to work on the national software work. You know I was at U.C.L.A. Still I actually after that I moved to. I thought I bought a Presto U.C.L.A.. We. I never certainly have never had a site visit. Because it was basically is me in a couple of the programmers. I certainly went to a lot of meetings. He's got. Oh I don't think the cons of the P.L.O. immediate assistance and this job pays

for of us going to be. There were OK. I was there or I truly was the where the. Chose not to be aware that perhaps problem what are we why I don't remember. Well I was there and have time to fix. Mean or regular meetings of the network working. And that was. The internal organization across the various sites are perhaps relatively little to do with. Well except a vent to took a very active role. In some sense with the leader of the network or you were the Internet where you can please. Wish I could just call you make it actually measure it with the. Structure. It was a tool to. How are you know I I didn't make measurements. And for publishing any results. I was mainly interested in the magnet or other interested the challenge of how to how to build a. It's actually a program which could we be efficient could be. We compile fact effectively compile the code at run time for the ticket or packet structure and. And then use I think to drive counters. Used to do sufficiently You place. Sort of. Well it has a blue need to know this one times I thought about this. If I think Ari to do. Logical operations a through to count the number of times that a condition. A and B. are not see or not see is true. So it has. Yeah yeah. Yes. You know what it's all. She calls its own research here. I don't know answer that. Trying to think is the samples. There certainly were tradeoffs that we dealt with her in architectural trade offs. More ash the one after the fact. Years after the fact I became aware that there was much more. Interaction that I had though at the time between Dave Clark and and vent. And it was a lot a lot of decisions and I thought were made by allies who are in fact. Maybe sit in the closet for had. So. Well I still didn't expect interaction. Because there was a roller priorities. For example one interesting question. Which could be asked is why didn't we do anything about security. I don't know the answer that you. We're. Yes. I six zero. I was more aware of the fact that we didn't see about that were that Rick management. Being a basically a software engineer. I have toys of a computer scientists been really a software engineer. I thought we might. We really ought to have some concern about designing a protocol so they can be debugged and maintained. And we never did. Dave call out the stack in this nine hundred eighty eight. Paper on the are in their architecture. They park. And I don't remember what he said about security in there was a security effort but. It didn't ever seem very factually and I wasn't particularly interested in security either. I'm a wreck. I recognize the importance of that I just did. I had that. Interesting challenge. And we were really starting to make a damn thing work. I thought I'd risk. Here any good will know what time. I've any easier. But in the I.B.M. desire to see or. Attention paid to. Him security issues. At one point I guess he really things think that we installed a. Security package which of all was a role based security. And it was a real pain. But once I think with use the easy to get large. You had to get all of all of security pins around and there's no pay. To securities threats were mostly physical security I think in the. I don't think it. I don't think the idea of an exploiter been invented in the early days. There's an I.B.M. you back. Any connected. That was not home. So my good. Forces which he drove her how we must of Slingbox side of that. I have no. But we didn't we didn't do a. We didn't encrypt passwords rating. Instead of by the plaintext password. I guess we have days. What we all are. And it was as as absolute true. It was a little bit early days like that nine hundred ninety one that the Internet was open to the general public and. Before that we assume that anyone who is there was legitimate so. You've

described finding guidance of his actions as you supervising you. How do you work with people. They only gave his diary. Guidelines. That is how I want to know that culture. Described. You know the. Really was a very good measure but I have it in general I was alone. But we were offering a production service. On on the I.B.M. mainframe. And it was coexisting with lots of other good production services and. Generally we had to set a very high standard of. Reliability and. By bug free code. So we couldn't be as casual as a typical researcher who would. Right now. So stating that the opposite. Funding was the author community. In fact in some way. Your work. He got the. The I.B.M. system of course didn't have any US and he seen language. The late sixty's. You. You use I.B.M. system. You basically had to write in the same with language. So I wrote to T.C.P. IP code in the seminary which. And I would I would go to meetings other people who are running. Prototype T.C.P. IP S. and they would I would come clear lugging my. My binder. To unstick binder. But for listings and seem to go and they would have a three page. Veges typewritten pages of seek out. They were laughing me. But by me or. So see when us came here. You just know they are. Right. You feel. This way. He he was certainly a lot of exchange about the protocols and what they meant and how to deal with Taker cases and who was wrong when with. When I was interrupted Billy failed. Oh we we like it we'll it was good personal relationships in general. I still count as good friends people I know. Charlie Klein for example. I see once every thirty years or so up at the record I have friends. They call it. A good friend. We both went to his. So I stripped. So it was it way we was a personal community as was a tech company in the say they park their very constrained lives. Maybe it's you doing. He was like you. And he's drunk. She seen go. Rage. We're going to have this thing back. You know how much interaction. Well in those early early on a lot of help a lot of you noticed the problems of got a this to stupid checks on the check. I think we have what we we had those are the first bake off when there are the sixty C.P. and when tensions were to try to erupt break. I think all the tour there were ever talk to each other that checksum. You know the others all had to say pleasure sextuplets amazing. Check downtown streets is very safe. So how can a Nobel artist. So there's a lot of ways to screw it up. So when much larger or if they can get from you if you think. You refer to the rage. Many of us that. Right. Yes it's. Oh I don't question we we really worked our tails off getting K K K ready for it and we were very nervous about. You look at other sites. For those demos. Yeah. I watched and then. I don't really remember the details. John. Yes. Whole lot. You should watch. You know God wash. Your life. It was amazing probably was that that sounds very plausible. And your memory is better than mine. And I know you remember the details how much I remember that it was you know where you screw up. Wench MIT sure. That's not her that. This guy's for you guys. Yeah well we collaborate a lot of the B.B.N. folks. Be. Because B.B.N. was sort of the focus of a lot of the early work as very good people and the pleasure to work with them and said people I still would come sprint. After thirty years. More. So in the inflow. You mention. It was a joke. We are in anyway. Military applications which is you. Military. Somewhere. It was always understood that robustness was important was the central attribute of. T.C.P. IP that it it. It to the system needed to the protocols. Needed to be able to survive and communicate. In spite of very bad things happening. No one ever said what a Very Bad Thing was. And we need that need. We need a little fellas. I

was pretty obvious. That well it is time nuclear war. Was in military. Mind you. Yeah. You know. You know. And it's quite proper Here they are now as a partisan some throw. It is always the way in which you saw. Well I mean it changed shifted the priorities but. But if it did it shifted a useful way because of the robustness of the protocol the fact that you can just hook that computer into the wall and who he is releasing that came up and his work. Let Oza lot to that the general plug and play capability of the Internet. Was a lot to the robustness principle. Most of the installer. So it had a really important. Civilian. Spent. Why there was a sort of mildly competing effort between I said Actually I sighed B.B.N. to develop a connection oriented protocol for multimedia and Steve Kaiser here and cardio topple check at the P.P.M.. We're doing packet video. A fairly early. And it but they had they had developed a S T two to action or in protocol and. In one of our telecom and we were actually used that there's this system for teleconferencing between I thought I and B.B.N. quite early. And one. Once we try to use S.T. two. And they just could not get everything synchronized. We knew it started up and one which crashed in there Anything but that is yellowed with crashes and. And he was really. He had were really not hable to easily get all the stink correct. Where you just plug together the the the. Isn't that and that. To IP packets load another their best effort in all works. So you know. If. Yeah. My connection with automation. It's really hard. So a different way. Oh the effort that was right for a car was I think. Application layer political and. I'm talking about now. I think the transport layer. To the lower limit or what. You. Yes. Yes. Well that was one of the things we're on the back room when I was that we first saw the the results of that. Danny and I think John. Pastel. Danny Cohen jump us now. Were very strong proponents of. Datagrams. So they could do packet. Voice and then you know. And that led naturally to the splitting up T.C.P. IP. The exact place you split it isn't always that is still a source of tension or. And certainly when we did it right but. Which side of the line the ports going but. But splitting it seems. What was it was so it was always when it was blamed. We all think Pertwee logical and make perfect sense it was I like Why would you think that the first place. She's tracking the story. Right here right here. Well as I mentioned the that to the particular P.M.I. Vint Cerf was very actively involved with the research about me. Later P.M.'s were not. Sixty's or oh your car park where he is she was fairly involved. But then after that when you mention. The. Yeah yeah. I generally didn't know he was director level of. Oh OK. Yeah. I. I know I know Larry but there are at that as stated in the very well. Of conscious. This is. So you know if I knew him I mean I know that I'm a vegan or in the real life. Where it meets your eye he got involved. You know issues that were involved. But actually left are pretty kind of volves with our city. Resources vision and the thought that that was after he was here. Was that he peed in the. But I I don't associate other Paul and. So. Culture. You know it's like oh yeah. She. Caps. I think it was a sense of excitement in the early days and look at DARPA that art rather than the. So I Robert Bobb con. That serves really really believes in what they were doing and communicated that to see as and to to the people the hard truth that. They had and we respect them I mean if you did is there were lay some later P.M.'s I didn't respect particularly. Well I think that's reverse Reese patch. So you know. If I have an air strike. She. Oh yeah so it's my impression that while the though the one example I worked example. So my last direct art

of finding was in ten years ago. I did most of the H.S. funny existence. I was deterred espec work for her. The last four years I have my salary came from the safer project that ARPA. And Judy this is was it was it because it is program. And I have the impression that fellow life rougher and a frustrating. At her for it. Yeah. He did that all rules regulations and paperwork and something they do it all paid and. I thought I could say the word Senate. Actually in pieces of hurts but it was a good good program and he intervened. Just enough. So you characterize what Mark. The ideal in the modern world. You mean living. Living in the legal and legislative environment of the current. I mean I think that that at a time bits surface and ideal for Graham measure. Are very savvy. Very personable. Very good persuading people. Of his you point of getting their cooperation. Perhaps the he was could be from was fall of the third time by some has for getting too deeply narrative the details and proud of who I thought as I guess that was probably a fair fair. And thank you notes. I don't feel prepared right job description but. We take you a journey. You summarize what was it that made it so successful. It was special. Now. Just getting the others are the very best people and. Let's say that freedom to do with it. Not need to be done. What he said. Well I'm a minimum of the explicit goal direction I guess we I don't think that that you think you want it in the early days. Really had a very good idea what. What will it mean the work of a leader to computers together and have you for solid for a while web. But the center came a surprise. Yeah. I mean we had fairly with a no no conception that would change society the way it has panicked. Of course the silicon revolution played its part to the P.C. burner. So all it was regional question. What characteristics that make sense of a business or the yes what I mean by saying free. You say. To match. Well there are certain then that there was a period in our print last few years. When the director was really hard nosed. And I think you know I mean. And. It was really tough to sell a program to him and he would YOU It turns people them repeatedly. Good people and. It's a Didn't says why is is ideas of what the right thing for. A military oriented research range to be. Well I think the fact that it's being ARPA really meant very little to the researcher except that it was stable funding. I mean that if you delivered. You could pretty much count on being funded again. And that meant that you could build up our pocket top of reservoir of experience knowledgeable people. And then we would be drawing that reservoir for the next twenty years. And without that continuity I don't think. The Internet whatever happened or least why that would not have been successful if that was also. You know. Well so so N.S.F.. Played a very important role. But only because the particular asset program manager was willing to risk a career I guess. And go outside the normal asset mold and and fund a two in our polite fundings stable funding a worker it's. These laws. Was it is very creases guys deserve a lot of credit for for doing that but that was very far outside the normal S.F.. On. And you'll grant for a graduate student the summer. Position. Is this broader. I mean the asset that did what was that a major commitment of punnet punter. Over a long period of time and. Sure how Stephen Pope. But he did so and it was very important. A formative stage of the Internet. But I think we learn to cook the way we were up we've OK. And that led to discover eventuates to congestion control and all of that this is the the the Internet. The S.F. That way the congestion collapse. And. And we learn the obvious. To try stuff like to form it breaks. So you know it's just the whole the whole I.D.F.

experience. Other than their life. There is the. And then research groups that chair for years. Very wonderful experience. Let's talk. Code. Well the. The one point the i'd be split up into into. Task Forces. And we were told by what I read to me being there may be that. Each of you will become Cherry task force or you're out. So this is my my area of work had been host. Protocols host. And one of the agents. Going back to that he wanted. I said OK I'll do end. Service. Not. And say volt over the years and I have all the. MO This method operation. Which was to close keep it closed by invite people myself and I basically a spa set of the best people I could bite. Van de Clark and Crete partridge and so on and so forth and they start group people. But I carefully balance among different organizations and different disciplines and. And the means are really exciting. We are just for a great. Debating Bates. The van and and David. Board. Working Q.Q. cueing models and so on just getting really really fun. And we played we played a role I think in in getting more we can score. To. Not not successfully a little that were not successful in the recent in this area. But. We certainly. We stimulated van and still a work on the variance of T.C.P. and and. Congestion control. They were that. That was interesting interesting time. Fun. It's a lot lighter. No it wasn't. In fact the A.B.C. was created by vent. DARPA. I am not sure I should say they are not sure that. I think Bobby Klee there is a way. But it was certainly an arp a a a committee to convene to advise arpa. But at some point Arpad stopped funding it. And it became a a a body that had tremendous influence over the Internet. But had no legal foundation and no no direct support is a very strange situation. And they kind of with him got with we got a loan for ten years before. Yes. This was the captain in peril of the end then group there was an engineering task force. And that's good to the I.D.F. and the eyes you have swallowed it's parents and took took over the world. Which was quite appropriate. Well. It's a lifetime. For forty years and. My freshman career has been our Arpanet her neck. He says. You know you know. Well I was a revelation for me that's less. Peter Kirstein was a very energetic saw and heard me for for a couple years. To work to. What are in his lab and. Yes I do. Night No of possibility at R.S. are you learning region. I think are probably not sure of of the charges. The appeal are anyway. The family. What was the work. Oh yes so if it was a revelation to me because I came at that point I was fresh out of the I.B.M. environment. So I learned C. and I learned. P.P.L. Evan. I'd be sickly switch cultures and two years. And I wrote a terminal gateway. Again. That's creation there gateway for tell that between T.C.P. IP. The Internet. And the English. X. twenty five academic network which they then use production for some weird. That was I was very very good experience. It was here. Yes You know he said he looked like the US history by Guy and he certainly can't tabs on everything but. But not in the intervening very much he seated Some were sometimes were a programmer would get stuck to just as work is why I had. And Peter would come in and straighten things out but. No it's very very English and the scribe it. Not now. Here was a exciting group of are good people. We. To evolve what they're doing. Those are funny years because Peter isa smuggle interface boards. Back and forth. They do it. So this is not at the veil that. Here and there that they had real troll the decommissioning there and they can figure out what to do with it it was it was. He was not officially there. Somehow I can't live in the country some hour and some pretext and then and there were guys who had that left in Peter's place and. At this was the government was concerned it was

there and then they think he could link. Is this computer. What they do with it. It's also a few I.C.'s Peter that I I saw him recently to year ago. You know. Well I'm sure I could revellers for hours but I know. You. See. Sure. Much. Not all of them in. And we live in different technical worlds. I did speak seen in speak. Three sixty. I had a few notable interactions with Steve. It. Well. One point. I thought I was afraid I even I was steeped in the I.B.M. culture. And I had noticed that all the products all those lines were coming out of B.B.N. were characters cherry off. If it's based that everything. Data structures were basically Unix type of file. Fights by string and in I.B.M. land and you data is the vital in the park and block as I count in front of it so you know how big it is. And you know how to look at each character. Looking for that to the not character. So it's more efficient. And I said to thieve one day why why why are you do that and I expected him to give me some serve. High falutin after he said that's an interesting question. This is the business of. You know it we have much. If you carry this year. Oh let me be the big your bill is so big it's hardware solution because right now you know. They're all OK Bob. I really missed the. Very much. You.