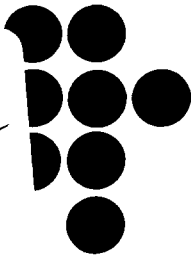


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"The Changing World of Communications"

May 7, 1992

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COMMUNICATIONS FORUM**

"The Changing World of Communications"

May 7, 1992

Seminar Notes

Dr. Robert Lucky, AT&T Bell Laboratories

Dr. Vincent Chan, MIT Lincoln Laboratories, Moderator

Elizabeth H. Prodromou, MIT, Rapporteur

Dr. Chan introduced today's speaker, whose topic dealt with the complex interplay of technology, economics, sociology, and politics that is changing the rapidly emerging world of communications.

The speaker was Dr. Robert Lucky of AT&T Bell Laboratories. Lucky began by noting that his talk would use a hodgepodge of overhairs, collected from as far back as the Bell System divestiture in 1984, all of which point to the fascinating array of changes that have characterized and continue to shape the communications field. Lucky remarked that the panorama of communications today is strikingly broad, and he noted that the engineers and other individuals involved at AT&T in broadening the communications field are actually making a reality out of ideas and technologies that, not long ago, were nothing more than dreams.

According to Lucky, the technical issues in communications begin in the "basement" of AT&T, because this is where the transmission engineers work. These are the people generating so much bandwidth that the rest of AT&T doesn't know what to do. People keep generating bandwidth, or transmission capacity, but the applications uses can't keep up with the growth in capacity.

We have reached a point of over-abundance on the curve for capacity of transmission systems. We have more capacity than we can use. And some people at AT&T feel that this is going to put us out of business, because the expansion of capacity is driving down the value of bytes to such a point that they are almost free. Communications may become independent of distance, in terms of cost, or they may become independent of bandwidth. The lag between experimental systems and commercial systems is about five years. For the people who make the transmission systems, the keeper of the channel is the physicist. But the physicist has no real concept of the communications system. And the communications engineer has no real concept of what the physicist does.

Lucky considered the capacity of optical fiber. We often talk about the capacity of a single optical fiber as being ten-to-the-minus-thirty terra, with a bandwidth of 25,000 gigabytes. We are talking about up to 25 terra bytes per second, multiplied by some distance.

We have been lying on the Moore Curve for some time, and this probably will continue unabated. But what really is the limit of the capacity of optical fiber? According too Lucky, the only real answer to this question is that nobody knows. Serial systems are sending at one bandwidth. This is how most systems work. The new systems being developed send at 10 gigabytes per second. With experimentation, we are finding some disagreeable things. Lucky remarked that, coming from a communications systems background, he has a simple view of what bandwidth is. But the concept of bandwidth needs to be reconsidered. There are about a dozen complex phenomena that intermodulate the different wavelengths, and we are now having arguments about whether or not these are intrinsically connectable effects.

In Lucky's view, there is a tremendous bandwidth capacity in the fibers already under the ground. Recently, thought, there have been some very big breakthroughs on these long-haul lines. Almost everything that's happening is changing the dynamics of human communications, particularly in terms of the psychology of human communications. Technically, the problem with repeaters is that they mute to a particular byte rate. The optical amplifier is a breakthrough that is too simple and too good to be true - and it works underseas and terrestrially. This erbium-doped, optical fiber amplifier helps to amplify the input system regardless of the optical line it was on. What you create is like a hollow tube that takes light and transports it intercontinentally. If you want to change the byte rate, you just change the modulation. This gives the network a very curious attribute of physical transparency.

Another fascinating possibility is the soliton. This is related to the transmission issues. The solitons have been studied for decades. All media are non-linear, as are optical fibers. The fiber is

also linear dispersive. The soliton is a special pulse that has the property whereby non-linear dispersion compensates exactly for linear dispersion. The has soliton created a big flap. People didn't believe the conclusion that the use of solitons meant that transmission has not significantly modified the pulse. But eventually, those who did soliton research showed that their equations were accurate and would work. It was a fascinating dialogue between an individual researcher who through he was right versus the management that disbelieved in the conclusions of his research. The story isn't over yet, though. Perhaps because the medium is non-linear, we can only analyze certain pulses. They are now working on ways to pull the solitons away from the noise generated by amplifiers. The non-linear signal can thus be persuaded to do certain things independent of the noise.

Transmission is the furnace that is heating up the entire field, but 99% of the people working in communications don't care about transmission. Lucky remarked that they see transmission as a commodity.

According to Lucky, the big push in communications is to get fibers into the homes but this still is not happening on a widespread basis. There are all sorts of communications companies that want to invade the home (e.g. CATV, satellite, IATV, etc.). In terms of the research to support this push, Lucky claimed that the research is limited because, basically, the problems associated with getting fibers into the home are political and economic in nature. But there should be more research done in the area of service - that is, concerning what people want if they do let fiber into their homes.

Within the last year or two, a new philosophy has taken shape that, in Lucky's view, will transform the network from circuit switch to packet switch. The idea is that of bandwidth on demand, which will accommodate all sorts of uses and will cohabit the communications infrastructure. The question is one of whether or not it is feasible that one single network will be able to do all of these things.

Lucky hypothesized that we may not be able to integrate the network but he explained that AT&T's answer to the network integration problem is ATM, or Asynchronous Transfer Mode. With ATM, all the information will be carried in the network in 48 byte packages and with 155 megabytes per second as the basic data rate. This is a connection-oriented system. The virtual packet and the virtual route will be prearranged. ATM represents a new kind of architectural philosophy for the network. While Lucky observed that there is a lot of debate about it - concerning whether the packets are too small or too big - AT&T is moving forward on ATM because it seems economical, and people are building the ATM switches. The ATM switch is a single size cell and this is what makes it, potentially, so economical.

The ATM switch transforms the network's problems from ones of signalling infrastructure and circuitry to ones of congestion, traffic control, pricing, etc. These are new problems for the communications system. Lucky also discussed the fact that, while the biggest single expense in communications today is billing, billing may become an even greater problem with the ATM systems. The cost of billing exceeds all the gains made by technological advances, so pricing clearly is a critical policy matter.

In doing the processing-intensive switching of the future, many propose that doing it by means of an optical computer is the best path to choose. Lucky confirmed that the Public Relations people at AT&T announced that AT&T would have an optical switch by 1995, but he stressed that the engineering people are unsure about his possibility. Currently, AT&T has no architecture to use the optical computer capability, and Lucky was not sanguine about the use of optics. In his view, the ATM switch is the prototype processing job of the future. AT&T tried to build an ATM switch using optics, but the electronics people argued that their method is cheaper. The economics argument won out. You can buy approximately one million electronic transistors for \$1 and only one lazer for \$1000. The optics people attempt to parallel everything. The

electronics people, because they have cheap transistors, can afford to actually parallel everything. So, the electronics view is winning out thus far, despite the intrinsic abilities of optics.

Lucky briefly discussed what he considers to be one of the major, yet under-studied, issues in communications today: the sociological problems associated with steadily expanding communications capabilities. We are headed to a time in the not-too-distant future where we will have wrist-watch telephones and other such technologies. But these sorts of communications capabilities will make the act of communications a very personal one, and access is a two-edged sword. We all want to be in touch with everyone, but we want restricted access to us. It doesn't necessarily work that way - the network must go both ways - and, according to Lucky, not enough thought has been given to the sociological dimensions of communications.

Image communications will bring to the fore this whole issue of access and two-way networking. Lucky noted that AT&T is going to offer picture phones in the very near future. These picture phones will be cheap video-technology, with cheap bandwidth and powerful compression, and will contribute to the steady advancements being made in the area of image communications. Despite the early failure of the PicturePhone (due to their high cost, poor technology, and social and interface problems), these new picture phones are in demand. AT&T envisions a small market for the new picture phones, but this new model is merely a stepping stone to more sophisticated image communications.

Lucky envisions that society will continue to move towards increasing use of messaging systems, including electronic mail, facsimile, and other messaging services. We will have to learn to use messaging more pervasively because the real time possibility of talking to a live person in a live call is steadily diminishing. AT&T is encouraging multi-media conferencing - it offers a shared visual space and will offer shared computer applications, shared pictures of the participants, shared documents, etc. Multi-media is an important concept in that it represents the model of communications for the future: an electronic room paradigm whose unique properties must be emulated. This paradigm offers a gathering place for people and for resources, it offers a shared space with entry and exit, it implies notions of conductivity and of what the object of communications should be, and it has persistence. Building-in such properties to the infrastructure and the software will determine what the phone call of the future will be, as well as what the model for communications will be.

In conclusion, Lucky stressed that we are witnessing the emergence of a rich, new communications infrastructure supporting high bandwidth with fast-speed switching and distribution capabilities. This infrastructure is itself in the process of changing very rapidly, as evidenced by the fact that AT&T has built an entirely new network since its divestiture in 1984. All sorts of new transmission capabilities and services are upon us, including wireless communications and message servicing, to recall just a couple of the examples mentioned in the talk. Lucky also noted that Internet is growing extraordinarily rapidly and is totally out of the control over either corporate or government regulators. Internet is growing at a monthly rate of 15%, versus the AT&T voice system which is growing at a yearly rate of 6%.

Question and Answer

The first questioner asked Lucky to elaborate on the potential growth in use of ISDN.

Lucky explained that ISDN is 64 kilobyte per second service. What is happening is that the world may sweep past 64 kbs ISDN and towards broad band ISDN and ATM. ISDN is happening too slowly. ISDN doesn't have a single application that carries it, and that's its problem. This is the case with most of the new technologies - they work very well, but it will be an economic fight, determined by regulatory and political constraints, that decides what catches on in the market.

The second questioner asked when videophones will become available.

Lucky said that AT&T has planned a very small market (approximately 50,000 units) for the videophone. There are a lot of orders already made, but some people claim that these orders are mainly from the catalog companies. AT&T sees these videophone orders as a sort of toy market, for the rich and as "grandparents' presents," with the real market yet to come. The big market for video phones will use wide bandwidth of every quality (from HDTV to bad quality). Lucky noted his skepticism concerning how the current videophone will take off. The videophone raises the issue of the nature of human communications and of where the impact derives from in the communications process (is it in the speech or in the picture). A wealth of psychological studies has yet to resolve to this question of where the information lies. Lucky argued that the bulk of the information is in the speech. He predicted that business use of the videophone probably will be quite slim. He emphasized that the pace of understanding human communications is slow. But he noted that we are rapidly changing the way we communicate and the way that we work. Seventy percent of the communications across the ocean occur by fax. People aren't talking by phone anymore.

The next questioner asked why we don't see more flat rate services.

Lucky responded that we will soon see a rapid growth in flat rate services. That is one of the interesting things about Internet. You can use as much as you want, but access come by paying for a given bandwidth.

The next questioner asked why Lucky claimed that applications of the various new technologies will depend on economic battles, if most of the cost in communications services lies in the billing rather than in the technologies.

Lucky emphasized that the battles will not be economic in the market sense of the word, but will be regulatory and political. This is more than economics, which doesn't necessarily imply the costs of the system, but also implies a concern for how deep your pockets are. And today, you have co-existing but different forms of technology that cost the same thing in terms of service. This implies that the cost of technology is not the determining factor but that the people costs are what determine the price of the communications service.

The next questioner asked why Lucky does not think that fiber will get into the home on a broader level.

Lucky responded that the world is ruled by rational economic and technological arguments and, on these bases, fiber can not win.