



White Paper

Five imperatives for data networking in a hyperconnected world

Hyperconnectivity is a mega-trend — a phenomenon through which everyone and everything that can benefit from being connected to the network **will be connected**. A recent issue of the *Economist* had a special supplement titled “When Everything Connects,” re-enforcing this mega-trend and asserting that, in the near future, wireless “will vanish entirely from view” — omnipresent, and yet so finely woven into the fabric of our lives that it’s invisible.

Hyperconnectivity is already a pervasive presence in the consumer space, as evidenced by the proliferation of networked music players, digital cameras and gaming consoles. While increasingly connected over a variety of network connections, the hyper-connected user still has to deal with multiple devices, multiple numbers and names, multiple inboxes and multiple security environments.

These challenges, though, are now being addressed within enterprises by what the industry calls unified communications, providing a consistent and simplified user experience. Unified communications is the unification of presence,

real-time communications (IM, telephony, video conferencing and application sharing) and near-real-time communications (email, voicemail, short message services) into a single user experience.

The potential of unified communications goes further still. The human delay inherent in many business processes can be streamlined through communications-enabled applications, allowing users to initiate unified communications sessions directly from within applications (e.g., presence-enabled applications) or through application-initiated unified communications sessions (e.g., IM notifications).

For enterprises, this is all about accelerating communications to gain a competitive advantage.

But the implications of Hyperconnectivity go beyond unified communications to an explosion in network-connected devices — for example, in the realms of energy and property management, asset and location tracking, telemetry and enhanced security systems. This is enabled by low-cost sensors and actuators that can detect over 100 different physical parameters, including temperature, radiation levels, door closures, visual and audio signals, and location — and that can cost-effectively transmit this information.



Take, for example, an enterprise with 1,000 employees. Its IP network will eventually have to support 10,000 to 100,000 network-connected devices that are integrated into various business processes. The heating, ventilation and air conditioning (HVAC) system of one particular hospital has 30,000 IP addressable points. Research conducted at the University of California, Berkeley estimated that 30 percent of North American energy consumption is in HVAC systems. A 25 percent reduction in energy use through sensor-controlled HVAC could have significant bottom-line implications. These savings can be complemented by passive and active radio frequency identification (RFID) in a broad range of form factors that can be used for people and asset tracking and management.

Clearly, CIOs need to engage their business owners to understand Hyperconnectivity-enabled business opportunities.



Fast forward now 15 years, to a time in which, according to a professor at MIT, there will be a trillion devices connected to the network, and most of them will be wireless. Hyperconnectivity will drive massive increases in network scalability and make the enterprise more dependent on its network than ever before.

The sheer number of devices on the network will complicate life for network IT professionals in a number of ways. For example, meeting reliability, security, bandwidth and latency requirements will be critical challenges going forward. Scaling the network by a factor of 10 to 100 can't be achieved within current budgets without fundamentally streamlining current networking environments. Hyperconnectivity demands simplification. But how will CIOs simplify their networking environments while delivering superior price and performance?

This technology white paper defines five building blocks for Business-Optimized Networks that CIOs must confront in order to successfully navigate through the Hyperconnectivity minefields while delivering a business advantage.

Five building blocks for Business-Optimized Networking

1) Converge and scale your core around resilient IP/Ethernet.

This building block starts with convergence and includes four key areas: architectural simplification, real-time reliability, network capacity and Power over Ethernet (PoE) access.

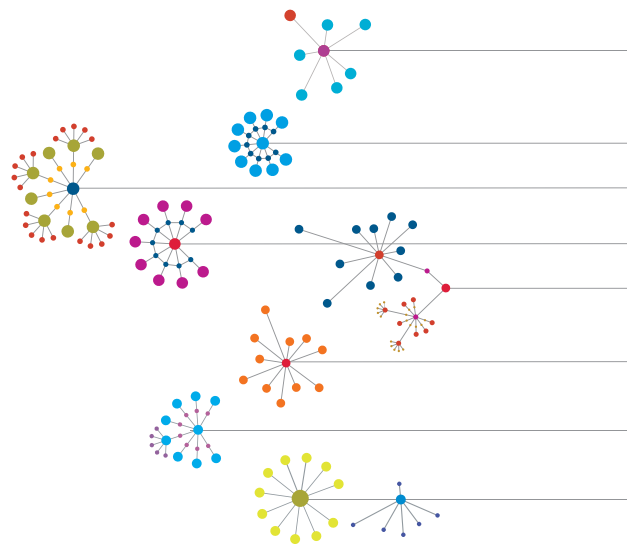
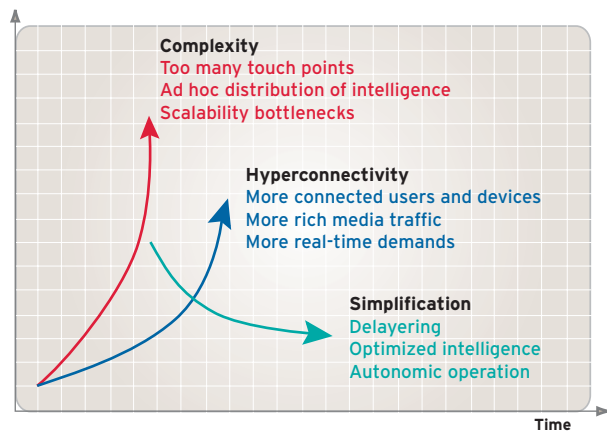
Network convergence remains the pivotal strategy in the hyperconnected world, with all users and devices connected via IP and Ethernet. This results in optimal price/performance, with a single network to manage, operate and secure.

However, current architectures often result in three-layer campus networks (with access, aggregation and core layers), with Layer 3-7 intelligence permeating across these layers (“the network is the platform” model). Given that traffic patterns in a hyperconnected environment will continue to direct the vast majority of traffic to the core, the network can be simplified by concentrating Layer 3-7 intelligence in the core and only moving intelligence to the access layer when there is demonstrable value in doing so.

Table 1. Transformational opportunities arising from Hyperconnectivity

Area	Transformational opportunity
Personal productivity	Consistent quality of experience across devices and modes of communications
Group productivity	Shorter time to product, service and problem resolution through rich collaboration, reaching experts wherever they are
Enterprise productivity	Accelerated business processes through communications-enabled applications, eliminating human latency
Asset utilization	Energy efficiencies through building management systems; lower costs through asset tracking systems; lower risk through enhanced security and compliance and better governance
IT effectiveness	More for less through software-centric unified communications solutions, IT simplification and autonomic systems

Figure 1. Hyperconnectivity demands simplification



For example, with 80 percent of LAN investment in the wiring closet, it makes sense to keep the LAN edge as operationally simple as possible while striving to achieve the lowest cost per port to support security and traffic management functionality requirements. Operational simplicity increases nodal reliability in an environment in which port redundancy is not generally an economic option. In addition, in many cases the aggregation layer can be eliminated by leveraging optical uplinks, resulting in a flatter, simpler architecture. Price/performance can be optimized by leveraging Ethernet networking in the access layer and can be extended between sites leveraging metro Ethernet networking.

Hyperconnectivity will, as stated above, make the enterprise more dependent on its network than ever before. Real-time unified communications traffic and enhanced or new device-enabled applications will drive the need for real-time reliable networks with extremely fast restoration times to avoid impacting these applications when failures occur. This starts with hot-swappable redundant switch architectures. Uplinks between layers should be dynamically load balanced with failure recovery in the

sub-second range. For example, Nortel's switch-clustering architecture, leveraging its multi-link trunking technology, delivers sub-second failure recovery with dynamic active-active load sharing and is used in mission-critical environments and in metro Ethernet networks.

According to tests undertaken by the Tolly Group, Nortel's architecture recovers four times faster than comparable solutions from Cisco.

With Hyperconnectivity, there will be potentially huge increases in aggregate/peak capacity needs. This will be driven by richer web content, multimedia unified communications clients and IP video surveillance devices. Taken individually, most network-connected devices, such as sensors, won't generate a lot of traffic — but together, particularly during peak times (e.g., when the HVAC is initially turned on), they will be significant traffic generators. For example, when implemented at the item rather than pallet level, RFID readers will be scanning hundreds or thousands of tags when a truck enters the warehouse. At larger sites and data centers, these devices will drive demands for

10-Gbps and greater uplink capacities and aggregate switching capacities in the terabit range. To optimize investments, all links should be provisioned to allow fully dynamic Ethernet-based load balancing across links, without the need for configuration-intensive traffic manipulation (e.g., using multiple configured virtual LANs or equal-cost IP routing protocols).

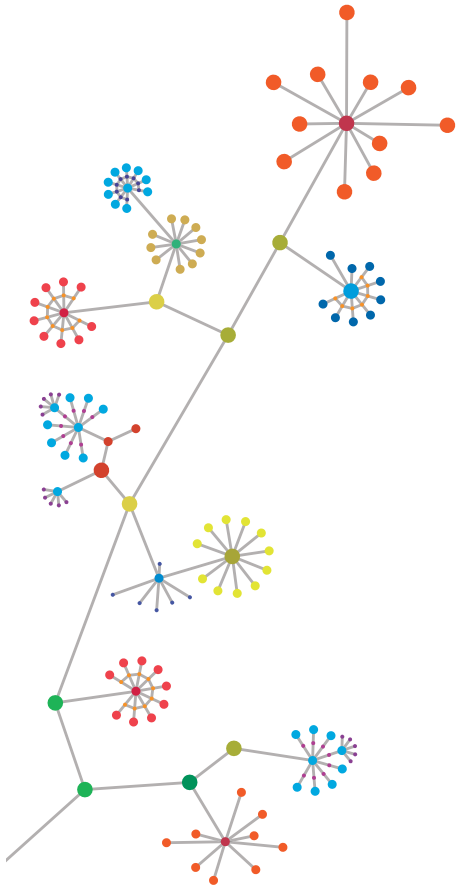
Nortel's Ethernet switch clustering technology delivers in excess of a terabit in capacity.

Power over Ethernet over 10/100/1000 Mbps wired connections will play an increasingly important role in the hyper-connected world due to the simplification and reliability associated with powering devices such as IP phones, Wi-Fi access points (APs) and IP video surveillance cameras. Enterprises should establish back-up power strategies commensurate with their business needs. For example, policies need to be established on how much power is provided, how long the power is supplied in case of failures and which devices should be supported.

To ensure success:

- ✓ Keep your network as simple as possible by concentrating intelligence in the core.
- ✓ Plan for exploding bandwidth demands by offering GigE to the desktop and 10GigE uplink and core switch capacity.
- ✓ Run unified communications and IP telephony with advanced resiliency technologies such as Nortel Switch Clustering.
- ✓ Power VoIP handsets, WLAN access points and security devices with stable and redundant-capable Power over Ethernet.

Nortel has shipped over three million PoE-switched Ethernet ports and is the first vendor to offer true stackability across 10/100/1000 Mbps Ethernet.



2) Extend and simplify access to the multisite enterprise.

Hyperconnectivity isn't restricted to campus or extended-campus sites. A CIO needs to consider how end users and devices can connect reliably, securely and with optimal performance at remote sites to enterprise communication and application environments. This building block includes two key areas: unified communications-integrated branch platforms with unified communications centralization and wireline performance.

According to studies conducted by Nemertes Research, today's average branch offices and remote sites have as many as seven networking devices. These might include Ethernet switches, routers, VPN gateways, firewalls, WAN optimizers, PBXs and voicemail servers. A key building block is to simplify these environments through a combination of unified communications-integrated branch platforms and unified communications (including IP telephony and voicemail) deployed on a centralized basis. Unified communications-integrated branch platforms combine data and security functionality with survivable unified communications media gateways, thus significantly simplifying the branch environment while extending central site services and applications to remote sites.

The Nortel Secure Router is the only unified communications-integrated branch platform with embedded Microsoft intelligence to simplify unified communications deployment at the branch.

Delivering wireline performance for unified communications users and time-sensitive applications (e.g., telemetry) is a key challenge. A common aspect of both these environments is that packet sizes are much shorter than typical data applications, either to minimize latency or because there is little data to transmit (as would be the case with RFID). Maintaining performance for short packet flows is a significant challenge for conventional routers, particularly when various security mechanisms — such as firewalls, VPNs and access control lists — have been activated. In fact, in most router architectures, turning on security functions and handling short voice packets results in a drop of up to 80 percent in packet-handling capacity.

Nortel Secure Routers maintain wire-speed performance under short packet loads and are capable of delivering two to seven times the throughput of equivalent routers from the competition, including Cisco. — Tolly Group

To ensure success:

- ✓ Reduce WAN OPEX expenses by consolidating WAN routing, LAN switching, VPN, voice and security into a single device.
- ✓ Ensure that branch routers have wire-speed small-packet processing to enable toll-quality VoIP and unified communications.
- ✓ Ensure wire-speed performance of branch routers under the load of advanced services such as access control lists, stateful firewalls and IPSec VPNs.
- ✓ Integrate unified communications capabilities into the branch router to simplify software and device software management.

3) Mobilize with ubiquitous access to all users and devices.

With Hyperconnectivity, there will be 10 to 100 times more wireless Ethernet nodes — not just for Wi-Fi and dual-mode phones but also for a range of network-connected devices. The latter, even if stationary, may be best served through Wi-Fi. This building block includes two key areas: reliable wireless and true broadband everywhere.

Wireless will play an increasingly important role in this highly connected world, as the underlying cost per unit of wireless bandwidth drops, making wireless connectivity of an impressive variety of devices an economic reality for enterprises. The wireless LAN (WLAN) architecture must ensure rock-solid resiliency through dual-homed APs, dynamic load sharing across APs to optimally use available spectrum and comprehensive RF management and coverage to reach devices requiring connectivity. For extended coverage across open air spaces (e.g., across multi-building campuses), wireless mesh networks deliver reliable wider area coverage through dynamic routing.

Finally, to reliably support a proliferation of wireless devices, a path to higher-capacity 802.11n is a necessity.

The benchmark for quality of experience (QoE) for mobile users is the performance they experience when connected to their campus Wi-Fi networks. With Hyperconnectivity, the coverage of these WLANs needs to be expanded to include any areas where voice-over-WLAN users want to roam and wherever wireless connectivity is required. In WLAN hot spots (e.g., homes, hotels, coffee shops), QoE is limited in some cases by WAN connectivity speeds and traffic demands across

multiple users. Across the public network, third-generation (3G) cellular systems offer from tens of kbps to perhaps a couple of hundred kbps, with latency making them unsuitable for VoIP but suitable for many non-real-time applications (including asset tracking). However, QoE can severely deteriorate for real-time and high-volume applications, including VoIP and video. Even with less than five percent penetration of mobile video, these systems would grind to a halt. 4G wireless systems, including WiMAX, abandon the voice-centric architectures of earlier systems to provide a true broadband experience across an IP-centric architecture.

Nortel's patented radio and multiplexing technology was selected as the WiMAX standard because of its superior performance, with five times the efficiency of today's 3G systems and lowest cost per Mbps.

To ensure success:

- ✓ Provide WLAN coverage and seamless integration with existing networks.
- ✓ Ensure highly scalable wireless capacity.
- ✓ Ensure rock-solid resiliency and security from RF through management.
- ✓ Initiate dialogs with service providers regarding their plans for true broadband 4G wireless services.

4) Accelerate and optimize applications across the network.

With Hyperconnectivity, the diversity of traffic on enterprise networks expands significantly and includes latency- and bandwidth-intensive applications associated with person-to-person, person-to-machine and machine-to-machine communications. With so many traffic sources, applications may become bogged down, creating an opportunity for network intelligence to make these applications run better, faster and more reliably. This building block includes two key areas: real-time performance and application acceleration.

Nortel's unique WLAN architecture offers distributed forwarding to allow low-latency seamless roaming.

Delivering end-to-end real-time performance for unified communications users and for time-sensitive sensor/actuator applications is a key challenge. Time-sensitive applications must operate within an end-to-end delay window (150msec for human communications, but potentially much less for telemetry). These applications can't tolerate packet loss because there's no time to retransmit. This drives the deployment of quality of service (QoS) and comprehensive traffic-management mechanisms to ensure that real-time traffic always receives priority treatment even in the presence of data traffic bursts. While achieving this across the bandwidth-rich LAN environment is relatively straightforward, doing it across WLANs additionally requires low-latency seamless roaming and application-based load balancing. Achieving real-time performance across the WAN mandates the elimination of speed bumps when crossing the MAN and the WAN by leveraging carrier-grade Ethernet.

Application acceleration serves as the foundation for providing application access at LAN-like performance across WANs, MANs and the Internet. Application acceleration delivers business continuity for applications, increased server utilization and greater scalability. Various application-acceleration techniques should be applied, including SSL server offload, connection pooling through multiplexing of multiple client connections to a single server connection, selective compression of HTTP traffic, browser and HTTP/FTP/DNS proxy caching, fast redirect eliminating additional round trips to receive and then process and TCP acceleration. Application acceleration — integrated with enterprise policy and deployed at data centers — can optimize performance and greatly simplify the enterprise environment, enhance business continuity, improve user productivity, increase server performance and utilization, and decrease WAN bandwidth.

The Nortel Application Accelerator can deliver up to 30 times improvement in WAN performance for web applications and is optimized, tested and preconfigured for IBM® Websphere, Microsoft® Outlook Web Access (OWA) and SharePoint.

To ensure success:

- ✓ Provide application access at LAN-like performance across WANs, MANs and the Internet.
- ✓ Prioritize mission-critical application traffic.
- ✓ Ensure business continuity, server utilization and server scalability by load balancing in your data center.

5) Secure and manage the resulting infrastructure.

One of the greatest impacts of Hyperconnectivity is in the security management area, and in the management area overall. This building block includes two key areas: layered defense and autonomic networking.

Layered defense ensures that there are no single points of security failure in a network. This is accomplished by using multiple approaches to security enforcement in different parts of the network, operating under enterprise-wide policies. Layered defense is further bolstered by adopting an open security philosophy that embraces partnerships and an ecosystem leveraging security leaders such as Symantec, CheckPoint and SourceFire. Layered defense in a hyper-connected networking environment must provide highly scalable capabilities, including pervasive end-point security for such diverse devices as mobility and integration with Microsoft NAP, media security to protect critical multimedia data in transit, virtualization and accelerated perimeter security to logically separate different forms of traffic over a converged IP network, and core network security incorporating dynamic threat protection and real-time device vulnerability fingerprinting.

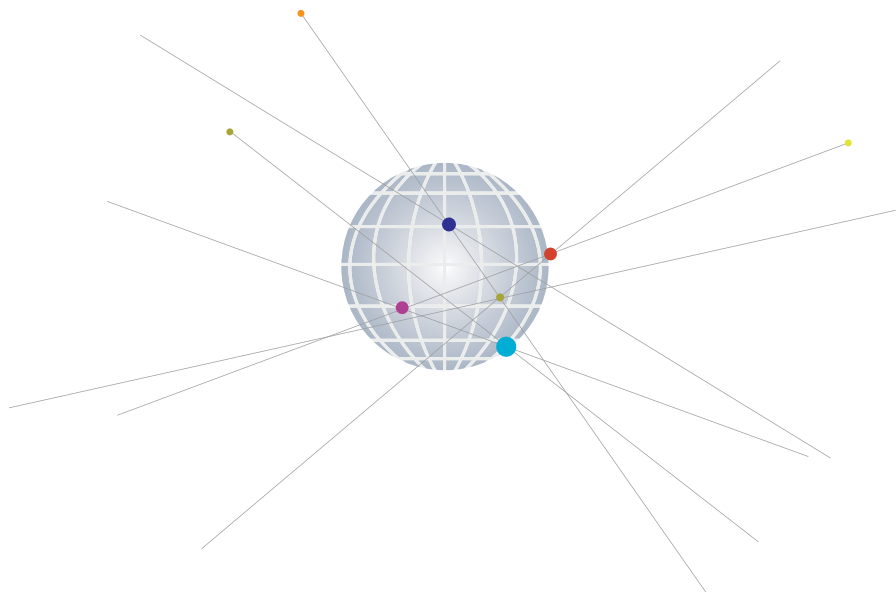
“This end-to-end security capability was a very significant ‘other thing’ that puts Nortel over the top of the Avaya/Cisco products the company looked at. We were most impressed with the way the security capabilities surrounded the entire Nortel [infrastructure].”

— The New York Times

Hyperconnectivity demands simplification, with less human intervention and fewer demands for IT skills. On the management front, the answer lies in the longer-term deployment of truly autonomic networking. Autonomic networking is a vision for building self-managing converged data networks that can dynamically adjust to changing conditions to optimize network performance and application/user QoE.

Autonomic networks are:

- > **Self-configuring:** Automatic configuration and reconfiguration of network elements according to policy
- > **Self-healing:** Automatic fault detection, correlation, diagnosis and remediation according to policy



- › **Self-optimizing:** Automatic continuous monitoring of the performance and the dynamic adjustment of QoS mechanisms according to policy
- › **Self-protecting:** Dynamic detection of new attacks, and isolating these attacks to limit business impact

A key technology is to leverage Service-Oriented Architecture (SOA) techniques to bridge configuration, policy, governance and SLA-management business applications and processes with the operation of the IT infrastructure, including the network, servers and storage.

Nortel's switch-clustering technology provides dynamic load balancing and very fast autonomic recovery from failures, while Nortel's Intelligent Traffic Management system autonomically drives Symantec threat profiles into the network.

To ensure success:

- ✓ Implement a pervasive end-point security strategy.
- ✓ Ensure scalable and consistent multimedia and mobile security.
- ✓ Establish an open security philosophy that embraces partnerships and an ecosystem (Symantec, Microsoft, CheckPoint, SourceFire, etc.).
- ✓ Partner with vendors who have a clear path to autonomic networking.

Conclusions

Hyperconnectivity is a significant inflection point in the industry, and it creates challenges and opportunities for enterprises. Unified communications will address the needs for simplified and more effective communications, and communications-enabled business processes will streamline business processes, while an extremely diverse set of networked devices will make businesses more effective. CIOs need to understand the implications of Hyperconnectivity on the enterprise network and rethink their strategic IT plans, tightly linked with the objectives of the business.

Nortel understands the challenges faced by enterprises in the hyperconnected world, and is focused on delivering lower TCO, increased employee productivity and stronger customer engagement through:

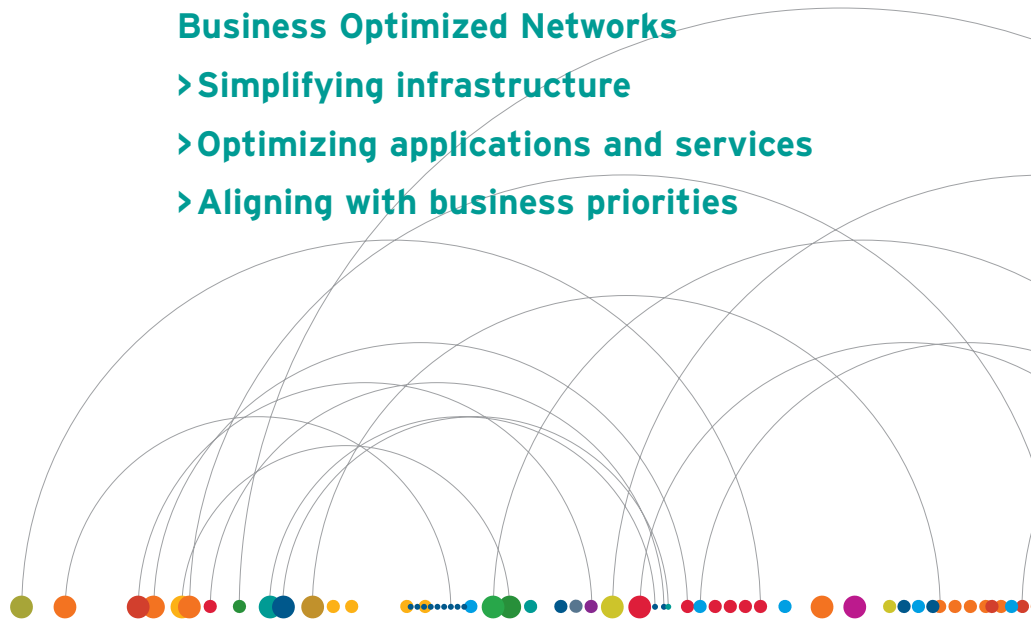
- › Ultra-reliable autonomic IP, Ethernet and optical networking that span data centers, campus sites and remote and branch offices

- › Fully featured real-time unified communications systems, including IP telephony, working with strategic partners Microsoft and IBM
- › Secure on-site and off-site mobility through “true broadband” wireless networking
- › More engaging customer service applications, including advanced speech self-serve and agent-assisted contact centers
- › Endpoint, perimeter, core and communications security systems
- › Service and network management
- › Professional services

Hyperconnectivity is driving a new era in enterprise networking. The five building blocks defined in this white paper — converge, extend, mobilize, accelerate and secure and manage — are intended to help senior IT executives address the scalability, security and performance requirements of the hyper-connected enterprise, and provide a sound foundation on which to enable an enterprise's transformation.

Business Optimized Networks

- › Simplifying infrastructure
- › Optimizing applications and services
- › Aligning with business priorities



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Nortel is a recognized leader in delivering communications capabilities that make the promise of Business Made Simple a reality for our customers. Our next-generation technologies, for both service provider and enterprise networks, support multimedia and business-critical applications. Nortel's technologies are designed to help eliminate today's barriers to efficiency, speed and performance by simplifying networks and connecting people to the information they need, when they need it. Nortel does business in more than 150 countries around the world. For more information, visit Nortel on the Web at www.nortel.com. For the latest Nortel news, visit www.nortel.com/news.

For more information, contact your Nortel representative, or call 1-800-4 NORTEL or 1-800-466-7835 from anywhere in North America.

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