



The Next 10 Years in Communications

By Jeong Kim, president, Lucent Technologies Bell Labs

We at Bell Labs spend a lot of time thinking about the future. But rather than coming at it from a rapidly changing technology perspective and trying to guess how today's technology will evolve over time, we prefer to observe human nature and behaviors, which are fairly constant, and then imagine how technology will support these needs in the future. This approach inspires us to innovate based on people's needs and enables us to do the orthogonal thinking that yields the insights and disruptive technologies that are sure to play a major role in the future.



In this piece I hope to give you a sense of some of the cultural trends that we see at play, how they influence what we are doing in the labs, and some of the activities we have underway to give Lucent a decisive advantage in the marketplace moving forward.

Where We Have Been and Where We Are Going

This year is not only a 10-year anniversary for Lucent, but, in many ways, a 10-year anniversary for the telecom industry as a whole. In 1996 the Telecommunications Act of 1996, along with other regulatory and innovative forces around the world ushered in a cycle of change for global communications, and led to an unprecedented build-out of all sorts of broadband networks - wireline, wireless, the Internet and more. I'm proud to say that we at Lucent have been at the technology forefront in leading many of the innovations that helped bring about these changes.

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Ten years ago the Internet was just a shadow of what it is today - with basic Web sites and e-mail services over dialup. Today, it has become critical infrastructure for global communications, commerce, and entertainment.

Ten years ago mobile networks were just beginning and cell phones were primarily used by a small portion of the world. Today, mobile communications networks are fairly universal, both for voice and broadband data networking. In fact, in some places cell services are used by more people than wireline communications.

Ten years ago, the core telecommunications network was primarily circuit based, engineered to carry the then dominant voice traffic on top of which data traffic was overlaid using modems. During the last decade the volume of data traffic has dramatically increased, overtaking voice. Today, almost all new networks built are packet-based, engineered to carry data traffic with voice overlaid on top of it (voice over IP) - a complete reversal of a decade ago.

And we expect this growth of the packet network (Internet/IP core, broadband wireline access, and mobile networking) to continue to increase in order to accommodate the explosive growth of the many new and richer ways people are beginning to communicate - sharing personal video, videoconferencing, playing mobile games, downloading music, and much more.

This has been quite a decade and the next major shift will be no less dramatic - this time driven not by just the growth of data and video, but by the changing relationship between users and the network as well as between each other.

In this new environment, we will see the value of the network moving far beyond just 'enabling communication' to now being all about REALLY 'interconnecting' people to their friends, colleagues, interest groups, and services - in powerful new ways that fundamentally change the role of the network in our lives.

This is the perspective around which Bell Labs is innovating the future, a perspective and framework we call **Natural Ubiquitous Networking**.

- **Natural** in that the interaction between the user and the network will become thoroughly intuitive both through the development of easy to use interfaces and through new network intelligence so it can recognize us, anticipate our needs, and instantaneously connect us to the people and services we want.
- **Ubiquitous** in that we will be able to access the network from anywhere, through any device, for any service. This is driven through new innovations in applications, converged broadband networks, service delivery architectures, and the development and deployment of sensors and elements throughout the environment, making the network available to you wherever you are.
- **Networking** in this context means two things. First and foremost I refer to social networking - enabling people to interact with each other in a fundamentally different and deeper way. I also mean networking in the ways we enable machines and services to interact with each other to deliver personalized, seamless services.

A New Relationship with the Network

When thinking about the future and the type of user who will drive expectations and services, I look at my teenage children and how they connect with their groups of friends - both location-based friends (from school) and interest-based friends (from around the world - some of whom they've never met in person).

These teenagers will be our primary customers a decade from now - using the network heavily both at work, at play and in ways we can't yet imagine.

As any parent is sure to have noticed, teens today like to share their worlds with friends, and at the same time want to be constantly aware of and connected to the world around them. They want to be kept informed of what's happening every minute of the day -- every change and nuance that occurs within their communities nearby and around the world. For example, one of the most popular applications in Korea today is a location service that allows teenagers to know where their friends are in relationship to them. This is not communications in the way we have traditionally thought. This is using the network to create a deeper sense of community - connecting everyone into a single social experience. And I expect that desire to continue into their professional lives as they enter the workforce.

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Being connected into this networked community has become a way of life for them, and they are often plugged into the network and with each other in multiples sessions at the same time - some of the sessions are short duration, such as SMS, IM, or a telephone call. Others are community, activity-based such as chatting while gaming online against friends and people they've never met before. And still others verge on being "always on" connections such as personal Web pages, Webcams, or iLocator-like services.

As a father I can say with some authority that many of these sessions have nothing to do with communicating ideas and everything to do with connecting with friends at a social level.

It's human nature to share stories and confidences with friends and family and to seek people who enjoy the same interests. It is also human nature to want to be engaged.

A good example of these two human desires and how they are uniquely served by the new network is online multiplayer gaming. Online gaming is engaging because it is personalized, interactive, less predictable, and provides the opportunity to take on new and interesting personalities and personas. Multiplayer online gaming also provides a virtual world that has blossomed into a new type of community, enabling people of similar interests around the world to meet and interact.

A Day in the Life

Let's fast-forward 10 years from now and imagine how today's teenagers - who will then be young adults -- will use the network and think about the sort of services they will expect and be willing to pay for.

Imagine today's teenager as a young working mother 10 years from now.

For starters, if she wants to, she can connect and chat with anyone in the world, because virtually everyone will be networked to a database that she can access. As she drives to work, if she is not telecommuting, she'll be unaware that her car is conveying information to her repair shop about a potential problem that will be remotely analyzed, and if necessary, very likely fixed at that moment. If it can't be fixed, the network will check calendars and propose a time to bring it into the shop.

At work, she will securely access her files through whatever computer she uses because the network will 'intuitively' recognize her and immediately provide her with the content she needs. She will be able to reach out and naturally collaborate with her colleagues globally as if they were in the same room through the media of her choice. The network will be her personal assistant - knowing where she is, where her key work colleagues are located, what meeting she is attending, who has authority to call her during that time -- and intelligently redirecting connections through whichever device is appropriate.

On the way home the local supermarket will have groceries waiting for her. As she reaches her neighborhood, this young mother will know where her children are, and if they've done their homework. Their PC will be linked to hers, so she can monitor what they are doing on it. When she sits down to watch television - whether at home on her TV or in a waiting room on her cell phone -- she will have the world of entertainment at her fingertips, with the network recommending topics and content based on her past preferences, interests, location, and time of day.

I believe that ultimately the network that delivers all of these services is not just helping her become more connected to her community; it is actually significantly enhancing her quality of life. She is engaged in an experience that is more interesting through more personal choices and more interactivity with people who share her interests. All with less effort than we expend today.

This enhanced and more pervasive relationship between the user and the network is the mindset and passion that drives the work we do and the networks we build.

Implications for the Network

To satisfy this ever-increasing need for multiple simultaneous sessions of varying length, we at the Labs are working to enhance the network with more intelligence, more quality bandwidth, better devices, and network/service convergence - all with the goal of making person-to-person, person-to-machine, and machine-to-machine connectivity more spontaneous, feature-rich and ubiquitous.

Carriers need much more bandwidth over their wireline and wireless networks. And these networks can't be dumb fat pipes - they need to be intelligent, flexible, and self-optimizing to handle the many different sessions and bandwidth requirements presented in this new world.

But beyond the network architecture, we need to add in a new layer of applications that bring intelligence to the network. In a sense, the new use of the network is to be "always on," enabling a closer relationship with the user - keeping track of and anticipating his or her work schedule, entertainment and information preferences, sports and other interests, and the various communities to which he or she belongs.

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Another technology imperative is work on the user interface. For this network to truly become a natural extension of the user it needs to be much easier to interface with than it is today. This requires an element of artificial intelligence so that users can interact and use the full power of these services as easily as they use IM or their TV remote control today.

Another critical technology imperative is security. As people begin seeing the network as an extension of themselves, they will begin sharing more and more information with it such as their personal interests, calendars, preferences, contacts, credit card, and even identification information. With this opportunity come challenges, and we at the Labs see security as a critical technology imperative in architecting the next generation network.

How Bell Labs is Making Natural Ubiquitous Networking a Reality: First Steps

To get to the next level of communications and ensure that we are part of tomorrow's world, we are dedicating resources across many disciplines and critical areas of innovation to help the industry realize **natural ubiquitous networking**. While we still have a long way to go, we have made the first few preliminary steps including:

- In our quest to deliver virtually unlimited high-quality, dynamically optimizable bandwidth over any network we have many strong research projects in **networking and device technologies and innovations**. Some of the projects that are bringing us closer to tomorrow's world include: passive optical networking (PON) for fiber to the home; improved broadband wireless through pioneering work on HSDPA and EV-DO Rev A; and more efficient transport of services through the core with our research in developing an Always-On architecture. We're also pushing the envelope with 100 GB/s native Ethernet transport, and conducting pioneering work in network optimization approaches and tools.
- Having a broadband network is powerful but you need to develop tools to bring **intelligence and personalization** into that network. We have quite a few projects underway to give the network this intelligence and integration, including extensions to our already announced Service Enhancement Layer including our Vortex rules engine, as well as work on information theory and artificial intelligence in our math and computer sciences departments. Another example of Bell Labs innovations in this intelligent, personalized area is iLocator, a location-based tracking application that can help you find friends and family quickly and easily.
- Once you have the broadband architecture and the intelligence in the network to deliver personalized **services**, the real changing factor is in the services themselves. Instead of going from one device or screen or network to another - each for a different type of service (dial tone, Web browser, television, email, IM, etc.), we are working on applications that blend all of the user services together into a single intuitive user experience. With blended services, network carriers can deliver any sort of content - communications, entertainment or information - in whatever way best suits the customer. A first-step example of blended services is Active PhoneBook, which helps you simplify and organize your business and personal contacts onto one list that can be accessed for email, voice mail, IM and any other method. Another pioneering effort in this area is MiViewTV™, which brings "roaming" capabilities to the television. Supporting this are network elements such as the Service Broker that enables this blending to happen.
- As this powerful, intelligent, and personalized network becomes more of an extension of ourselves rather than simply a resource, we will need to trust the network both in reliability and in protecting our personal information. Bell Labs is working on new **security** technologies, architectures and solutions that will enable this level of trust between the user and the network. A good example of this is our work in the X.805 security architecture, which has since become both an ITU and, more recently, an ISO standard. We are also heading up a cross-Lucent team looking at security in its many dimensions from network reliability to user identity protection.
- So now you have an architecture where users are interfacing with megabit and terabit networks through a few bytes-per-second keyboard. It would be much easier and more natural if the network could have 'eyes,' 'ears,' and other 'senses' everywhere so the network becomes universal and the interaction becomes natural. This is why we spend a great deal of effort and resources in our **nanotechnology** and physical sciences research and development, yielding innovations such as the mini-microphones, nanobatteries, liquid lenses, and electronic noses to name just a few examples.

Delivering this future of communications requires innovations and insights from many different disciplines, such as wireless and wireline networking, network intelligence software, advanced multimedia and interactive services, mathematics, information and game theory, physical sciences, quantum computing, nanotechnology, photonics, human factors, and many other important sciences.

Lucent Bell Labs is unique in that it has all of these research disciplines interacting daily on hundreds of projects, each addressing the challenges of the next 10 years and beyond. Some projects are focused on the near-term impact on Lucent, giving it a decisive advantage in the marketplace, and others are far-reaching programs that are aimed at generating truly new and disruptive technologies and approaches necessary to realize this larger view of the future.

We are at the edge of a real transformation in communications - a transformation in the way people entertain, share information and connect to everyone, everywhere to virtually everything - seamlessly, simply, and securely. That's the promise of tomorrow's Natural Ubiquitous Networking - a network future that I believe Lucent, through innovations out of Bell Labs, can have a leading role in.

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