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Network Planning for Next-Generation Services

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As Communications Service Providers (CSPs) worldwide are adjusting their business plans to align with the increasing overlap of wireless, wireline, cable, broadcast, and Internet communications, they are finding themselves having to introduce new, unfamiliar services at an unprecedented rate. Some of these services are information-rich and many, like streaming video, Web 2.0 applications and multi-player gaming, can require 100 times or more the network bandwidth of traditional voice to support them.

Most of these services are being touted as highly reliable and high-quality. To support these claims, carriers are choosing new or enhanced packet-based IP and Ethernet infrastructures to ensure Quality of Service (QoS). This shift, however, creates the following issues for network planners as they plan network additions to support new services:

- Determining the most overall cost-effective network configuration for supporting these services, including multiple layers of new access technologies, Metropolitan Ethernet (including the emerging Provider Broadband Technology), Internet Protocol (IP), Multiprotocol Label Switching (MPLS), Fiber to the X, and

Automatically Switched Optical Networks (ASON).
- Designing the network to achieve the QoS required during normal and exceptional network events such as overloads and network failures, while taking into account the complex layering and interconnection of these multiple technologies.
- Taking estimates on adoption rates in various markets from the marketing organization and turning them into resource requirements. Equally challenging is doing so in the face of uncertain service adoption rates, which can lead to further uncertainties in the timing and placement of network resources required to support these services with a high QoS. This is especially true for bandwidth-hungry video services, where small differences in market adoption rates mean large changes in the network resources required to support them.

To do this job effectively and avoid the above issues, network planning organizations are increasingly utilizing a new generation of comprehensive Integrated Network Planning systems that can:
- Plan multi-technology, multi-layered networks in a holistic manner – across technologies and geographies, while taking into account all of the services to be carried.
- Plan across the multiple layers of the network to ensure that outages in underlying layers do not cause QoS violations for the various IP-based services.
- Re-plan the network as service adoption rates and demographics become clearer.

Holistic Network Planning

Integrated Network Planning systems plan multi-technology, multi-layered network in a unified manner – across technologies, across geographies and taking into account all of the services to be carried, instead of layer-by-layer, as manual methods used to do. The traffic presented to the metropolitan network by the access network is assessed to allow the Ethernet aggregation network to be sized and designed as it routes some traffic within the metro area and presents the long-haul traffic onto the IP/MPLS core network. An Integrated Network Planning system plans all of these together, taking into account the specific QoS requirements for the various services riding on the IP and Ethernet networks, as well as the underlying physical optical transport network that carries all of this traffic (actually, it is even more complex, with legacy network technologies and services, as well as VoIP and signaling traffic sharing the network fabric). Traditionally, the planning of each of these "domains" (be they technology, geographic, or even temporal – with planners for various time periods) was done separately, with little information interchange among them. In contrast, a strong, multi-technology, multi-domain Integrated Network Planning system provides a set of plans that automatically mesh into a single, coherent, cost-effective master plan for the next-generation network, avoiding inefficiencies and stranded resources, while assuring sufficient network capacity in the right place, at the right time to support the new services.

Multi-Layered Backup Planning

The various layers of the network need to be planned to ensure that outages in underlying layers do not cause QoS violations in IP-based services. Integrated Network Planning systems design networks to ensure diversity of the layered transport links and preserve the integrity of backup routes to network failures, to the extent required by the services riding on the IP networks.

The first constraint of a network design involves the underlying transport network, which itself is a layered architecture. It contains interface cards using links, which ride on wavelengths, which are multiplexed into fibers, which are bonded into cables, which are placed in ducts, conduits, holes, or placed on poles and routed within or between central offices. Diversity among the designated primary and backup links within the transport layer must be maintained (at some level) to keep single points of failure from disrupting the transport layer.

Planning such diversity requires full knowledge of the facility hierarchy within the transport layer. This can be done manually, but laboriously, by a transport engineer using a good network resource management (e.g., inventory) system. It can also be planned automatically by an Integrated Network Planning system that has full knowledge of the facility hierarchy and network layout.

But, for most services, this is not good enough. The Integrated Network Planning system has to ensure that all routes, especially those that require a high-QoS, are diverse among the technology layers.

As an example, when planning for a set of IP/MPLS paths that will carry a high QoS service, planners typically set up diverse paths between the routers (1:1 or 1:N), which are automatically switched into service if a failure occurs. Sophisticated Integrated Network Planning systems automatically provide designs that include knowledge of the underlying transport network that carries these paths. They check that the diverse IP/MPLS paths do not share a transport facility, piece of transport gear, cable, etc. and that the protection path is fully diverse from the main path.

Figure 1 shows an example of this. The IP layer has a main path and a backup path, but in this case both the main and backup paths are routed on the same transport facility - not a good situation, but one that is very difficult to avoid without a deep knowledge of the current and planned network topology.

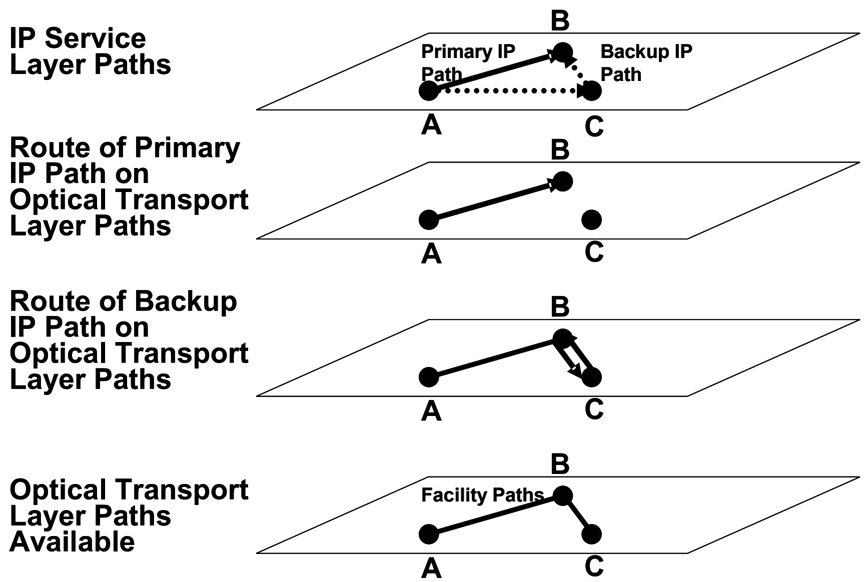

Figure 1: An example of an incorrect backup diversity plan

Proper diversity planning also requires the ability to determine if diversity exists among network layers – with IP/MPLS on top of ASON being an example, as shown in Figure 2. However, diversity can be engineered into the network at many different layers.

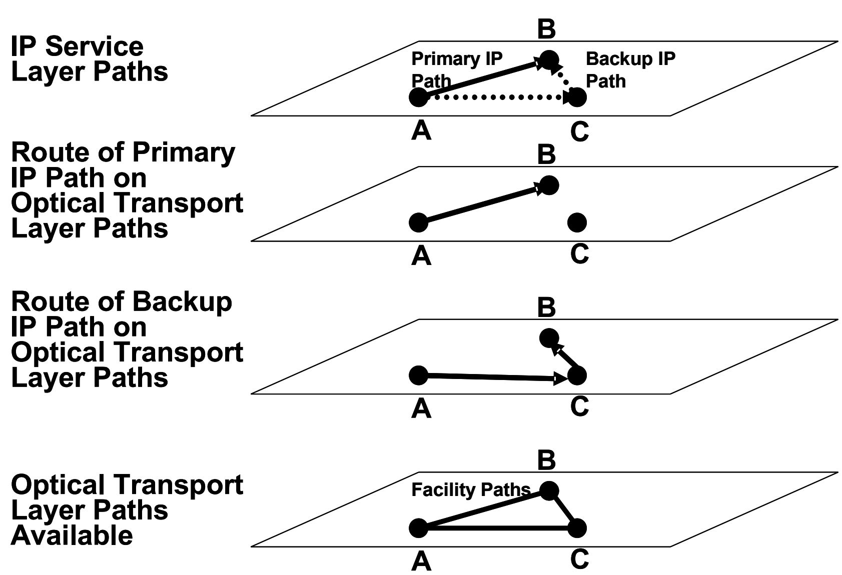

Figure 2: An example of a correct backup diversity plan

So what is the best strategy? Should diversity be engineered in at the highest level only, e.g. at the IP layer (ensuring, of course, that paths are diverse in the underlying transport network)? Or just at the lowest layer of the transport network? Or a combination of the two? And how should that diversity be maintained as the network evolves and additional layered capacity is added? These issues are at the leading edge of modern Integrated Network Planning systems.

Re-Planning to Match Service Adoption Characteristics

New service adoption rates and demographics are often unknown, even with market trials, as early results often are applicable only to early technology adopters. Thus, as a new service – especially a bandwidth-hungry video service – is marketed, network architecture must be adjusted by geography and timing to match the network capacity of bandwidth, signaling, transaction processing and information storage. Failure to do so can lead to under-resourcing and low QoS – death to new service adoption – or over-consumption of precious capital. This has driven leading carriers to move from yearly to quarterly planning cycles – with an ultimate goal of monthly or twice-monthly planning, in a move toward "just in time" network capacity augmentation. Good Integrated Network Planning systems do this planning quickly, enabling these short planning cycles.

Integrated Network Planning Systems and New Services

Modern Integrated Network Planning systems meet the three main challenges of planning for new services head on, quickly providing comprehensive, holistic, robust network designs and, as a result, allowing the network to be planned – and re-planned – to match the requirements of the new services, while optimizing precious capital resources.

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