Technical Brief

# Network Resiliency and Availability

## Market Requirements

**Time is money — so is downtime! An e-commerce Web Site recently suffered a 22-hour outage with dramatic results (San Jose Mercury News, June 12, 1999): "The company's stock price dropped Friday by $16.81 to $165.88, a paper loss of $2.1 billion. And it also lost about $15,000 in fees every hour it was down." For some companies, such outages can be fatal!**

As the following MERIT analysis of 1867 IT surveys shows, network downtime can cost a huge amount of money, as a result of lost sales at the instance of failure.

| | |
|---|---|
| **Mean cost per hour of downtime** | $100,000 |
| **Mean systems availability per year** | 98.5 % |
| **Average work year (hours)** | 2000 |
| **Downtime hours per year** | 34 |
| **Annual downtime cost** | > $3 million |

(source: www.meritproject.com 08/97, total of 1867 business and IT executives)

Such factors as loss of employee productivity, customer frustration and dissatisfaction, and tarnished company image may have even longer-lasting effects detrimental to the business. And as businesses become increasingly more dependent on networks for e-commerce, and as the world evolves towards a networked economy, network resiliency and reliability can determine the success or failure of many businesses.

While the focus is on Quality of Service (QoS) to deploy eye-catching applications, and Web sites with animation, video, voice, colors, and images to attract and retain customers, the fundamental requirement to delivering any level of service is Network Availability. And Network Availability is enhanced by resiliency and redundancy features in the network devices and infrastructure. This means networks and network devices should:

- Be reliable, in providing access to applications through the network when they are expected to be available
- Provide redundant links to allow logical grouping of multiple connections for greater resiliency and bandwidth
- Provide redundant switch fabrics and power supplies to allow automatic failovers and continuous operation

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- Provide scalable bandwidth and switching capacity needed to minimize delays and provide the QoS needed for all those attractive and, especially, realtime applications
- Allow load balancing, so that network devices, links and servers are fully used in an optimized manner
- Ensure no single point of failure as far as possible
- Be self-healing, re-routing over alternate paths and gateways without operator intervention, if a link or device in the network infrastructure should fail
- Allow hot swapping of hardware components if operator action is required to remedy a hardware failure.

These resiliency and redundancy features should be available not only at the physical level but also at the higher layers of the OSI protocol stack.

## Technology Overview

Much of the technology exisiting today addresses Network Resiliency and Availability in fairly vendor-specific ways. This is understandable, because hardware, and to some extent software, capabilities are mostly vendor-specific. But standards are being developed, for example, in the areas of link aggregation and trunking. The features that provide network resiliency and redundancy are, therefore, key differentiators between vendors when selecting a network implementation. Nortel Networks provide a rich and comprehensive set of features that greatly increases resiliency and Network Availability in networks, critical to an increasingly networked world of e-commerce.

## The Nortel Networks Solution

With availability being the foremost requirement in any network, Nortel Networks provides significant hardware and software capabilities to maximize network resiliency, redundancy, load sharing and load balancing in the Passport* family of switch products. These capabilities include:

- Redundant Silicon Switch Fabric/ CPU modules
- Redundant and load-sharing power supplies and cooling fans
- Hot swapping of hardware components such as power supplies, interface modules, etc.
- MultiLink Trunking (MLT)
- Gigabit Ethernet LinkSafe
- Spanning Tree Protocol FastStart
- Virtual Router Redundancy Protocol (VRRP)
- IP Equal Cost MultiPath (ECMP)
- Application Server Switching, Redundancy, and load balancing.

### Redundant and Distributed Switching

In the Nortel Networks solution, switching capabilities are distributed to the I/O interface modules, thus ensuring scalability and no single point of failure. Critical components, such as the Silicon Switch Fabric/CPU Modules, are duplicated, with both modules in active and productive use. This architecture provides optimized resource usage, load sharing, increased switching capacity, and automatic sub-second failovers if one switch fabric module fails.

### Redundant Power and Cooling

Each Passport Switch is also powered by up to three power supplies. These power supplies not only share the electrical load between them, thus extending the life of an individual unit, but are also able to take over the load should one of them fail, thus providing N+1 redundancy. Cooling fans are also duplicated to ensure adequate flow.

### Hot Swappability

If a hardware failure requires an operator's remedial action, the power supplies, switch fabric and interface modules are all hot swappable; units can be replaced without having to power down a switch. This minimizes disruption to the network.

### Redundant Trunks and Links

To ensure resiliency, MultiLink Trunking (MLT) allows up to four 10/100/1000 Mbps Ethernet links to be grouped together for critical switch-to-switch and switch-to server connections. Up to eight MLT groups may be established per switch. With traffic flowing over the aggregated links, MLT not only protects against a single link failure "bringing down the network," but also allows scaling of link bandwidth up to 8 Gbps (now) and 32 Gbps (future). For Gigabit Ethernet, the LinkSafe capability allows one port and link to be active and the other on standby, in a two-port module, ready to take over should the active port or link fail.

### Fast Network Convergence

Changes in switch topology may disrupt the Spanning Tree Protocol (STP) structures established to prevent loops in the network. Such changes cause new Spanning Tree structures to be established. The STP FastStart keeps network disruptions to a minimum by enabling a Passport Switch port to be quickly ready to forward traffic (compared to the normal STP convergence times).

## Redundant Gateways

End stations on one subnet communicate with other subnets through a default gateway router. If this gateway fails, it can be catastrophic, causing a (sometimes substantial) portion of the network to be isolated. The Passport Switch eliminates this single point of failure, allowing multiple routers using the Virtual Router Redundancy Protocol (VRRP) to be deployed. Each redundant router can provide the default gateway function for one subnet while simultaneously acting as a hot standby for another, ready to take over automatically and quickly if the normal default gateway fails.

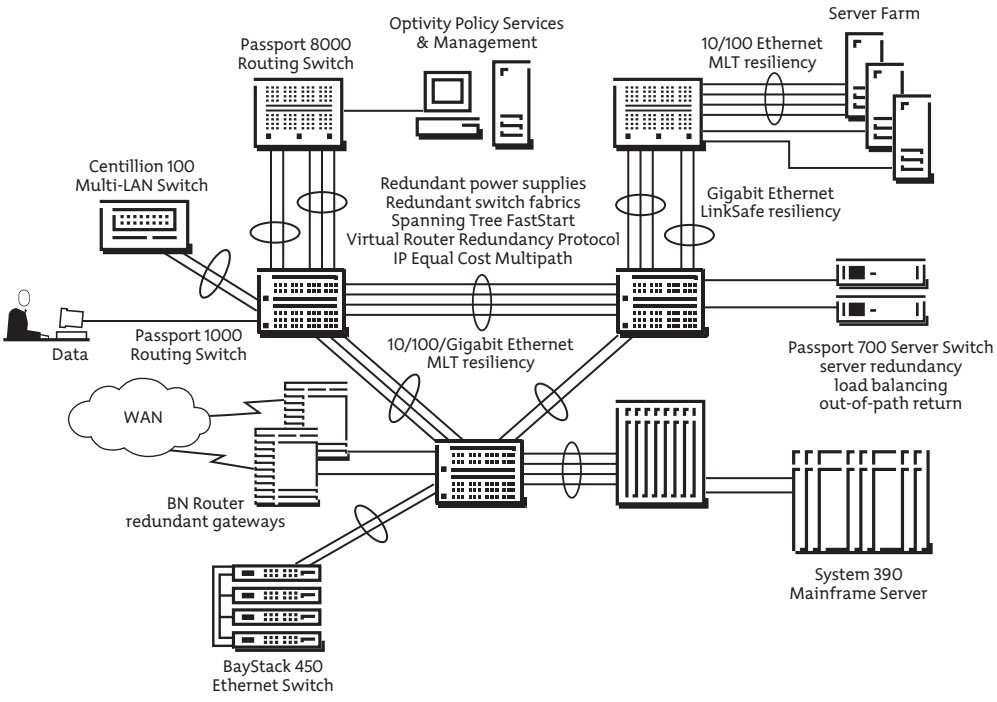
## Load-sharing Data Paths

Typically, only one path with the least "cost," determined by routing protocols such as OSPF and RIP, exists between an IP source and its destination. This single path can be a bottleneck that may degrade performance to the point of the network being unusable and thus unavailable. The Passport Switch allows multiple equal-cost paths between the same source and destination points across the network. This feature, called Equal Cost MultiPath (ECMP), provides load distribution over multiple paths through intervening routers and switches, and results in much better network performance.

## Redundant and Load-sharing Servers

To further enhance all these lower layers of network resiliency and redundancy, the Passport Server Switch allows multiple servers to be used with the same virtual IP address when providing user access to applications. Thus, more than one server may serve the same application. These multiple servers provide server redundancy, transparent to the user. In addition, the Passport Server Switch enhances performance as seen by the user, by selecting the least loaded or most appropriate server for the application required; this selection can be based on response time feedback, server resource availability, or even content of the user request. The Passport Server Switch redirects around errors in server or application availability without the user's need to be aware. The Passport Server Switch itself can be deployed in a redundant configuration, with one server switch monitoring the heartbeat of the other, and is ready to automatically take over if the normal active switch fails.

*Figure 1: Passport Network Resiliency and Availability.*




## Competitive Offerings

With many competitive products, much of the resiliency, redundancy and performance features are either unavailable or only available in parts, requiring multiple add-on devices to achieve the same result. Others provide rudimentary functions at the very low layers of communication without addressing equally important and critical needs at the upper layers.

## Benefits of Nortel Networks Solution

The Nortel Networks solution for Network Resiliency and Availability offers a total package with the following benefits:

- Layer 1 and 2 Resiliency and increased Network Availability, using features such as redundant switch fabrics, redundant power supplies, hot swappability, MultiLink Trunking, Gigabit Ethernet LinkSafe connections, and Spanning Tree Protocol FastStart.
- Layer 3 Resiliency and increased Network Availability, through capabilities such as Virtual Router Redundancy Protocol and IP Equal Cost MultiPath.
- Layer 4 through 7 Resiliency and increased Network Availability, through application- and content-aware server switching.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