Nortel Networks Forges Broad IP Telephony Strategy for Enterprise Nets

The Tolly Group examines Nortel Networks IP Telephony strategy for IP PBX solutions that delivers one network with uncompromised reliability, scalability and availability

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Table of Contents

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1. Choice Determines Destiny

The problem today, with so many vendors focused on delivering voice traffic alongside data on a converged IP backbone in enterprise networks, is that they write a rigid architecture prescription for convergence and then sit back and wait for users to implement it exactly as defined. Oddly enough, many users do just that without a thorough understanding of the long-term architectural impact of such a decision.

What these IP infrastructure vendors fail to grasp is that enterprise networks are as unique as the business units they serve. A rigid prescription for IP convergence in one business unit may be just the tonic that the doctor ordered, but it could be a bitter poison pill to other facets of the business.

Network architects, and the business units they serve, deserve more than leaving their convergence strategy to architecture rigidity. They deserve a convergence architecture that is based upon flexibility and choice. After all, according to the old business maxim, it is choice – not chance – that determines your destiny.

IT organizations moving to a converged world of voice, data and video really need an architecture that delivers choice, yet also offers a consistent experience to users no matter where on the network they reside. What's required is a unified network infrastructure that eliminates the boundaries between users, applications and network resources.

During April 2003, The Tolly Group dispatched a team of engineers/analysts to Nortel Networks' Belleville, Canada, facilities to examine the company's Succession 1000 IP PBX and its IP Telephony convergence architecture.

The Tolly Group inspected the Succession 1000 for a multitude of features, functions and performance — including call quality, reliability, effectiveness of management characteristics, usefulness of standard and advanced features, and availability characteristics.

Overall, the Succession 1000 impressed reviewers with the enormous flexibility offered by the Nortel Networks architecture. Nortel Networks Succession 1000 provides not one, but three migration strategies to cover the possible migration scenarios in the enterprise network – extend, surround and evolve. Extend the IP realm to existing Meridian 1 PBXs by IP enabling them; surround IP across your enterprise network by implementing Succession 1000 IP PBXs, or evolve

your IP network to rich multimedia applications over a converged IP infrastructure via deployment of the Succession MX application server.

This trio of migration strategies should appeal to traditional Meridian 1 clients when they are ready to move to converged IP nets, to classic PBX users who want to embrace IP networking, to Greenfield users ready to deploy converged nets, and to existing IP PBX users who want to embrace multimedia applications. The upside for users is that Nortel Networks provides options to enable clients to embrace IP Telephony at their own pace, while still maintaining functionality of previous PBX investments.

The Succession 1000 impressed reviewers with the investment protection it offers to installed bases of traditional PBX clients who need to merge their TDM devices into the IP-based PBX realm. And finally, reviewers noted the innovative features and functions that Nortel Networks has built into the Succession 1000 and how such capabilities will transform the way enterprise business units manage information and serve clients.

In-depth analysis of the Succession 1000 made clear also that the product architecture draws heavily on interoperability and openness with third-party gateways. Moreover, unlike some IP Telephony architectures – notably Cisco System's AVVID -- that bind users to the switch maker's IP switching infrastructure, Nortel Networks Succession is more open. Through its gateway strategy, Nortel Networks provides the mechanism to bring third-party devices into its converged network fold.

In the chapters that follow, The Tolly Group provides ample evidence that Nortel Networks' Succession 1000 is a distributed architecture for converging voice, data and video onto the same IP switching infrastructure while providing maximum flexibility and choice to end users.

2. Architecture for the Enterprise

Nortel Networks Succession 1000 is an IP-based platform that unifies voice and data onto a single, high-performance, QoS-enabled network infrastructure. Call and connection management are distributed across the network to guard against any single point of failure; switching is fully packet based, and management of voice and data is unified. And, with all the telephony features of a traditional PBX, and new innovative features made possible by IP technology, the Succession 1000 is an extremely elegant and scalable platform for enterprise networks.

Moreover, applications such as unified messaging, call center and interactive voice response raise the watermark for functionality by delivering capabilities that reshape the way end users conduct business with voice, data and even video.

What makes the Succession 1000 attractive to enterprise clients is the distributed nature of its call processing and the underlying IP infrastructure flexibility it delivers. Unlike some voice over IP architectures that bond IP Telephony call processing into the underlying switch fabric – such is the case with Cisco's AVVID – Nortel Networks Succession architecture distributes call processing and call setup onto signaling servers and call servers distributed across the network. These servers make use of an underlying IP switching infrastructure, but that network does not have to be a homogenous composition of Nortel Networks switches – unlike Cisco that takes a more invasive approach and basically dictates to users that AVVID traffic requires an underlying Cisco switching infrastructure.

What this means is that an organization with a heterogeneous switching infrastructure – perhaps with a Nortel Networks Passport switching core and other brand IP switches in remote access point locations – can layer IP Telephony call processing on top of the IP switching infrastructure.

Moreover, Nortel Networks approach to network and systems management delivers to users a cohesive platform of target management applications and high-level management platforms that pull together the real-time control of voice, data and video under a single management umbrella.

Regardless of what brand IP Telephony solution your enterprise elects to deploy, there are a handful of fundamental functions that must be provided that are common to all IP Telephony architectures.

Any enterprise IP Telephony solution should provide: call management, IP Telephony gateway service, Quality of Service mechanisms to ensure IP Telephony traffic is treated appropriately, PSTN (public switched telephone network) interfaces and voice mail/unified messaging. Arguably, network management and breath of applications should be considered in the mix, too.

Vendors may refer to these functions in a slightly modified fashion, but essentially the functions are the same: Call management delivers the functions previously available in black-box PBX systems, such as call routing, calls on hold, etc. The IP Telephony gateway provides the analog and digital TDM voice to packetized voice conversion using various coding/encoding techniques. QoS provides the facility to identify traffic types and apportion bandwidth according to policy parameters. The PSTN interface offers a link from the IP infrastructure to the public switched telephone network to provide both connectivity to the analog world as well as provide an alternate path in the event there is congestion or an outage somewhere on the converged IP infrastructure. And voice mail/unified messaging delivers value-added IP Telephony features/functions that are common to PBX systems.

In the case of the Succession 1000, management and applications mix to play an integral role, too. Nortel Networks management of the Succession 1000 strives to provide a uniform Web-based interface and rich set of capabilities for administrators to utilize anywhere on the network, or from a remote location. And Nortel Networks offers a broad set of applications for the Succession platform, too (See Chapter 6.).

The following subchapters detail the key architectural elements of the Succession 1000 and what roles they play in delivering highly resilient voice services and premium call quality to enterprise users.

2.1 Succession Call Server

The Call Server controls the call processing features of telephone sets and trunk interfaces in normal modes of operation; it can scale to support up to 1,000 IP phones and up to 432 analog/digital telephones. It also pulls double duty as a database server for synchronization of configuration information with all Media Gateways, the latter which can act as alternate Call Servers in the event the primary Call Server fails since Media Gateways contain an embedded form of the Call Server software.

The Call Server runs the VxWorks real-time operating system and resides on a single board where it performs call control, signaling and routing for all TDM and IP calls placed across the network. (The single-board Call Server uses chip-based memory rather than mechanical hard disks, which are more prone to failure.)

2.2 Signaling Server

This is an off-the-shelf single board computer from Intel that provides call control services such as registration of IP terminals and gateways, call control, IP address translation services, and bandwidth control. It also runs the VxWorks real-time operating system.

A trio of software modules reside on this device: a Terminal Proxy Server (TPS), a Signaling Gateway, and an H.323 Gatekeeper. The TPS module essentially is the IP station interface, providing registration, TFTP service, and bandwidth control and feature delivery to the IP stations.

Signaling Servers can be deployed in a redundant, load-sharing configuration for increased scalability and reliability of the TPS. Moreover, should both Signaling Servers become unavailable, phones will register with Succession Media Cards located in Succession Media Gateways. This provides tertiary redundancy for the Terminal Proxy Server.

The Signaling Gateway software module translates Nortel Networks IP Telephony protocols into H.323 to communicate with local H.323-compliant devices. The H.323 Signaling Gateway can also be engineered with redundancy on a separate Signaling Server.

The H.323 Gatekeeper software module resolves addresses unknown to the local Succession 1000 Call Server. Typically, a primary gatekeeper is deployed on a Signaling Server while alternate backups may be deployed in “hot standby” mode anywhere in the network. Additionally, other H.323 Gatekeepers may be deployed on local nodes in

"failsafe" mode in the event a primary and secondary gatekeeper becomes unavailable. This provides three levels of redundancy for the gatekeeper. Secondary and other backup gatekeepers automatically synchronize configuration data with the primary gatekeeper device.

2.3 Succession Media Gateways

Media gateways are the primary means to interface with all TDM lines and trunks.

Media gateways reside in a multi-slot chassis that contains a controller card (identical to the Call Server CPU card) with room for four gateway cards – trunk/line cards, application cards or Voice Gateway Media Cards. An extender chassis can be melded to the main chassis to expand to eight the number of cards supported, (in addition to the Gateway Controller).

2.3.1 Gateway controller

This card contains software that controls the interface and application cards equipped in the gateway; the gateway controller also can produce all of the hardware resources (tone, local switching and conference circuits), plus it can be pressed into service as an alternate Call Server if the primary Call Server becomes unreachable, since embedded software resides onboard.

2.3.2 Succession media cards

These cards come packed with digital signal processors (DSPs) to perform media transcoding between IP voice packets and TDM-based devices. Media cards also provide echo cancellation and compression/decompression of voice stream.

2.3.3 Trunk/line and application cards

These cards deliver a range of analog and digital interfaces. Also, application cards, such as CallPilot interfaces, can be housed in the Media Gateways.

2.4 Succession 1000 Branch Office

These gateways provide access to the PSTN and analog/digital line interfaces located at branch offices using the H.323 signaling protocol. Branch Office IP phones can be configured to register through a central (headquarters-based) Call Server but still connect to a local PSTN trunk through a locally routed direct IP media path, which also provides for survivability if the WAN connection goes down.

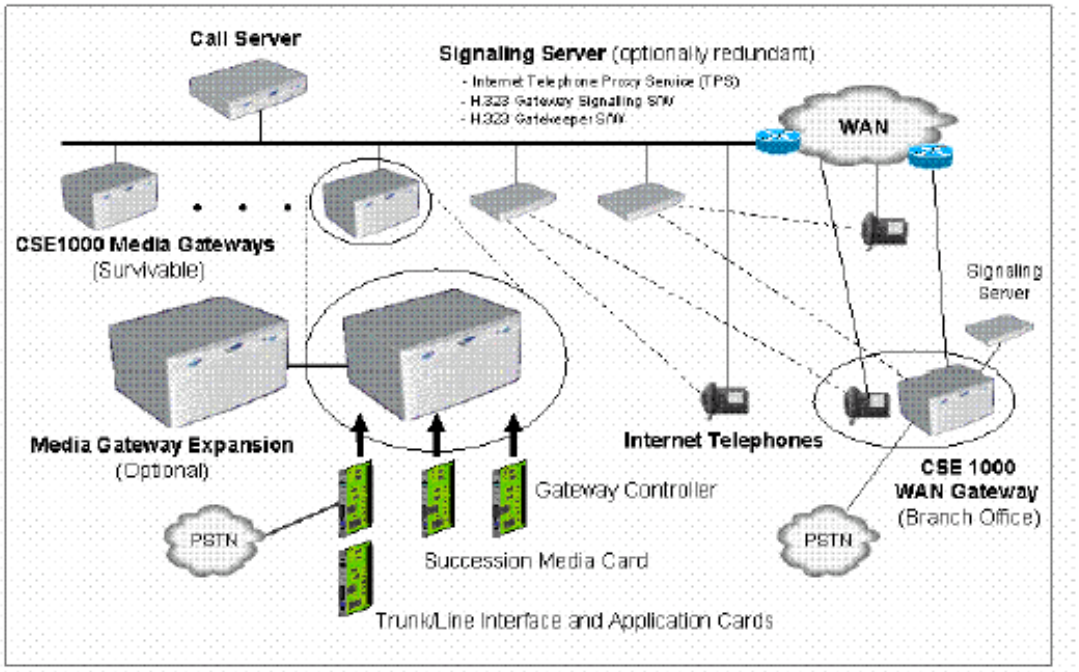

Figure 1. Succession 1000 architectural deployment

3. Performance – Call Quality and Scalability

Tolly Group engineers measured call quality of the Succession 1000 by using two common metrics to paint an accurate picture – the Perceptual Speech Quality Measurement (PSQM) and the Perceptual Evaluation of Speech Quality (PESQ).

PSQM represents an attempt to create an automated means for assessing objectively the quality of speech flowing across a telephony network. It measures the distortion of a speech signal taking into account the human perception and processing of speech. PSQM scores range from 0 to 6.5, where the lower the number the better the score. A toll-quality call is usually considered anything less than a 1.29 with a business audio quality score falling in the range of 1.30 – 1.59.

By contrast, PESQ is an enhanced perceptual quality measurement for voice quality in telecommunications. PESQ was specifically developed to be applicable to end-to-end voice quality testing under real network conditions, like IP Telephony, POTS, ISDN. With PESQ scores range from -1 to 4.5, with the high range representing a perfect score; a score of 3.8 or higher represents toll quality, with business audio quality falling in the range of 3.30 – 3.79.

Engineers measured the call quality and the one-way delay for three scenarios (See Figure 2.): (We set out to test call quality end to end with IP phones as end points but encountered interface limitations with the test tool used, so we instead moved to analog phones. In the end, this was more stringent since it introduced transcoding of the voice signal from analog to digital and back again.)

Scenario 1: Call quality was measured between an analog interface on a Media Gateway in the main office and an analog interface on an H.323 analog gateway (Quintum A400 H.323 FXS/FXO Gateway) residing at a remote site across the IP network.

Scenario 2: Call quality was measured between analog line interfaces on two different Media Gateways, one located in the main office and one located in a Succession Branch Office. The testing was conducted between analog interfaces on a Media Gateway in the main office across the IP network to an analog interface in the Branch Office.

Scenario 3: Call quality was measured between the two remote sites, (Succession Branch Office and the Quintum A400 H.323 FXS/FXO Gateway). Testing actually was conducted between analog interfaces on the Succession Branch Office Gateway across the IP network to an analog interface on the Quintum A400 H.323 FXS/FXO Gateway.

All traffic traversed the underlying IP network, comprised of Nortel Networks Passport 8600 core switches and Nortel Networks BayStack Fast Ethernet switches.

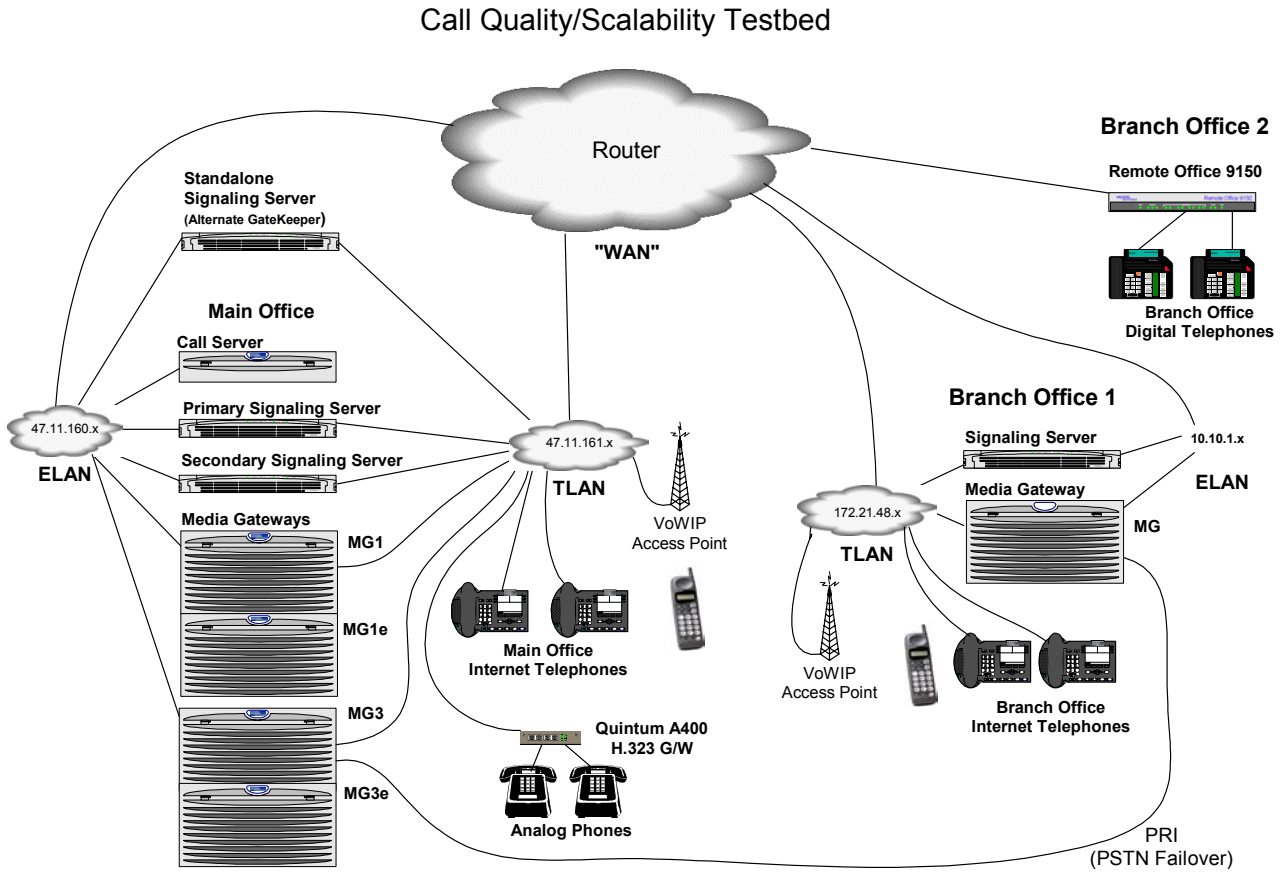

Figure 2. Call quality testbed

In each instance, Tolly Group engineers recorded three test iterations and determined an average from the three samples.

3.1 PSQM results

On the PSQM side, the Succession 1000 delivered excellent voice quality for two of the three scenarios and good "business-quality" voice for the remote site-to-remote site scenario. The Succession 1000 earned a score of 0.69 for the main office to remote H.323 scenario – well below the 0.8 threshold for excellent quality voice (lower numbers are better with PSQM). The Succession 1000 again demonstrated excellent voice quality when tested in the main office to branch office scenario, earning a PSQM score of 0.81 – right on the mark for excellent voice quality. In the branch office to branch office scenario, the Succession 1000 scored 1.23 – still within acceptable business quality audio limits. (See Figure 3.)

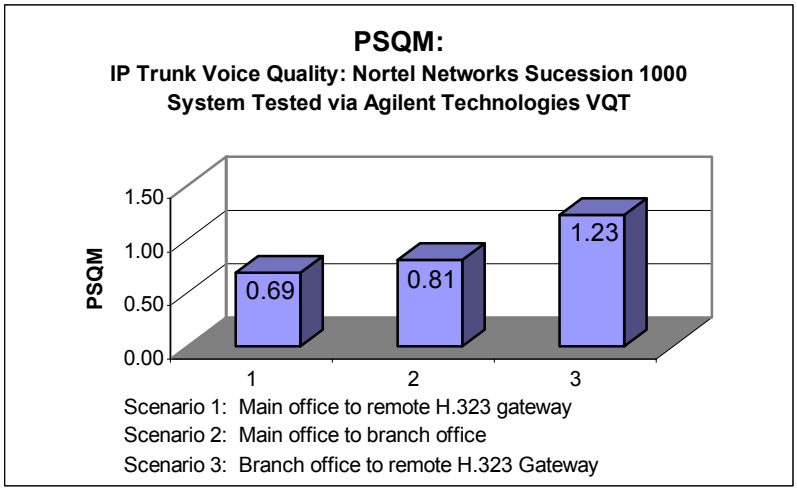

Figure 3. Call quality scores as measured via PSQM

3.2 PESQ scores

PESQ is considered a more objective arbiter of voice quality than PSQM, since it takes into account some element of delay. Consequently, Tolly Group engineers began to see a truer indication of the Succession 1000 voice quality levels. In each of the three test scenarios, when tested with PESQ, the Succession 1000 achieved a score higher than 3.8 – the threshold for excellent voice quality under PESQ. Scores of 3.8 to 4.5 represent excellent call quality with PESQ. (See Figure 4.)

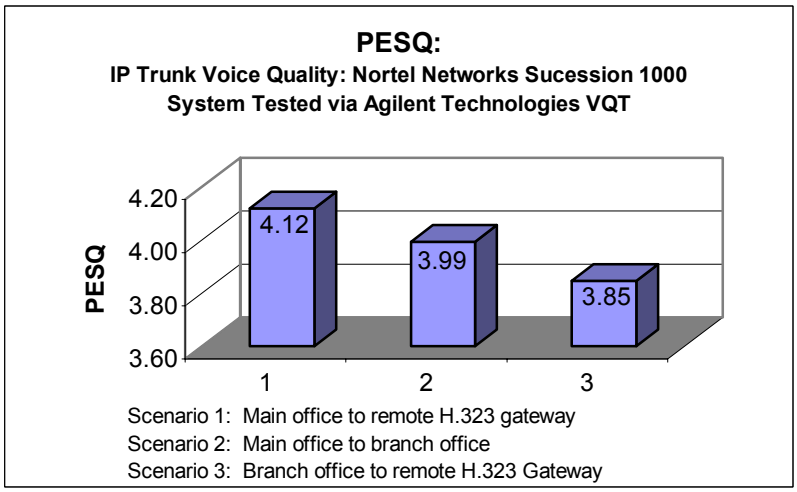

Figure 4. Call quality scores as measured via PESQ

3.3 One-way delay

Call quality alone is not the only important factor in measuring acceptable voice quality; latency, or delay, plays a pivotal role, too. For better voice quality, the less delay present, the better voice quality will be. Typically one-way delay should be less than 150 milliseconds. In tests, the Succession 1000 delivered almost half of the allowable one-way delay – meaning delay remains well below the maximum allowable ceiling to maintain call quality, which means users are certain to receive high-quality voice. Delay ranged from a

low of 62 milliseconds for the main office to branch office test, to 89 ms. for the branch office to branch office test. (See Figure 5.)

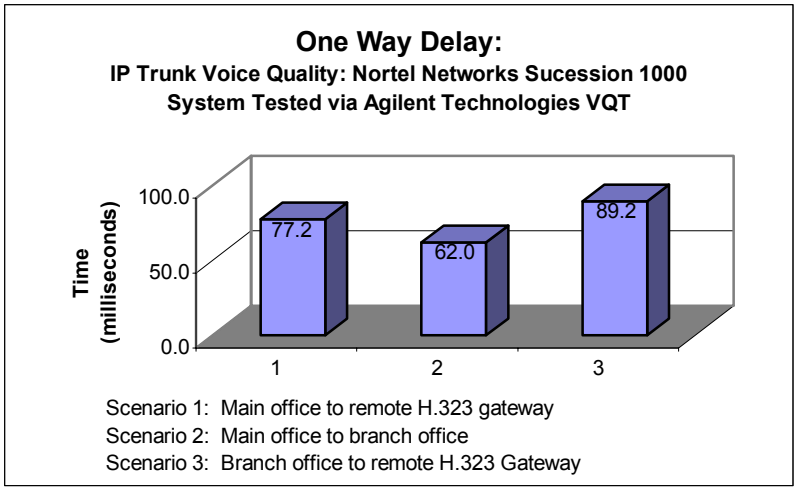

Figure 5. One-way delay for IP calls over an IP trunk

3.4 Scalability load tests

In this test, calls were placed via an Ameritec Crescendo CRS-DX from the main office to a remote office via IP connectivity. The Ameritec test tool connected to the system under test via PRI, and sent calls via 23 B-channels for 23 hours. The Nortel Networks Succession 1000 demonstrated that it was able to maintain a high volume of call traffic for the entire test duration.

Over the course of the 23-hour test, the Nortel Networks system was able to setup 100,113 calls. 100% of the calls were completed without error, and the audio paths were verified via the test tool.

4. Reliability and Availability

One of the Succession 1000's greatest strengths is that the IP-based PBX platform draws upon considerable reliability and availability knowledge that Nortel Networks has gleaned from years of developing solutions for both the carrier and enterprise markets.

In this section, The Tolly Group delivers its analysis of Nortel Networks reliability and availability in its Succession 1000 based upon our hands-on observations and testing.

4.1 Carrier-class reliability

4.1.1 Call Server redundancy

In the unlikely event of a Call Server failure, redundant Call Server capabilities are built into the network and cut over in times of need. In Tolly Group tests, the primary Call Server was turned off to simulate a failure and the Call Server failed over to an alternate Call Server built into a Survivable Media Gateway, which took over, as the database server and the call processing server for the IP Telephony services. Signaling servers subsequently registered at the alternate Call Server and operations resumed with the alternate Call Server using local Media Gateway line cards.

4.1.2 Failover to PSTN between branch and main offices

In the event a problem develops in a WAN connection between the main office (where the Call Server resides) and a branch office, tests show that Nortel Networks Succession 1000 automatically fails-over to backup PSTN connections. In the test performed by The Tolly Group, when an IP link was broken, calls immediately used a backup PRI connection to provide connectivity from the main to the remote office. Interoffice calls (that did not need to traverse the WAN connection) were still IP based.

4.1.3 Survivability of remote sites

Besides the PSTN switchover for the failure of a WAN link, remote sites also draw upon other methods to provide for the high availability of the telephone system if other "gear" issues arose. These sites utilize survivable media gateways, Signaling Servers, and gatekeepers; use of this type of system proved that failure of any one component did not bring down call connectivity network wide. If a remote site was unable to contact the primary Call Server, the media gateway (with embedded Call Server software) acted as a Call Server backup to provide full-featured call services.

4.1.4 Signaling server redundancy via the Terminal Proxy Service

In addition to the remote site survivability of the system, Succession 1000 relies upon a great deal of redundant systems to provide for maximum uptime. During failure scenarios launched against Succession 1000 components, all users were able to continue to use the phones regardless of a server component failure. If the Terminal Proxy Server (operating within the Signaling Server) experienced a

primary failure, it immediately failed over to a backup server that was ready in the system. If both the primary and backup Signaling Servers failed, additional redundancy provided failover to an additional media card. In our tests, all systems functioned flawlessly.

4.1.5 Survivable media gateways

Engineers also examined the survivability of Succession 1000 Media Gateways. All of the Succession 1000 Media Gateways can be optionally equipped with a full set of call processing software components and maintain a configuration database that is periodically synchronized with the primary Call Server. If the Call Server fails, the media gateways are survivable in that any TDM user devices can continue to operate and access the PSTN if there are trunks connected to the media gateway. In that way, the Media Gateways act as standalone TDM PBXs serving local users. IP user devices also can continue to operate, assuming that there is at least one Succession Media Card present, and one trunk-card present in the Media Gateway chassis.

Tolly Group engineers watched first as the IP campus test network was failed and then the Succession 1000 Distributed Media Gateways entered survival mode. IP phones reregistered with a voice gateway media card in the Media Gateway and operation resumed at the survivable.

4.1.6 Gatekeeper redundancy

In this test, the Signaling Server that was running the Primary Gatekeeper function was unplugged from the IP campus network. Tolly Group engineers witnessed the failover of the Gatekeeper to the alternate Gatekeeper. This had no impact on established calls or making new calls across the network. Then the LAN connection to the alternate Gatekeeper was disconnected, demonstrating the failover to the “Failsafe Gatekeeper” configured in the network, which keeps a “cached” copy of the Gatekeeper routing database. The failover to the failsafe gatekeeper was shown to have no effect on in-node calls.

4.1.7 IP phone DoS attack survivability

A Nortel Networks i2004 IP-based telephone was demonstrated to be resilient to Denial of Service (DoS) attacks. Traffic was generated in the form of a “Ping blast” from multiple sources to a single IP phone with an active call. The phone’s user did not experience a call drop or even noticeable difference in call quality during the DoS attack; this demonstrated the resiliency of the IP-based end-user phones.

4.2 Reliability and survivability impressions

Overall, the level of commitment Nortel Networks has to reliability and survivability impressed us markedly.

This is the type of reliability typically reserved for carrier-class products but now is being integrated into Nortel Networks enterprise-class IP Telephony offering. Here, Nortel Networks demonstrates its clear understanding that voice service must be consistent and reliable in a converged enterprise network.

The alternate Call Server functionality, Survivable Media Gateways and triple redundancy of the Gatekeeper function impressed us.

We also were impressed that IP phones automatically re-register to Media Cards if a primary or a secondary Signaling Server fails. The Media Cards can assume the Terminal Proxy Server functions, up to 128 IP phones can be registered per media card.

There's good news for branch offices too, since they are fully survivable for up to 400 IP users. IP telephones at a branch location obtain full feature service from the branch Signaling Server or gateway if the WAN or main Signaling Server or Call Server is unavailable. In this case, any resources available at the branch (e.g. PSTN trunks) are available to such telephones.

5. Succession Features

The Succession 1000 not only contains most features that users expect from a business telephone system, including call forwarding, multiple lines, etc., but also delivers a variety of features that users requested and may not be available on other systems. In total, the Succession 1000 contains more than 450 features, far too many to be chronicled in this white paper. Instead, we summarize a handful of features that stood out for their vision and usefulness to clients.

5.1 Virtual office

Users can log in to an IP telephone at a guest cubicle and gain access to their personal user-profile and full range of call features/functions typically available at their desktop. All calls to that user's telephone number will be directed to the remote guest phone, which temporarily acts as the user's primary phone, including speed-dial keys, function-keys, voice-mail indicator, etc. This can be a very useful feature for telecommuters or mobile workers temporarily visiting a corporate building for the day. The virtual office feature can be set to automatically log out users at a configurable time (like 3 a.m.), in case they have forgotten to do so. Users may also manually log out from the guest phone or from their own phone.

5.2 Ad-hoc conferencing

Conferencing allows additional parties to be added to a call (up to six), without the need for additional hardware. Parties can reside on any telephone-type (IP, digital, or analog), as well as outside callers (on-network from other systems connected via IP or traditional lines, or external callers from the PSTN on various trunk types). Display options allow digital and IP phones to view each phone on a conference call, and selectively drop specific selected people from the call.

5.3 Malicious call trace

Malicious Call Trace (MCT) allows users of selected telephones to activate a call trace that results in a printed report of the calling and called parties. The report includes time and date, call duration, call source, call destination, caller-ID (if available), dialed number, terminal number (actual phone unit used, as opposed to an extension number that might appear on several phones), and other relevant information. This feature works across CO, DID, ISDN, IP and other trunk-types, and supports recording of the call via a recording trunk. This feature can be used for internal, as well as external, calls.

5.4 Auto Answer Voice call

This handy feature is helpful for users that require hands-free phone operation – such as in surgical rooms. It allows an incoming call to be answered automatically and placed on speakerphone. Since the call is on two-way speakerphone, anyone in the room can simply answer back without having to touch the phone.

5.5 Sidebar: IP phones

Nortel Networks offers a powerful mix of IP wired phones and wireless options that provide consistent features sets for basic functions. Moreover, both the i2004 and i2002

feature an integrated Layer 2 switch that splits Category 5 cable into two feeds to serve both PC and phone connections. The switch prioritizes the voice port.

5.5.1 i2004 Internet Telephone

This 12-line device is Nortel Networks next-generation desktop IP communications device; it comes integrated with a three-port Layer 2 switch or add-on Internet Telephone Switch Module and Power over Ethernet offerings. The i2004 is Nortel Networks most full-featured IP phone and comes equipped with a full-duplex speakerphone, DHCP support, context sensitive soft keys, 12 programmable line/feature keys (6 buttons with shift key), and power over the LAN options.

Figure 6A. i2050 Soft Phone

5.5.2 i2002 Internet Telephone

This four-line IP phone comes in a smaller footprint than the i2004 and has a smaller display than the i2004. The i2002 comes standard with DHCP support, four programmable line/feature keys, a full-duplex speakerphone, context sensitive soft keys, and power over LAN options.

Figure 6B. i2050 Soft Phone

5.5.3 *i2050 Software Phone*

This is a customizable PC-based GUI client, supporting an extensive feature set like the i2004 while utilizing a high-quality USB headset. The GUI on this device is optimized for a graphical environment but can be adapted to how users utilize the software on a daily basis. It also supports a TAPI interface to link with Outlook to use its directory info for placing calls.

Figure 6C. i2050 Soft Phone

5.5.4 Wireless options

The Succession 1000 supports Symbol Technologies Inc.'s NetVision Phone family, providing a wireless telephony solution for mobile telephony users over a standards-based 802.11 wireless LAN. These 802.11b wireless phones offer a good subset of features available on Nortel Networks Succession 1000 wired phones. (See Figure 7.)

Figure 7. Succession 1000 wireless option

6. Applications

This chapter explores a sampling of Nortel Networks IP Telephony-related applications and reveals the benefits that The Tolly Group has identified through hands-on analysis.

One point worth mentioning is Nortel Networks approach to serving applications. IT organizations are not forced to deploy applications servers specifically for dedicated applications; instead Nortel Networks applications reside on powerful processor cards that fit into the Succession 1000 system chassis and can take advantage of Nortel Networks reliable hardware architecture.

6.1 802.11 Wireless IP Telephony

Tolly Group engineers witnessed a demonstration of Symbol NetVision™ wireless IP telephones with the Succession 1000 system. These phones provide a familiar and easy-to-use telephone interface, while still preserving feature-access, caller information-displays, and other value-added features. These phones closely resemble a wireless phone one would use at home or around an office if analog phones were used. Wireless IP Telephony is supported via a wireless application card in the Succession Media Gateway. This card features a standard Ethernet connection to the network, independent from the wireless infrastructure to which it is attached.

Although the wireless phones had slightly less functionality than their desktop relatives, they still provided connectivity to the system via standard IP networking. The wireless phones functioned as one would expect for typical 2.4-GHz wireless phones, so someone who was using one of these phones might not even realize that their call was being transmitted via IP until they used some of the features associated with IP phones. Call quality was not officially tested on the wireless phone, but was audibly "similar" to other types of analog, non-cellular based wireless phones.

6.2 Personal Call Director

Personal Call Director (PCD) is a one-number, follow-me telephony application. PCD provides users with the capability to screen and route calls to multiple phones based on customized profiles, all controlled by the user via a simple-to-use Web interface. Call routing decisions can be made based on calendar, type-of-call, and who is calling (by caller-ID, caller-name, or key code). Callers can be greeted with a customized recorded message, and given the option of transferring to voicemail, or holding while the system attempts to locate and route the call to the dialed party. Calls can ring multiple extensions (internal: wireless, IP, digital and analog phones; external: home phones, cell phones, hotel phone, etc) either one-at-a-time, or several simultaneously. Security restrictions can be placed by the system on calls forwarded off net. If the Personal Call Director, for instance, reaches an employee on an outside number (i.e. a home or hotel phone), the system can verify it has reached the user via prompting for password authentication, and deliver caller-identification before asking if the user wants to accept the call. It can also authenticate the end-user via passcode before allowing the call to be connected. This feature also prevents calls sent to a home number being answered by someone other than the user (such as a child).

The principle benefit of this application is that it enables users to distribute just one telephone number to business associates. That way, sales professionals or executive

managers can be reached by critical callers no matter where they are, and they don't have to hand out personal telephone numbers.

During a hands-on examination of PCD, Tolly Group personnel found the application is exceedingly easy for a user to administer via a Web interface, and straightforward in its operation. Calls that entered the Personal Call Director system were routed to the appropriate lines as configured, and we witnessed multiple IP phones, and a cell phone ring simultaneously in an effort to track down the called party.

Personal Call Director easily can be a boon for Marketing and Sales professionals on the run, for Customer Service employees, and for other client-focused professionals. Since this tool is administered via a Web interface, changes can be made to predefined rules on the fly, even on the road from a hotel or a remote site provided Web access is available.

6.3 CallPilot Unified Messaging

CallPilot (CP) is Nortel Networks unified messaging application. Unified messaging provides the capability to obtain any type of message (voicemail, E-mail, fax, etc.) from anywhere – at your desk, via phone, or even hand-held personal digital assistant.

In our hands-on assessment of CallPilot, we came away impressed with the slickness of the integration between Nortel Networks software functionality and its integration with Microsoft's Outlook messaging application.

Like other unified messaging applications, CallPilot brings together voicemail, E-mail and fax onto a user's desktop. But in CallPilot's case, it's how it achieves that integration that makes the product special. For instance, voicemail/fax mail servers and existing E-mail servers are maintained separately so that they don't disturb one another or require heavy modifications. Yet CallPilot taps into existing Outlook and other mail databases for user info and for integrating voicemail with E-mail. CallPilot maintains the voice and fax messages on the voicemail storage server principally to ensure that E-mail servers do not become overtaxed.

Voicemail is available from a user PC (via E-mail client integration such as MS-Outlook, Lotus Notes or several other leading messaging platforms (Nortel Networks supports the largest variety of E-mail clients in the industry), from a public PC (via a Web browser), or from any telephone via the touch-tone or speech recognition interface. Fax messages can be retrieved in a similar manner.

E-mail messages also can be retrieved not only from the usual PC and Web interfaces, but can now also be retrieved from the voice interface via text-to-speech technology. In one interesting exercise, Tolly Group analysts witnessed a cell phone caller prompting his CallPilot unified mailbox to playback voice calls and E-mail messages, forward mail to other parties, and even originate calls back to parties that left voicemail – all by speaking simple commands.

Navigation of messages can be performed via both the touch-tone and speech recognition interfaces. CallPilot certainly demonstrated that it could become a mission-critical application to road warrior users.

6.4 Meet-me Conference services

Succession 1000's Integrated Conference Bridge application provides a conferencing service to network up to 62 telephone lines into a single conference call. Conference calls can be set up by a user or an administrator via a simple Web interface. Conference chairpersons have access to all conference call information (such as duration, and who is connected) via the chairperson screen; from this screen they can also access chairperson controls to drop callers from the call, extend the conference call past the originally reserved time, add additional channels, schedule follow-up meetings and other common tasks.

The Tolly Group observed that the conference bridge application functioned flawlessly and allowed for easy administration by the users; this helps to free up systems administrators for tasks other than scheduling conferences.

7. Management Considerations

When it comes to management of the Succession 1000 and other elements of a Nortel Networks converged network supporting IP Telephony, Nortel Networks stays true to its promise of one network with many choices.

Network administrators can lean on two point products for managing their IP Telephony infrastructures: the Succession 1000 Element Manager as a site-specific management tool and Optivity Telephony Manager (OTM) 2.0 for system-wide management– both of which can be managed by Web interfaces.

Having fully distributed its IP PBX architecture, Nortel Networks realizes the importance of a coordinated suite of system wide management tools that unifies various components into an integrated system. Both the Succession 1000 Element Manager and OTM products offer well organized graphical user interfaces (GUIs) and fit nicely into Nortel Networks collapsible, hierarchical tree design. Yet each of the products offers a distinctly different function for managing in a IP Telephony environment.

7.1 Focus on the Succession 1000 Element Manager

The Succession 1000 Element Manager is just that – a Web-based tool that is used to configure, manage and report on Succession 1000 units. It is used to manage a single Succession 1000 and its inherent components.

Typically, Succession 1000 Element Manager is used to configure individual Succession 1000 models, enabling administrators to define, time, trunks and routes, digital trunks, Signaling Server data, IP Telephony capabilities such as QoS, and gatekeeper functions.

From a system status perspective, the Succession 1000 Element Manager helps users perform maintenance tasks, run backup and restore utilities, download software updates, and implement software patches. It is used often for maintenance of Call Server components. (See Figure 8.)

Element Manager also is used to establish/define all ESN data blocks for the Call Server as well as the configuration of the gatekeepers.

We liked that Succession 1000 Element Manager's capability to organize device parameters into logical groups where single Web pages provide access to information traditionally spread into multiple screen overlays.

Another benefit to Nortel Networks Succession 1000 Element Manager is that is provides full text description of device parameters (as well as the acronyms when such exist) and simplified choices for selecting parameters values (pre-selected defaults values, usage of drop down list of choices, etc.) that ultimately translates into reduced configuration errors.

Element Manager versus OTM 2.0	
CSE 1000 Element Manager	**Optivity Telephony Manager**
Web-like interface for the baseline management of a ***single*** system and its components	Portfolio of intelligent applications and tools for the management of a ***network*** of CSE1000 and/or Meridian1 systems
Direct management to CSE 1000 elements	Off-line management / scheduled tasks
Ideal for initial commissioning and daily configuration changes on a system	Ideal for high CPU consumption tasks (collection - filtering and correlation of data / reports generation)
Handles date/time	Scalable (client-server / multi user)
Used for configuration of trunks and routes	Identifies network-wide faults and triggers alarms
Used to set IP telephony capabilities such as QoS	Oversees LDAP and directory management
	Used to manage call accounting and run telecom billing system
	Station adds, moves & changes
	Produces call cost reports
	Provides a general cost allocation system
	Used for traffic reporting/analysis
	Implements secure user access and authentication policies

Figure 8. Management program comparison

7.2 Focus on Optivity Telephony Manager

OTM is based on a client/server architecture with server-side software available to run on either Windows 2000 Servers or Windows NT 4.0 servers. Client-side software can run on Windows 2000 Professional, Windows NT 4.0 Workstation or Windows 95/98 clients and the Web browser client can operate in either Netscape Navigator or Microsoft Internet Explorer environments.

OTM is a suite of standard management offerings that provide common services such as scheduler, navigator, watchdog and Web navigator services bundled with fault management, configuration management, accounting management, security, system access and applications (directory, HP OpenView integration and Optivity Network Management System integration.

Network administrators can opt for enhanced packages that bundle in extra fault management capabilities such as alarm notification or a Web alarm browser, premium configuration management tools including Inventory management, ESN analysis, or even performance management upgrades such as traffic analysis or applications such as LDAP synchronization.

One of the inherent advantages of the Element Manager/OTM combo is that both rely upon a Web-based GUI, unlike some IP Telephony infrastructure managers, such as Cisco's AVVID, that require users to toggle between Web-like interfaces and old school command line interfaces that increase the learning curve for users. Element Manager can be launched directly from the OTM Navigator.

Moreover, the Webified CLIs for Element Manager and OTM enable network administrators to troubleshoot issues from home, or via a laptop on the road, rather than burrow into the network on a CLI via a dial-up connection. The Tolly Group noted that both Element Manager and OTM deliver a consistent look and feel to their interfaces, which will vastly reduce the learning curve for those who are new to configuration of this system (See Figure 9.).

Extensive Web-based reports are also available that generate billing/cost reports, including toll fraud alerts. Web based alarm reports are also available to system administrators. A Web-based scheduler can be used to schedule reports, LDAP synchronization, and other regular maintenance procedures.

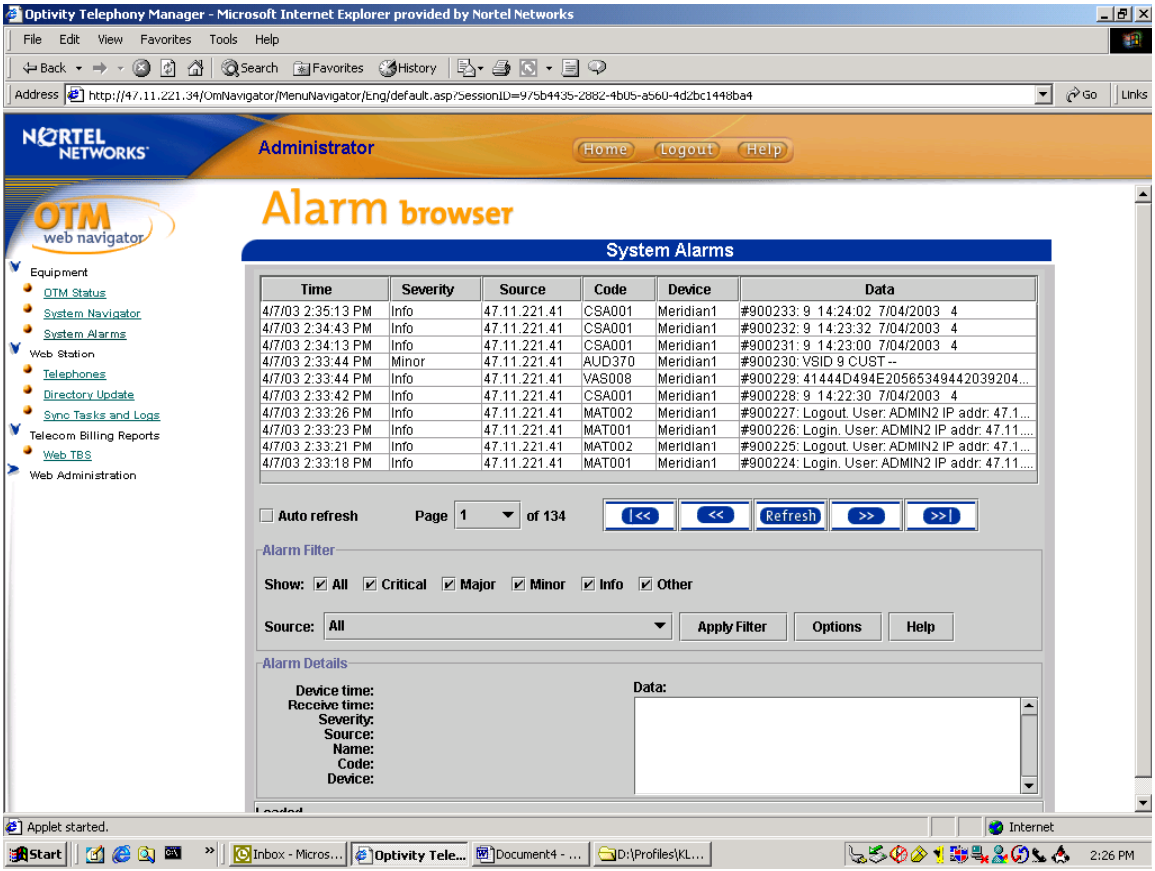

Figure 9. Screen shot of Optivity Telephony Manager Alarm browser

From an applications standpoint, OTM offers one of the most detailed and complete accounting/billing systems we have seen to date. The OTM software's Telecom Billing System's tight links to LDAP directories means administrators do not have to bore into individual systems to make adds, moves and changes, but can administer the changes centrally and distribute them via directory updates.

On another front, we liked the OTM "navigator" functions built in to a number of Succession 1000 elements. Gatekeepers, Call Servers and Signaling Servers are all

represented in the OTM navigator with the capability to launch OTM applications or to access associated Web-based element managers. (See Figure 10.)

Another impressive feature are so-called “courtesy changes,” which enable the system to bypass the transmission of changes when sets are busy and consequently protect the disconnection of active calls.

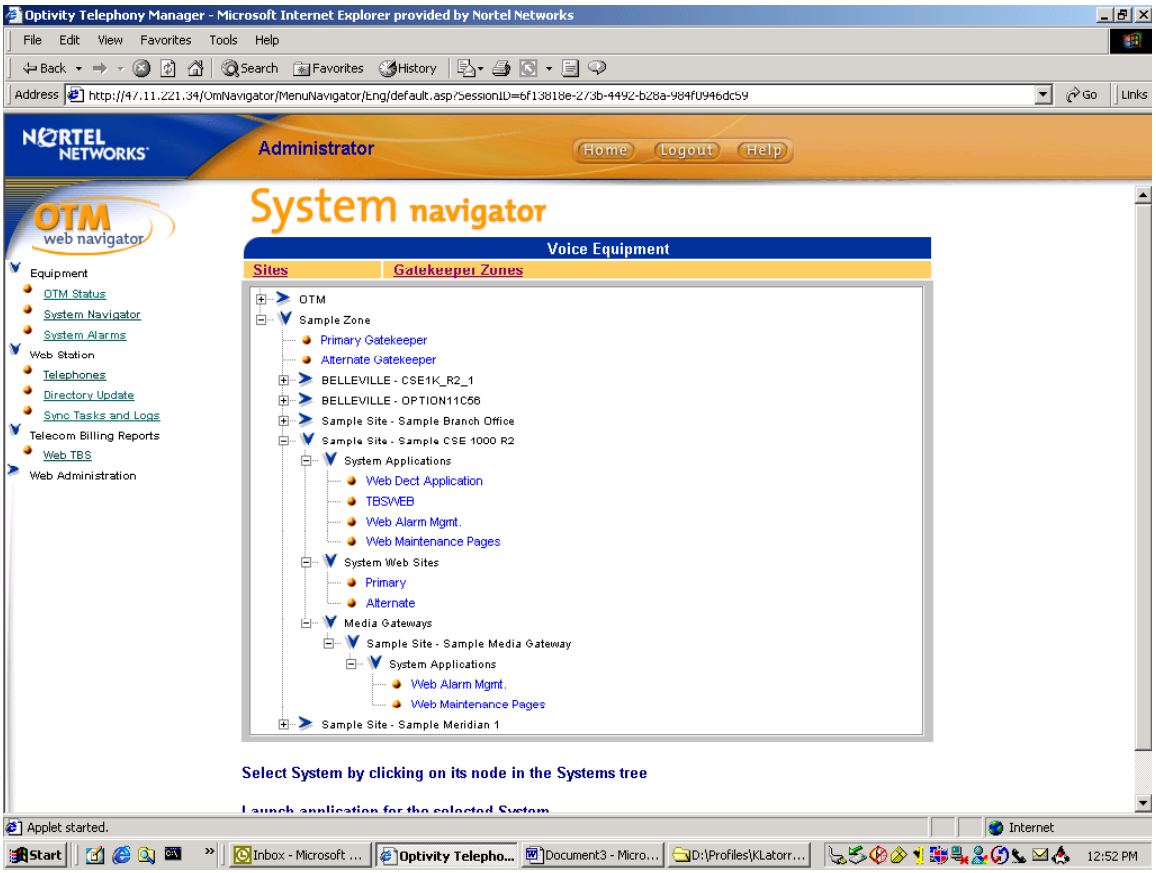

Figure 10. Screen shot of Optivity Telephony Manager’s System Navigator

8. A Succession Story

The Tolly Group's examination of Nortel Networks Succession 1000 IP PBX reveals a converged network architecture that is rich in features, rock solid in reliability and provides unsurpassed levels of flexibility to enable users to adopt a converged IP infrastructure at the pace they so desire.

From an architecture standpoint, Succession 1000 delivers distributed IP call processing that ensures that device failures of critical components not impact call processing to any major extent. Nortel Networks has gone to great lengths to replicate key portions of Call Server and Signaling Server software at different points across the network – providing not just secondary backup, but tertiary backup contingencies to ensure call processing continues even in the unlikely event of critical device failures.

Nortel Networks Succession architecture also provides the framework for third-party PBXs and other devices to connect into the converged network. This is extremely important for organizations that don't wish to scrap legacy investments in PBXs, or in third-party switches at remote sites and branch offices. Utilizing Succession 1000 gateways, non-Nortel Networks gear can co-reside in a converged voice/data network utilizing an underlying IP network based largely upon Nortel Networks gear.

Testing also validated that Nortel Networks converged network infrastructure surpasses toll-quality standards for voice call quality and establishes a high watermark of "excellent" call quality at various critical points across the converged network. Certainly, Nortel Networks Succession 1000 call quality scores were as good or better than those delivered by other network products tested over time by The Tolly Group.

And, with hundreds of features, it is evident that Nortel Networks will continue to fine-tune standard IP PBX functionality as well as invent advanced capabilities such as virtual office, ad hoc conferencing and malicious call trace. From an applications perspective, all one needs is to tinker with CallPilot to understand the enormous implications it can have for any business. And any road warrior will pencil in Personal Call Director as a must-have tool. Nortel Networks is also giving users wireless options for handsets with its support for Symbol Technologies NetVision 802.11b wireless IP phones.

Lastly, Nortel Networks has pulled together voice and data management nicely under the Optivity umbrella. Initial device configuration and direct management of Succession 1000 elements is provided by the Succession 1000 Element Manager, while an Optivity Telephony Manager application is used for administrative reports, billing oversight, alarm notification and a variety of network-wide management services. And, all the while users manage Succession elements via Web interfaces, or optionally via CLI interfaces, should they so desire. Again, Nortel Networks stays true to the flexibility of providing users the options they prefer for operating and managing their converged nets.

No matter what part of Nortel Networks Succession 1000 product line you examine, the common thread pops up over and over again: it is choice – not chance – that determines your convergence destiny. Nortel Networks is committed to enabling users to make intelligent choices to build their converged voice and data networks.

