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Application of SONET Adaptive Rate to Multi-Carriers Transport Network

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Abstract: This paper provides a current assessment of SONET Adaptive Rate technique from the local access service provider perspective. It also highlights how it shortens the service provisioning and activation processes from weeks to hours.

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1.0 Introduction

Enterprise customers and Information Technology (IT) departments of major corporations are looking to their primary Local Access Service Provider (LSP) for quick service provisioning and activation for supporting unscheduled or ad-hoc events. These events may be video conferencing between a corporate head office and its branches, scheduled periodic data storage backups and maintenance, data path temporary switchover for maintenance or multi-office TDM/Ethernet services. Support for geographically widespread end customers, LSPs may require interconnecting their networks by leasing transport facilities from one or more carriers. With 50Mbps granular bandwidth scalability, today's carrier networks are SONET based. An LSP may lease multiples of STS-1s to serve their customers. Consider this as a service model for fast service activation with significant bandwidth savings, where end customers pay only for bandwidth that is needed (in terms of STS-1s). LSPs usually manage their access networks, serve many end customers, and are expected to add or delete service with no intervention from transport carriers.

This paper describes key requirements for providing fast service provisioning and activation in a multi-carrier environment. It also addresses the remaining challenges to realizing full end-to-end support for LSP and transport carriers.

2.0 LSP Requirements from the Carriers

LSP A and B lease a SONET STS-n path to support their end customers from one or more carriers as shown in Figure 1. This path may be configured in multiple STS-1 built on ten (10) network elements passing through three (3) carrier networks (carriers A, B and C) as shown in this example. In SONET terms, this is an STS-n pipe interconnecting LSP A and B with an up and down links. This pipe occupies a fixed range and uses pre-assigned consecutive time slots, e.g. 1 to 48 or 49 to 96 for a bandwidth equivalent of 48 STS-1 or 2.4Gbps, from SONET interfaces at X and Y. However, the pipe could be allocated from an OC48 or OC192 interface. Also, the up and down links could be the same (symmetrical) in both directions, or different (asymmetrical) in both directions. For example in asymmetrical case, the up-down links could be 12 and 48 STS-1, respectively.

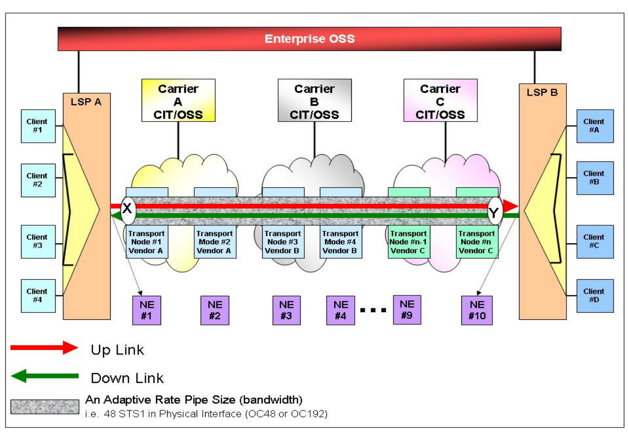

Figure 1 – SONET Adaptive Rate Architecture

The rule for supporting number of end customers at any instant is as follows.

1. The equivalent bandwidth of all end customers must be less than or equal to the size of the pipe. If up link pipe size is 48 STS-1, then the total bandwidth for Client #1 to #4 must be less than or equal to 48 STS-1 or 2.4Gbps. However, the payload type may be different between clients, e.g. STS-1, STS-3c, 12c, -48c, etc.
2. For network resource management, LSP operators are responsible for facilities inventory; client-to-client service provisioning and activation between LSP networks A and B. They are also responsible for ensuring the pipe handoff is within the pre-assigned time slots and that all clients are configured consistent with their service requirements.

This section highlights the overall requirements and the following section will describe the technical requirements. It requires all network elements, ex. NE#1 to #10, are capable to adapt to the incoming SONET payload types and send SONET pointer adjustment to the downstream Line Terminating Equipment (LTE) within the pipe.

3.0 Principle of Operations

The implement is based on standard SONET Virtual Concatenation and Local Link Capacity Adjustment (LCAS) techniques. The process begins with Pipe initialization and cross-connect provisioning. At this point, there should be no SONET Path Alarm Indication Signal (AIS-P) alarms within the pre-assigned pipe time slots. The end-to-end path(s) have been established. Whenever an AIS-P alarm occurs, an upstream LTE that receives Line Alarm Indication Signal (LAIS), for example NE #1 received payload mismatch from LSP A, then sends an AIS-P to the intermediate downstream LTE or Path Terminating Equipment (PTE) by setting the proper H1 and H2 pointer bytes. The purpose of this is to alert the downstream PTE of a defect on the upstream LTE's incoming line signal. The Adaptive Rate Processor must be able to determine the source of the alarm and whether it is from the pre-assigned pipe STS-1 boundary. If it is, the processor must be able to clear the alarms. This may necessitate modifying the existing cross-connects to match the incoming payload types on all pre-assigned STS-1s. Multiple iterations may be necessary to clear all alarms, for example, NE#1 started the process and corrected the payload alarms, then NE#2 and so on until #10.

Since the pipe is capable of adapting to the incoming SONET payload type and adjust the cross-connect accordingly, it can be called a "SONET Adaptive Rate" pipe, or "AR". The adaptive mechanism is based on SONET virtual concatenation and LCAS techniques with *NO* formal standards.

4.0 AR Interoperability Today

Verizon NGN Lab conducted Multi-vendor AR interoperability tests. Results show multi-vendor AR enabled networks work well and demonstrated no major technical issues. Although current vendors' support feature sets vary slightly, it is interoperable with some known limitations. The major differences are in two areas as follows:

1. Support symmetrical or asymmetrical up-down link bandwidth size (n x STS-1 or -3).
2. Support number of AR pipes per physical interface, e.g. an OC48 supports only one AR pipe.

These deficiencies could be resolved if carriers and service providers work together to set establish a common requirements. However, it should not be an impediment to deployment.

5.0 Opportunities for SONET Adaptive Rate Service

AR technique changes the process for service provisioning and activation. The process is dependent upon the local service providers rather than all participating carriers in terms of provisioning and circuit activation. The AR pipe supports mixed client payload types, ex. STS-12c, -3c or -1. The following sections show two (2) potential applications for utilizing AR techniques.

- **Control Plane Enabled Local Service Provider Networks**

  The industry's ultimate goal is to deploy client-to-client control plane enabled networks. However, for near term deployment, some carriers may not be ready for deploying control plane enabled transport network, ex. Carriers A and B, as shown in Figure 2. In this case, Carriers A and B provide a transparent path, i.e. AR pipe, for interconnecting two LSP A and B. In this application, all client should be able to initiate and teardown a connection without Carriers A or B's intervention. This is totally based on LSP A and B's capabilities.

- **Client-to-Client Data and Video Conference on Demand Services**

  Figure 3 shows two applications: #1 - LSP A and B provide data service (data path) to end customers and #2 - the end customer would wish to set up proper bandwidth to support video conferencing. These services have a common characteristic - bandwidth modification without carrier intervention.

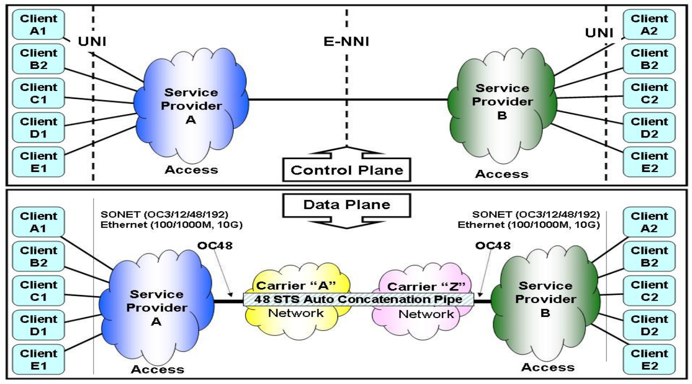

Figure 2 – Two Control Plane Enabled LSP networks interconnected with an AR Pipe

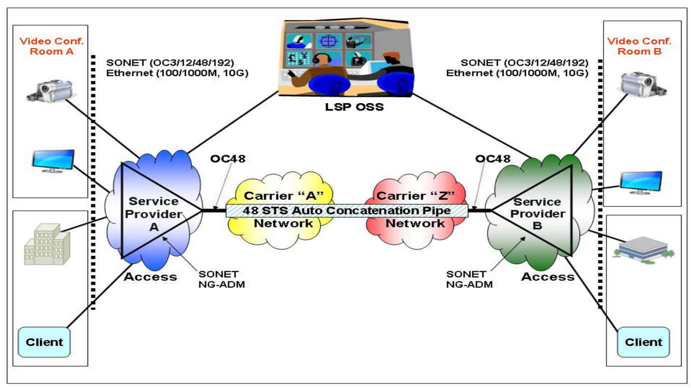

Figure 3 – Permanent or Ad Hoc Data and Video Conferencing Services

6.0 Summary and Challenges to the Carriers

AR techniques certainly will be an asset to the LSP for providing rapid service provisioning and activation without metro or long haul carrier intervention. However, service providers and carriers have to work together in defining a common set of requirements. AR is not defined in a specific Standard. It is the result of creating a new process by utilizing existing SONET payload mismatch (AIS-P) alarms and then clearing the alarms by matching the payload types. Industry interoperability forums, e.g. Optical Interoperability Forum (OIF), must lead the effort to incorporate the AR technique into an industry wide implementation agreement.

Based on lab test results, the following conclusions can be drawn:

- All network elements on the AR pipe route must support AR features
- All carriers must prepare and deploy AR enabled platforms
- Sufficient bandwidth in terms of STS-1s as requested with consecutive time slots are needed

AR features certainly will be useful for fast service provisioning and activation in a Multi-carrier environment. However, the challenge is to gather full support from the carriers, service providers and equipment vendors. The telecom industry must continue to investigate and to confirm the usefulness of AR technique.

6.1 Acknowledgements

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7.0 References

[1] Telcordia Technologies GR-253-CORE Issues 3 September 2000, "Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria"