

Oral History of Jan Uddenfeldt

Interviewed by:
Marc Weber

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Marc Weber: I'm Marc Weber of the Computer History Museum, and I'm here on August 31st with Jan Uddenfeldt, pioneer of Mobile Telephony and GSM and longtime CTO of the Ericsson Group and now Sony Ericsson, and a board member here at the museum. Thank you for joining us.

Jan Uddenfeldt: It's great to be here. Thank you very much for inviting me.

Weber: Good. Really, I just want to ask you about your whole career, starting with your life. Where were you born?

Uddenfeldt: I was born in Stockholm, Sweden. It's more than 50 years ago, it's almost 60 now; so it's a long time ago. I took my Ph.D. at what is called the Royal Institute of Technology in Stockholm, in the '70s. Of course, before that I took my Masters, and that was in telecommunication. I really was deep into telecommunication theory and signal processing, and I did my Ph.D. in voice coding in Stockholm in '78.

Weber: As a child were you interested in electronics or technical things?

Uddenfeldt: Yes, I liked to play around with things. I was very eager to learn things; I really liked to do that all the time. Of course, I played with technical things. The electronics was not so advanced in those days, so it wasn't all that great fun. You couldn't do very much except building a radio, and then you had to talk to people very far away. That didn't really catch me very much. Of course, when it comes to learning new things, I've always been very keen to do that. That's also what drove me to going into a Ph.D. Then later on I really felt that to work with advanced telecommunication [was] a fantastic thing because [there were] so many things you could do with this technology.

Weber: Were your parents in a technical field?

Uddenfeldt: No, they were not. My father was a businessman. He was more from that side. He didn't really teach me anything of that; that I had to do myself.

Weber: Any early experiences with technology that stand out, that inspired you?

Uddenfeldt: Oh, I don't know. It was great fun with just things like the integrated circuits because all of a sudden one realized kind of you can do so many things with it. It's predictable, it's not just some strange things happening. It just went on from that, really; to take all the logic circuits and to multiply from that. Later on when I was going through my Masters, came the microcomputer that really revolutionized things.

Weber: Talk a little bit about what you studied and what your interests were specifically.

Uddenfeldt: When I did my Ph.D., it was more in the telecommunications field and very advanced algorithms to see how to convert voice from analog to digital. I was studying a lot of the other things, like modulation theory and information theory and signal processing; all these kind of algorithms were

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extremely complicated, extremely advanced. The strange thing is that all of these things I actually have been able to use in my professional life; all of these things came through. Although when I was studying it, it was really too complex to even comprehend that it would even ever be able to really build those things. But it was really a fantastic education because in practice I have had a lot of use of all this knowledge.

Weber: When you were studying it, it was purely academic?

Uddenfeldt: It was a bit academic at that time, absolutely; complex mathematics, yes.

Weber: What led you to Ericsson?

Uddenfeldt: Ericsson is a big employer in Stockholm. That was natural from that point of view. What really led me there—back in '78, when I joined; so that's more than 30 years ago—when I joined it was the fact that that part of Ericsson, which was called Ericsson Radio, was doing the first mobile telecommunication equipment. Not the first, but this was really when it became the first automatic systems that were really for the mass market. That system then later was introduced in '81. This was really a very exciting area to go into. I was working a lot with the first generation analog systems. Very soon I started to work with the second generation, the digital cellular systems and that was later called GSM. Those things were really there on my radar screen also in the early '80s.

Weber: What was your first position at Ericsson?

Uddenfeldt: I joined what was called the Research Department. I joined that as a member of the research staff back in '78. Then I got some promotion and so on, and then I took over that department, a couple of years into the '80s; something like '83, '84.

Weber: You were living in Stockholm.

Uddenfeldt: Yes.

Weber: In the city?

Uddenfeldt: No, I really haven't lived in the city. I lived outside the city. I was brought up at a little city outside Stockholm called Lidingö, which is just basically an island. It's more or less in the archipelagos. It's a great place because you can always go out with boats and things like that, if the weather permits, and so it's much nicer than to be living in the city.

Weber: But not too far from—

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Uddenfeldt: Right, it's only six miles or something; yes, very close by.

Weber: What was it like to be at Ericsson in those years?

Uddenfeldt: I said it was great fun, because this was a new area. Ericsson was a big company. This part of Ericsson was small but it grew and grew and grew. Funny this, while it's part of Ericsson back in the early '80s, it was just a [small] percent of the total company. Then it grew and it basically doubled the revenues every second year, until Year 2000. When I joined it was police radios and military radio, and it was maybe something like 30 million dollars. Then it grew to about 30 billion dollars until the late '90s. It was a thousand fold increase of this company. It was just great fun to work with this company. It was growing dramatically.

Weber: How many employees when you joined compared to how many today, for that division?

Uddenfeldt: Oh, for that division? That division today is just the old part of Ericsson, of course. It took over the whole Ericsson company. When I joined maybe it was 1,500 people, and then it grew to about 100,000 people now.

Weber: It was 1,500 out of already a very large company at the time?

Uddenfeldt: Yes, right. I think the companywas probably 30, 40,000 people.. It was a big company at that time, absolutely.

Weber: Were there people there that were important mentors to you?

Uddenfeldt: Yes. We had a great guy who was the CEO of the Ericsson Radio part. He was really the guy building up, pioneering the first generation of mobile business. Ericsson Radio did both the mobile phones, but also the base stations and the equipment needed in the system part. He was really the guy driving all of this, at that time. His name was Ake Lundqvist, and he was the head of this unit for the whole '80s and up to early '90s.

Weber: Whose vision was behind moving into mobile telephony and mobile data?

Uddenfeldt: Yes, that's an interesting story. I think some of this vision also came from a customer, like the Swedish tele market, who was setting up the networks. They were absolutely part of driving this future as well. When it became a global business, then it was more Ericsson that started to really drive it. There were different parts of it. We started [in] the early '80s to really look into what we call digital cellular, and that was extremely advanced and complicated. That is really what later becomes GSM. GSM was coming to the market in '91. We had the first test systems back in '85; or we had something even before that where we were testing the whole concept, going for what was called a TDMA [Time Division Multiple Access] system, which then allowed multiple users to share one radio channel, because that makes it cheaper. It was very complex because the radio channel is a very ugly medium. It really destroys the

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signal dramatically, and one needs very, very complex algorithms to handle this. Also to conserve spectrum, one needs a lot of smart modulation and voice coding, to really take down the bandwidth. Normally in those days when voice was converted to digital, it took 64 kilobits per user. We were able to take it down to eight kilobits, or at least close to that. That was a big factor to really take it on because spectrum is a very scarce resource. Then we had to do smart modulation where you didn't have to take so much of the spectrum. That was only kind of the start of it. Then the problem is that the radio media destroys the signal dramatically. If you send away a packet, or rather a bit, then it is really destroyed, because there is time dispersion on the radio channel. It is being blurred. If you send something like a microsecond or a 10 microsecond long bit, then it will be being propagated and delayed. You get echoes up to maybe 30, 40 microseconds. It's a big problem to handle that. That's not only it. It's also the fact that you move all the time. That also creates what is called frequency dispersion. You have both time dispersion and frequency dispersion. There was an early book by a guy called Jakes who wrote the bible for mobile communication. He more or less said that it's almost impossible to make this work because you have frequency and time dispersion. Somehow we had to solve it. We worked very hard with what are called equalizers. They were becoming very complicated but we didn't really stop because of that reason, because we knew that Moore's Law will solve a lot of that. Still, to design it, it was very complicated. We used what is called frequency hopping to take care of the frequency dispersion. Somehow after a lot of work we managed to—

Weber: Describe that, how that works.

Uddenfeldt: Yes. Frequency hopping means that one is changing the frequency 100 times per second or something like that. The problem is that when you have these reflections that you get, they create a standing wave pattern in the air. If you're standing still, you may very well be standing in a hole where there is no radio signal. Then, if you move a little bit, only a foot, then it gets very good again. When you draw it, you go through this thing. If you stand in a hole like this, then if you change the frequency to another frequency just very close by, it works fine. All these things you have to discover and learn how it works, and then you have to find the solutions to it. In those times universities didn't do very much. Radio was a forgotten area; it was somehow not very popular. I guess that was good for us, because we came from a small country, and we had to invent all of this stuff, and no one else really had done any inventions in this area. It was a very virgin area to do these things; very few universities were working on this stuff. It was great fun. We were learning a lot. We were the first ones to build what became a GSM system, and we had that, as I said, up and running in '85. It became a standard in early '87. That was a big political fight because already at that time Ericsson was the dominating infrastructure player. We had mobile phones. We even had pocket phones in those days, back in '86-'87. We were a very strong player. I think the European countries like France and Germany really wanted to take that over and have their own companies. They poured in a lot of money into their own companies and it became a big fight what technology to really use. There were a lot of proposals on the table, but what was finally selected was the technology that we had proposed—the TDMA technology, what was called a narrowband TDMA, a 200 kilohertz wide narrowband channel where one can have eight users simultaneously. We didn't want to have too many users, because if it was more like 30, 40 users per TDMA, then it would be very complicated with the equalizer. Also you need peak power, very high peak power, to really transmit, and in those days one couldn't afford those very high power transmitters.

Weber: Did you work at all at the ARPA funded research, like the packet radio, ALOHAnet?

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Uddenfeldt: Yes, we did. That was one of the first things. I had a great guy who was heading this research division when I joined. His name is [Sven?] Urich [ph?] and he was heading that and he had lots of good visions and great ideas. He was also the guy that was driving a lot of this vision to make digital cellular happen. One of the first things he gave to me was the packet radio, the ARPANET study for packet radio. That must've been like the late '70s. It was great when I saw the bus outside; and we talked about that when I was here. Actually then we had a lot of military in those days. We were doing these kind of packet [radios] for what is called combat radio, where you [have] the radio on your shoulders. Then. in order to get a good communication between units, we introduced the hopping radio, instead of having an [antenna] because that was more a distributed network.

Weber: Right, ad hoc [Latin: “for this”].

Uddenfeldt: Yes, an ad hoc network; that was really an ad hoc network. We were deploying these ad hoc networks for the military back in the early '80s.

Weber: That was your division doing that?

Uddenfeldt: That was also within Ericsson Radio. A lot of these good things like frequency hopping and CDMA [Code Division Multiple Access] and all these things actually came from the military. So it was good that we had this military unit in those days that were also working on advanced radio concepts.

Weber: Do you know if there was any—the NRDE is what? Norwegian Defense Research Establishment.

Uddenfeldt: Yes something like that.

Weber: They were one of the sites for the internetworking experiments with the packet radio.

Uddenfeldt: Oh yes?

Weber: It's too remote for these, yes.

Uddenfeldt: I don't recall who was talking with who then. I remember we implemented these things and read about it. I don't know to what extent it was duplicated. Anyway, I don't remember the Norwegian connection in those days.

Weber: Sure. And ALOHAnet, that was also ARPA funded.

Uddenfeldt: Yes.

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Weber: Did people—?

Uddenfeldt: I cannot recall that to any detail right now.

Weber: But definitely the packet radio research?

Uddenfeldt: Yes.

Weber: Let me ask you first, at the beginning were you thinking more of digital voice, digital data or both?

Uddenfeldt: I think we were thinking about both. But in reality data was a very small thing in those days and it wasn't very much bandwidth either. It wasn't the dominating thing. Although this company, Ericsson Radio, actually did do data trials before I joined the company. I joined in '78 but already in '72 there were some data trials, very early. You didn't really have the technology that you could do it with. There was a lot of thinking about data. We always talked about that. In reality in the digital cellular was really voice, and it was really Pan-European network GSM that was dominating. We had a different division [that was] thinking about data, and that was called Mobitex, which grew up in the U.S. This was also Bell Cellular; and also Cantel did a lot of things on that. That was really well implemented. Tthat was also the basis for what is today RIM [Research in Motion, Ltd.], which is the company doing these BlackBerrys. The early BlackBerrys were actually done by Ericsson in those days. We set up these Mobitex networks, for Bell Cellular and Cantel and later for AT&T. In the early networks, this was really built on the BlackBerrys that were done by Ericsson. Of course, they were specified by RIM. I don't take any credit from RIM by saying that. It was just that they didn't have the capability themselves really. We did the networks so it was important that we also set up the devices. In those days the data was a little bit outside the cellular. Cellular was so focused on voice. That did change in around '95. Then we introduced packet data in GSM.

Weber: Going back just to the roots, most of the ARPA work was on data, where packet voice was one subset of that.

Uddenfeldt: Yes.

Weber: You were coming from the opposite approach where voice—

Uddenfeldt: Yes exactly.

Weber: Did you look at the packet voice or was that—

Uddenfeldt: Yes, we were considering packet voice. We've always done that. I wouldn't say that we did do that.. If you go back to the early '80s and the mid-'80s, we were not. This was more coming in like a natural evolution of voice for the circuit switch. We did start to work very much on that around 1990, to

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really realize that in order to make this good for the future we should have also then—and the Internet was coming around about these days as well. We can come back to that later when we talk about 3G. In the 2G context we didn't really bring it up, no, and it came more in the 3G context.

Weber: Mobitex started when?

Uddenfeldt: The first systems for Mobitex were[started] around when GSM started. So GSM started in '91, and the Mobitex network started about the same day; '91. We were working on a lot of different things. We also introduced what is called the cordless phones in those days. In other words, we drove the standard for digital European cordless phones, DECT, which are still being used. If you go to a store here today in the U.S., that's what you buy. This is what we invented. That was a guy working for me. He did all the specs for that. That was about the same time. Late '80s, we really did all the specs for these DECT cordless phones. It was a really good digital system, as well, that we developed and specified.

Weber: You were selling the handsets as well for that of course?

Uddenfeldt: Yes. I think this is an important part of these early days of Ericsson. Later on I became the research head back in the '80s, and then I became the chief technology officer for the radio group and then for the whole Ericsson group, and that was from '89 up to 2003. That was almost 15 years. A lot of this time it was—especially in the early days—it was both the network and the devices. We were doing both of these things; both for GSM and for cordless phones and for the Mobitex stuff. That was very important. Then, of course, Ericsson had such a dominating market share in the network part, and we became very successful for the first generation systems in the U.S., and that generated a lot of revenues. Very soon we got 40% market share in the network business worldwide. Then when we went to GSM, we could expand on that and became even more. While on the phone side, even if we were successful, we were not really number one. Motorola was number one and Nokia was number two. We were number three. We had maybe 10, 15% market share but we were never a dominating player when it comes to the devices. Ericsson, [has] always been very close to the systems. That means that later on in my life when I continued being the CTO for Ericsson the phones were no longer there and it was only the network side. Now I have joined Sony Ericsson. I have been based now in the valley for three years. I came here with Ericsson,—oh, two years ago it is, and started to set up the IP [intellectual property] business. I've been living here, working in San Jose. I moved over and took over the chief technology officership for Sony Ericsson, and that is based in Redwood City. I will continue to drive these things from the valley.

Weber: We'll have [to] come back to that.

Uddenfeldt: Yes. I don't know why I came into that.

Weber: From handsets I believe.

Uddenfeldt: Yes, that was just to take that context, that I'm coming back to that now. I've been there before and now I'm coming back to it.

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Weber: For instance when your group did the DECT standard, this was in order for other people to adopt [it] as well.

Uddenfeldt: Absolutely. We have been very much standards driven, and that has been extremely successful. I must say I'm very happy about the fact that we did do that. Of course, we could have taken our proprietary technology and all of that, but then Ericsson would not have been where it is today. GSM was the most important thing, but we did that for the other things as well, to really open up and create great standards. I think GSM is today five billion users. We wouldn't have been even close to that if we had taken our own technology only.

Weber: Tell the story of GSM kind of from the beginning.

Uddenfeldt: Yes. Well, let's take it. At Ericsson we were looking at the technology from the early '80s, had our own first demonstrators in '85, where we really took this advanced TDMA concept, and we demonstrated that it worked and we had all the technology developed for it. Of course, there were other companies doing similar things, and there were other companies in France and Germany doing other technologies and trialing that. We had a big test in Paris in late '86 where all these technologies were tested against each other.

Weber: In what context?

Uddenfeldt: That was by the standardization organization, what was in those days called CEPT, which was French for “European Communication” or something. They were really the guys setting the standard. The idea was to compare these different technologies. The outcome from that was basically that this narrowband TDMA technology that we had been working with and that we had in our demonstrator was the one being selected. We had demonstrated something like 300 kilohertz TDMA with 10 timeslots, and then [it] was decided to have 200 kilohertz with eight timeslots. It was almost the same thing, and we could very easily do the first prototypes for the market as well. We did that already in '87, '88, and so we were very early to market them.

Weber: What were the advantages of your system over the competitor?

Uddenfeldt: Yes, there were some other proposals. Some of them were more narrowband, more like FDMA [Frequency-division Multiple Access] where you only have one user per radio frequency; which is not very cost-efficient because then you cannot share the cost when you're setting up towers and things like that. That's very costly. That was not good for anyone. There were more wideband proposals also where you could have 40 simultaneous, or maybe 25 simultaneous users, on the TDMA carrier. They were basically not good enough because it was too high peak power and too many problems to handle the time dispersion. There were also some early CDMA networks or trials, but they were really not mature at that time. They were not competitive. That was too early to introduce CDMA technology; which came later. In that context it was really too early. Then this was what was called the narrowband TDMA technology that really became the standard; including the equalizer and the frequency hopping stuff, and all these things before that was really necessary to have. It was extremely complex. People didn't believe in GSM at all because it was—like a company like Motorola, they basically said that this will never fly.

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They continued with the analog instead. They had to pay dearly for that because they had to give up their leadership on phones to Nokia. Nokia saw the opportunity. They saw what we had done and they really went for it as well. Many people were very hesitant. It was complicated to build and to understand, and we had to do very, very advanced things and simplifications in thinking in order to implement it, especially in the phone. It was not easy to implement these things. Today it's a piece of cake because Moore's Law is just making things easier every year. In those days it was extremely complex.

Weber: Describe some of the specific challenges.

Uddenfeldt: Yes. To implement an equalizer, for instance, you couldn't do that with any of the signal processors that were around. To do it with straightforward implementation of the algorithms, it couldn't be done in a small hand portable phone. It needed a car phone. We had some smart people inventing some really smart algorithms so one can get around this, and replacing all the multiplications with just simple additions and table lookups. That solved it, that really solved it. Then it became low power and good battery life. There were really some very smart algorithms behind this, to solve it, in the early days.

Weber: To be able to use simpler circuitry and lower power—

Uddenfeldt: Yes, car phones: there was no idea to introduce a car phone in a Pan-European network, because car phones already existed. What's the good of that? What you wanted was to have a pocket phone that you could carry around when you were traveling. That was the market we saw going for GSM, and we had to make that happen.

Weber: For voice, what was the primary advantages you saw for using digital as opposed to analog?

Uddenfeldt: Yes. I think one can say that it was lower cost; no question about that, when it comes to the infrastructure part. Of course, the fact that we could do data; that we could transmit data, and we should have that implemented. People didn't take so much notice [of] the data, but for us it was important that we could do that. Then on the other side we had to realize that this was a Pan-European network also. It was a big, big market for it. In those days, we didn't think that it could be. Then a few years later, China was the biggest GSM market. When we worked with this in the mid-'80s, China was [a] completely closed country so it was out of the question. Then China opened their borders like in '93, '94 and then it started to boom there and GSM grew dramatically in China and many, many parts of the world. In [the] U.S. it was a little bit different. In the U.S. and Japan people wanted to have their own standards so GSM was not accepted. I'm talking about late '80s now. In the U.S. there was this discussion [of] what technology to have and so since Ericsson was a big player in U.S., we had what was called AMPS [systems which was the analog system in those days in the U.S. and other parts of the world. Then we had another kind of TDMA system which was only 30 kilohertz wide and that fitted more into AMPS because AMPS was also 30 kilohertz. We could put three users into that and that was of course a cost saving in itself. It also increased the capacity of the network that we could then basically threefold the capacity of the network. That became the standard in the U.S. back in '88, '89. We had a big fight there also with other people like Motorola and Lucent and proposing FDMA technology but they had to give it up. This TDMA technology became—to our surprise, we were able to set the standard in the U.S. back in '89 which was really an achievement. That was then later deployed by AT&T and lots of other companies, so that was really good.

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Weber: There were three users whereas GSM was—

Uddenfeldt: Eight users, but that was a wider channel though.

Weber: Yes.

Uddenfeldt: Then Japan had decided that they're going to use more or less the same standard as [the] U.S. and that was funny because then they had to rewrite their plans because they didn't think that TDMA was going to win in U.S. That also brought us into Japan. We set up the first Japanese systems for the digital cellular back in '93, '94. Then at that time the U.S. was up and running with the TDMA system. We had three different digital cellular systems we were developing at the same time.

Weber: Why was the Japanese one different then?

Uddenfeldt: They wanted to have their own standard. It was like the U.S., the U.S. wanted to have their own standard.

Weber: Did they have existing things there; they were trying to be backward compatible?

Uddenfeldt: Oh, yes. Japan had first-generation analog systems, as well, and they actually started very early, so they were one of the advanced countries.

Weber: They were trying for backward compatibility in some way?

Uddenfeldt: Yes, I guess you can say that. They were kind of a little bit like that, yes. In those days a lot of the drive in the '80s really came from the U.S.. The U.S. was a leading country and Europe was very fragmented. It all changed when GSM came; then it shifted around 180 degrees and then Europe became the leading market. It really meant that these five billion users eventually came on this European system. That was not the case in the late '80s; then it was U.S. that was dominating the picture. It's interesting to see how fast that switched with going over to the digital GSM. It was very complex when they introduced it but then a few years later it wasn't that complicated to implement any longer because Moore’s Law is helping us very much all the time.

Weber: Describe a bit the process of it being adopted as a standard in the late '80s.

Uddenfeldt: Yes, to be adopted as a standard, [there] are always competing alternatives. In Europe, there was a big fight there on what technology to have. France and Germany were not so happy that their technology was not being chosen. We had to have a lot of discussions with people at the ministry level and make evaluations of technology. We were sitting in a big room with those people and they were asking questions and they had both camps there and it was a room with 30, 40 people. It was very firm questions and answers and then they took time to make the decisions. In Germany it was all in German

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so it was tricky for me but they were polite enough to let me talk in English which was good. I understood German but I couldn't really express myself in German, it's a complicated language. Then that turned out very well so we managed that. Then it was only France left and they had to basically give up at the end.

Weber: Were you demonstrating a working system at that point?

Uddenfeldt: Yes, it was built on what I call this Paris tracks [ph?] at the end of '86, so they were kind of the determining factor. Then it was an intellectual debate on how to show things. In the U.S. it was different. We set up a demonstration where we had a van in LA. We invited customers to come there and then the other companies did [it a] similar way. That was, as you say, seeing and believing in life and then customers made some judgments based on that. There was a big, ballroom debate where you can talk and say something good and then the other party could say something—some guy asking and all the people sitting in that big ballroom. It's after that that we voted.

Weber: What sort of event would that happen at?

Uddenfeldt: There were already the standardization organizations. When it came to the U.S. it was called TIA and I was on the CTIA organization that was the operator organization. They were kind of participating in this TIA and they were casting their votes. The votes were actually in this TIA. But CTIA has a lot of influence on these decisions. In Europe there was another organization called ETSI which was European Telecommunication Standardization Institute and they were making the decisions. They were mainly operator-centric.

Weber: So there would be lobbying, obviously, before this and then…

Uddenfeldt: Yes, lobbying and big standardization meetings where everyone is participating and giving input papers and giving arguments and proofs. That is still the same thing. A lot of these for 3G and for 4G [have] so many more people than there were in those days. The principle is the same; you have meetings every month and you have a lot of papers and discussions around these matters.

Weber: This was a significant part of the task, obviously.

Uddenfeldt: Yes, of course. It's a good process to have a deciding body to really make the decisions otherwise everyone can do their own decisions and that doesn't help very much. It's tedious, yes. But you have to be clever, also. You have to be better than the competition; you have to prove your case. It's not the lottery, it is really built on skills. It's very skillful people who are there and they can judge things and it's a working method. Of course, when it's growing out of proportion it could be difficult to manage it. Even on 4G, which is now coming out on this LTE standard, it has been really good work in these committees, I must say. Although, it takes time. On the other hand, if you look at the economics you don't need a completely new technology every year. In fact, history has shown very clearly now that it is basically every tenth year. If we look at the first-generation analog system, it was the early '80s. In the Nordic countries, it was '81, Japan about the same time, '81, U.S., '83, '84 and then other countries later. Digital, which was the second generation; the first implementation came in '91 of GSM. Then it came a little bit later in U.S.

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and Japan; '93, '94. These 10-year cycles are repeating themselves into 3G; the first implementation of 3G was in Japan in 2001 and then in Europe in 2003. Then comes LTE now in 2010. The first network was actually eight months ago; it was just this year, but that was a very small system in Stockholm implemented by Telia. It will come this year in like Verizon and DoCoMo [NTT DoCoMo, Inc.] will come this year and there will be other networks next year. This 10-year cycle is more determined from economics than from technology. From [a] technology point of view, [we] could do it faster but then it would be smaller jumps and then they might not be motivated to build a completely new system. It's very costly to set up completely new systems especially if it's five billion users out there covering the whole globe. It costs a lot of money to do it. You cannot afford to just make it in very small steps; you like to do a little bit bigger step.

Weber: What is the lead time before? In other words, when, say, 3G started in the laboratory it was how many years before—?

Uddenfeldt: Yes, there is a lead time there. For GSM the first test system we had like in '85 to prove it and then the system was on the market like '91. For 3G, [it was] very similar; we had our first test system proving what became the standard—the wideband CDMA technology—we had it in our lab in '94, '95. It was standardized in '97, '98, and came to the market in 2001. There are a few years there.

Weber: Also, the analog cellular started mid-'70s.

Uddenfeldt: Yes, the analog was a simpler technology to deploy. You're absolutely right; there were early test systems—especially in the U.S.—that started in '79, and then it came to the market. in the U.S. in '83, '84. The U.S. were really ahead when it comes to trialing the first-generation system but then it took a long time to decide on how to set it up and who was going to be allowed to set up the networks so there was a delay.

Weber: You mentioned briefly your dealings with DoCoMo in the late '80s, so that was a very important…

Uddenfeldt: Yes, I think DoCoMo has been a really interesting thing. We have worked very close with DoCoMo on some of the early technologies. When we started to talk about 3G, we came into a very close cooperation with DoCoMo because the discussion in Japan was that they did not want to have another proprietor of Japanese technology. They had that for first-generation and for second-generation. Now going to 3G, they didn't want to have that. That meant that that was really good to work with them; they're a very advanced company, very skillful people. We were able to develop the 3G technology together between Europe and Japan in a very good way. We set up the early trial systems in our lab back in '94 for 3G and then DoCoMo was doing similar trials. Then we actually shipped our equipment to DoCoMo so they could try it out as well. Based on that, we formulated the standard for 3G; to build it on what we call 5 megahertz wide channels where we can have what you call your wideband CDMA technology. That was very powerful because one can have lots of users on that channel then; maybe 50 or even 100 voice calls. Of course, then data was more important than voice. We didn't talk so much about voice; it was much more about data for 3G. When we started to think about how to define it in '93, '94, '95, then the Internet was coming and that made it very natural to make a real packet-based system out of it. We wanted to have a strong packet radio offering. We had already done that in GSM. In that timeframe around '95, we introduced what is called GPRS in the GSM network, but that was very narrowband. It was only 10 kilobits

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or maybe 40 kilobits at best. Here we targeted to be at least 10 times better and the real spec we had was that it should be 10 times faster. The first 3G specifications we targeted for 400 kilobits but then we were thinking about taking it up beyond 2 megabits per second. We even achieved 10 megabits. In 2005 we had 10 megabits in the HSPA networks. [With] 3G, we started early and we discovered that data has to be the primary mode. Then when we first introduced it, we had 400 kilobits, but that wasn't really enough because when you're using your laptop, the applications are not written that way; it has to be higher.

Weber: Was that a primary use, for tethering laptops?

Uddenfeldt: I don't know. I think we had both things in mind. Of course, the primary target we had was to have advanced phones. That was the primary idea we had for this. If we now jump into the situation when this was introduced then we talk about years like 2003. Then it became obvious that there were laptops that you could carry around. It has to work with that plus you have to be able to put into some kind of [?] or card into the laptop and be able to use it in this wireless network. To really have a mobile broadband network for Internet access, it should be accessible both for laptops and for phones. We were thinking about both applications but the truth is that it didn't really fly with 400 kilobits per second. Then we introduced just a few years later—like 2004, 2005—we introduced what is called the HSPA technology which is a version of this 3G which is just simplifying a little bit. That took us immediately up to 4 megabits per second and later up to 10 megabits per second. Then it started to grow dramatically. Now we have seen a growth rate in the 3G networks [at] about more than 200 percent in traffic growth and that has been going on for the last three years. It is growing dramatically. There are 500 million people using 3G networks for data access. It is fantastic the way it's growing.

Weber: Under pure GSM, how many people used data, used GPRS?

Uddenfeldt: Yes, do I remember that?

Weber: It was not a big percentage, is that correct?

Uddenfeldt: No, it didn't really become a success; it wasn't good enough. GPRS was built into all the devices, so the question is more how many people did actually use it. If I say 50 million then I don't know. It wasn't more than that.

Weber: You had hoped that that would take off more like today?

Uddenfeldt: Yes, that's a good question. GPRS, I personally did not believe [would take off] because that was too narrowband. Personally, I didn't realize that we had to go up to like 4 or 10 megabits per second because we were coming from this world where you could do compression. It's so simple to do compression on PowerPoint or whatever, technically it's very simple but no one cares about doing it. Then that kind of application is just killing the network. We were hoping that there were some people—we were trying to work with some people that were going to do this compression, but no one cared about doing it. The Internet world was having their own life and mobile people had their own life. When 3G came, then

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we met in the marketplace. We're talking about 2005. Before that, people in the mobile world and the Internet world didn't really know each other. Then came the iPhone in 2007 and all of a sudden it was just dramatically obvious that this was one world going forward. I don't think that anyone in the Internet world or in the application world would have listened to the mobile people. They all came from Europe anyway and the Internet people are all based—not all but very much— here in the valley. That was one of the reasons why I also moved here; to realize that we have to build this bridge between the mobile world and the Internet world. That is happening now, big time, but that wasn't the case if you go back only three or four years.

Weber: Could [you] recap what the intended uses [were] for mobile data from the beginning? When you're first thinking of things that led to GSM, obviously that was before most people were doing computer networking in their daily lives. Then it radically changed. Why have data in the late '80s; what would it be used for?

Uddenfeldt: People were using data in some way; they were hooking up to things like AOL—these things did exist.

Weber: But you could do that over an analog…

Uddenfeldt: Let's look at the history of data speeds now with the mobile networks. With analog it was 1 kilobit per second. With GSM in the first instance it was 10 kilobits per second. Then we improved it and took some what was called the EDGE technology and we got it to 100 kilobits per second. Then 3G came and we were able to, by 2005, take it up to 10 megabits per second. Now we have 4G, which means we are actually running 100 megabits per second in the LTE networks that are up and running commercially in Europe and now is coming here as well as in Japan. We have gone from 1 kilobit per second to 100 megabits per second. In the last 15 years, the data rate has been growing 10,000 times. That, I think, is a real achievement. We've done that all the time and we have to think about having a technology that is spectrum efficient, power efficient. It's just not a matter of taking anything. It must meet to specifications [so] that you can have spectrum constraints and power constraints and cost constraints coming into a small device. We are talking about going from 1 kilobits per second to 100 megabits per second which is basically [a] 10 to [the] 5 increase in speed. You couldn't do it on analog.

Weber: In the early days when you were making internal pitches to people to support, what would you list as the use or the importance of mobile technology?

Uddenfeldt: Yes, we talked about the things that one could use [for], for your personal benefits and you can access things and get data transmitted. We talked about facts, which was kind of ridiculous because you cannot get the facts—look at them, anyway. The screens were not that great. Also a company [could use it for] running their data transmission to the people working for the company so they can get email. Email was coming around in those days. But, of course, it was really too early to do that. It was more like we had ideas. Always when we really talked about them, it was not obvious that they were going to fly.

Weber: So, for instance, pagers already worked in an analog way, having the pager Mobitex was for more than simply messaging. Vertical apps, were those something you were…

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Uddenfeldt: Yes, that's what I meant, big companies running their network.

Weber: For instance, the UPS DIAD [United Postal Service Delivery Information Acquisition Device].

Uddenfeldt: Yes. All of these systems were up—what we had done there was to introduce [them] earlier than we had [introduced] GSM. We had data networks for—that was really where Mobitex came from as well; from the vertical applications like taxes [ph?] and [?]. We had [these systems] in that other division back in the early '90s and late '80s.

Weber: Which division was that?

Uddenfeldt: It was all in Ericsson Radio, but we had different divisions. One was for cellular systems and another one was more for these vertical systems. That came from a long history because it started with things like police radio and taxi radio. Police radios were in the '40s but that was only voice. We introduced a taxi radio which was fully automatic based on only data. That was up and running in 1981. That was 10 years before GSM came and that was data only. But that was a private network. We kept that little bit outside the cellular networks because it was more for enterprises to actually deploy them. That was there before we got the cellular system. It wasn't really until we put things like GPRS into the cellular systems—and we had 3G coming then—this more or less went away. Nextel is a little bit of that. They have that kind of origin also. There are things that do exist but [are] very small scale today. Private companies and enterprises, they use the cellular systems instead so that [is] going away. If you talk about the early '90s, that was still an important business in itself.

Weber: The military part of Ericsson Radio also was another inspiration.

Uddenfeldt: Yes and that became very small, compared to this cellular. Cellular really outgrew everything else, so we moved that over to the military side within Ericcson and that was later sold to another company.

Weber: For the history of Mobitex, anything more to say, just to give a thumbnail [sketch]?

Uddenfeldt: I think we covered some things about that already. It started in Sweden and then it grew in the US and Canada and it was a very important part. RIM was completely concentrating on that and they were almost coming a little bit late to understand that they should do things like GPRS. This was for them a little bit [of a] proprietary system. That was a good business while it lasted, but it never really became a big thing. It didn't take over the world in any big, big way so we felt that we had to move away from that and put the packet radio into GSM and of course into 3G.

Weber: There were several handhelds of different kinds—I'm thinking the Palm 7—there were add-ons for a bunch of handhelds to use Mobitex or other kind of early data networks.

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Uddenfeldt: Yes, maybe there were. I didn't follow that so well and I guess you're right, there were some hybrid products, is that what you said?

Weber: Yes.

Uddenfeldt: I don't recall that.

Weber: And like the Palm, right. Some were as an access—but you didn't see at a major market..

Uddenfeldt: No, we didn't. No, we thought, that's not going to fly. We realized, "We better put it into the mainstream and make that happen." Maybe I didn't follow that too closely, what you just mentioned, because I cannot recall that right now.

Weber: For the history of 3G, we covered a little bit at the beginning. You were working on it starting—?

Uddenfeldt: We started 3G work, I would say, around 1990. Before, GSM was really out there. We started on the next generation. That was even a little bit before that but that's really when we started to consider things more on a conceptual basis and understood the importance of having something that comes after GSM. Then around '93, we had started to work much more on it. We made these demonstrations and then we compared different technologies and then we understood that this CDMA technology was a pretty good thing for data. It didn't bring anything for voice, but for data we thought it did. We wanted to have as wide a channel as we could because then you can get high-speed data in there. The version of CDMA that was deployed in the US was not really wideband. It was more voice communication oriented and didn't give the high-speed data rate that we were going for. Even though the first implementation was only 400 kilobits, we were targeting multiple megabits per second. That was kind of the drive and of course [the] Internet coming out there, as well. We didn't really understand exactly what kind of speed was needed, but we realized, "We need a new generation and let's make it wideband." We have learned that [it is] best to take a big step rather than to take a small step To go for dramatically more than 5 is complicated because you need to have spectrum allocation. At about the same time, there in '91, there was a spectrum conference. There was new spectrum allocated. This was a 2 GHz band that later was where all the European and Japanese 3G deployments were. The rest of the world, except the US, were really deploying in that band. That was a really good thing that spectrum came available at that time. That also meant that we started to work much more with—

Weber: Why did it become available right then?

Uddenfeldt: There was a spectrum conference in those days and they didn't have these kind of spectrum allocation conferences very often. It's only like every tenth year—I don't remember. It was important that that spectrum was allocated because without it we couldn't really have gone for 3G. It was worldwide except in the US but it was good. Then we went for this 5 MHz technology. We compared a little bit with different technologies like OFDM [Orthogonal Frequency-division Multiplexing] technology and CDMA technology but wideband CDMA was really what we decided to go for. DoCoMo had the same choice. Therefore, we started to work very close together and that then meant that we had

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demonstrations. But it was only us and DoCoMo more or less. We also said that we wanted it to be based on GSM, so therefore we could use some of the basic things that we have developed for GSM in the co-network. Not for the radio part, but we could use some of the packet radio things that we had for GPRS. We can reuse things from the network. It really was going to be a European standard.

Weber: Wait for the helicopter. [Helicopter passing overhead.]

Uddenfeldt: Yes.

Weber: We are so close to Moffet that there is a lot of—

Uddenfeldt: Yes.

Weber: Okay.

Uddenfeldt: We really wanted to build 3G with backwards compatibility to some extent to GSM. Of course we didn't; it was not a matter of having the radio technology but more in the core network. We can re-use some of the packet switching technology and also some of the circuit switching technology in the network.

Weber: Including specific pieces of equipment that you could—

Uddenfeldt: Yes, maybe equipment, but I think more or less than one could gradually upgrade.It was very important to have them be dual mode devices, so they could handle both the GSM and the 3G. It was good to have some commonalities in their protocols. The Japanese, they really accepted that as well. That was interesting in itself, because we had this discussion in Japan—and this must have been like ’95-’96—and they said that they would like to have an international standard. It was decided not to have a proprietary [standard] by the government and the ministry in Japan, that they wouldn’t allow another proprietary Japanese standard. They wanted to have an international standard, and the only thing that they could really take that was even conceivable to have our and the US’s CDMA standard, because that existed. As we didn’t want to have that, we were really then promoting this heavily to build upon the GSM and to do this wideband CDMA. We really helped that to happen then, because the ministry was very surprised about that, that that could happen. The truth was that in ’95-’96, it wasn’t the standard, so we had to just tell the ministry that we were going to develop the standard for it. In Europe, there were mixed feelings about this: to have a standard together with the Japanese. In Japan, it was a great thing that they wanted. Now all the companies doing phones the enter the market. Europe was a little bit afraid of this. We thought that that was really important because if there was another standard in Japan, that could influence not only Japan, but also China and then the CDMA 2000 would really grow very much. We pushed very hard in Europe and we managed to get Nokia on board, so they were following us. From then on, we had to drive it together with Nokia. Basically, the two of us were against the rest of the industry.

Weber: But you also had DoCoMo.

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Uddenfeldt: Yes, then we had DoCoMo, but they were Japanese. We had to convince the Europeans, right? All the other companies, like Siemens and Alcatel and all of these companies, were really against it. They invented some of their own versions to propose. They got also some other companies to support them, because they felt that Ericsson and Nokia should not drive it <laughs> and there wasn't room for anyone else. They got Motorola on board and they got other companies on board, like Nortel. We had to fight them all, but that we succeeded very well with that, to really get the vote in. [We] called [European Telecommunications Standards Institute], this got them committed and so we got the vote in our favor.

Weber: When and where?

Uddenfeldt: This was early '98. That was really when the decision for 3G technology was done.

Weber: Where did that take place?

Uddenfeldt: That was in Paris. It was one of these ETSI meetings in Paris. I didn't go to ETSI meetings in those times. I did that in the early '80s or mid '80s, but now I was chief technology officer so I didn't go to these meetings. But I went to that [one] and we had some meetings with some other high level people from the other companies as well. It was all settled in that meeting.

Weber: When did you become CTO of the whole group?

Uddenfeldt: I became CTO in '97. That was CTO for the Ericsson group. Before that I was CTO for the Radio group, which was basically almost the same thing. In '97, the Radio group was maybe 70 – 80% of Ericsson.

Weber: Wow.

Uddenfeldt: Yes, it has grown from 2% to 80%.

Weber: The business of selling switches and those sorts of things is still much smaller than the mobile?

Uddenfeldt: Yes, and most of the transition of the switches for mobile networks, was a big business, and continued to be so. For the fixed networks, it was more or less done, by that time. The transition started in the '80s and then it was over in the mid or late '90s. That didn't grow anymore, so to speak. The cellular had a tremendous growth. During all of the '90s, we were still growing and doubling the revenue every second year. It just went on like that. It wasn't until 2001 when the whole IT bubble crashed and then it stopped. Until then, it just went up. It was continuing to be extremely good.

Weber: Once 3G was accepted, what happened next?

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Uddenfeldt: We had some other complications. Then, it was really a standard and it was not only the ETIE, but also the Japanese standard. Then, what is called 3GPP [Third Generation Partnership Project] formed, which is a worldwide standardization organization with the US being part of it. It was all confirmed, but then Qualcomm came around and they said that they had some IPR [Intellectual Property Rights] problems with this. They said that they didn't want to license their patents to this new standard. They, I think, had been sleeping all this time, when the standard was set. Then, the fact of the matter was that at Ericsson, we had patents that Qualcomm was infringing on. We had some very basic patents that were relevant for the Qualcomm CDMA technology that was also already deployed in the US. It became a big IPR fight. We said, "We are not going to license our patents for the Qualcomm CDMA technology." It was standing against each other. But we started to talk to each other and I think Qualcomm realized that there would be a market for wideband CDMA. Ericsson also didn't have any products for CDMA and Verizon and other companies were building CDMA networks, so we were out of that market. It wasn't the dominating market, but there was a market. We struck a deal in '99, between the companies, where we cross-licensed the IPRs. We also made them so they were publicly available. We didn't stop any patents for CDMA 2000 nor did Qualcomm stop any patents for the WCDMA [Wideband Code Division Multiple Access]. So it was peace. We also bought the Qualcomm infrastructure division, that was building CDMA base stations. That was done in year '99; it became an Ericsson business instead. We took that over, so to speak. Since then, Qualcomm has been promoting WCDMA, very much, all the time. We haven't had any problems to offer them, accommodate CDMA 2000 in our portfolio. After the decision of 3G in Paris, in 1998, then it was about a year later that we struck this deal with Qualcomm. I remember going to Japan there—they had arranged a big seminar in Tokyo where they had Ericsson and Qualcomm on the stage, and we were going to be confronted and fight each other. This was just a month after we had struck the deal. <laughs> So we were just great friends; <laughs> it was kind of funny. 3G then was accepted by everyone, and it started to be deployed all over the place; starting with Japan and then these European networks. Then, AT&T and everyone else [deployed] as well, so it became really worldwide, very well deployed. Again, it didn't take off in the first couple of years. So it was deployed in by DoCoMo in Japan in 2001, and then the first systems in Europe started March 3, 2003—3/3/3. By this company called Three. Right? <laughs> Yes, they had networks in many countries. They started the service, and then everyone else caught on; like Vodafone and Orange and Telefonica..

Weber: Right before that, there were also a number of companies buying up spectrum, right?

Uddenfeldt: Oh yes. <Laughs>

Weber: There was a kind of run on..

Uddenfeldt: Oh yes, you are so right about that and that's very important chapter in this history. In order to deploy 3G you have to have spectrum and luckily enough 8 or 9 years before, the WWRC—which is World Wide Radio Committee—allocated spectrum. In year 2000 there was going to be an auction, of selling the spectrum to whoever wanted it. Europe has learned now that it is good thing to sell spectrum. The US had done that for many years. This was before the bubble burst, so this was in those days where money was something strange and the value of money wasn't understood. I don't know how to put it. They were overpaying, dramatically. I cannot recall the values right now, but they are well documented and they were much too high. Of course, that didn't help when the bubble crashed. First it was only the IT business that was affected by the crash, but then people realized that this mobile business is not good either. Now

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they have to pay more money to get the networks up and running. That delayed it a little bit, I would say, maybe 2 or 3 years.

Weber: Yes, that was my understanding.

Uddenfeldt: There were bad times anyway and we didn't stop any of the development. Somehow, we always saw that when you have new technology you have to fine-tune it anyway. From that perspective we got some extra time to do that. Then everyone started to deploy the 3G networks. It wasn't until we have upgraded them to HSPA which was around 2005-2006. Actually, I think the first one that did this update was AT&T. They were the first one deploying HSPA. That took it up to like 4 megabits first and then to 10 megabits per second. Now we have even higher data rates that we can achieve with this technology. Even 3G doesn't stop with 10 Mbps, it can do even more. Then it really took off when we introduced HSPA technology. Since then it has been growing dramatically. [There are] more than 500 million users now and the gross is 200% per year. My phone. <music ringtone plays> Okay, something is wrong with this. Hmm. It's an alarm. There we go. It's the alarm.

Weber: This makes me feel better. If you have this problem, I won't feel bad.

Uddenfeldt: Yes, I put it on the alarm somehow, which wasn't very clever. <Laughs>. Maybe I should make sure it doesn't happen again.

Weber: No, I won't.

Uddenfeldt: Let's get rid of this thing here. There we go. Sorry about that. Where were we now?

Weber: Whether 3G can go up to—what did you say—10 Mbps.

Uddenfeldt: Yes, I talked about 10 Mbps, correct.

Weber: But then, with the—not LT, the—

Uddenfeldt: Yes, we have some further improvements over the 3G technology so we can go even beyond 10 Mbps. But, there is a limit to what we can do with 3G. The 4G technology is now capable of doing 100 Mbps. The LTE technology and [4G] is now coming to the market, so there will be a little bit of a gradual transition phase from 3G to 4G. But 4G is happening because it is a new technology and it's more bandwidth; it's 20 MHz instead of 5 MHz. In [the] US it's 10 MHz. Two times 10 MHz. For a company like Verizon, it is giving ten times more data than they can achieve today. It is a dramatic step that is really being introduced by the 4G technology.

Weber: That was approved when?

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Uddenfeldt: The 4G technology was approved about three years ago, 2006. Then specs were done and that was another of these big political struggles to get it. This time, it was a little bit different with 4G, because everyone agreed; Qualcomm, DoCoMo, Europe, Ericsson, we all had the same view. Except there was this WiMax scene coming up then. WiMax was driven by Intel. Intel didn't tell the history in this business, so they couldn't take the technology all the way; they didn't really understand that you need to build a network around it, you have to have ecosystem, and you have to have buy in from a lot of operators to really deploy it. It's not just a matter of putting it into the laptops, you have to do much much more; you have to build networks as well. Of course, the commitment from the operators, or the carriers, have been to do LTE technology. It's healthy to have this kind of competition, as well; to have people coming with different technologies to the table and sort it out. It did become much less political. People feel that, now we are into one technology, into the future. We don't have to have these fights. If you look at this evolution now—go back to before GSM, everyone had their own standard. Then Europe got their standard together. The US, Japan, did not want to align with that. But they did have to deploy GSM later on, anyway, because that was such good technology. Then we come to 3G. First Europe and Japan made a deal, and then the US joined in, with Qualcomm joining in. Then, we got it there, but still we had different technologies because we had the wideband CDMA and we had the CDMA 2000. There were still different technologies on the table. Now with LTE, everyone joined in here. It's really healthy for the industry that we don't have to—there are so many other things we have to worry about. We have to get the applications, we have to get the software right. There are so many things that are now becoming much more important and not only the technology of the air interface itself.

Weber: You feel that the telecom and computer industries are cooperating more closely than they did?

Uddenfeldt: Yes, people now have realized that it's extremely important to have the right cost level. The right cost level you best achieve by having a global technology, then that really takes prices down. We have seen the telecommunication business —which is now more than 30 years—prices have come down dramatically with bandwidth going up. The bandwidth has gone up 100,000 times in those years. From 1 kb to 100 Mb; that is 100,000 times. Prices have not gone down 100,000 times, but it has gone down. Still, the fantastic growths of the data are there. It is a different ball game today, than what it was before. No question about that.

Weber: Good. Can I ask you to step back to one particular thread. More at the user interface level, you had some involvement with phones that were touch-based, and also with Symbian. How did you get into the Symbian Alliance?

Uddenfeldt: Yes, we can talk about that. That is a great thing.

Weber: How much time do we have? We have 57 minutes.

Uddenfeldt: Yes, let's talk about Symbian and the early touch phones. This was something that was very much driven out of our mobile phone division with Nils Rydbeck being the head of that. He felt that there has to be a better device than just a normal phone that you just use for voice calls. The vision was to have a combined data and voice device. We're talking about '98 now. Then the technology became more obvious. We had things like the Palm Pilot, in those days. But the Palm Pilot was only something you scribble on and then you put it into your pocket. You didn't use it as your only device, your only phone.

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The idea was to have "my only phone." It was a device that is exactly like we have today. Most people like Android or iPhones. You use it both for voice calls and for all your Internet access and for all of your emailing and everything. That was the whole idea. Then we realized they had to be touch-based phones. That makes it so much easier for the user to handle. Instead of folding out the keyboard and writing on it. BlackBerry's proven that you could do it differently as well. But that was the approach we took. It has to be touch-based. Then we had the pen because Palm Pilots had a pen.

Weber: There was an Ericsson—I mean you did do a communicator similar to the Nokia..

Uddenfeldt: We did do that, but that was not the main strategy. The main strategy was clearly to do touch-based phones. We came out with what we call an R380, which was '99 or 2000. I think it was '99, we released that. That was actually the first Symbian product that was not only the first Ericsson Symbian product, but it was the first Symbian product.

Weber: Not just touch-based.

Uddenfeldt: It was the first touch-based phone.

Weber: First touch-based Symbian.

Uddenfeldt: First touch-based, first Symbian, yes.

Weber: Oh, and first Symbian of any kind?

Uddenfeldt: Yes, exactly. It was the first Symbian of any kind. That is the interesting thing; we went into the Symbian Corporation, and that was based on this idea from discussion. We were all considering using Microsoft, but they wanted a lot of money, and they didn't really understand the business either. So we managed, and that was a lot. Nils, who did that, managed to get a good discussion with both Nokia and with Motorola. That led to setting up—you've seen the Psion technology to set up the Symbian. We had different visions of exactly what to use it for, but it was a good thing to making things go forward. We all bought into that and we started it. Ericsson wanted to do touch-based phones, within Symbian. Nokia did not want to do any touch-based phones. They wanted to have keyboard stuff. So we were a little bit divided there. That was a little bit unfortunate because it would have been good if Nokia would have taken the touch-based phones because today, it has proven to be the leading choice. Although, of course, now it is without the pen. It is a different thing, and I think Apple did a good thing. They did multiple things we didn't do. These touch-based phones were very popular in Europe and in China. China loved it because they can write the Chinese characters; just scribble a little bit and you get four alternatives. You pick one and you're done. You cannot do that with a keyboard, you need this special kind of keyboard to do that. You couldn't really implement it, so that was very popular. Anyway, Nokia did not adopt those things, but we had R380, P800, P900 and all of these devices that are really the first smartphones of the world using touch-based technology. They were combined data device and voice, so they were very good examples of what one can do with new technology. Then Apple did their own version of that without the pen and with a lot of other things that they introduced as well. They made it much nicer for the end user and the apps

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store and so I think they took it to another level. But the early pioneering part of that work was actually done by Ericsson and that was interesting.

Weber: So the pen base came from within Ericsson; you asked Symbian to basically do a version of the operating system to support that?

Uddenfeldt: That is correct, yes. The idea came from Ericsson, but it was implemented within the Symbian, yes.

Weber: Was Charles Davis the name or David Potter?

Uddenfeldt: It was David Potter, I don't remember all the other names.

Weber: Describe Ericsson's role in setting up, because you were involved in the beginning with setting up...

Uddenfeldt: Yes, Ericsson was involved from the very beginning and the main person with that was really Nils Rydbeck. He was doing these and negotiations but it was very clear that all three companies—Nokia, Motorola, Ericsson—all understood that we need to do something. We cannot just rely on Microsoft to solve this because that would not really be good enough and will not really happen. There were going to be all these licensing discussions anyway. So we really needed something.

Weber: At that point Palm was not yet—?

Uddenfeldt: No, Palm was not—they were only doing it like a calendar and they didn't do a device that was wireless at that time. Of course, they were probably thinking about it. Coming back to this, seeing about geographical situation again, there wasn't so much momentum in the US really. Europe was leading the mobile phone business; Nokia was the leader, Motorola was second at that time and then Sony-Ericsson— Ericsson it was at that time—was number three. It was kind of natural for them to have European—but I don't remember why Palm was not part of it. I guess they had some other ambitions.

Weber: Yes, it was a little early for their phone stuff.

Uddenfeldt: Yes, could be.

Weber: Anything else in general, you want to—?

Uddenfeldt: Yes, let's see, what have we talked about now?

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Weber: Then I have some other specific questions, but..

Uddenfeldt: Yes. We have covered a lot of things. As to this road map, when it comes to the evolution of cellular, when it comes to data rates, it's good to memorize. Now we're up to 100 Mbps, but it's only 15 years ago that we talked about 10 kbps. This has been a breakthrough and I think this is even faster than what you can do in Moore's Law. It is a very, very fast development and it's not the end of it. We demonstrated 1 Gbps in Barcelona this year.. It will continue if spectrum allocations can be done. It's really good to hear now that we have a lot of support for finding new spectrum. LTE of course will help a lot. LTE is more efficient and it has new frequency bands. With all the growth of data we have to find new spectrum to new frequency bands; to be able to deploy all of this need that people really have for communication.

Weber: Good. Well, thank you.

Uddenfeldt: Thank you. Thank you very much. Great.

Weber: Then for the exit theater—think in terms of, "This is short sound bytes, for an ordinary person." What are you working on now, and why are you excited about it?

Uddenfeldt: Yes, it's so fantastic. We live in this world where mobile broadband is really all over the place and is growing so dramatically. Now we are introducing a new technology, the 4G technology, and that will give even more data rates. What does that mean? It means that we get things like 3D video and all of these things can be done with very good picture quality. We can get it to a mobile device—being it a smartphone or being it a pad, tablet device, or being it a laptop—we can make this happen now. We get perfect picture and 3D. These are things that are really going to happen the next couple of years. It's extremely exciting to see these things. That will be for games—we will see 3D games. You don't necessarily have to have glasses, one can do this without glasses. That, I think, is important to realize.

Weber: Okay. 3D.

Uddenfeldt: 3D in 4G. So that's a good one. 3D in 4G.

Weber: I'll ask that as a separate one. 3D in 4G. <laughs> Good. What do you think is the next big challenge for the technology industry?

Uddenfeldt: If you look at the technology industry, it's going ahead. We will invent new things, so that is working pretty good. I think what is important is also to be able to make sure that people understand that we have to have spectrum policies and to really free up more spectrum. Even then, when we do that, it will not be possible to have it completely open. It will not be possible, maybe, to have it completely unrestricted. Somehow you have to limit the amount of data that people transmit because spectrum is a limited resource. Somehow we have to solve this debate about network neutrality in a good way. I think there is a lot of understanding in many parts of the world but I think if that continues, it's going to be a little

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bit of a problem. So that is one, of course. I think that now the challenges in our industries are more about money than about technology. Technology is dramatically improving.

Weber: Yes, I was going to come back to it, but sure. Do the, do the sound byte version.

Uddenfeldt: <laughs> Yes, sorry. How do I do that?

Weber: Think of this will be one of these quick snippets.

Uddenfeldt: Yes, exactly.

Weber: So you know, cut it down.

Uddenfeldt: Yes. One of the main challenges, I would say, is to get access to more frequency spectrum. We really need it in the wireless industry to satisfy the demand of the all the uses in the world.

Weber: Good. What problems do you think the technology industry can solve for society in the future?

Uddenfeldt: I think for society, we can bring these fantastic things that [enable] people [to] communicate wherever they are. This is good for the developed world, and it's extremely good for the non-developed world. They can really leapfrog, and they can set up businesses and they can do things they never dreamt about doing. It is a fantastic way, just to look at the GDP growth. Mobile communication does more for the GDP growth than anything else.

Weber: Do you want to say it again, there was a moment when you—just so try that one again.

Uddenfeldt: Yes, I think for society, mobile communication is one of the best things one can do. Both in the developed world, where we see that people can use these devices and communicate with each other, but also in the non-developed world where we can see that people can leapfrog, setting up new technologies, setting up their own businesses and do things they have never dreamt about doing. So it is completely different things. The GDP growth in those countries is just fantastic.

Weber: There was something that you guys said about x amount of mobile connection increases GDP by some measure.

Uddenfeldt: Yes, we have data on that, but I don't remember the numbers. But exactly, exactly.

Weber: How do you think the computer industry will change in the future?

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Uddenfeldt: Yes, the computer industry and the mobile industry are both changing dramatically. They are merging and we see that with the smartphone and with the tablets.,It is going to be dramatically different. We like to carry it with us, we have to have simplicity of use. Touch-screens are one of these things. It is completely different situation going forward.

Weber: How will technology jobs change in the future?

Uddenfeldt: Technology jobs? In the sense that what you are doing?

Weber: People working in the technology industry.

Uddenfeldt: What will they do that they don't do today?. Obviously, we are going to need very clever software people and we need clever hardware people. We need good material, we need people that have good inventions when it comes to both hardware and software. I don't think it's dramatically changing; it is just that it's very, very global. It's only the best players that actually win and you have to think very globally. There may be fewer and fewer needed somehow. I think, from the way you're working, it is absolutely not changing in my mind.

Weber: What do you think will be the next big thing?

Uddenfeldt: The next big thing, I think 3D. 3D also for mobile devices is really going to be very important. That is so enjoyable to watch short videos and to play games with 3D. You just like it, as an individual, so I think that's one of the really important things happening going forward.

Weber: What advice would you give to a young person just starting out on their career?

Uddenfeldt: I would give the advice to try to be very innovative, but also work with things in a very profound way, to make sure that you really learn things, and take that thing forward. I don't think you can just jump into things without understanding and do it in a clever way. I think that is extremely important. Always think about doing new things at the same time. I think that combination is so important.

Weber: Good. What call to action would you give to a young person today?

Uddenfeldt: Hm. What do you mean by that phrase? "Call to action"?

Weber: I think it's—

Uddenfeldt: What they should do?

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Weber: Yes, what should motivate them, what sorts of problems they should solve.

Uddenfeldt: We must realize that technology goes on and as Western countries are continuing to be leaders, we have to be very innovative all the time and take new ideas to the market. It's happening more and more, it is going faster than ever, I think.

Weber: And specifically for young people, what call to action would you give to young people today?

Uddenfeldt: I would say to young people, learn new technology and educate yourself so that you actually have the right background to make this happen.

Weber: You want to say that—

Uddenfeldt: Yes. My advice to young people would be to have the right education and understand that technology is something that is still shaping the world and will continue to do that. Actually this goes faster and faster every year, so it's a good future.

Weber: How do you envision the technology in an ordinary person's life, looking ten years from now.

Uddenfeldt: Ten years is a long way. I mean it's a long horizon.

Weber: Five.

Uddenfeldt: Yes, if you look at five years, I think we will see dramatic changes in the home. Today, it's very complex thing about the home. You have your computer, you have your television and you have your Playstation, you have a lot of things just spread out. This is something that will change dramatically and I think we have to realize that this must be much simpler for people to use. To have fantastic quality and HD is not the end of it; 3D is coming as well. I think we will see dramatic things happening in the home as well as in the pocket. In the pocket, that's where you have your smartphone or small tablet. But the home will change dramatically. We will see television and PC coming together.

Weber: How will this change people's lives?

Uddenfeldt: I think it will change people's lives a lot. They can bring pictures with them that they just took and they can just display them on the big screen at home and it will make things much easier. They can make things, they can do things while they are watching TV, they can do different things, they can share it with their friends, they can get pictures coming in from friends while they are watching television and they are sitting there with their family. These examples just from the home are things that will be very much different. The social networks are already changing things dramatically and pictures and videos will be stronger and stronger as part of all this. And so that's it.

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Weber: Good. Why is computer history important is for this? Why does computer history matter?

Uddenfeldt: Yes, computer history matters a lot because what it is today, and that's a little bit of the story about smartphones. Smartphones are a combination; it's a computer and it's a phone. It's really what it is, and again we talked about the smartphone that Ericsson launched in the year 2000 or 1999, that was really a smartphone and this is what it is today. This is where computers go, they go to tablets and they go to smartphones. That will be the dominating personal computer for the future.

Weber: And why does the Computer History Museum matter?

Uddenfeldt: Oh, the museum matters. Personally I think museums are very important. It tells you the story of how things happen and how you can create new things. It's so amazing just to look upon things and how things like IBM started. How do things really happen? It creates [an image in] people's minds; they know that everything starts small and then you realize that you can change the world by having ideas. But you have to relate it to what other people have done. If you just don't understand what people have done in the past, you cannot really shape the future.

Weber: Good. Did you want to get in the 3D in 4G, just put that in one sentence?

Uddenfeldt: Yes, I didn't say that, right?

Weber: Put it in one sentence?

Uddenfeldt: Yes, one of the important things going forward is that we have 3D going into 4G devices; that is going to happen.

Weber: Good. Those are the questions; I have a few on the network. These don't absolutely have to be on tape.

<crew talk>

Uddenfeldt: So we take another 10 minutes?

Weber: Yes. What are the main challenges of networking over radio as opposed to over wires? [What were] some of the challenges you faced in developing? What are some of the main technical challenges?

Uddenfeldt: Yes, it's so dramatically different having networks over wireless and to have networks over wires. First of all, there are all these challenges to handle it within a limited spectrum. When people do things for a wire network, they don't think about bandwidth. You have to do that when you are designing anything for a mobile network, because otherwise there won't be enough spectrum. There won't be

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enough bandwidth. That is number one; take care of that. The other thing is that is a very nasty media. It really destroys the signal in a terrible way. You get all of these things like fading, taking away the signal and also the dispersion of the data when you send it. It just comes back from all the reflections and looking awful so you need to understand that there are a lot of errors when you send data over a radio channel. Of all these basic things. Then you put it into a small device that you carry in your pocket, so you need to take care of battery life. Battery life is so important, too. You cannot just transmit very high power. You cannot have machines that take too much power inside. All of these things are completely different when you are designing wireless network. The other thing is when you are deploying a wire line network, you can start in a small part of a city and you deploy something in a city, and that's it. You cannot do that with a wireless network because the users move around, and they expect it to work. Basically, you have to deploy things all over the place. You have to build coverage, as we say. You have to build coverage all over the country, and all over the world, because people move around and they expect it to work, and if it doesn't, they don't trust it. You don't get the users hooked to the network. That is another part of this; you have to realize that you need a lot of investment every now and then to be a completely new network. I would say most of the things are dramatically different.

Weber: I'll ask you more offline, but the early pagers—Ericsson was involved from, the what the 1950s, right?

Uddenfeldt: Yes, we had some early pagers in Ericsson, absolutely.

Weber: Okay.

Uddenfeldt: Most of the pagers in those days were on-site pagers, where you have something on the premises of the company, and you can carry around a small device in your pocket and it beeped. Then later on, there were more wide area pagers that you could carry around when you were outdoors. They never really caught on because they were almost coming out the same day as the cell phones came. But the on-site pagers, there were pretty good distance for a number of years before the cell phones came.

Weber: You didn't mention at all Korea.

Uddenfeldt: Korea.

Weber: Is there anything that I should be paying attention to about it?

Uddenfeldt: I don't think we have to bring up Korea. I don't think Korea has been the driving force in the business really. I think Japan has, and Europe has and the US has. Korea is a very advanced market, they are very advanced, they are very early users and they love new technologies like they do in Japan but you know it's not dramatic.

Weber: I remember at Telecom '99 in Geneva, Samsung was announcing a whole bunch of 3G things—but that was presumably nothing that they were spearheading.

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Uddenfeldt: In ’99 I don’t remember. In ’99. It’s an interesting observation that you are hinting on. If you look at the top players in the mobile phone market, none of them are Japanese. Two of them are Korean. So I guess maybe that tells you a little bit about the difference between Korea and Japan also that, Japan are much more domestic, while Korea has understood that they have to rely much more on other markets.

Weber: But in terms of setting standards they have not been especially active.

Uddenfeldt: No, no, no.

Weber: Good, I think that’s the main. Perfect.

Uddenfeldt: Okay.

Weber: Thank you very much.

Uddenfeldt: That’s it.

END OF INTERVIEW

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