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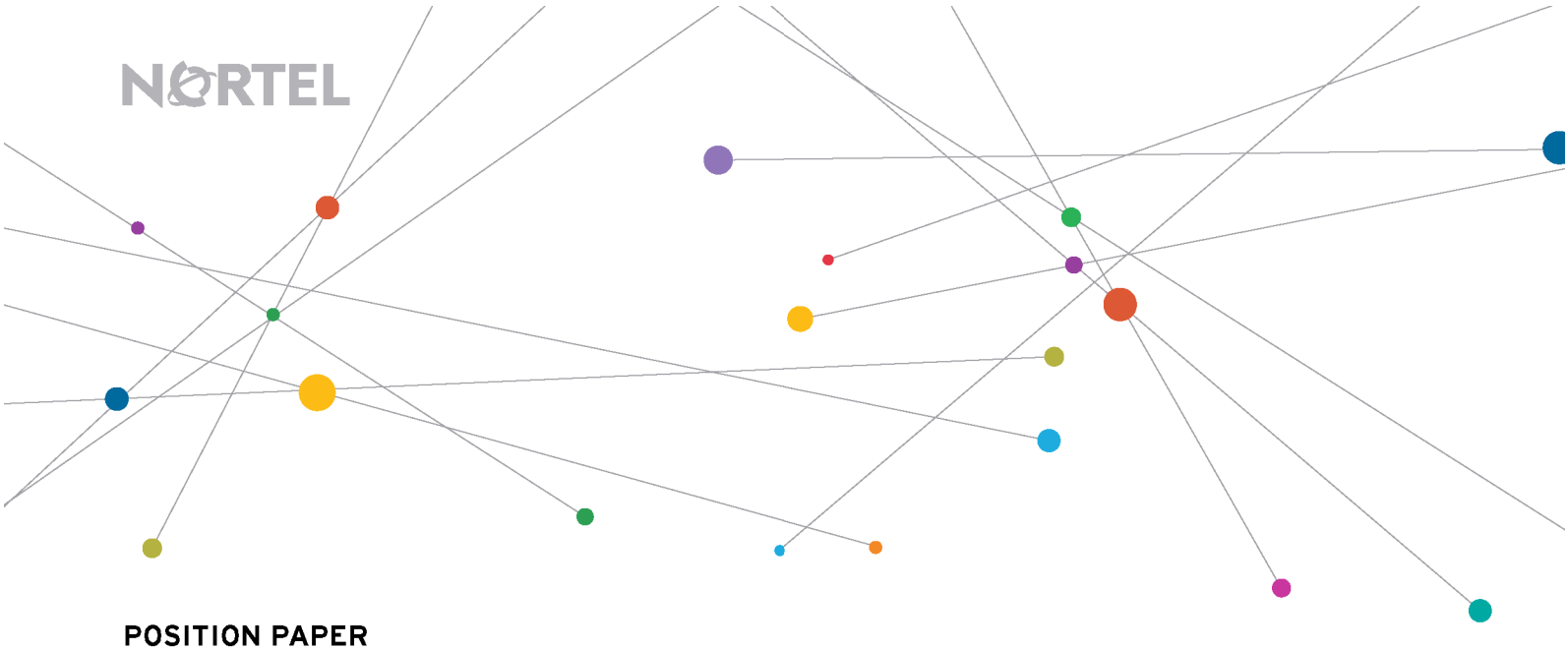


POSITION PAPER

HYPERCONNECTIVITY: AN UNSTOPPABLE FORCE OF CHANGE

Hyperconnectivity—what we at Nortel define as the state in which the number of devices, nodes and applications connected to the network far exceeds the number of people using the network—is fast becoming a reality. It's an unstoppable force of change that is demanding action now to rethink the way networks and applications are built.

CONSIDER THESE FACTS:

- About 2.8 billion mobile phones are already in use, with another 1.6 million being added every day.[1] Nearly 67,000 every single hour.
- In Europe, in-use mobile phones already outnumber the population, with penetration at about 103 percent.[2]
- In just over six years, Apple Computer has shipped 100 million iPod devices[3], not one of them yet connected directly to the network...but that's just a matter of time. As well, the company recently released Apple TV, which essentially functions as a home-theatre-connected iPod to wirelessly play digital content from your computer on your widescreen TV, including movies, TV shows, music, photos and podcasts.[4]
- Sports equipment retailer Nike has introduced sensor-enabled running shoes[5] that provide up-to-the-minute performance data—distance, time, pace and calories burned—directly to the runner's iPod nano. That data can be downloaded to a web site for future analysis and shared with friends, family and other athletes around the world. Again, it's just a matter of time before those sensors will communicate directly through the network, without the need for any middleware.
- Every year, billions of microprocessors are sold and embedded in everything from household appliances and toys to cars, electronics and robotic systems for factories. Most are not yet connected to a communications network but would benefit if they were.
- And some futurists (for example, David Clark from MIT) are predicting that in 15 to 20 years time, more than one trillion devices, most of them wireless, will be connected to global networks.

The rate at which devices and objects are being connected to the network is ever-increasing. And, clearly, it's not just PCs, PDAs, cell phones and iPods. It's also cameras, sensors, radio frequency identification (RFID) tags, cars, appliances, medical equipment, industrial machinery and even irrigation equipment on farmlands. It's also not just physical entities being connected. More and more business and consumer applications are connecting to the network as they are enabled with communications capabilities.

Welcome to what is quickly becoming the hyperconnected world—a new era in communications where anything that would benefit from being connected will be connected to the network, which has become the largest and most complex machine mankind has ever built.

This new era, however, is about much more than just sheer numbers of new network-connected devices, nodes and applications. It is also about taking "always-on" to new extremes. It is about providing pervasive access to, and continuous presence on, the network, where anyone or anything can interact with anyone or anything else no matter where they are located. Being "out of the coverage area" will be a thing of the past.

Why? Because the independent, technology-specific networks of the past—which were deployed to deliver specific services, such as voice, data and mobility—are converging and evolving into a single, intelligent, all-IP network that is providing a new platform for innovation in a dramatically different and much richer services environment. This network can support any type of traffic, all kinds of machines and devices and every mode of communications. And, while the network itself is far more complex than ever before, for users it is presenting a communications environment that is more seamless and simple to use.

HYPERCONNECTIVITY: THE DRIVERS

It is this simplicity that is fueling the ability to communicate in entirely new ways and driving the move to "more"–more human-to-human communication, more human-to-machine communications and much, much more machine-to-machine communications.

HUMAN-TO-HUMAN COMMUNICATIONS

With voice communications commonplace in just about every corner of the globe, this mode of communications is by far the most familiar and visible. But consumers are taking it to a new level, by fueling new ways to communicate and to create and share content within cyberspace. Examples of these new ways include innovative, web-based phenomenon such as MySpace and entire virtual worlds like Second Life, where some 2.5 million people create virtual characters and live out virtual lives in a digital world. At the same time, enterprises are turning to unified communications, the bringing together of various forms of multimedia communications into a unified communications experience for the user, and are exploring business applications for such consumer-driven capabilities as wikis and blogs.

HUMAN-TO-MACHINE/MACHINE-TO-HUMAN COMMUNICATIONS

Today, in addition to traditional browser-based and transaction environments (such as bank debit cards), new applications are emerging that rely on direct communications with the network and with each other, without any manual intervention required to invoke the communications capabilities. It's the thermal or chemical sensor that can manage industrial processes. It's first responder systems that automatically track down the right emergency response team members and alert them to an environmental emergency in a particular room, building, or even a forest, sending real-time video from the scene. It's the RFID tag that can send a message to security personnel when an expensive asset is being moved and advise them where it is. It's a car's GPS device that knows you're headed into traffic congestion and directs you to a different route before you're delayed.

MACHINE-TO-MACHINE COMMUNICATIONS

Machine-based traffic—where communication is carried out among machines without any human involvement at all—is fast extending beyond the realm of the data center to become a part of everyday life. In fact, Nortel research suggests that in the next three to five years, machine-oriented traffic over public networks will surpass people-oriented traffic—an event that will be as fundamental as when data traffic surpassed voice in 2001. From a microprocessor perspective alone, billions of small TRON-enabled computers—sometimes just simple 8-bit microprocessors—are embedded every year in everything from household appliances and toys to car electronics and robotics systems. (TRON is the most widely used operating system in the world, ahead of even Microsoft Windows and Unix.) Also, varying kinds of sensors are connecting to the network to transmit information for applications such as: in-building asset tracking systems; building automation systems giving heating, ventilation and air conditioning control; real-time fleet tracking; critical infrastructure protection (airports, seaports, bridges); and health monitoring. Most important, these are not the passive sensors of old. They are active members of the network, able to act upon information and automatically trigger a communication with another machine, person or application on the network.

No longer confined to separate, disparate infrastructures, all of these modes of communications will be free to interact effortlessly with any other. This hyperconnected environment will forever change the way we live, work and play, and offer an enriched, more connected and more productive communications experience for consumers, businesses and society as a whole.

It will also create significant new revenue opportunities for network operators, equipment vendors and applications developers. Before these opportunities can be fully realized, however, fundamental challenges need to be addressed in the way networks and applications are built.

HYPERCONNECTIVITY: THE OPPORTUNITIES

First, let's look at the opportunities from the perspectives of revenue, an enhanced overall communications experience and a much more connected world.

FINANCIAL OPPORTUNITIES

Without a doubt, more connections—and more interactions among them—will create both top and bottom line opportunities for both enterprises and carriers.

Enterprises, for example, will benefit from new revenue-generating services (e.g., location-based advertising), new ways of delivering customer services (e.g., remote diagnostics for household products) and new ways of automating processes (e.g., asset tracking). These new services and processes will drive the need for much larger networks and communications ecosystems, which, in turn, will translate into opportunities for carriers to offer all kinds of new services to consumers and businesses; for telecom and IT vendors to significantly grow their revenues by offering new products, systems and solutions to network operators; and for applications providers to create new, much richer applications capable of capitalizing on the opportunities of Hyperconnectivity.

In the world of Hyperconnectivity, however, it's important to think beyond the way the industry today traditionally measures opportunity, i.e., via ARPU (average revenue per user). On a mobile network, for example, if you assume that most people are already connected, that means that the only way to grow the network is to charge each user more for the use of the network by their device. Mobile phone plans today, however, are not inexpensive, so the ability for an individual customer to pay more is limited. On the other hand, if you focus on Hyperconnectivity, you create a system where, in the ARPU equation, the U (user) value can grow dramatically as you add entirely new classes of devices to the mobile network.

Although providers may not be able to charge the same price for an MP3 player on a network as they would a phone, even at lower cost, the ability to move to Hyperconnectivity increases node count by orders of magnitude and, with that, total revenue available to the industry increases in a dramatic way.

A BETTER COMMUNICATIONS EXPERIENCE

Hyperconnectivity also creates the opportunity to provide better connections and significantly opens up new possibilities.

- **For consumers** Imagine if your fridge knew when you were leaving work and sent you an instant message telling you to pick up milk on your way home and, by the way, a particular grocery store on your route home was having a sale? Imagine the value of being able to watch your favorite television program or music video whenever and wherever you want, with the network sending the video to whichever device you happen to be using at the time—a cell phone, laptop or PDA—and automatically adapting the video to fit the device screen size.
- **For businesses** Consider how much time could be saved setting up a conference call with colleagues around the world if you could simply send an email that would automatically check everyone's availability, set up the call and immediately notify each person of the specifics without your manual involvement. Or, the time that could be saved by allowing a businessperson traveling in another city to securely open a corporate application on a laptop while in the taxi en route from the airport, set up a videoconference session and continue that session uninterrupted in a hotel room because moving across wireless and wireline networks is seamless and uninterrupted.

- **For governments** Consider how Hyperconnectivity could help address a range of issues, from public safety and emergency response situations to environmental concerns. Electrical authorities, for instance, could economically deploy sensors on consumers' power meters to monitor consumption levels, enabling them to better optimize the flow of electricity to perhaps reduce peak-hour demand enough to avoid the need to build a new power plant. Or, first responders could be guided to the scene of an accident via the shortest route possible and their progress tracked by the dispatchers through a real-time location system.

A MORE CONNECTED WORLD

And, there are benefits at the level of societal good. If we can economically connect an environmental sensor in a building to a network, for example, or an automobile to a broadband communications infrastructure, or an MP3 player to the Internet over wireless, then the economics necessary to do that could make it much more cost-effective to connect people in developing or emerging markets, closing the "digital divide" that now exists. 4G wireless broadband, for example, has the potential to lower the economic barriers to connecting to such networks, and perhaps to simplify large-scale wireless deployment to a level where it could be extended to these markets.

HYPERCONNECTIVITY: THE CHALLENGES

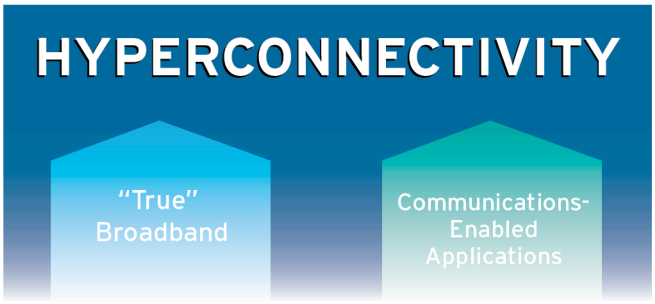
In addition to opportunities, however, Hyperconnectivity also brings with it new challenges for the industry—not only in creating new business models and service strategies to capitalize on the opportunities, but also in preparing networks and applications for the coming era. To address the challenges of Hyperconnectivity, the industry needs to:

- scale networks to support the staggering traffic loads and potential complexity that will be generated by the coming diversity of network-connected devices and emerging bandwidth-hungry applications like video;
- redesign networks to accommodate the very diverse set of endpoints with different needs and capabilities in terms of authorization, authentication, security, OAM, and intelligence;
- converge the IT and Telecom worlds to blend the richness of IT applications with the sophistication and intelligence of telecom networks to create a much richer communications experience; and
- address privacy concerns in a world in which everything is connected and possibly tracked.

Hyperconnectivity, in short, will require us, as an industry, to fundamentally rethink how we put networks together and to completely reinvent our applications model. These challenges will not be addressed by simply building a better router, a better switch or a better base station. They are not just about the technology or individual products. Rather, the challenges will be met by building the right systems—end-to-end networks that can seamlessly handle, adapt and integrate communications across the entire spectrum of networks, devices and traffic types, together with the reliability and quality of experience that have been hallmarks of the telecommunications network for nearly a century.

HYPERCONNECTIVITY: ADDRESSING THE CHALLENGES

Specifically, the industry needs to focus on two critical transformations that are the "pillars" of Hyperconnectivity: 1) achieving "true" broadband, and 2) communications-enabling today's IT applications.



Pillars of Hyperconnectivity

INDUSTRY TRANSFORMATION #1: ACHIEVING "TRUE" BROADBAND

Nortel defines true broadband as being a communications experience so seamless that users no longer have to consider which technology—wireline or wireless—is being used to make a connection. They simply communicate anywhere, anytime from whichever device is most convenient—essential in a hyperconnected world. Moreover, the broadband experience becomes so economical that the range of uses exceeds any experience of the past. For machine-to-machine environments, the definition of true broadband can be extended to include a seamless low-latency "experience" across thousands or even millions of devices that are required to support a particular function (e.g., location tracking) and that together require broadband connectivity.

Although the industry has talked about the concept of true broadband for many years, it's a promise that has yet to become reality. To deliver it, we need to solve a number of technology challenges in today's networks. These include: scaling the access network (the on-ramps to the Internet); scaling the metro network and long-haul network (the Internet); and providing transparency and unified communications across all networks—wired and wireless, public and private. Let's look at each of these areas in turn.

SCALING THE ACCESS NETWORK

The first challenge in achieving true broadband is scaling the access network. High-speed and high-bandwidth capability already exists in many enterprises today from both a wireline perspective—where access networks are already scaling from 10 and 100 Mbit/s Ethernet to gigabit and 10 Gbit/s Ethernet—and a wireless perspective through Wi-Fi 802.11a/g/n technology. But the same communications experience that someone has in an enterprise today, or even at home on a high-speed modem connection, is quite different on a mobile device on a cellular network. It is a much slower, degraded and often frustrating experience.

Because wireless will play such a prominent role in a hyperconnected world, it's critical that we extend the wireline-quality experience and the enterprise Wi-Fi experience into the cellular wireless domain.

At Nortel, our drive to achieve this is focused on 4G wireless technologies. Why? Because today's 2G and 3G cellular systems (GSM, UMTS, CDMA), although well-suited for voice and adequate for basic data, are simply not up to the task of meeting the huge bandwidth demands that Hyperconnected services like video will bring. While mobile video is possible on today's 3G networks, it can be delivered to only a limited number of subscribers or only for a few basic broadcast services.

4G technologies such as WiMAX, Long Term Evolution (LTE) and Ultra Mobile Broadband (UMB) can provide mobile access at greatly improved speed, cost, capacity, and spectrum efficiencies over current cellular technology and are optimized for the diverse world of Hyperconnectivity.

4G provides a much simpler network model and method for connecting devices of all kinds while at the same time driving out complexity and cost. Here's why:

- Unlike circuit-switched transport, which is what today's cellular systems are based on, and its "nailed-up" connections, packet-based IP transport (which is what 4G is based on) enables all kinds of traffic (voice, data, video and multimedia) and all types of devices to be connected without customization or modification.
- Advanced radio access is changing the economics of the network because it is based on a combination of two breakthrough technologies: orthogonal frequency division multiplexing (OFDM) and multiple input, multiple output (MIMO) antenna technology. Combined, OFDM-MIMO allows more users and more data per user for applications like video to be packed into the available spectrum at speeds four to five times faster than the latest 3G technology. OFDM-MIMO, in fact, is the foundational technology for all 4G implementations.

Nortel has long been at the leading edge of OFDM-MIMO development, accumulating an impressive list of industry firsts while advancing the technology through

the standards bodies and demonstrating real calls and sessions using the technology. We are, in fact, one of the key contributors to the development of the IEEE 802.16 standards, which form the basis for WiMAX, and more than 60 percent of Nortel's 164 contributions submitted to the IEEE 802.16 standards have been adopted. With a demonstration in March 2007 of the industry's first live call over a UMB network delivering high-definition video and VoIP, Nortel became the first to complete live calls using MIMO advanced antenna technology in each of the major 4G technologies—WiMAX, LTE and UMB.

To support 4G and Hyperconnectivity, Nortel is also developing a robust ecosystem that includes infrastructure, chipsets and devices, working with industry leaders like Intel, LG Electronics and Kyocera to bring these products to market.

SCALING THE CORE NETWORK: METRO (MAN) AND LONG-HAUL (WAN)

As traffic volume from access networks increases, more bandwidth will also be required in core networks—in both MANs and WANs. In both of these network domains, technology innovations need to take place across the entire footprint of the fiber-based infrastructure in order to meet the demand for video-class bandwidth.

The metro network is one area where video traffic has undergone enormous growth and as a result has received significant recent attention. In fact, some analysts predict that Internet-based video applications, such as IPTV, video-on-demand, music videos, and video-enabled personal communications, will drive bandwidth demand in excess of 60 percent per year for the next five years. The bandwidth glut that resulted from the excess build-out at the start of the decade is coming to an end, primarily as a result of the increase in the use of bandwidth-hungry services and applications such as video-sharing.

In terms of the technology of choice in the metro network, the industry is rapidly moving toward Ethernet, which is the dominant transport protocol in the enterprise but which, until recently, has been considered inadequate as a networking technology for carriers. Nortel, however, has made several breakthroughs and driven into standards several technologies that enable Ethernet to acquire all the capabilities and attributes that service providers require to run a network efficiently, yet still retain its sought-after virtues of low cost, high performance and simplicity.

At the top of that list are **Provider Backbone Bridges (PBB)** and **Provider Backbone Transport (PBT)**—technologies that could be considered mandatory for scaling the metro core, achieving true broadband and, by extension, preparing the network to support Hyperconnectivity.

Here's why. If Hyperconnectivity means billions, and eventually trillions, of IP-enabled devices, machines, and objects connecting to the network, then it also means that the network core needs to recognize and process the same number of individual IP addresses and MAC (Media Access Control) addresses, which are used for forwarding packets through the network. PBB removes the need for Ethernet networks to know anything about the addresses when they travel through the core. It does this by essentially encapsulating the end addresses of all devices communicating through the access network, grouping all packets headed to a particular segment of the network, sending them through one super-fast, low-delay path, and then de-encapsulating the packets at the receiving end, where they then proceed to their specific destinations. In this way, PBB allows switching to happen more simply and efficiently in Layer 2 Ethernet networking versus in more complex and costly IP routers. By enabling millions of service instances per metro network, PBB makes the network more capable of delivering bandwidth-hungry services to large customer bases.

PBT builds on the capabilities of PBB by bringing to Ethernet the robustness of a SONET/SDH network. SONET/SDH have long been the dominant optical transport standards and have set the benchmarks for robustness, reliability and resiliency. Pioneered by Nortel, PBT enables deterministic service delivery with traffic engineering, quality of service, resiliency and OAM capabilities. Nortel's experience to date has shown that the simplified PBT model enables operators to reduce OpEx expenses by up to 40 percent while delivering high-band-

width services. In addition, Nortel has reduced CapEx costs associated with system complexity by 40 to 60 percent—getting what could be termed enterprise economics on the carrier scale—to drive down overall costs.

Long-haul network: As in the metro network, scaling the long-haul optical core network, or the WAN, involves meeting the rising demands for bandwidth while at the same time simplifying the network to drive down infrastructure and operating costs.

In the past, these networks were designed and optimized for specific applications over pre-engineered, well-defined network paths. As the number and diversity of network-connected devices grows exponentially, however, it will be impossible to forecast bandwidth demand, routing patterns, or quality-of-service requirements. As a result, we will need smarter and higher-capacity optical networks that are extremely adaptable to changing bandwidth requirements.

Nortel's advanced technology teams are continuing their track record of pushing the limits of physics to meet this challenge while continuing to deliver the greatest number of bits over the greatest distance, using the least spectrum and power, at the lowest cost. Here are just two examples of Nortel's leading innovations in the optical area:

- **40 Gbit/s wavelengths that,** an industry first, can be deployed on existing fiber plant with no re-engineering, avoiding the tremendously expensive alternative of laying more fiber and dramatically lowering the cost per bit.
- **electronic Dynamically Compensating Optics (eDCO),** another groundbreaking technology, functions much like a modem but uses electronic rather than optical technology to compensate for dispersion in optical networks. eDCO dynamically adjusts the modulation of individual wavelengths to overcome the inherent physical limitations of fiber and enable fiber spans of more than 2,000 km. eDCO significantly reduces the cost and complexity of optical transport networks by eliminating 100 percent of the optical compensators and nearly 50 percent of the optical amplifiers.

NETWORK TRANSPARENCY

The third challenge in achieving true broadband involves designing systems where users and applications have a continuous presence on the network, able to seamlessly move across multiple networks without interruption—even enter and exit the enterprise network or the residential network and cross over to the carrier network.

Customers and vendors see network transparency as the new mobility frontier but recognize that there are many technical and business challenges to be solved. Near-term technical challenges include a reduction or mitigation of hand-off time between different networks and inter-network security. Network convergence in a Hyperconnected world will also take reliability needs to the next level, requiring very fast recovery times and low end-to-end latency to support such real-time services as voice and video, and certain classes of sensors and actuators.

Nortel's fixed-mobile convergence (FMC) solution provides services to a single device over multiple access types, including cellular (GSM, UMTS, and CDMA) and wireless broadband IP (WLAN and WiMAX). Breaking the link between the phone number, network, and device in this way increases reachability and productivity for users, while controlling and simplifying communications. Nortel's FMC solution also supports emerging 4G technologies, including WiMAX, LTE, and UMB.

Meeting the needs of Hyperconnectivity, however, must also go beyond simple convergence. Other areas that must be considered, and where Nortel has active R&D programs, are:

- providing a consistent service across multiple networks through common "middleware" frameworks like Service-Oriented Architectures (SOAs) and IP Multimedia Subsystems (IMS). Both are discussed in more detail in the next section of this paper;
- achieving a common management/OAM framework across different technologies and networks for such administrative functions as common billing, auditing, and decision-support functions; and

- ensuring inter-network security. This includes comprehensive configuration management and endpoint security for the many diverse devices and applications connected to the network; media security to protect critical data in transit; virtualization and peripheral security to logically separate different forms of traffic over a converged IP network; and core network security to provide another layer of defense against new forms of attack. Coordinating and rationalizing the many different security systems, architectures and technologies across carrier and enterprise networks will be critical.

INDUSTRY TRANSFORMATION #2: COMMUNICATIONS-ENABLED APPLICATIONS

To deliver on the promise of Hyperconnectivity, however, it will not be enough simply to provide a seamless broadband experience at the infrastructure level. We must also fundamentally transform—essentially unify—the communications experience at the applications level so that it is seamless across devices, networks, applications, and enterprise boundaries.

A key to doing this will be marrying the capabilities and intelligence that exist today only in the telecom network with the rich world of IT applications to create a new type of application—a "communications-enabled" application. These applications include what may be called "environmentally aware applications" that incorporate real-world information received from network-attached sensors and act on them appropriately.

A communications-enabled application will bring together all communications services—including voice, IM, video or network services such as conferencing, location, presence, proximity and identity—into the total applications experience. These applications will essentially leverage the capacity, sophistication, and intelligence inherent in a true broadband network and make that power available to the range of existing—and new—business applications and processes.

Consider this simple example of a communications-enabled application: An insurance agent, working on a client's file with the customer, notices that the policy has been changed by an associate. To get clarification on this change, the agent instantly sees that the associate is online and available, through presence information embedded in the insurance application. The agent then initiates a call with the associate directly from the application and is therefore able to rapidly address any questions raised by the customer.

A more sophisticated and complex example could be the following: John, traveling on business, checks into his hotel room and immediately his RFID badge communicates with the room's location sensors. He scans his thumbprint into the room's scanning device to complete a short authentication process. Instantly and invisibly, the network adapts to John's personal preferences. The room's phone is automatically personalized with his service set, the television with his favorite programming and movies, and the in-room PC with his customary applications environment, security requirements, and any other preferences. The moment John leaves his room, all calls are automatically forwarded to his mobile device.

Communications-enabled applications like these will help eliminate one of the biggest barriers to business productivity in enterprises today—human delay in business processes. The root issue for human delay is that applications are not aware of communications environments, most of which are not integrated. Workers have multiple passwords or identities, each linked to a specific location and device. For example, our phone number at work is tied to our desktop phone. Our mobile number is linked to our mobile device. We have separate access for multiple email accounts—work vs. personal—and instant messaging—Yahoo or AOL vs. corporate messaging services.

The integration of IT, telecom and business applications will eliminate the barriers to productivity that exist today and enable enterprises to dramatically speed and automate their processes. The ability to deliver the right information to the right people at the right time, in minimal time, will enable faster and better decision making and enhance agility and adaptability. In a hyperconnected world, applications that are not enabled by networks and communications will be inadequate; networks that know

nothing about applications will be irrelevant.

At Nortel, our goals, and the focus of our development programs, are to:

- remove barriers and unify all types of communication and applications into a single, simple-to-use, secure, and powerful experience that is transparent across devices, networks, and applications;
- drive complexity out of the IT world by reducing the number of separate networks and separate technologies needed to provide a simple and effective user experience;
- extend the unified communications experience beyond the enterprise to include the supply chain and customers, which will multiply productivity exponentially;
- bring about a dramatic jump in value for enterprises and carriers of all types, as well as consumers; and
- transform the way people communicate and collaborate today, and invent entirely new and more productive experiences.

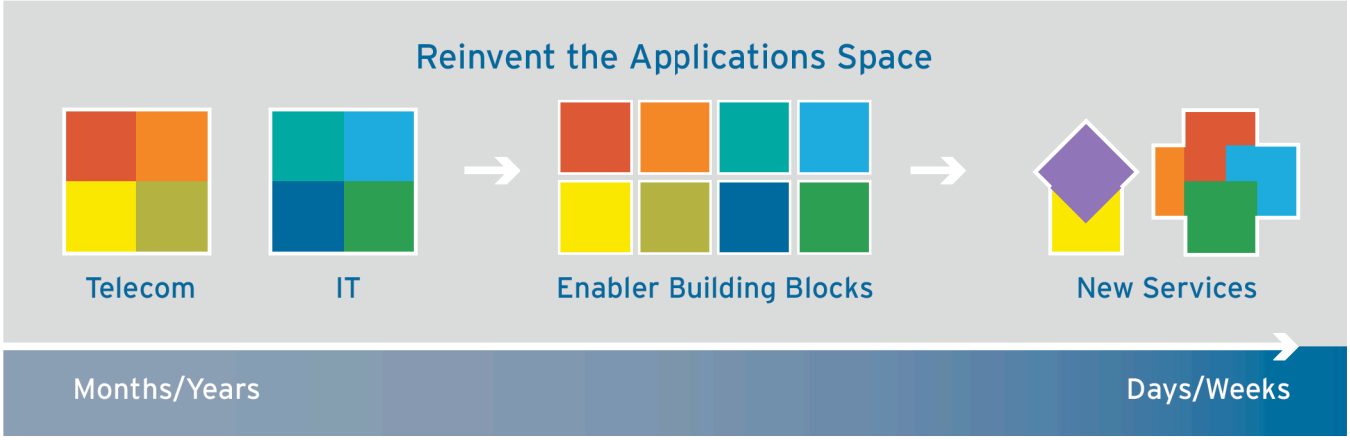
Reinventing applications to become communication-enabled requires expertise in three key areas: 1) in the network transport and signaling systems to expose the communications capabilities of the network infrastructure; 2) in the middleware layer to link these capabilities to the business applications; and 3) in applications and partnerships to build the communications intelligence into the applications such that they leverage the power of the network.

A critical first step in this reinvention is to translate the functions of IT applications and in all existing types of networks today, along with their myriad idiosyncratic protocols, into a common "language," essentially creating a toolkit of common building blocks usable by any applications developer. Achieving this universal "language" is vital in a hyperconnected world, where users will expect to rapidly, easily and dynamically assemble new services that enable any number of devices, machines, applications or business processes to interact, regardless of the legacy infrastructures, control and signaling processing, or protocols already in place.

This is the premise behind such architectures as IMS and SOA, which set out frameworks for abstracting the underlying capabilities of different "worlds" – whether wireless and wireline, or telecom and IT—into a library of simple functions that can be easily mixed and matched to form new types of services that operate in all worlds. In the case of IMS, this carrier-driven framework abstracts the functions of fixed and mobile networks, enabling users to establish sessions that bridge both. Similarly, SOA is an enterprise-driven architecture for bridging across various enterprise applications. SOA, however, was never designed to leverage the communications capabilities of networks and therefore must be enhanced and extended to handle highly complex and highly personalized real-time sessions, at a very high scale and across all network, application and device types.

IMS is an important platform in the carrier space that is considered by a diverse set of network operators and standards development organizations worldwide as the architecture of choice for delivering real-time multimedia services over next-generation converged infrastructures. At the heart of IMS is Session Initiation Protocol (SIP), a standardized signaling protocol that specifies the creation, modification, and termination of multimedia sessions. IMS plays a key role in adapting the fixed and mobile network infrastructures to be device, application and access-aware, "opening up" the communications capabilities to make them more accessible to the business applications.

Despite the widespread acceptance of the basic IMS architecture, extending and adapting IMS to become the converged network architecture of choice for seamless operation of any service, across any access type, raises a number of challenges. These challenges include: policy control to direct the network to behave appropriately and apply the right resources for each traffic type; architectural alignment to ensure the adaptations to support the requirements of each access type do not diverge such that networks do not interwork; and services consistency to



ensure parity of existing legacy services as well as services consistency across all domains, with equivalent functionality, reliability and quality.

IMS will be an important carrier platform for a hyperconnected world. At Nortel, we are well positioned to lead in IMS because of our real-world experience in all key IMS pillar technologies, including VoIP, SIP multimedia and wireless IP core networking. Nortel's IMS solutions have been tested with a number of services, including IM, presence, VoIP, videoconferencing, video sharing, PoC, file sharing, collaboration, IPTV, VCC (Voice Call Continuity), video surveillance, unified messaging and multi-player gaming.

In particular, Nortel has the largest number of contributions to the standardization of VCC, a SIP-based handover technology that provides seamless voice call continuity between any cellular technology and any VoIP-capable wireless access network. VCC, currently under development in 3GPP R7, extends an IMS network to cellular coverage, addresses handover between WLAN and cellular, and provides for the use of a single phone number (for SIP identity).

While the industry is largely still in the early trial stage and IMS standardization activities are ongoing, Nortel has already amassed significant experience in deploying and trialing IMS-based solutions with customers around the world and across all network environments. In addition, Nortel has already gained many years of experience in deploying IMS-like capabilities with its Multimedia Communication Server (MCS) and Communication Server (CS 2000) products. While these products are considered pre-IMS due to IMS standards being immature, they are based on Session Initiation Protocol (SIP)—the signaling protocol at the heart of IMS. Nortel currently has some 500 operators around the world with pre-IMS deployments that could migrate toward IMS.

As IMS further evolves, Nortel will continue to build on its leadership and innovation to allow operators to leverage the intelligence, flexibility and richness that IMS offers.

Services-Oriented Architectures (SOAs): While IMS is an innovative technology that enables the decoupling of applications and services from the network infrastructure, SOAs will fundamentally change the way in which applications interact with the network. SOA, which applies equally to IMS and enterprise environments, will change the very framework of how we develop, test and deliver applications and services to users.

Today, most vendors develop products by combining multiple capabilities into a single system. For example, a PBX may include voice services, voice mail, audio conferencing and contact center functionality. In an SOA environment, applications and telecom capabilities become individual, modular components that can be reused, reassembled, or combined with other components and then orchestrated into workflow processes that connect people and business processes.

In essence, SOA is the "middleware" through which network capabilities (such as presence, proximity, identity

management, quality of service, security, session management, etc) and advanced services (such as multimedia customer interactions, click-to-call, presence-based call-backs and natural-language-based self-services) can be tied together with business applications (such as those available from Microsoft, IBM, SAP and Oracle)—which is the core of what unified communications is all about.

The focus on SOA has grown dramatically in the past few years, principally driven by such web services efforts as .NET from Microsoft, WebSphere from IBM and many others. But there is still much more to do to really leverage the interplay that could be possible if the network and applications could interact more fully. In many cases, for example, these architectures consider the network as a "cloud" of transport and nothing more. This approach is very shortsighted given that future applications will take advantage of network intelligence. Moreover, if the role of the middleware is to create the richest foundation possible for those applications, then the middleware must also interact as much with the network as it does with the applications.

And that is where Nortel is focusing significant effort. We are working directly with SOA framework providers, such as Microsoft and IBM, as well as with the standards development community, to accelerate the evolution of SOA through the development of technology that will integrate the communication capabilities of the telecom world with business processes and applications. For example, Nortel and Microsoft have formed a strategic alliance, the Innovative Communications Alliance, based on a shared vision for unified communications. At the same time, Nortel and IBM have been working together to accelerate enterprise transformation through communications-enabled applications.

Context-aware applications: In addition to SOA and IMS, several other technologies are critical to communications-enable applications. Most notable are those that will provide "context"—any information that can be used to characterize the situation of an entity, whether that's a person, place, or object/machine. Primary context information is location, identity, proximity and presence.

To harness Hyperconnectivity and improve the way we work and communicate, we need to distill the flood of data that will be available into information relevant to our tasks—into "context." We then need to apply this context to enhance application mobility and collaboration, creating a seamless experience. The goal of context-aware services is to create a fluid, natural and intuitive user experience that is transparently optimized to business and personal needs, in a system that invisibly adapts to different networks, devices and environments.

Nortel, for instance, is currently working toward context-aware seamless services integrated with workflows. Initial prototypes have integrated precision location, RFID, sensors, and alarms inputs with communications systems for various business scenarios. Recent explorations include the use of role-based information in improving communications, and ongoing development of a collaboration server for emergency events.

Nortel's strengths in a wide range of intelligent networking technologies, together with its experience in large-scale network deployments, and expertise in signaling, management systems and real-time applications, is helping to drive innovation in this evolving market and to accelerate the realization of a truly unified communications experience.

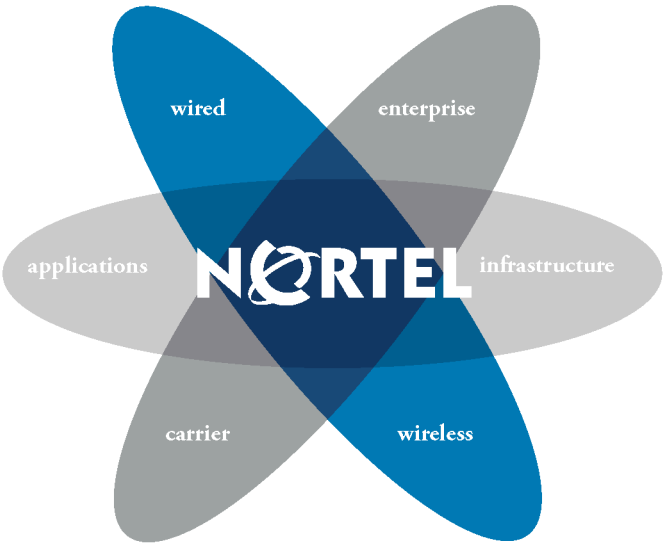
PARTNERING TO LEVERAGE THE STRENGTHS OF OTHERS

Nortel is also working to complement its suite of strengths with those of other industry leaders. Indeed, the right partnerships will enable the industry as a whole to more quickly address and solve the complex challenges of achieving Hyperconnectivity, roll out unique and highly valuable innovation for customers, and unlock the full potential of Hyperconnectivity.

While Nortel can provide a great deal of the infrastructure and signaling systems and some of the real-time applications and network intelligence, more is required for Hyperconnectivity—including such elements as interfaces, office productivity applications, and computing hardware, among others.

That's why Nortel is committed to creating a very rich and broad ecosystem that includes such industry leaders as Microsoft, IBM, SAP and Accenture; joint ventures (such as the LG-Nortel joint venture); and relationships with many of the largest carriers and largest applications providers in the world.

These relationships allow us to cross-leverage one another's strengths and capabilities, which is important because the next generation of telecommunications will not simply be about an individual company trying to do it all. The telecommunications and IT industries are converging, and most future problems will be solved by a coming together of applications, telecom, communications, networking, and services functions.



THE NORTEL ADVANTAGE: CROSS-DOMAIN EXPERTISE

Tackling these industry transformations to Hyperconnectivity—achieving true broadband and communications-enabling IT applications—will require a special blend of expertise that is rare in our industry. The required expertise must cross multiple domains: carrier and enterprise, applications and infrastructure, wireless and wireline.

Nortel has both the pedigree and experience to undertake this challenge. For one, it has broad multispectrum expertise across all these domains and fully understands the synergies across them. It has the tools, from technology innovation itself to a strong solutions focus and proven customer engagement to business planning processes. Nortel also has significant experience in delivering services and in solving the new, hard challenges of these industry transformations. And, the company understands the needs of its customers, recognizing that customers don't have infinite capital, that they can't simply "rip and replace," and that they need an evolution plan that allows them to reuse and derive continued value from their existing network investments.

Moreover, with a 10,000-person-strong Global Services organization tightly aligned to our technology initiatives, Nortel is working hand-in-hand with customers and channel partners to ensure that their networks are deployed, managed and evolved to meet the challenges of Hyperconnectivity. Whether it's an outsourcing arrangement, a collaborative service, or consulting services, this relationship allows enterprises and operators to focus more on their business and less on the technology supporting their business. Global Services, in fact, is an area where Nortel brings significant leadership. Through this team, Nortel already runs many of the world's largest and most mission-critical networks. As well, this organization operates Nortel's own enterprise network, one of the most advanced converged networks in the world—a showcase for what convergence and, now, Hyperconnectivity can make possible, and a real-life environment for gaining insights into solving the key challenges ahead.

NORTEL'S MISSION: BUSINESS MADE SIMPLE

As Nortel pursues both of these industry transformations—true broadband and communications-enabled applications—it will be vital to stay focused on reducing network complexity and achieving simplicity. If we think about the hyperconnected future where large, complex, heterogeneous networks support a hugely diverse range of attached end systems and applications, simplicity will matter more than it ever has in the past.

That's why we are focused on making it simple for our customers to capitalize on the transformations that

will drive our industry and realize the possibilities of Hyperconnectivity. This is our Business Made Simple value proposition. Much more than a tag line, Business Made Simple is the fundamental principal behind all of our initiatives. That focus, we believe, will be critical to ensuring that the technologies and solutions we develop will combine to deliver a truly transformed communications experience, and it will be vital to realizing the full benefits and opportunities of Hyperconnectivity.

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Nortel is a recognized leader in delivering communications capabilities that enhance the human experience, ignite and power global commerce, and secure and protect the world's most critical information. Our next-generation technologies, for both service providers and enterprises, span access and core networks, support multimedia and business-critical applications, and help eliminate today's barriers to efficiency, speed and performance by simplifying networks and connecting people with information. Nortel does business in more than 150 countries. For more information, visit Nortel on the Web at **www.nortel.com**.

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