ProXit

Managing increasing network complexity - A primer on simplification

Background

The infrastructure of Service Provider networks is continually evolving towards multi-purpose/multi-service switching platforms and the unification of networking protocols. The TCP/IP protocol is capable of providing more and more services to end users on a single backbone, including unicast best-effort services, multicast differentially tagged services, and real-time voice/video services in premium service classes. Virtual Private Networks (VPNs) with different Quality of Service (QoS) and end-user security are now being implemented on an infrastructure that previously simply routed packets indiscriminately of application and user. The ubiquitous nature of TCP/IP networks and the openness and interconnectivity of these networks lies in stark contrast to the closed nature of previous generations of networks. These beneficial aspects of current networks however come at the expense of distribution of operational responsibility, information completeness, and complicated customer service. In many operational environments, the situation has become dramatically more complex with stranded assets, poor configuration management, and unhappy customers.

In general, open multipurpose platforms are more complex to operate than the previous generation of single purpose proprietary network elements. With the increased functionality available, comes the greater burden of additional parameters that must be configured, monitored, and repaired quickly when outages ultimately occur. The early and unfortunate outcome of this more flexible network is an increased complexity for the ill-prepared Operator.

This new environment, although inherently complex, carries a great opportunity because the complexity is not anymore dispersed among many different physical elements at many network layers, but rather it is concentrated on single multipurpose machines.

This document briefly addresses the challenges and opportunities created by the new situation illustrating the ***ProXit*** approach to address the operational complexity issue and gain from the opportunity.

Applications Aspects

Various Operations Support System (OSS) applications including Customer Relationship Management (CRM), Fault Management, Provisioning, and Mediation are typically in place and operational in Service Provider organizations. These applications tend to be focused on a particular aspect of the network life cycle and often are replicated for various layers of the network (SONET/SDH, DSL, IP, etc). In such an environment there is a great deal of specificity to the application area for each of these products. There is one product for design and modeling, another for network configuration, another for fault management, and so on. The fundamental problem created by such a segregated approach is that of information segregation. The network information contained in each of these applications becomes trapped serving only the original narrow purpose for which this application was installed. The reality of networks is that they

always evolve and change as new services are conceived, network devices brought to market, and businesses merged or acquired. Therefore there must also be some fluidity to the usage capability of the OSS applications otherwise a "truck roll" is required as each new business or network event is encroached. Traditional approaches to solving this issue involved costly multi-year "integration" efforts where connectivity of these information islands was the goal. However this simply increased the amount of "data" available between the applications, not the "information" that led to effective trouble-shooting, integration of networks, rapid introduction of new services, or informed decision making.

The impact of this is that the global network picture is difficult to grasp and to understand. Questions that cut across network and service boundaries such as cost per customer or total interfaces out of revision are nearly impossible to answer. Working across these various organization, information, and application boundaries has become more prevalent and each department is its own country with little correlation of information and worthwhile events that allow the profitable operation of the entire organization.

For effective Customer Care, accurate and correlated information must be at the customer rep's fingertips to give the customer confidence that the Service Provider is capable, cognizant, and expert at keeping the network operating efficiently.

As OSS applications become more specialized, this problem becomes worse. Only by taking a wholistic, clean-sheet approach can this complexity be minimized. While taking advantage of legacy applications and corresponding data, a new approach to network information collection, management, minimization, and correlation is paramount to Service Providers delivering desirable and profitable network services to an increasingly skeptical customer base.

The *ProXit* approach to simplifying network operation

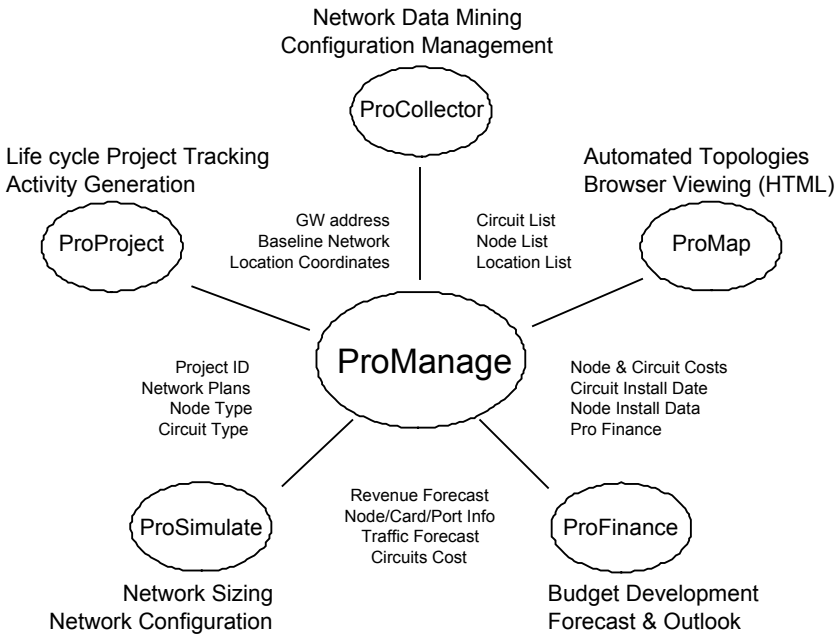
Founded by career networking professionals, ***ProXit*** has developed the ***ProTools*** OSS suite of applications that integrate easily within the current Service Provider operations infrastructure, treat the active network elements as the "database of record," and are designed for a wide range of users from customer service representatives to business analysts.

The core of the ***ProTools*** suite is the ***ProManage*** module. This module provides the basic data repository for the system as well as the associated input/output functions. Other applications operate on the data collected and organized within the data repository to allow specialized personnel (network engineers, provisioners, operators, customer service reps) to have different views and exposed capabilities that allow them to function efficiently, and to have the necessary abstraction where useful.

Fundamentally the ***ProTools*** application suite is designed to assist networking personnel during the entire network life cycle. The applications and are not highly compartmentalized into one functional area or network layer and are somewhat agnostic to the underlying network elements. Any technology that can be modelled and business rules developed for can be captured and managed within the ***ProTools*** canvas. The application suite has the following attributes:

- Capture and organize information about the current network infrastructure, either via manual data entry or automatically via electronic data collection from the operational network.
- Provide applications that can assist technical personnel in the preparation of engineering plans and work orders.
- Display and report on current network information
- Allow for future plans and evolution of the network
- Define routing structure, plan and monitor actual routing for connection-oriented services
- Enable facility planning and management
- Highlight implementation time and in general the time required for changes in the network configuration
- Support network budgeting & control
- Analysis of performance indicators
    - Budget versus spend, benchmarking, cost per attribute (route, location, etc.), capacity requirements
- Quality of service
    - Delay, congestion, other
- Project Implementation
    - Implementation times: MTTI, project tracking, work orders

The following diagram illustrates the structure of the ***ProXit*** applications.



ProXit applications

The ***ProTools*** suite will not be the only system that Service Providers will use and must not exacerbate the existing system/information segregation problem. The suite must be able to interact with other systems in a cooperative manner and simplify the operational burden. The system is therefore built in a three-tier architecture, where the user input part is separated from the actual business logic part, which again is separated from the database access part. This will also enable the system to generate automatic outputs or traps based on triggers defined in the system.

ProManage Primary Features & Usage

ProManage is the heart of the ***ProTools*** application suite. First and foremost, ***ProManage*** is an asset inventory database system detailing the location and characteristics of all network-based assets worldwide. It is the basic repository of all network information for a Service Provider's communications network. It also contains important supporting administrative information such as revenues, customer names and addresses, staff names and locator details, and other relevant detail as desired.

Information may be entered into ***ProManage*** either manually (through forms, tables, or graphically) or via electronic collection methods. The electronic collection can be either through ***ProCollector*** or other 3rd party collection/auto-discovery applications.

Basic input screens for entering information into the system database for:

- Network Equipment; Routers, Switches, Card, Port etc.
- Links & Channels
- Sites
- Support Information; Currency, Location, etc.

A vital part of the ***ProManage*** module is the ability to generate reports on demand. A set of predefined reports is available highlighting the most useful operational metrics. A simple report creation capability is exposed via the ***ProManage Developers Kit (PDK)*** that allows for customized and rapid report generation based on the problem of the day. This data-mining capability, including selection of reporting options on the fly, is often the difference between informed decision making and educated guesses.

The basic predefined reports for network information includes:

- Listing of details for a given network element or group of network elements, e.g. node, link or site
- Status Report for ongoing network projects
- Simple financial capital investments
- Simple financial operations expenses

Any of these reports can be customized based on attributes in the database including by region, manufacturer, in service before a certain date, etc.

Basic Information Model

ProManage is able to store information about all operational parts of the network. This module is also the main data source for network information used in other modules. Data integrity is key to accuracy of the overall capabilities and as such the database utilizes a combination of data upload from static sources (CRM, Provisioning, Order Entry systems) and auto network discovery. A reconciliation module and resident business rule template address the inevitable data conflicts that arise in large networks. A flexible and extensible data schema has been constructed with user-specified parent child relationships to allow for different modes of operation and the inevitable changes in network technology (IP over ATM, ATM over IP, etc.). User defined fields in the data model allow for simplified extensibility and future proofing.

The concept behind the basic information structure is that any network can be described as a number of inter-related objects (*network elements*). To each object a generalized set of attributes can be assigned and maintained. The fundamental elements are:

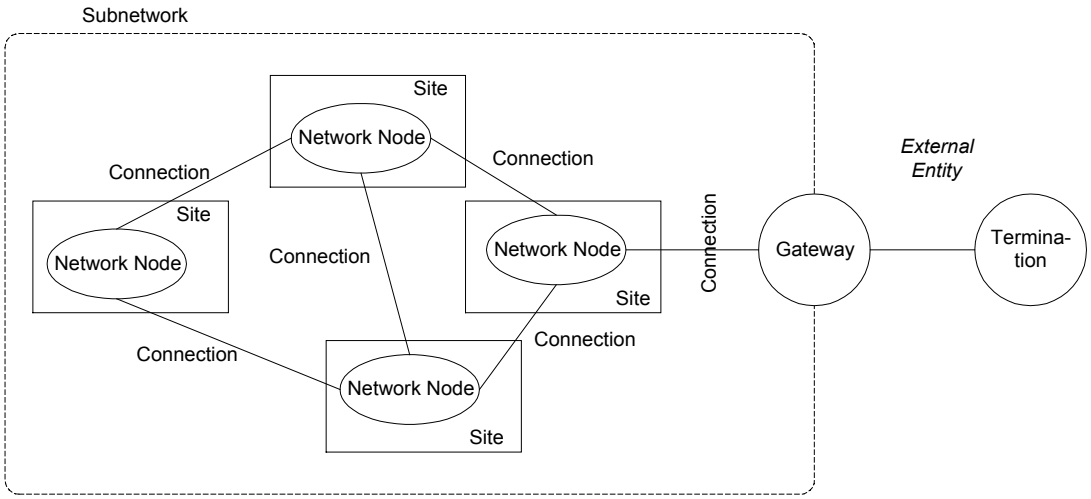
- Sites; describes a physical location where one can install
  - Connections; links to join together two network equipment nodes and to carry network traffic between these. Connections can be
    - Links; physical transmission lines
    - Channels; logical connections between nodes over Links (e.g. MPLS tunnels)
- Node; describes a switching or processing point for network traffic
- Gateways; an interface point to the network for exchanging traffic with other carriers (peering or settlement points) or customers (CPE).
- Termination; external entity (carrier or customer)

Any number of attributes can be assigned in a uniform way to all *network elements*. These network properties are:

- Cost Property; describes and tracks any form of cost related to a Network Element
- Event Property; describes and tracks any unique dates related to a Network Element
- Entity Property; describes relationships related to a Network Element
- Information Property; describes various network information
- Audit Property; describes the various audit processes completed for reconciliation

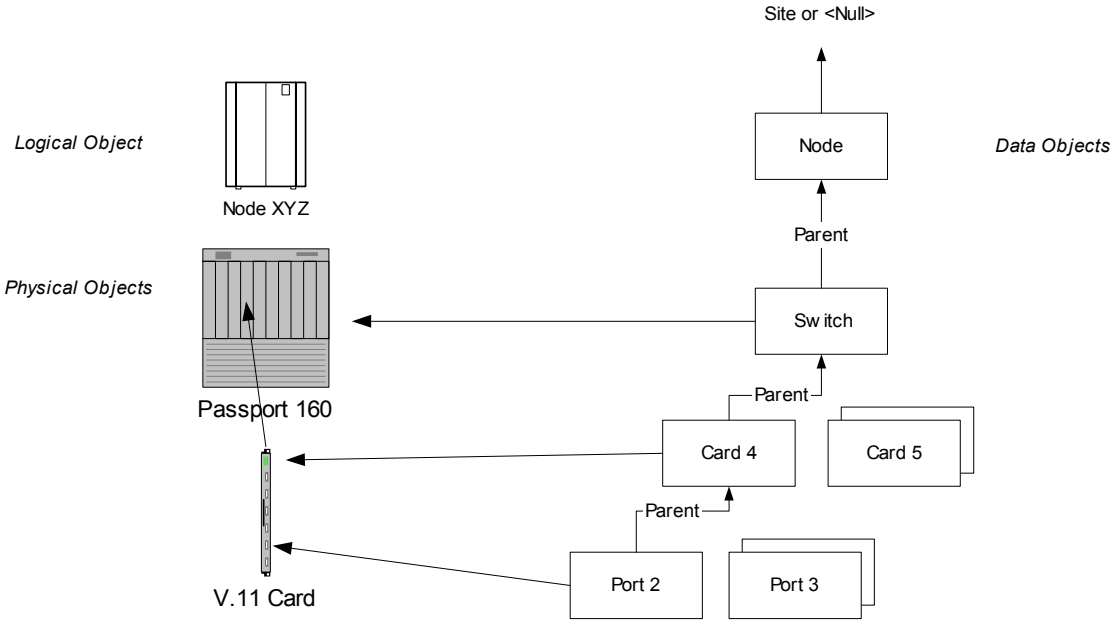
Each *network element* may have assigned specific properties such as bit-rate for a connection, which may not apply to other types of *network elements*. New and unlimited types of *network elements* can be defined and this gives great flexibility in the ability to expand the data model based on events that may not be foreseen. The model can be populated with a minimum set of objects and related attributes (e.g. a plan to install an IP router of unspecified type and facility identifier in Japan at a future date) and relevant data added, as the plan becomes reality.

In order to provide a better overview of complex networks, all *network elements* are assigned to a Sub-network group. This enables the system to handle each sub-network as a separate group.
The following diagram illustrates the relationship between *network elements*.



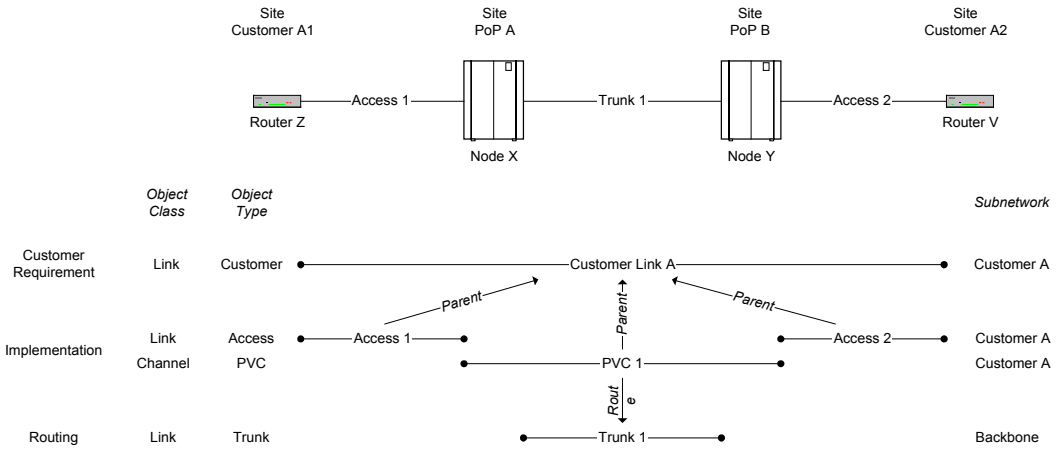
Logical Overview of Network Elements

The following diagram depicts the parent-child relationship between nodes and equipment elements.



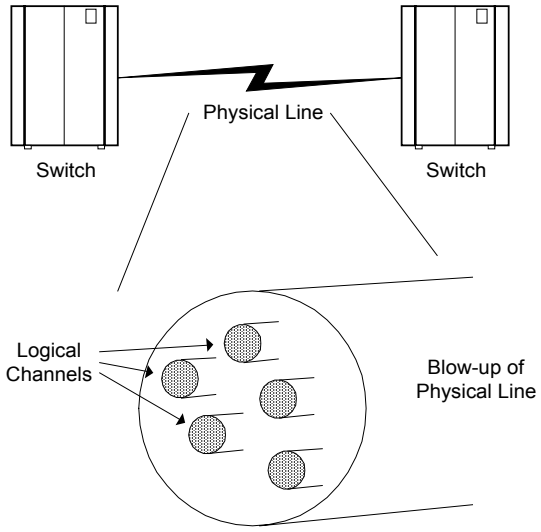
Overview of Nodes and Equipment Elements

A connection can either be a Link or and Channel. The physical connectivity between the nodes in the network is provided by a number of Links. These links can be anything from a cable between two nodes in the same room to a complex set of purchased lines on sea cables between the USA and Asia. These physical Links provide the containers for the logical channels defined on the network equipment and which routes the traffic on the network will take. This is illustrated below:



Connection Example and related Objects

The end-to-end traffic requirements are provisioned by configuring the required link on the end nodes where the traffic originates and terminates in the network. Then the nodes establish the channel by routing the traffic over the network inside one or more of the physical links mentioned above as illustrated here:



Logical Channel versus Physical Link

In order to capture this type of information two types of Connects objects are defined:

- Links; to describe the physical links in the network
- Channels; to describe the logical channels inside the network

Any number of individual link objects can be created to describe a complex circuit (undersea cable, backhaul, local access, etc.) within a single container.

Another important part of the network information is to document the logical channels in the network. This is the traffic carried on the network between the nodal (router, switch) elements. This is very similar to links and is therefore also described with a connection header and a set of detailed objects or channel elements. Similar in structure to a link, a channel can pass through 1 or more nodes between point of origination and termination. Whereas a link always only can connect two nodes together, a channel can pass through additional nodes for layered networks. The application and underlying data schema must support this capability to allow for effective information management and operations.

Queries and Reports

A pre-developed set of queries and corresponding reports comes standard with the ***ProManage*** application module. These reports describe the major characteristics of the network, or what may generally be called Key Performance Indicators (KPI).

1. All operational (in-service) locations by country
2. Number of locations by country
3. All leased circuits by country, cost, and termination
4. All purchased circuits by country, cost, and termination
5. All LSPs by identifier and path
6. Ratio of purchased to leased circuits in Mbps
7. Ratio of purchased to leased circuits in cost
8. Transmission Network Unit Cost [TX Bandwidth / TX Cost (monthly)]
9. Transmission Network Unit Cost by product [TX Product Bandwidth / TX Product Cost (monthly)]
10. Number of customers by product by country
11. Number of ports by product by country
12. Revenue by country
13. Revenue / Investment (annual period expense) by country
14. Provisioning interval by customer
15. Provisioning interval by implementation type
16. Total investment to date by country
17. Total capital period expense (annual) by country
18. Total transmission period expense (annual) by country
19. Total operations period expense (annual) by country

Conclusion

In order to cope with the evolution of the network environment a suite of applications has been developed allowing the operational simplification of the increased network complexity.

Traditional information islands can now effectively be bridged and critical correlations can be made that bring about operational efficiency and lower network costs. The linkage between items such as logical channels and customer data is strengthened allowing the management of the network across organization and information borders.

The object-oriented and open structure of the system developed in the ***ProManage*** suite of applications enables the organization to cope effectively with a more complex network structure. Objective assessment of global network performance from network configuration to return on investment is not only possible but predictable allowing for sound decision making.

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