Andrew Viterbi

Interview conducted by

Joel West, PhD and Caroline Simard, PhD

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Andrew Viterbi

Dr. Viterbi is a pioneer in the field of Wireless Communications. He received his Bachelors and Masters degrees from MIT, and his Ph.D. in digital communications from the University of Southern California (USC). He taught at UCLA and consulted for the Jet Propulsion Laboratory (JPL) immediately after obtaining his Ph.D. He was a co-founder of Linkabit in 1968, a small military contractor, and co-founded QualComm with Irwin Jacobs in 1985. He created the Viterbi Algorithm for interference suppression and efficient decoding of a digital transmission sequence, used by all four international standards for digital cellular telephony. QualComm is the recognized pioneer of the Code Division Multiple Access (CDMA) digital wireless technology, which allows many users to share the same radio frequencies, and thereby increase system capacity many times over analog system capacity. Awarded the 1990 Marconi Prize for his achievements in the field of digital communications in many adverse environments, particularly through his widely-used algorithm, Viterbi is a Life Fellow of the IEEE, and was inducted as a member of the National Academy of Engineering in 1978 and of the National Academy of Sciences in 1996. He received the 2007 National Medal of Science from the President of the United States and the 2010 IEEE Medal of Honor, the Institute's highest honor.

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WEST: We're kind of surprised that nobody's done a book about the San Diego telecom industry. We've even gotten icy stares from some people at UCSD because we are from out of town doing the book, when it should be somebody from UCSD. But it seems like an interesting story, and I think we'll have enough data to do that, so that's our goal.

VITERBI: I assume you've read the various articles on the family tree.

WEST: That was actually one of our questions.

SIMARD: Our first question related to that tree is why do you think Linkabit has such an influence leading to the formation of so many companies? Directly or indirectly.

VITERBI: Certainly, the time was right for that industry, for the combination of the satellite communication industry and the wireless cellular industry.

WEST: You're saying that there was a market opportunity and somebody was going to exploit it?

VITERBI: It was multi-market. It was a combination of market, technology, the industry's coming of age, and the ability to do all sorts of things. And government funding. I can't say that all of this would've happened in one way or another, but the way it happened is certainly through the ability to grow unretained earnings. In the good ol' days of the '60s and '70s, government funding

for DOD, still the cold war era defense, was generous.

WEST: We talked to people who said that sometimes military technology investments seem to take people away from things that could have become commercially relevant. Or you have companies like SAIC or Titan that never really manage to transition into the commercial side. If we had seen a cluster of defense electronics companies in San Diego spinning off from Linkabit, that wouldn't have been surprising. But to see a bunch of commercial companies spinning off from a company that, at least initially, was getting most of its money from the government to do advanced military research—that seems unusual.

VITERBI: I'll try to summarize it somewhat. Linkabit got started in the very late '60s, but it was essentially through all of the '70s that it went from seven people to probably 300 or 400 people. It was growing unretained earnings, and doing some very advanced for the time work mostly for satellite communications for the military, and a little bit for NASA. Our first contracts were with the Army, and then the boost came with the Air Force, all of which used digital technology in a more forward-looking way. They were doing signal processing that nobody at that time thought was other than academic. It just wasn't going to be practical. The first people using the technology had to have deep pockets, and the only ones who had the deep pockets and the interest were a few R&D development agencies in the DOD.

SIMARD: I guess this was also in the context of the cold war, so there was a big push to do more research and innovation to be a step ahead of the Russians.

VITERBI: Correct. And it was before the Pentagon went to single-program procurement, where they would get one large major contractor and let them handle the whole thing, which is what happened in the '80s. That was one reason why Qualcomm steered away from military contracts very early on.

WEST: Do you think Qualcomm would have done more military contracts if it were not for this

single-program procurement?

VITERBI: Oh yeah. Let me just finish the rest of that story. So around 1980, we were acquired, and it was fortuitous because we had a couple of opportunities which were significant commercially. It was our first launch into commercial work. One of those opportunities was the VSAT, very small aperture terminals, which started with Schlumberger for the oil fields and then went on to hotel reservations and various other things. The big push came with Walmart buying it for all their stores for data. That was the VSAT program. Also, we were approached, partly because of M/A-COM connections to HBO, Home Box Office, to do video scrambling. All of this, again, was signal processing digital technology that we had employed with the military and had now developed in the VSAT program. I have one interesting sideline. The original version was actually built for the Shah of Iran in 1978 under contract to AT&T. They called themselves American Bell Iranian International, ABII, I think. It was a very, very large contract for the time. It was, I believe, in the billions or at least hundreds of millions, which, by today's standards, would certainly be billions. It was to do essentially their whole communication infrastructure. We were doing a modem similar to the previous military modems for Bell Labs, which was a subcontractor to this American Bell venture.

WEST: They needed you for modems?

VITERBI: Yeah. Well, [Laugh] no. Bell Labs today is almost nonexistent as a research entity. It's still a developer. At that time, they were terrific theorists, but they weren't that involved in implementing. It was great working with them, but [Laugh] they had blinders on. I remember in February or March of '79, I went over there, and we had a very, very good technical review, at the end of which [Laugh] I said, "You really believe these people are going to be in power to continue this contract?" They said, "Oh, yeah. We don't worry about it." A month later was when our hostages were taken and everything collapsed. At that point, the first reaction was, "We'll cancel the contract, but tell us your cancellation charges." We said, "We've done 90 percent of it," in

which case they said, "Why don't you finish it?" We did deliver it. That became the heart of the later VSAT business that we got into in the early to mid '80s.

SIMARD: Was it a natural thought to apply it for commercial purposes?

VITERBI: Oh yeah. It was a satellite modem. With a moderate-sized dish, about 1-2 meters, it was attempting to bypass… At that time, it was very difficult to get a T1 line, even in the United States, [Laugh] and we were in Iran. We were aiming for T1, although the first modems were about 256 kilobytes. That's kind of the Linkabit story. The biggest thing we did, actually, was that videocipher business. M/A-COM acquired us in 1980. In 1985, we left after several [Laugh] iterations in the corporate structure at M/A-COM. After that, they sold that business to General Instruments. They sold the VSAT to Hughes for a pittance, under a hundred million, and they were doing about 250 million a year in business within a couple of years. [Laugh] They sold the jewels, but that's beside the point. In 1985, when we were starting Qualcomm, the natural thing to do was to go back to our customer base, and that was primarily the military. We did some very interesting studies including the LEOS, the Low Earth Orbiting Satellites. We did that with Hughes for the space division of the air force.

WEST: This would be for tactical communication?

VITERBI: Yes, it would've been for tactical communication. That was the forerunner of GlobalStar, which later was picked up by Ford Aerospace, which then became Loral. But initially it was a military study. We did other things that were interesting. A rather strange opportunity to work with Allen Salmasi at Omninet came along. I'm sure you've heard of him. After [Laugh] about two years of struggling because he had gone through quite a bit of money and couldn't raise more—it was actually mostly family money, because the venture capital market certainly wasn't what it later became—he brought in some partners. They ran out of money, and ultimately we had to buy them out. In 1988, we launched the OmniTRACS program, which is the mobile satellite

mostly for the transportation industry.

WEST: So the OmniTRACS idea was actually something that Allen Salmasi was working on?

VITERBI: Salmasi was definitely working on communications for the transportation industry. At that time, there was a company, I believe called Geostar, which had a downlink only. So he worked on the uplink and figured that he could strike an alliance with Geostar, which never happened. At some point, we agreed to do both ends, and that was perhaps the first highly successful commercial application of spread spectrum. I can't think of a successful one prior to that. Spread spectrum, like a lot of other things that we've talked about, came out of the military way back.

WEST: How far back? Of course, ignoring Hedy Lamar.

VITERBI: Yeah, right. [Laugh] Which is real, by the way, but never took off as such. I would say that really the first widespread use of spread spectrum was in military satellites starting in the '60s.

WEST: What was this? Was it to be jam resistance?

VITERBI: Yes. Anti-jam modem.

SIMARD: I think the DOD's first patent on this was sometime in the 1940s or '50s.

VITERBI: Oh definitely, probably in the '40s. There was several significant developments, notably NOMAC, which was a Lincoln Labs development built by Sylvania. It was all terrestrial, though. The other one was JPL's CODORAC All Spread Spectrum. That was being used for sending commands for radio guidance of missiles. In fact, that was the predecessor to the first U.S. satellite, the Explorer 1.

SIMARD: So had you worked at JPL with spread spectrum?

VITERBI: Yeah, I've been working on spread spectrum for 45 years since my first job at JPL, Jet

Propulsion Laboratory, in 1957. The direct sequence spread spectrum for that application was later used for tracking space vehicles for NASA, which much later gave rise to GPS. Global Positioning Satellite is a direct descendent. In addition to the morsel that I made, a room full of equipment was reduced down to a fraction of a chip, but it's really the same intellectual basis.

WEST: So the spread spectrum that you were working on at JPL and the spread spectrum that Linkabit was implementing in the '70s were roughly the same technology other…

VITERBI: Not exactly. It's much closer to the 1985-90 OmniTRACS and later the CDMA cellular telephone technology. What we were doing in the '70s for the air force, the army and the navy was frequency-hopped. There were a number of reasons for using frequency hop.

WEST: It was mainly for triangulation, wasn't it?

VITERBI: No, it was primarily for anti-jam. All of these techniques can be done as well for position location, but…

WEST: You're sitting in Desert 1 and the President wants to talk to you, and…

VITERBI: No, I don't think so. This all has to do with probability of detection, and I can't say that frequency hopping is less detectable than direct sequence spread spectrum. The reason for frequency hopping was partly technological. If you wanted to spread over a gigahertz at that time, it was much easier to do it by hopping the spectrum rather than by having something that would switch at a gigahertz or gigabit per second. That was part of the reason. The other reason was proximity, the near/far problem. That is almost unsolvable when you have a nasty enemy, but it's very easy if you have a lot of relatively friendly users who are sharing your spectrum but aren't trying to drown you out. Whereas a hostile user can overcome your front-end. But that's a different story. So the direct sequence spread spectrum derives from JPL and Lincoln Labs and other places, starting probably in the '40s, and certainly in the early '50s. That's an interesting half century of [Laugh] evolution.

WEST: So frequency hopping is better for military communications because of this near/far issue.

VITERBI: Correct.

WEST: And CDMA went the other way because you have the cooperation to do the power control.

VITERBI: Exactly. Not that there aren't mitigating ways. Part of it is antennas, so I'm not saying that. With satellite communication in the military, direct sequence makes more sense because your jammer is likely… You don't really have the near/far problem as much if your jammer is also earthbound. Because you're transmitting to the satellite and he's also transmitting to the satellite, but certainly from a different traffic area. He's not going to have a near advantage over you, because, with just stationary satellites, you're both going to be 40,000 kilometers away. That's why direct sequence really took hold, especially with army systems, in the '60s. It's interesting because we worked with, I believe, RCA on that system, and it was a huge antenna. We just did the error correcting coding on that job, back in probably around 1975. They were mobile, but they were [Laugh] antennas that were about 3 meters wide. A big truck.

SIMARD: Needed a big truck to be mobile.

VITERBI: And it cost a million dollars for [Laugh] for a modem.

WEST: And now people can get that with a GlobalStar handset.

VITERBI: Yeah, right. [Laugh] So we were with Qualcomm. We talked about OmniTRACS, which was a struggle initially. It was making use of resources that were in orbit and were underutilized, because the early direct broadcast satellite business didn't take off. This was probably because Rupert Murdoch got cold feet at the last moment, opted out and waited 20 years until the technology was mature so he could buy it cheaply. So there was all of this resource lying fallow, but it was specified by FCC and, I think, ITU requirements that it be for the fixed satellite band, meaning for fixed terminals. However, as a secondary use, mobile was allowed. Secondary

meant that you could utilize that satellite if you weren't interfering with anyone else. If anybody interfered with you, it was, “Too bad.” So it was a natural for spread spectrum because the spread spectrum can hide. It looks like just the raising of the noise floor level a little bit, and at the same time, it can turn other interference into white noise, so it is easier to mitigate. That was the natural thing to do. We had spread spectrum encoding in something that a lot of people said couldn't be done in the late '80s.

WEST: Why did they say it couldn't be done?

VITERBI: Because there were a number of hurdles to overcome. That was one of them. The other was having a small antenna and rotating as the truck moves, turns a corner and so forth, which was mostly Irwin Jacobs' development. That business ultimately took off. It originally had an experimental license for 600 trucks, and after we demonstrated that, around 1988, they gave us a license for 20,600 trucks and then kept adding to it. Today it's probably 500,600 because somehow [Laugh] they always leave that number. [Laugh] They leave in the lower insignificant digit.

WEST: Just to be clear on OmniTRACS, it sounds like you were the experts in how to apply spread spectrum to this particular problem. Were you thinking about this problem when you went to go start Qualcomm?

VITERBI: Not really. However, Allen Salmasi called me about a month before we incorporated Qualcomm and said, "Can we work together?" We didn't take him too seriously at the time. It took us about six months, and then he came up with a little study contract for $10,000, and we built up from there. But I can't say that we thought, "Yeah, we have this spread spectrum technology, let's apply it here." We studied the problem, and that seemed to be the natural solution. By the way, that took well over a year because initially we were just looking to do an uplink, and only later did the work on a two-way.

WEST: Why did you leave Linkabit? We didn't mention that.

VITERBI: I did tell you. I said because [Laugh] the person who originally acquired Linkabit, the chairman/CEO, was pushed aside by the board around 1983. After that, things went downhill. I don't mean downhill just economically in business, but in structure and management.

WEST: Was that personal relationship important when you made the decision to be a part of M/A-COM? Did you trust this guy and…

VITERBI: Yes. I still consider him a friend. He was farsighted and basically a good manager, but somehow he lost control, although his decisions were correct, including some alliances he wanted to set up, which were torpedoed by his troops. Actually, Irwin and I had three-year contracts, and we stayed five years. I don't feel bad about that period at all. M/A-COM turned out to be a very good strategic investor or, if you will, a bank, for us to pursue those commercial applications. We didn't have the means, although we could've gone outside. But that was certainly the most benign venture capitalist in developing the VSAT business and the videocipher product.

WEST: Why did you leave at the time that you did?

VITERBI: Because there was a management shift, and Linkabit, for all intents and purposes, was put under another division that we didn't particularly agree with.

WEST: Was it the DCC, Digital Communications Corporation?

VITERBI: Right.

SIMARD: A lot of people talked about a shift in culture in these years. They talked very fondly of the Linkabit culture and that culture being so innovative and special and…

VITERBI: You probably talked to Rob Gilmore. [Laugh]

SIMARD: …academic. Yes.

WEST: We talked to a lot of people, and Rob was one of them.

SIMARD: But a lot of people link the culture to your leadership style. What was the culture like? How would you describe it?

VITERBI: All I can say is that if I had a major impact, which I think I did, it was in recruiting. It was in attracting some of the best talent and in supporting them. A lot of those people are either still at Qualcomm. I'd like to point out that Linkabit was sold to M/A-COM which was sold to AMP, which was told to Tyco. Some people ask me, "Why didn't you ever patent the Viterbi algorithm?" I explain to them the reason was that our patent attorney at the time, in 1968, who also incorporated us said, “This is much too complex. It will only be used by the U.S. Government. You're wasting your money.” However, if we had patented it and if it had been renewed after 17 years have gone by—there are ways to renew patents—it would now belong to Tyco, [Laugh] which…

SIMARD: Yeah, maybe that was a good thing.

VITERBI: But back to the cultural question. So there are lots of people around who have started more than one company somewhere in this family tree who just had talents. They started out with very solid academic background, innovative research, and were capable to utilize all the tools that the enabling technology put at our disposal. They have grown into very remarkable technologists and innovators.

WEST: Anybody come to mind?

VITERBI: Sure. There's a lot. One of the people who is still there is Roberto Padovani, who's a CTO at Qualcomm. Rob Gilmore is a good example, who's now VP at VIA Telecom. Itzhak Gurantz, who was with us at Linkabit, went to ComStream and just visited on Friday and has a new company called Entropic. These are some of the superstars. I'm sure I'm leaving out a lot of good people. Butch Weaver, who, I think, led the videocipher development at Linkabit, and also led a good part of OmniTRACS. He was also our [Laugh] lead technologist in all the lawsuits with

Ericsson. [Laugh] The lawyers got all the credit, but it belongs to the guy behind them at their sleeve who said, "No, that's not the way to go." [Laugh] Klein Gilhousen, of course, who had the guts to propose CDMA. [Laugh] Franklin Antonio. These are people who are still at Qualcomm. They may come in various categories. A lot of them had Ph.D.'s before they came to us, and some were just innately bright. Gilhousen and Antonio are examples of the latter. To some extent, Gilmore and Weaver are on the other hand. The way I viewed it is, a Ph.D. is very good experience but not critical to be successful.

WEST: How would you recognize somebody then? A lot of companies, Adobe Systems comes to mind, are started by Ph.D.'s. They hire other Ph.D.'s because they go based on…

VITERBI: There was a silly article in the New York Times, maybe in the Sunday paper, about a month or two ago, pointing out that Google is so much better than Microsoft because they hire mostly Ph.D.'s. That's a lot of nonsense. Google is a terrific play in more ways than one, including the way they're approaching their IPO venture, or not so much the venture, but the investment banking community. Both Larry Page and Sergey Brin are much to be admired, as is Schmidt. To begin with, I don't believe that they only hire Ph.D.'s. And it's not that big a difference. The Ph.D. is valuable but not critical. I don't think the way they made a clear distinction was quite appropriate. Linkabit and Qualcomm's approach was if the guy or gal shows real talent, we don't think that the Ph.D. is critical, although the founders are going to obviously have Ph.D.'s. How do you judge? You judge a lot of it in the interview and also in the resume. Quite frankly, I used to say, "It's best when you get them young, out of school, they haven't learned bad habits." I would say that the vast majority of the people who developed into leaders at Qualcomm and at Linkabit were people that we got virtually straight out of school. All the names I gave you came from a variety of places, some from UCSD, a number from MIT and from other places. You give them freedom to develop.

WEST: Reading the IEEE interview they did with you…

VITERBI: That keeps coming back to haunt me.

WEST: Well, it's on the Internet. If you were hiring people in the '70s to do digital communications and they had work experience, I imagine they would've been working at a fairly conventional government contractor.

VITERBI: That's probably true, yeah. We hired some of those. There were periods when we were growing very rapidly, and we had to add staff. Those were the periods where I think we were least successful in building the company.

WEST: Because these weren't of the caliber or because they had gotten bad habits?

VITERBI: Because they weren't of the caliber.

WEST: To go back to Caroline's earlier question, everybody we talked to who was at Linkabit at the time said that something changed between 1980 and 1985. Obviously things changed after you guys walked out the door, but things were changing before you walked out the door.

VITERBI: It became more bureaucratized. We had to harmonize with the other divisions, some of which went well and others less well. Also, we grew a lot, because when we were acquired, we were probably around 300 people, and when I left, we were something like 1500. That's also the period that we took on some large jobs, although not the two that I mentioned. We did some things for Satellite Business Systems, which was a joint Comsat/IBM venture, and a data aggregator and a central reference system. We had to grow very rapidly in order to fulfill those. They developed some very good people, but also we had to build large teams which weren't quite as effective. I think that's what people are referring to.

WEST: Do you think it was the dilution of the talent or the fact that it got so big that your personal influence no longer had much of an impact?

VITERBI: Yes and yes.

WEST: Okay. Plus the bureaucratization.

VITERBI: And also the lack of focus because you had duties up the line and spent time on corporate matters.

WEST: We were actually joking that we were going to write a paper someday about destroying value in acquisitions. Knowing what you know now, do you think that the acquiring company could have gotten more value for its money if it had done it differently?

VITERBI: Oh sure. I think if the original visionary, Larry Gould, had remained, it would've gone better because he had more of an eye for talent, and his successors didn't. The other problem was—you sort of alluded to it—that there were two divisions with somewhat different cultures that were both in the same business. There was some of that competition, which wasn't helping. They had some good people. Some of them I still see occasionally, but on the whole, it was a different culture. As a matter of fact, it was a very different culture. We used to have joint meetings, and one time, I remember the person who, I think, then was the V.P. and who later became CEO in that division and who went up the line after it was sold to Hughes, said to me, "I never recruited from the top universities because the people don't fit into the organization." So, the culture's at 180 degrees.

WEST: I can't remember who it was, but we talked about somebody else whose San Diego company was bought by a Boston company. You've given us a very clear intellectual culture difference, but we were wondering if there was also maybe an East coast/West coast kind of thing.

VITERBI: I think there was some of that. I think there is a difference. On the other hand, great companies have developed, some of which don't exist anymore. For example, there is the Digital Equipment Corporation, and I'm sure there are dozens of other examples. But in the '70s, I would say the East coast was closer to Europe in its values. There was nothing wrong with them, but they were more conservative, less willing to take risks and more hierarchical, and large corporations

dominated. Now, a lot of that has changed, so we're much more similar, much closer.

WEST: That's an interesting point.

VITERBI: I'm on the board of two startups on [Laugh] the East coast.

WEST: Would you say that both Linkabit and Qualcomm were very inclined to take risks? Because you're contrasting these two. Or were they different in that regard?

VITERBI: Linkabit was different in that our customer was primarily, almost exclusively, the U.S. Government. It's hard to say. They were technological risks, but they weren't financial risks. Although they could always cut you off, but…

WEST: Right.

VITERBI: Was Qualcomm willing to take risks? Yes, more than the average company on the East coast, yes.

SIMARD: Right.

WEST: What would you say was a big risk? CDMA, I guess, would be the…

VITERBI: Yes. OmniTRACS was a big risk, and we paid much too much for the acquisition of our customer, Omninet. With CDMA, we would never have gotten off the ground without a company that was then called PacTel Cellular, which ultimately morphed into AirTouch, which then became, for a little while, GlobaFone, and then Verizon. They were believers, and they put investment into us. We also got support also from Ameritech and, I believe, NYNEX.

WEST: Was there anybody in particular at PacTel Cellular?

VITERBI: Yes, William C.Y. Lee, who was the CTO and who advised management. The decision was made by the CEO, whose name I can no longer remember, who was ultimately fired, sadly, and replaced. I don't think it was because of CDMA [Laugh] because at that time, it was just

a glint in their eye. But Bill Lee was intrigued and he wanted to be part of this revolution.

WEST: It seems to me that since he had written textbooks about CDMA, he had enough technical depth to get beyond the common reaction that this can't be done. You and other people have explained that Europeans were saying in 1996 that it couldn't be done.

VITERBI: [Laugh] Yeah, some very good Japanese companies said, "We tried that, and it didn't work," and I remember one of our guys saying, "Well, there are thousands of ways to do it wrong, but there's usually only one or two ways of doing it right." [Laugh] He had enough vision to see that. I think that's a fair statement.

WEST: Was there any other sort of pattern to the people who believed in CDMA early on, other than technical depth?

VITERBI: Partly because of PacTel, which had a major foothold in Korea, and Dr. Park—whose first name was Hen Suh— Dr. Park, who had been a student of a close friend of mine at Cornell, Fred Jelinek, and who was an ally of Bill Lee's. He ran the pager business, I think, for PacTel in Korea, and he was instrumental in introducing CDMA into government circles. In '93-'94, Korea actually voted in parliament for a standard and chose CDMA as their only standard. With the help of ETRI, the government lab, they introduced it to three major commercial corporations, the largest one being Samsung, Hyundai, and a third one being LG. Two of those have a thriving business, particularly Samsung. It wasn't only in cellular, but certainly in that. They're number three in the world in cellular, and that came about as a result of embracing CDMA. Of course, it also launched CDMA. I strongly believe that if Korea had not come onboard, CDMA would not have gotten strong enough traction to make it. Besides the two I mentioned, the person who really deserves a lot of credit there is Allen Salmasi, the guy that we acquired through OmniTRACS.

SIMARD: He was part of that acquisition?

VITERBI: He was. Not his partners, but he was. [Laugh]

WEST: What was his role?

VITERBI: Marketing.

SIMARD: What's interesting here is that although Linkabit was kind of the original seed to make this cluster of companies, CDMA really put San Diego on the world map. You mentioned LG and Samsung, which both have presence here. Then you can think of Nokia, Ericsson, and Siemens and all the others that opened an office here.

VITERBI: That's true.

WEST: How is it different after CDMA? It seems to me you're under this scrutiny now. Now obviously, you have that period of four or five years where you're fighting with the Europeans.

VITERBI: They still haven't won in Europe. [Laugh] Well, they have and they haven't. They have because 3G has gone CDMA with somewhat different standards. The changes have really hampered the growth of 3G, at least the original 3G.

WEST: Why? I know CDMA 2000 is software compatible, but…

VITERBI: That's part of it. The one thing they did that has really hurt is they insisted on having unsynchronized base stations. That is, not synchronizing time among the base stations. In developing CDMA, we argued that the most expedient way of synchronizing base stations was to just put a GPS receiver in each one. The argument against that, which is kind of spurious in my opinion, is that GPS is managed by the U.S. Government, which can always turn it off. But if they turn it off, it turns off [Laugh] not only the CDMA phones, but also all of the position locations worldwide. It's not likely to happen. In any case, on that basis, they modified the system so that, rather than having almost trivial, almost automatic acquisition as you move from one base station to another, you have to reacquire. There's a certain amount of complexity, but it isn't the complexity that hurts you; it's the power in the handset that is consumed in reacquisition. Therefore, battery life

has been very, very short. That has hurt them. I was in Italy recently, and I [Laugh] talked to some people that didn't have an axe to grind, and they said, "Yeah, we drop a lot of calls between base stations." [Laugh] Any new technology or any technology where you've made a significant change, there's a certain maturation period, and they're just going through that. So it's going to work, but I think it set them back a couple of years. Plus, the auctions. There's a lot of economic reasons that they've had troubles, but that in itself is probably worth a year's delay. Even so, it's happening. In Europe, NTT and DoCoMo would only go for CDMA if they made major changes. DoCoMo wanted its own IPR, and they thought that they could get around the Qualcomm patents, but they haven't been able to.

WEST: That was the reason they made these changes, to get their IPR?

VITERBI: I think with DoCoMo, it was partly IPR, partly hubris, thinking we can do it better. It's NIH and they have to do it their own way. As it is, technology keeps moving forward, so it's [Laugh] silly to fight that way.

SIMARD: Does Qualcomm get the same fees no matter which version of CDMA is used?

VITERBI: I've been gone for four years, but as of four years ago, yeah. As long as you have royalties, it isn't a question of how many claims. As long as you have one claim, you can enforce royalties. As far as I know, the only difference in royalties has been a commercial reason.

WEST: Or that whole China/Korea thing, but that's…

VITERBI: China in particular.

WEST: When you were there, were you expecting that Qualcomm would be able to win this patent issue? They were trying to work around the patents, and did you…

VITERBI: Yes. I think nobody on our team ever questioned that that we had the basic patents. As a matter of fact, the most concerted challenge was put up by Ericsson, who fought us all the way

from the beginning. They put up, as I recall, four patents, none of which really had anything to do with CDMA. They were TDMA patents. I was disappointed that we didn't go all the way through, but it turned out that that settlement was a great victory for us because of a variety of reasons, [Laugh] which weren't quite as obvious at the time, but they settled all of the intellectual property rights issues. They bought the infrastructure business, which was losing money, and we thought would actually advance the technology by their taking it over. As it turned out, the real winners were Samsung and, to some extent, Lucent. Lucent embraced it and got much of the infrastructure business. They didn't do so well in other industries—I think they were a bit slow. And ultimately Motorola was pretty good in phones, but they lagged in infrastructure.

WEST: They've always had switching problems.

VITERBI: Switching, exactly. At one time, they allowed Alcatel to buy out Digital Switch Corporation, DSC from Texas, from under them. They were their switch supplier, and after that, they really had big problems.

SIMARD: So to close the conversation, after the 'telecom nuclear winter,' as some have called it, what do you view now for the future of the San Diego region, the telecom industry?

VITERBI: There are many offshoots of this business. Qualcomm then and even today is primarily into cellular. There's also WiFi, there's distribution within the home, there's still satellite communications. There is a wealth of applications that digital signal processing makes possible, and it comes down to finding the right ones. There's some great technology out there. Sometimes it just doesn't find a market. The kinds of things they're doing, for example, in optical signal processing to get up to 40 gigabit per second links are terrific, and yet the market isn't ready for them. But I think technology moves on and there is a thirst for new gadgetry and new applications. On the whole, we tend to be surprised. Even Microsoft missed the boat on much of the Internet and on search engines. Nobody thought that that could be commercially monetized the way Google has.

WEST: When you finally retire, what can you think of as your contribution to the communications industry?

VITERBI: I was in the right place at the right time, and…

WEST: What place was that?

VITERBI: My career started essentially with Sputnik. Three months after I started working in my first job, Sputnik got launched. There was a tremendous boost in American technology, and communications was a good part of it. That was a good start. I also had a passion for the academic life, for teaching and research and I spent almost half my career doing that. I learned an awful lot from it, and I was able to enhance the knowledge there. Then I got bitten by the entrepreneurial bug and I was able to do both to some extent, although after a while, the corporate duties got a little too heavy and I was teaching only very rarely. So what was my contribution? I wrote three books, I wrote a bunch of papers, and a lot of them are still cited. The algorithm is used not only within communications, but it got into voice recognition and is even a pattern for the DNA sequence alignment, things of that nature.

WEST: Would you consider yourself to be a pioneer of digital communications or digital radio or the application of digital technologies? If you nudged things forward when being in the right place at the right time, what part did you have the biggest nudge on?

VITERBI: I'd say definitely on the various aspects digital communication. Second, it would be digital signal processing, within a broader set of areas.

SIMARD: That was great. Thank you so much.

WEST: Thank you very much.

END INTERVIEW

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The San Diego Technology Archive (SDTA), an initiative of the UC San Diego Library, documents the history, formation, and evolution of the companies that formed the San Diego region's high-tech cluster, beginning in 1965. The SDTA captures the vision, strategic thinking, and recollections of key technology and business founders, entrepreneurs, academics, venture capitalists, early employees, and service providers, many of whom figured prominently in the development of San Diego's dynamic technology cluster. As these individuals articulate and comment on their contributions, innovations, and entrepreneurial trajectories, a rich living history emerges about the extraordinarily synergistic academic and commercial collaborations that distinguish the San Diego technology community.