This objective of this presentation is to illustrate how effective planning of multimedia networks can result in significant cost savings to the network organization.

Initial planning of a network is the first step in optimizing a network to meet the organization's needs. Often overlooked is the ongoing process of feeding measured network information back into the planning model. Performing this process effectively will optimize your network for the needs of today and the future.

Magellan provides the tools and expertise to optimize your network. The Magellan data collection strategy, and planning and analysis tool sets, as well as a customer case study are discussed.

About the presenter:

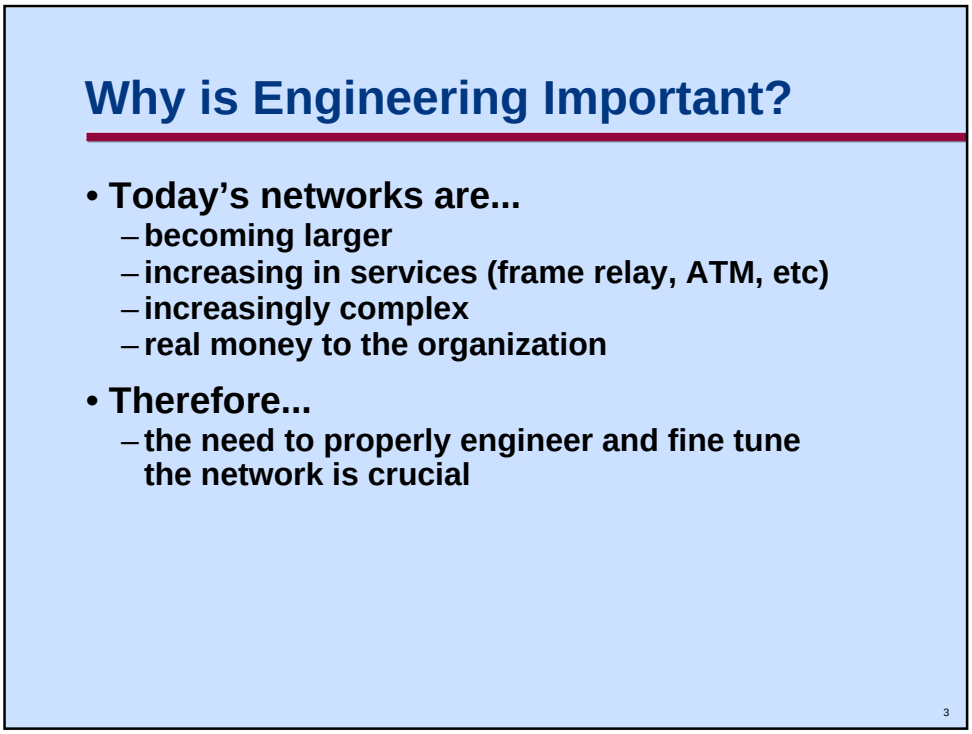
Doug Bundgaard is a product manager in the Magellan Network Management business group. Previously, he worked in the engineering group of a Canadian service provider, working with network operations in deployment and support of services. He also worked for a Stentor member company, deploying a network solution.

He has a B.Sc in Electrical Engineering from the University Of Calgary, and is a professional engineer.

This workshop will focus on how to optimize a Magellan network.

A brief overview of the planning process and the Nortel solution set will be given, but the majority of time will be spent on a case study which illustrates how the Nortel solution set was used by a Magellan customer to deploy and further optimize its network.

If you are interested in further discussion on this topic, you are encouraged to attend the various whiteboard clinics and hands-on workshops provided.



The importance of effective engineering is directly proportional to the size and complexity of the network.

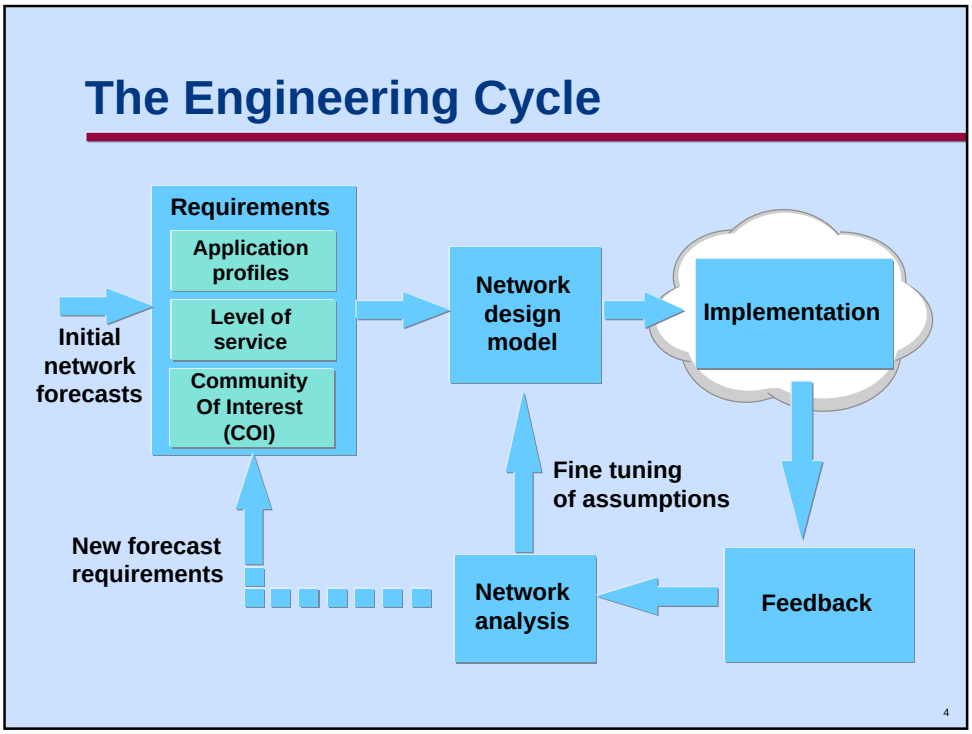
The trend in our customer base is to consolidate networks as much as possible. As a result, networks are becoming larger in size and number of services.

Also, the importance of the network to the organization is increasing. In addition to service providers' quality of service agreements, internal mission critical services are being provided.

Taking the above factors into consideration, it becomes clear that network engineering is essential to a network's success in terms of organizational objectives.

Nortel provides...

- the complete solution set for the customer to engineer the network
- the expertise to assist customers in engineering their network and recommend viable solutions



Network Engineering is a cyclical, three-part process.

Typically, **requirements** are defined by the network planner to determine the level of service that network applications will demand. The network planner gathers this information, along with application profiles and community of interest (COI = who communicates with whom), as input to the design process.

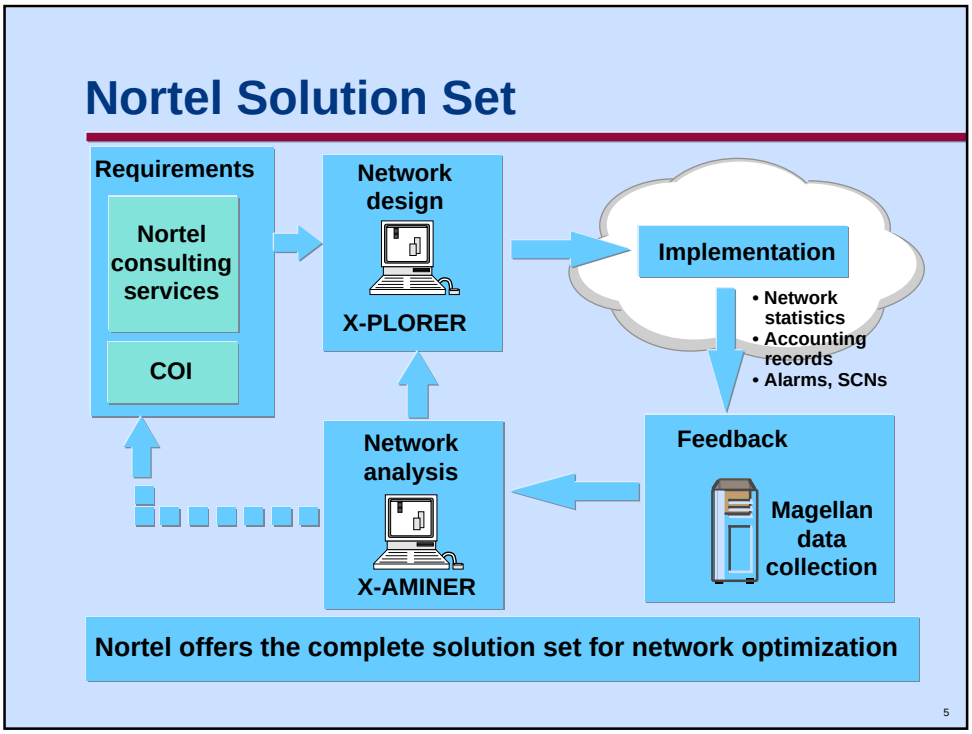
Node and backbone engineering are **network design** functions. Nodes and network topology must be engineered so that they meet all of the customer requirements in addition to taking into account local tariff structures and individual hardware characteristics. The network design is the basis for the network **implementation**.

After network implementation, **feedback** from the network in the form of performance data must be collected as input into the **network analysis** phase.

Network analysis is performed to ensure that:

- the required level of service is being met
- assumptions about application profiles and COI are accurate

The results of the network analysis act as input to the **requirements** phase (if new traffic forecasts/topology changes are required) and/or the network design phase. This ensures that the network is fine-tuned as it evolves.



Nortel provides the complete set of applications and expertise to optimize a Magellan network.

Depending on the network planner's desired level of control and time frames, the planner may take advantage of Nortel consulting services to plan and analyze the network. As the network grows in size and complexity, and as resources dedicated to this function are justified within the organization, these tasks can be taken over entirely by the network planner.

Initial requirements can be determined using forecasted data either from current offered services or input from the marketing group. If necessary, this phase can be accelerated by taking advantage of the vast experience in the Nortel engineering group.

The network design phase is accomplished with the Nortel **X-PLORER** tool set. This tool set consists of a number of modules which provide accurate modelling of a Magellan network.

The implementation phase can be accomplished either manually by utilizing Magellan configuration applications, or automatically through X-PLORER optional modules.

The feedback phase is accomplished using **Magellan data collection**, which provides extensive information from the service to the network level.

The network analysis phase is accomplished through the **X-AMINER** toolset. X-AMINER analysis can either be automated or user interactive (on request).

Agenda

- Overview of planning process
- **Nortel solution set...**
  - **X-PLORER**
  - **Magellan data collection**
  - **X-AMINER**
- Customer case study
- Summary

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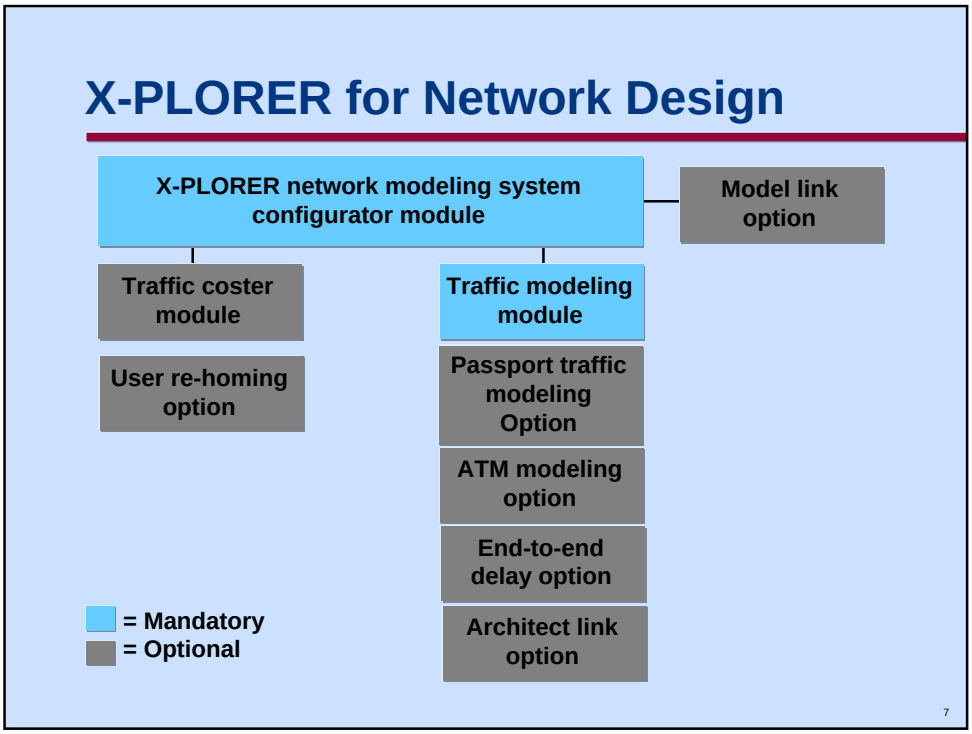
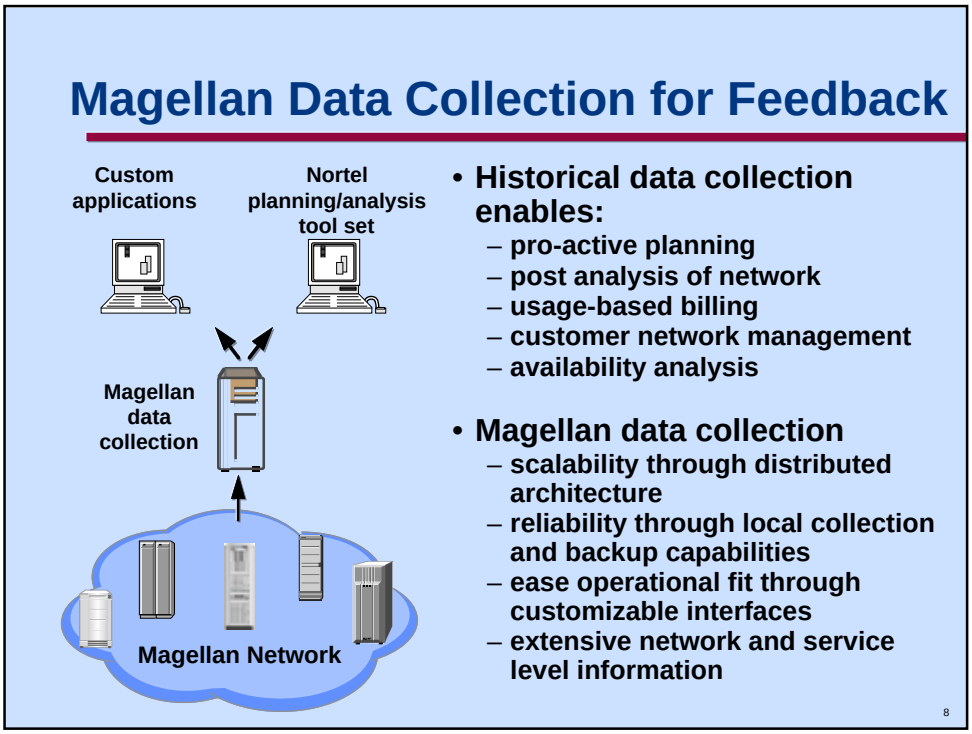


The X-PLORER tool set consists of the following modules.

- **Configurator module** (base module) - used to generate the network topology, switch configurations and switch inventory database for Magellan. The configurator is a mandatory module.
- **Model link** option - used to import Magellan configuration files to enable quicker and more accurate building of the network model.
- **Tariff coster** module - enables the operator to calculate on-going operating costs for circuit rental based on distance and connection arrangement.
- **User re-homing** option - enables automatic re-homing of access connections to the closest switch geographically.
- **Traffic modelling** module - used to analyze the effect of different traffic load conditions resulting from new users, new services or changing user behavior on the utilization of the DPN-100 and MAS network components. It can then facilitate the re-design and optimization of the network.
- **Passport traffic module** - enables the user to analyze traffic in the Passport environment.
- **End-to-end delay** option - available within the traffic modelling module—enabling the user to predict the network delays between specified sets of users.
- **Architect link** option - enables the user to model preferred path routing across both the backbone and the access layer. It will generate and download the service data for automatic provisioning.



Historical data is the input for a variety of applications ranging from network planning to usage based billing.

Network performance data is essential to effectively and proactively forecast network requirements and to respond to network conditions.

The method which Nortel uses to collect statistical and accounting information is a major differentiator compared to our competitors. This is illustrated in the following:

High data integrity

- data is collected locally to avoid possible loss in the network
- backup collection sites (Magellan Data Provider) can be established, so if one site goes down, the other will take over

Extensive data content

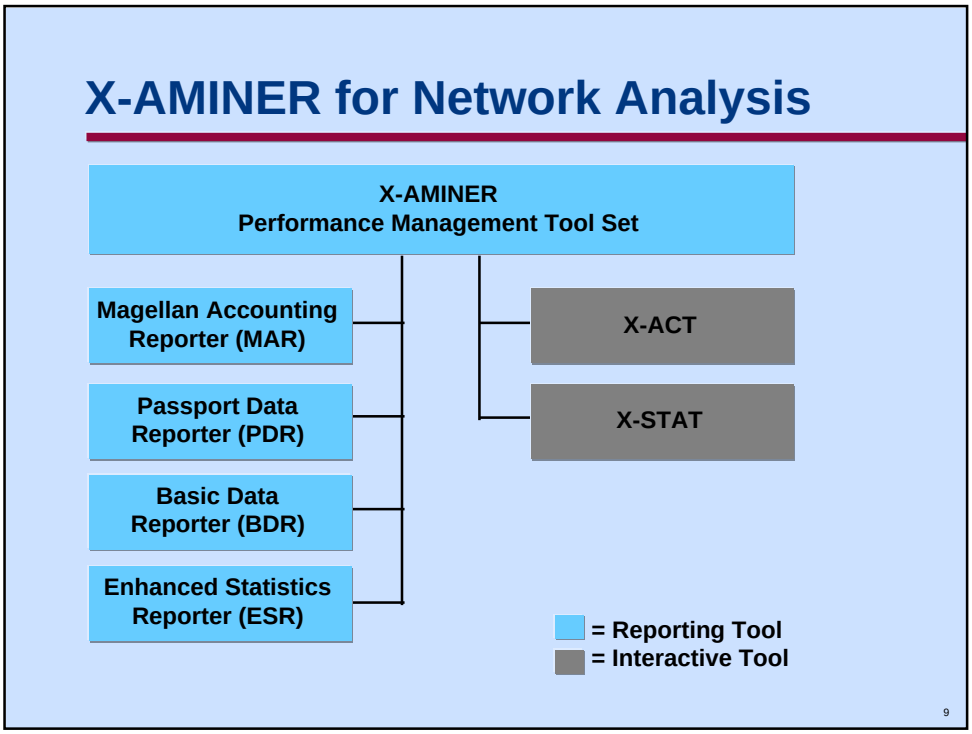
- Magellan network and service level statistics provide raw usage information, as well as value-add information such as peak water mark (PWM), maximum trunk utilization, etc. PWM and maximum trunk utilization are measures of the maximum value attained during the measurement interval.

Scalable solution for all network sizes

- distributed architecture can scale to an infinite network size
- local collection and file transfer architecture requires less bandwidth and network resources than an SNMP polling architecture

Ease of fit into operational environments

- customizable bulk data format



The X-AMINER tool set is comprised of the following modules.

Magellan accounting reporter (MAR) - enables operators to view and analyze accounting records for both DPN-100 and Passport for quality of service and network usage reports.

Passport data reporter (PDR) - enables operators to view and analyze Passport performance records.

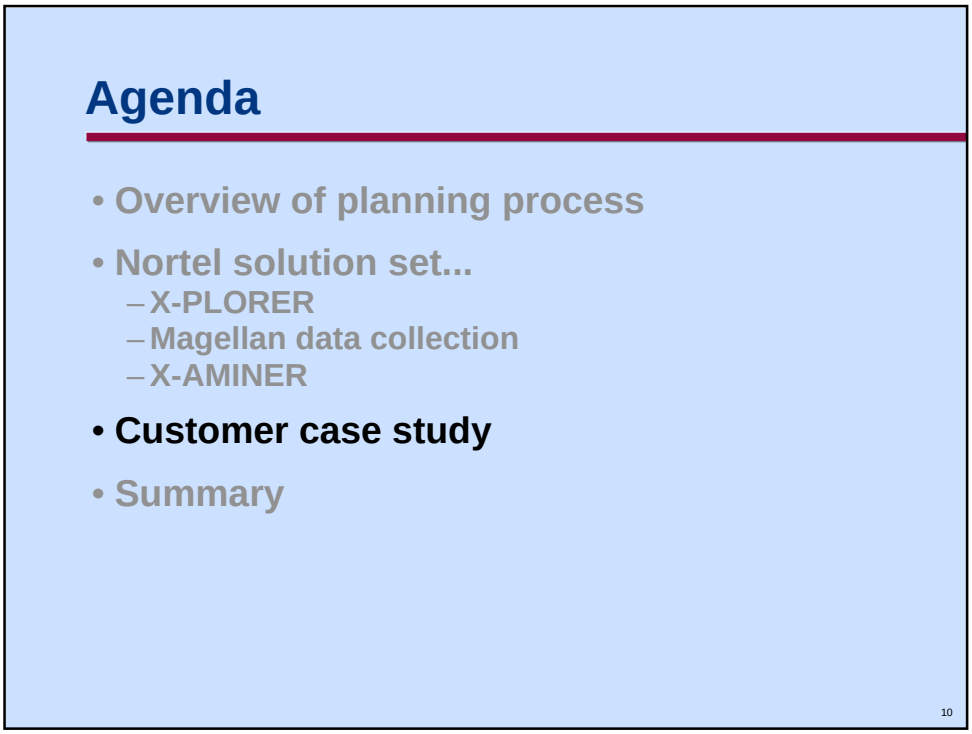
Basic data reporter (BDR) - produces general reports based on alarms, statistics and operator log.

Enhanced statistics reporter (ESR) - provides analysis on defined threshold levels. ESR complements the interactive X-STAT tool.

X-ACT - interactive tool that allows operators to analyze network user traffic by looking at the accounting data.

- The **X-ACT COI** (community of interest) option enables the Peak Traffic Matrix to be exported into X-PLORER for modelling.
- The **X-ACT availability** option calculates the end-to-end availability of PVCs.

X-STAT - interactive tool that allows operators to measure network utilization. A new statistics feature will be added shortly to enable analysis of DPN-100 frame relay statistics.



At this point, an overview of the planning process and a brief description of the Nortel solution set has been outlined.

The following case study illustrates how all these components were used to deploy and optimize the network.

Customer Case Study

Customer environment

- 3 major sites
- Longest hop = 700 km
- Expensive local tariffs
- Single tariff structure
- Very high level of service expected

Networking requirements

- Community of Interest (COI) estimates
  - see next slide
- Level of service
  - end-to-end delay < 40 ms
- Application profiles
  - router access 64K - 128K
  - frame relay (connectionless)
- Engineering guidelines
  - trunking = E1
    - max = 85%, avg = 60%
  - 2:1 oversubscription factor

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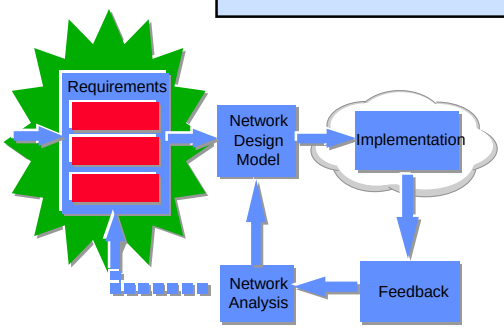
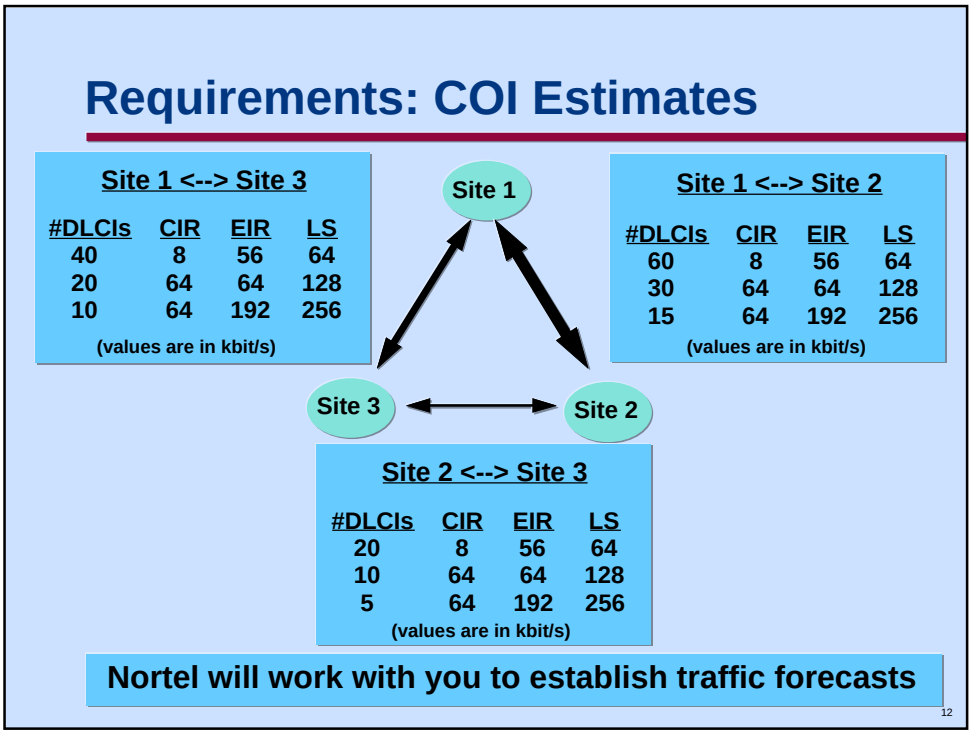
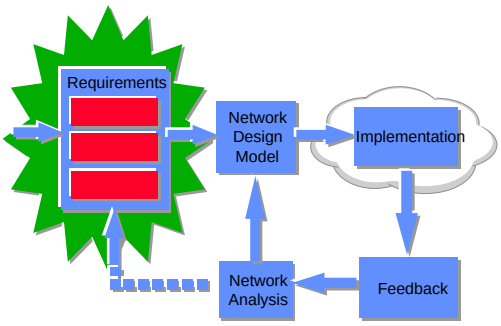


The customer's essential requirements are outlined above. The initial requirement was for a frame relay service network spanning across three major sites. Future evolution to ATM is expected. Expensive local tariffs made it imperative to effectively use bandwidth, and, in addition, meet a customer expectation for very reliable service.

It was extremely important to achieve a delicate balance between effectively utilizing bandwidth and offering reliable service to the customer. Initially, a 2:1 oversubscription factor would be assumed on EIR offered traffic. The bandwidth engineering goal to achieve an average utilization of 60% with 85% for peak traffic times.

Oversubscription relies on the assumption that not everyone will be utilizing their services to full capacity at the same time (otherwise known as statistical multiplexing). For example, assume that a Passport has 10 access ports, each with a line speed of 64 kbit/s. A worst case analysis would result in 10 x 64 kbit/s bandwidth requirement. However, with an oversubscription factor of 2:1, the resulting bandwidth requirement is half of that (10 x 64 kbit/s / 2). By assuming a factor of 2:1, the bandwidth expense is essentially reduced by half.

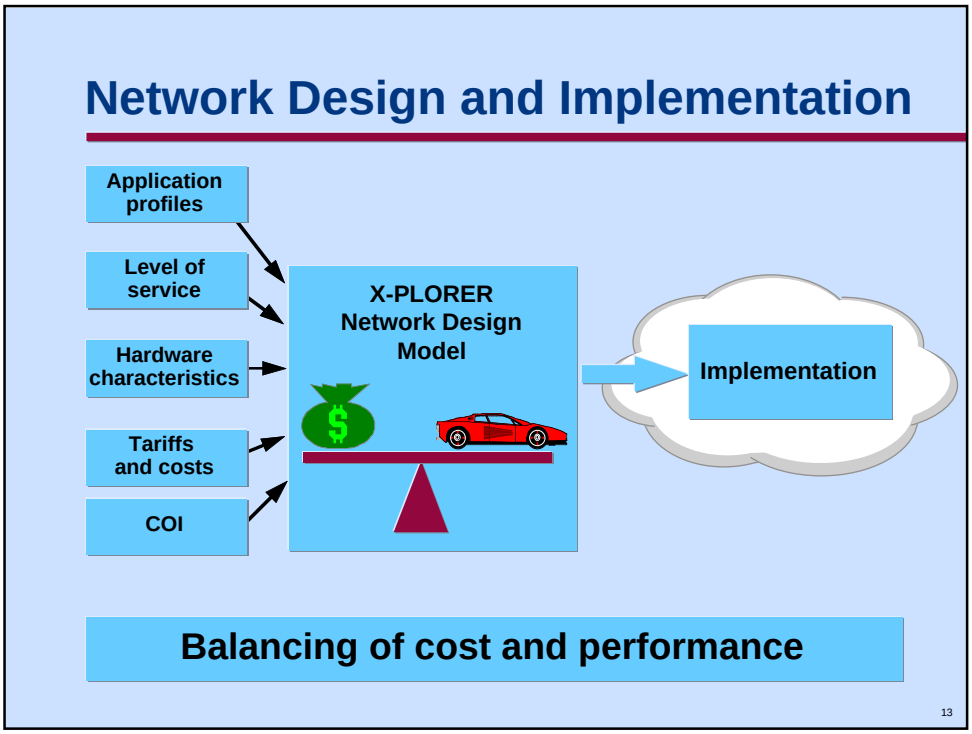


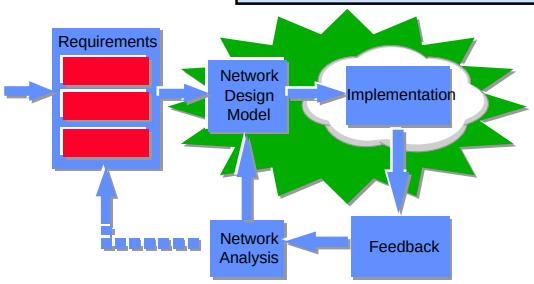


As part of the requirements phase, it is essential to have an estimate of the COI traffic. In this case study, the traffic between the three sites was estimated.

The COI figures shown above summarize the various frame relay service offerings from the service provider. For example, there are 60 DLCIs between Site 1 and Site 2, CIR (committed information rate) = 8 kbit/s, EIR (Excess Information Rate) = 56 kbit/s, with a LS (line speed) = 64 kbit/s.

The estimates above predict the highest concentration of traffic will occur at Site 1. The oversubscription of 2:1 will apply against the CIR value, which is guaranteed to the user.

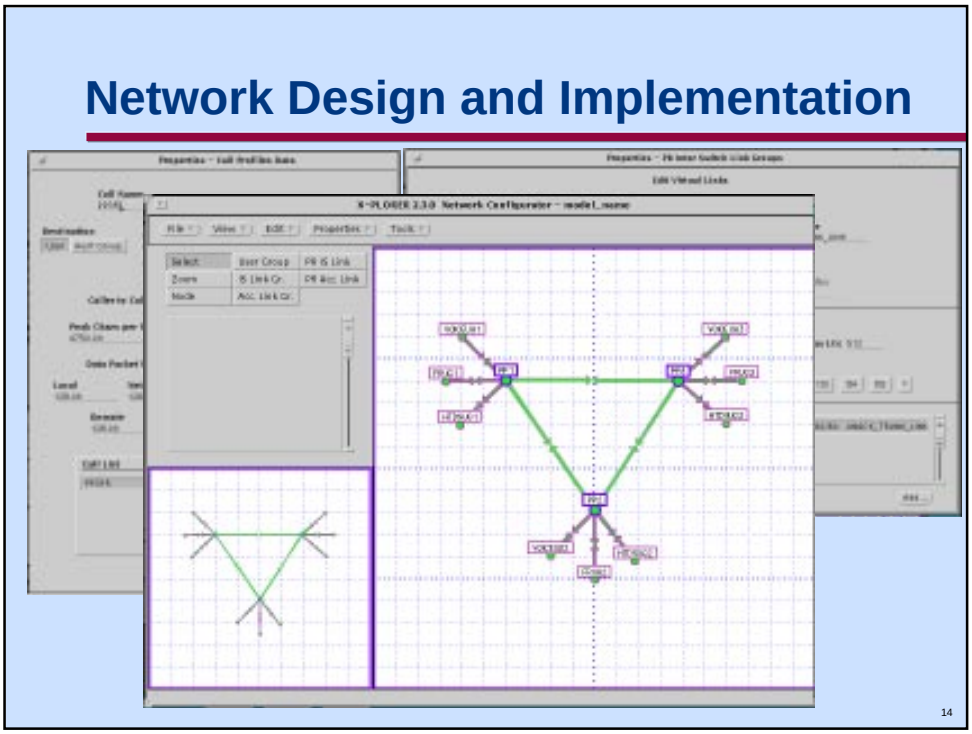


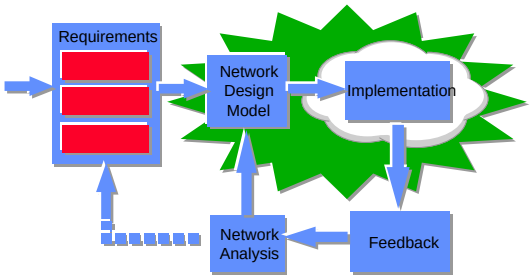


An important step in any network planning exercise is to capture the network in a model. This is crucial for ease of planning and analysis as the network evolves and its traffic characteristics change.

Once the COI and topology requirements are designed, this is fed into the X-PLORER design modelling tool. Optional modules were used to automate the tasks in X-PLORER.

Using X-PLORER, the user must balance bandwidth and equipment costs with network requirements to generate a workable network implementation. For example, modules such as Traffic coster and Traffic modelling enable the user to perform “what if” scenarios.

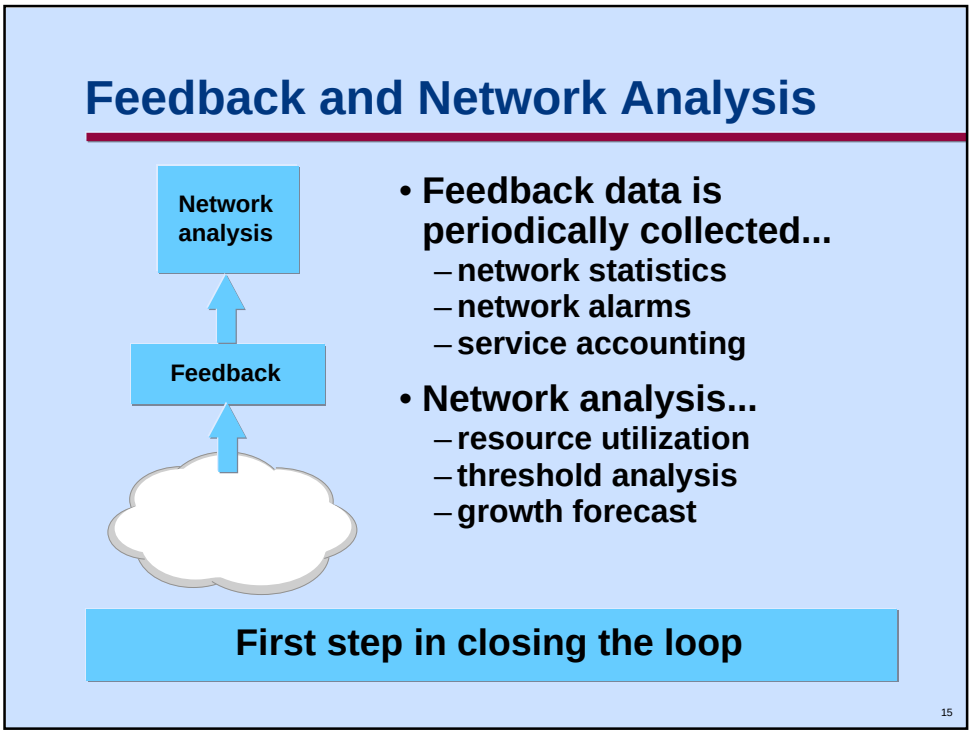


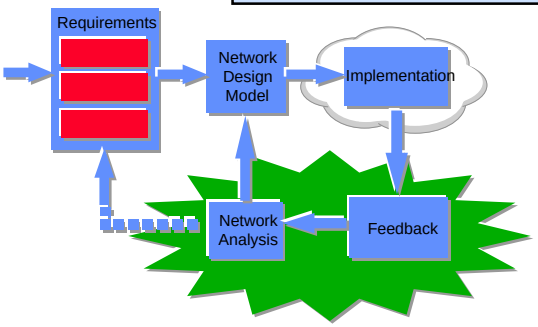


This slide shows the X-PLORER GUI representation of the case study topology. This was determined from all the inputs (level of service, traffic, etc) established at the **requirements** phase.

As mentioned, the planner can choose to purchase optional modules to automate and/or simplify tasks in X-PLORER. The planner should balance the initial cost of the optional modules against the cost benefits (in terms of automating/simplifying) of the optional modules. The cost savings in resources by automation of these tasks could pay back the cost of the optional modules in a short time frame.

The planner may choose to start with the mandatory modules and, as the network evolves in size and complexity, to purchase the optional modules as they become justified.



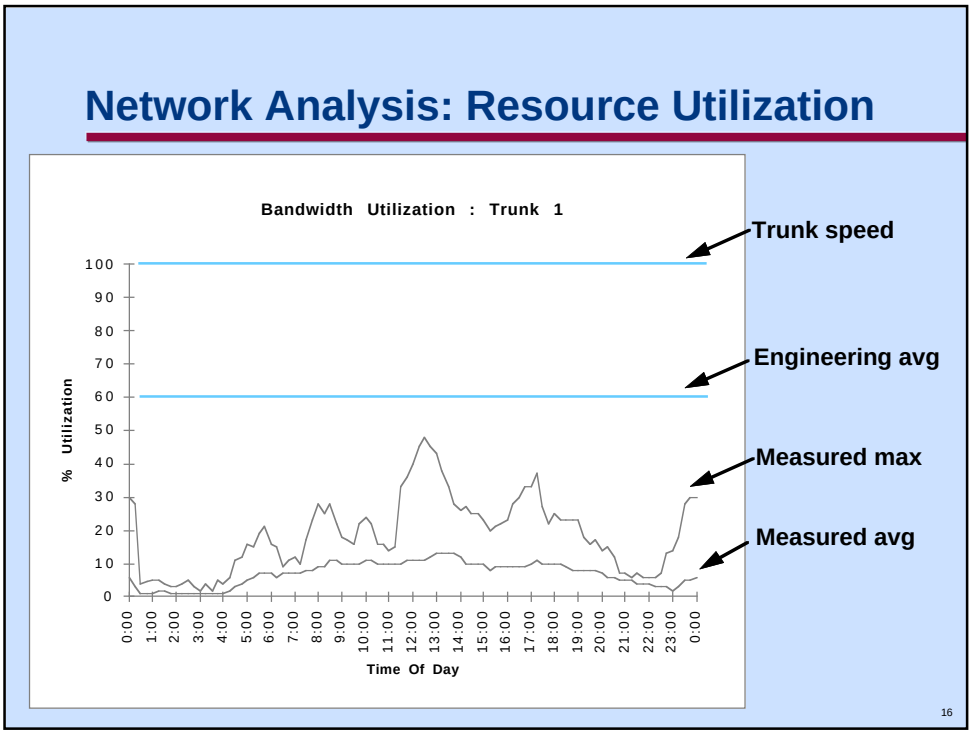


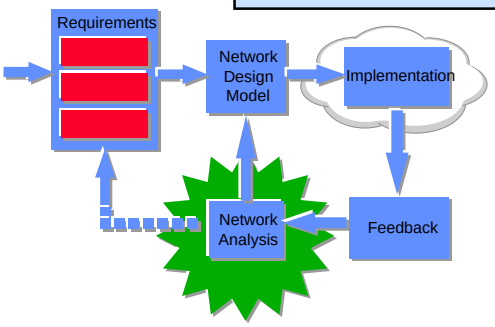
Once the network is implemented, the feedback and analysis stage is commonly put off until congestion levels in the network are reached.

This procrastination is not due to the planner's unwillingness to carry out the planning process, but rather to the inadequacy of the typical tool sets on the market.

The Magellan tool strategy overcomes these inadequacies by automating the feedback and analysis stage as much as possible.

In the case study, information was collected on a continuous basis for several months. Collecting this information is the first step in *closing the loop.*



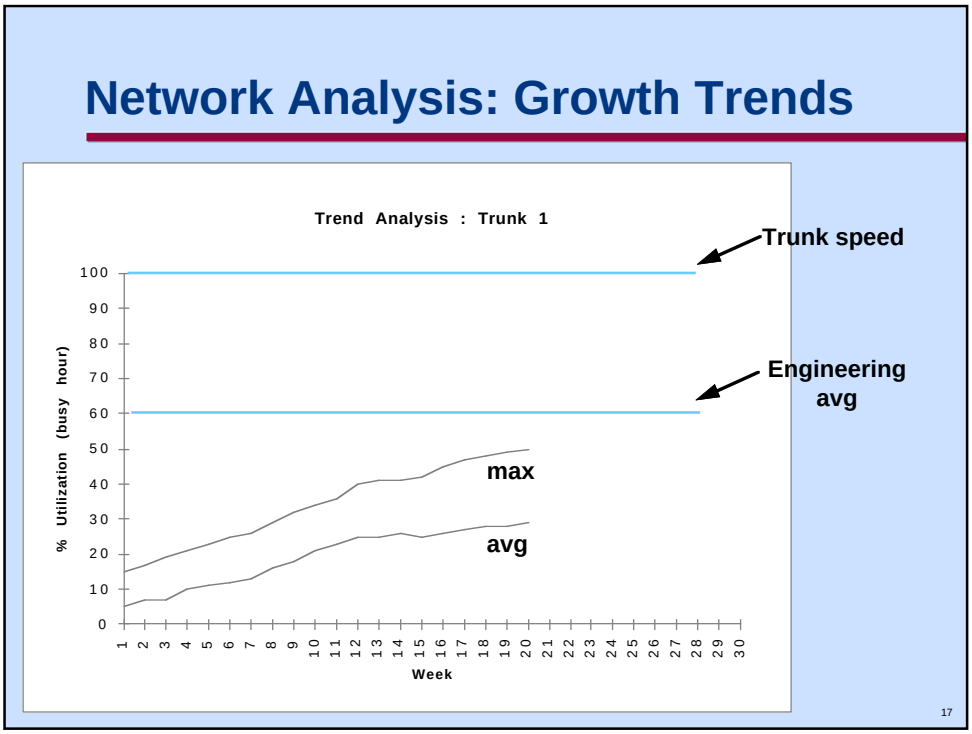


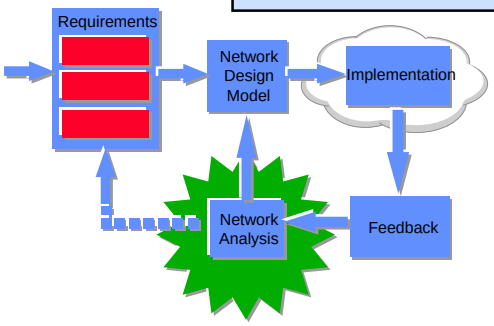
This step in the network analysis phase is a basic reporting of the utilization of the network. The X-AMINER tool set was utilized to generate this information.

The graph above illustrates the bandwidth utilization during a typical day. The initial guidelines of 2:1 oversubscription and average/max utilizations are seen to result in a low utilization of network resources. A similar report can be generated for other network resources.

This graph can also be used to illustrate periods of low usage in the network. The periods of 8:00 am to 6:00 pm are the only intervals in which the bandwidth utilization approaches 50%. Outside of this time frame, the network is very under-utilized. This information can help identify opportunities which take advantage of these non-peak times. For example, offering reduced rates during these off-peak times would help flatten out bandwidth utilization. Also, applications such Internet dial-up, whose service usage typically peaks during these off times, could be offered to the end customer without major topology changes.

This analysis presents the network planner with opportunities to save money and, in some cases, even make money for the organization.





This step of the design process deals with predicting the future. Although it is impossible to guarantee the precision of such predictions, it is possible to create a reasonably accurate view.

The above analysis was performed using Magellan data collection of Passport network statistics such as maximum and average trunk utilization, and the X-AMINER reporting tool set, to provide a meaningful analysis.

If the network is much larger than this start up network, for example in the hundreds of nodes, it may prove too cumbersome and time consuming to analyze each network component in this fashion. The compromise would be to use the X-AMINER tool set filtering capabilities to produce analysis for the “worst case” 500 trunks, and the “best case” 500 trunks (worst case being the trunks with the highest utilization).

In the graph above, it is concluded that the bandwidth is still below engineering guidelines. However, the network is steadily growing, and by extrapolation, will reach (but not exceed) engineering guidelines this year.

The remaining step is threshold analysis. In this case study, defined thresholds (85% trunk utilization, end-to-end delay guidelines) were not exceeded during the initial planning cycle. If threshold violations were found, it could be an indication that the engineering limits of the network were being reached. Further analysis would be required to isolate the network condition which caused the threshold violations. X-AMINER tools such as ESR will assist in this analysis.

Closing the Loop - Fine Tuning

Analysis has proven that 2:1 oversubscription factor is conservative

- **Action: Engineering decision on implementing a more aggressive factor (4:1)**

Analysis has shown that the network is growing

- **Action: "Date for a date"...estimate when forecast should be re-visited**

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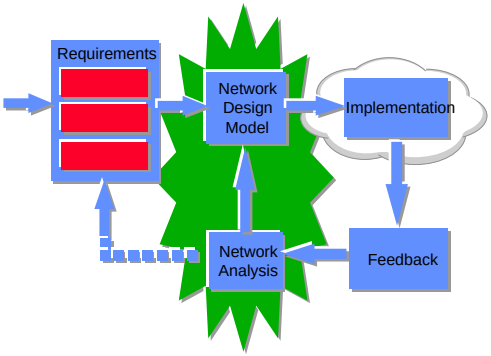
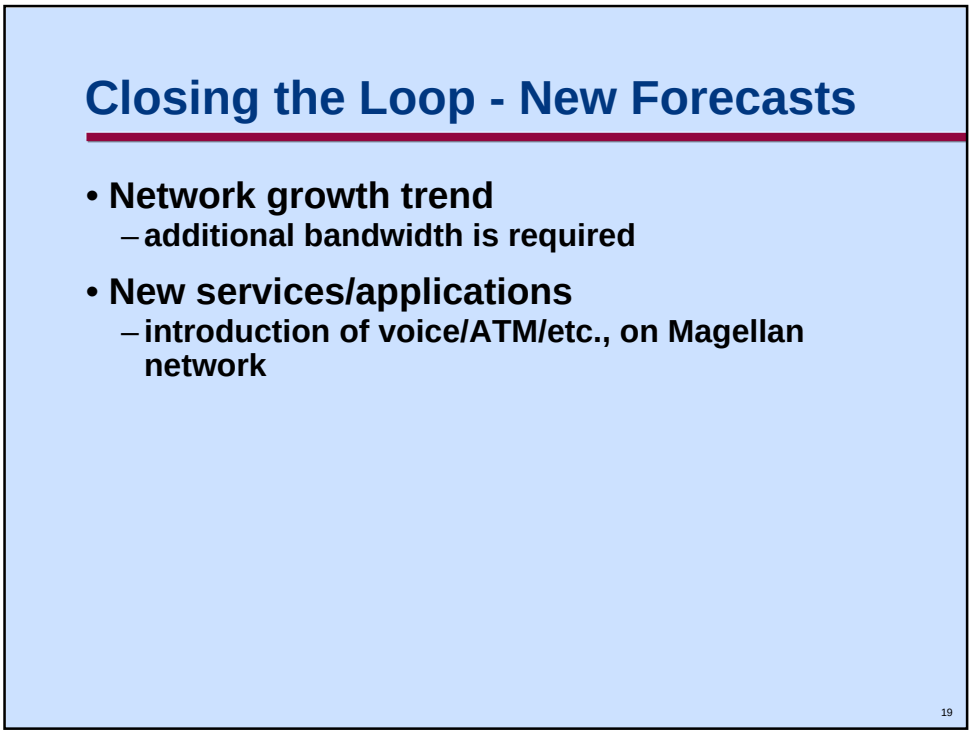


The previous analysis illustrated that the engineering guidelines used were very conservative.

The result is that a major portion of bandwidth was incurring expense to the organization without producing any benefits (other than providing an exceptionally available network).

To make more efficient use of bandwidth expense, the oversubscription factor was elevated to 4:1 and finally to 4.7:1. As a result, the ratio of bandwidth expense to customer access declined drastically.

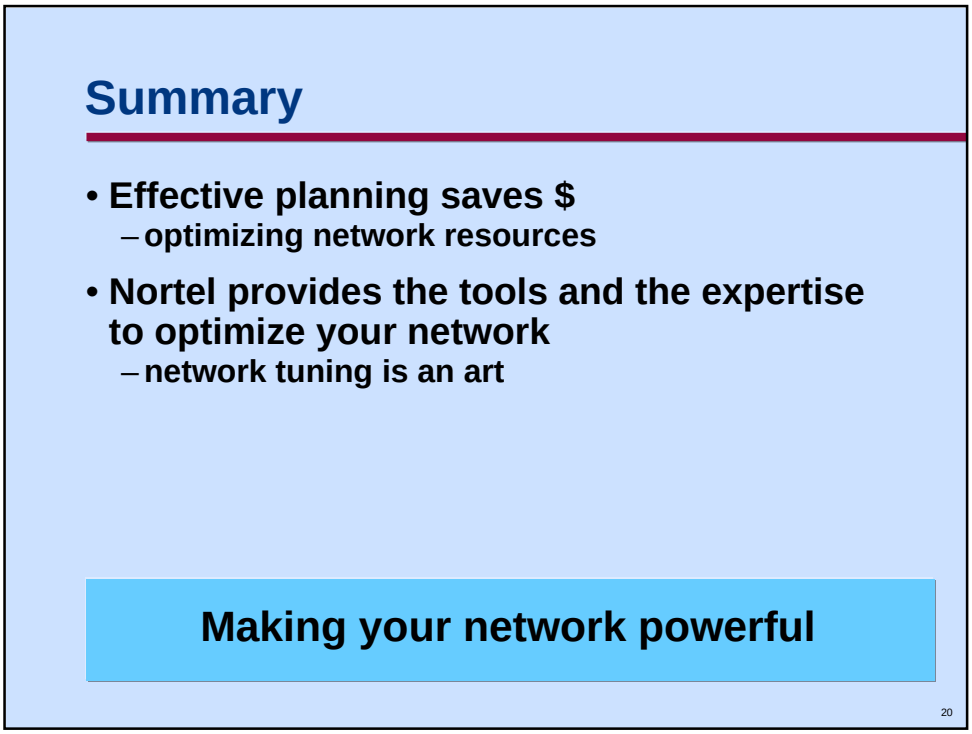
It was also noted that the network is growing. By extrapolation, it was decided that the initial traffic forecasts should be re-visited within six months.



As stated, the network planner in this case study predicted that in several months the initial forecasts should be re-visited. At that time, another variable was introduced.

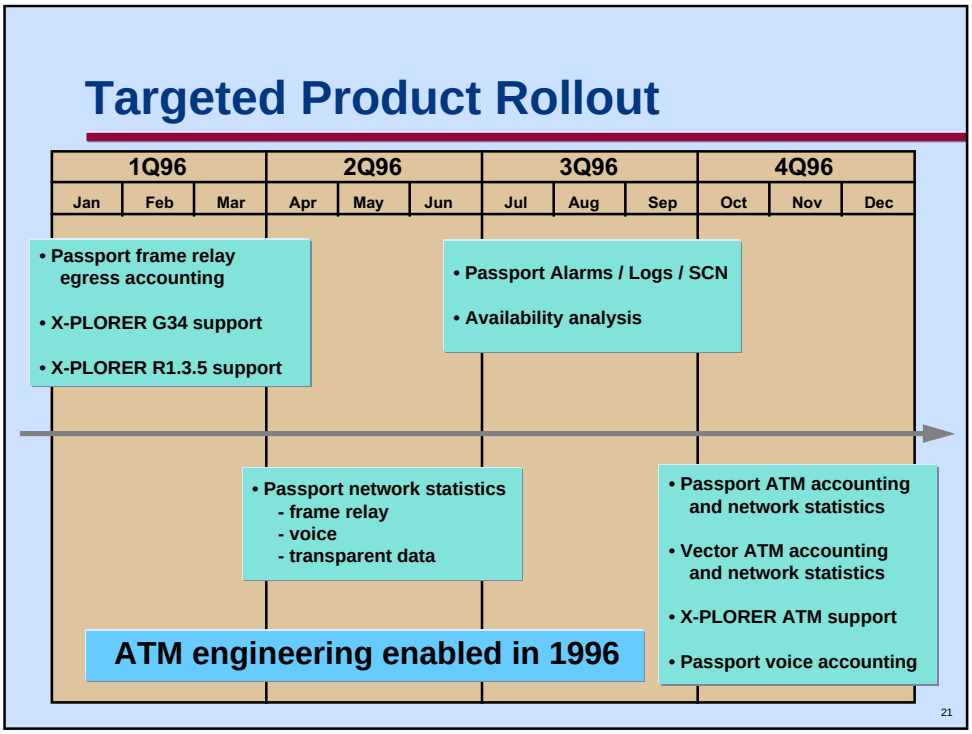
Due to market opportunities and the reliability of the network, it was decided that voice service should be introduced into the network. Although this service has different level of service requirements, the engineering cycle is essentially the same, with the same Nortel solution to evolve the customer network.

Using the re-visited forecasts for frame relay, along with the new forecasts for voice services, the engineering cycle was followed through.



For more information, please plan to attend:

- Engineering whiteboard clinics
- Planning and Analysis Tools hands-on workshop
- Magellan Management Overview and Directions workshop
- Magellan Open Management: Fit and Flexibility workshop
- Demonstration Center
- Frame Relay Network Engineering workshop


Targeted Product Rollout
1Q96
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Dec
• Passport frame relay egress accounting
• X-PLORER G34 support
• X-PLORER R1.3.5 support
• Passport Alarms / Logs / SCN
• Availability analysis
• Passport network statistics
- frame relay
- voice
- transparent data
• Passport ATM accounting and network statistics
• Vector ATM accounting and network statistics
• X-PLORER ATM support
• Passport voice accounting
ATM engineering enabled in 1996
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