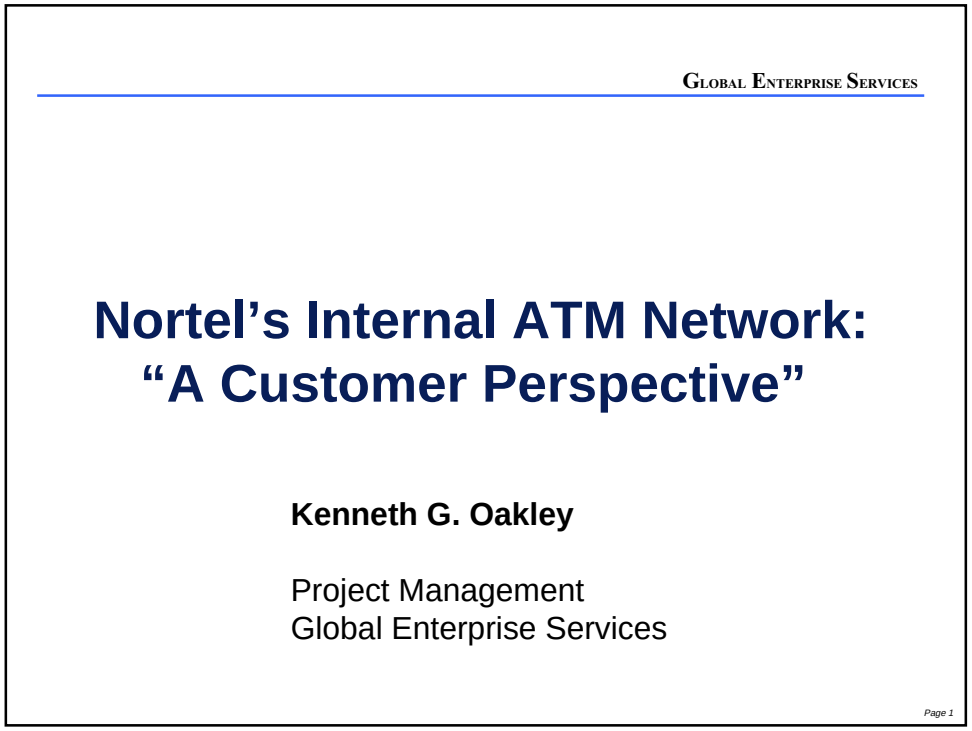


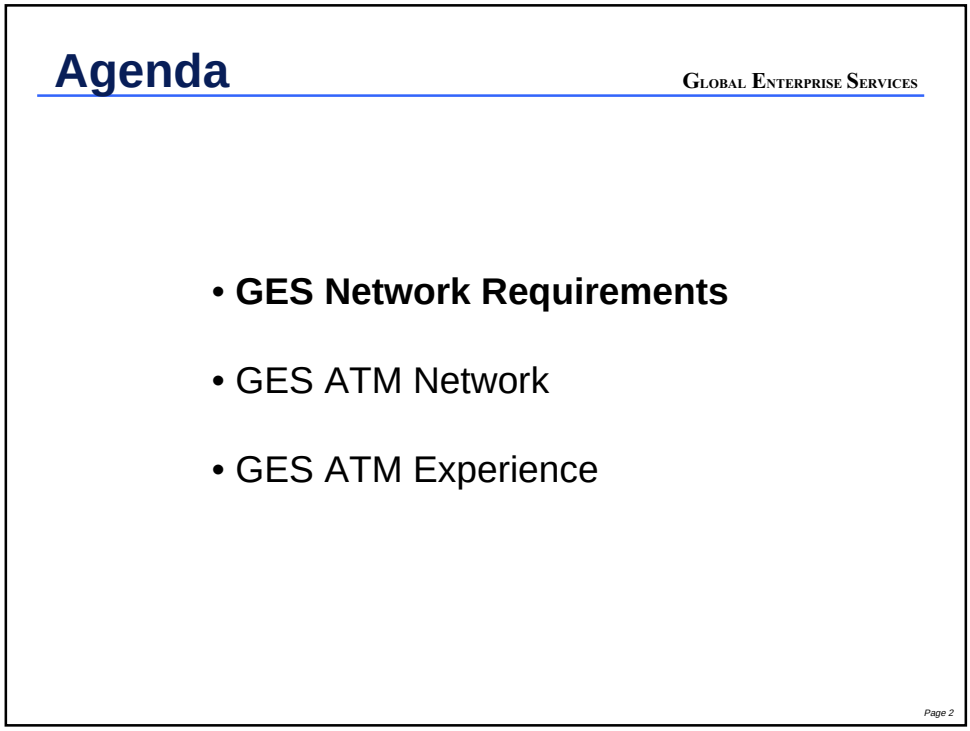
This workshop examines how GES, Nortel's internal network provider serving approximately 60,000 employees worldwide, transitioned its wide area enterprise network from TDM technology to ATM, using Magellan products. The extensive ATM deployment from the evolution of the TDM network, to network consolidation, through to ATM is discussed—focusing on business drivers, benefits and lessons learned. GES is one of the early ATM adopters to successfully consolidate voice, video and data traffic.

About the Presenter:

The presenter is currently the GES Project Manager, responsible for the deployment of Nortel's internal ATM network.

Ken Oakley has more than 25 years experience in the telecommunications arena. He joined Nortel in 1972 in London, UK, where he was responsible for European technical support for a range of data communications products. In 1976 he relocated to the US and was responsible for providing global input into the product planning process and various other assignments.

Oakley was a member of the Magellan organization from 1988 until 1993, and was responsible for deployment and support of customer networks in the U.S.



What will this workshop cover?

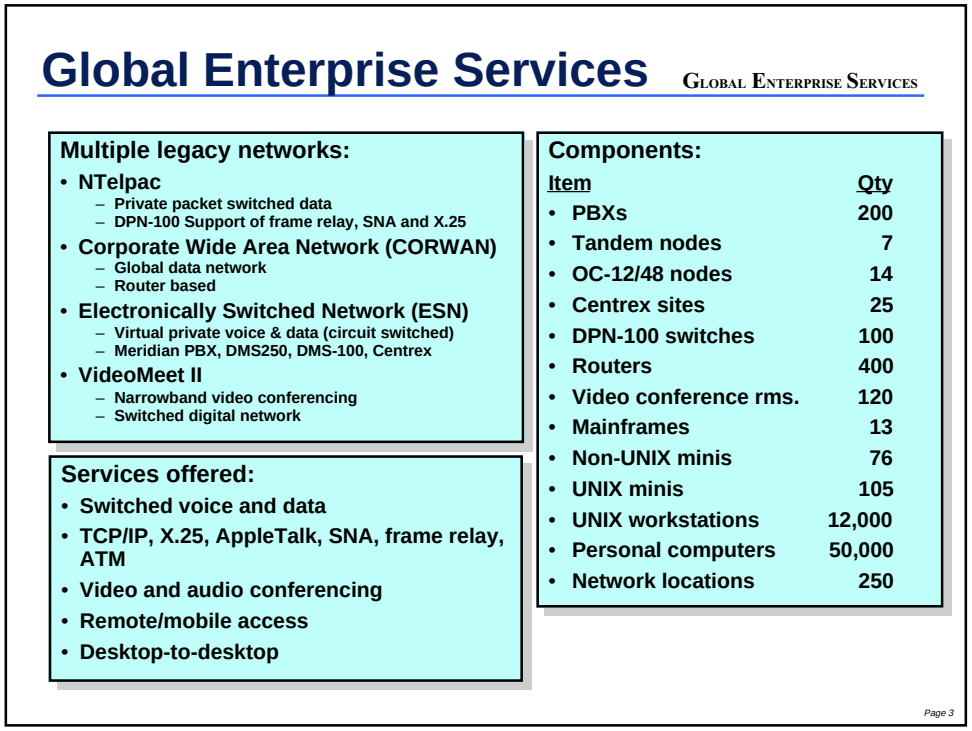
The purpose of this presentation is to provide an overview of the implementation of a leading edge ATM network. The topics that will be covered are: the networking requirements, ATM architecture, project scope, implementation, benefits and experiences. The presenter does not plan to review the technical details of the deployment.

The key points are:

- ATM technology works today
- The enterprise network enables the applications that provide the business value and support re-engineering
- The benefits of ATM are being realized

When this project was initiated in late 1994, the thrust was to consolidate—using ATM technology—the several legacy networks that were in place, and to dismantle the existing TDM networks.

The Nortel vision was to build an ATM wide area network that would utilize Magellan products, prove the viability of ATM, gain real life ATM experience and provide valuable product feed back to Magellan.



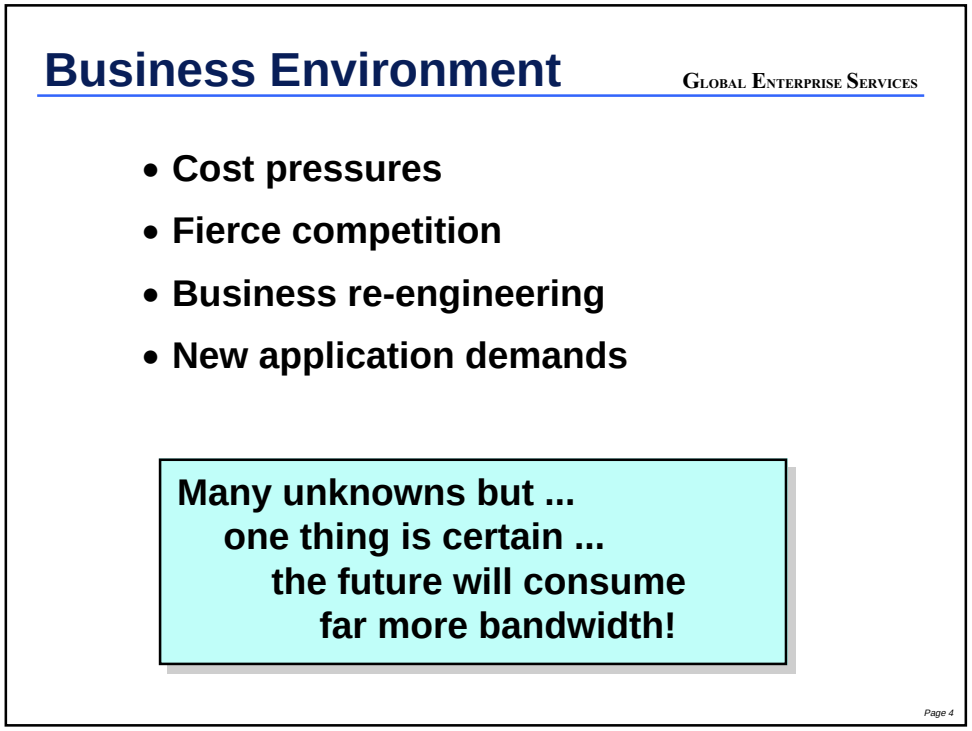
Who is GES?

Global Enterprise Services, or GES, is the provider of computing and networking infrastructure and services to Nortel and its customers.

GES's some 2000 employees are part of the MCS division of Nortel and are committed to providing high quality and competitive services on a global basis.

An important point here is that GES is a network operator, just like many in the audience, and has similar objectives and pressures.

Recently, the Network Transformation Service (NTS) organization was consolidated with GES. NTS is in the business of providing network integration, consultancy and outsourcing services to meet external customer requirements.



The Business Environment

The business environment that GES faces is no different from that of many network providers. There is the constant requirement to do things faster at reduced costs, in order to be competitive.

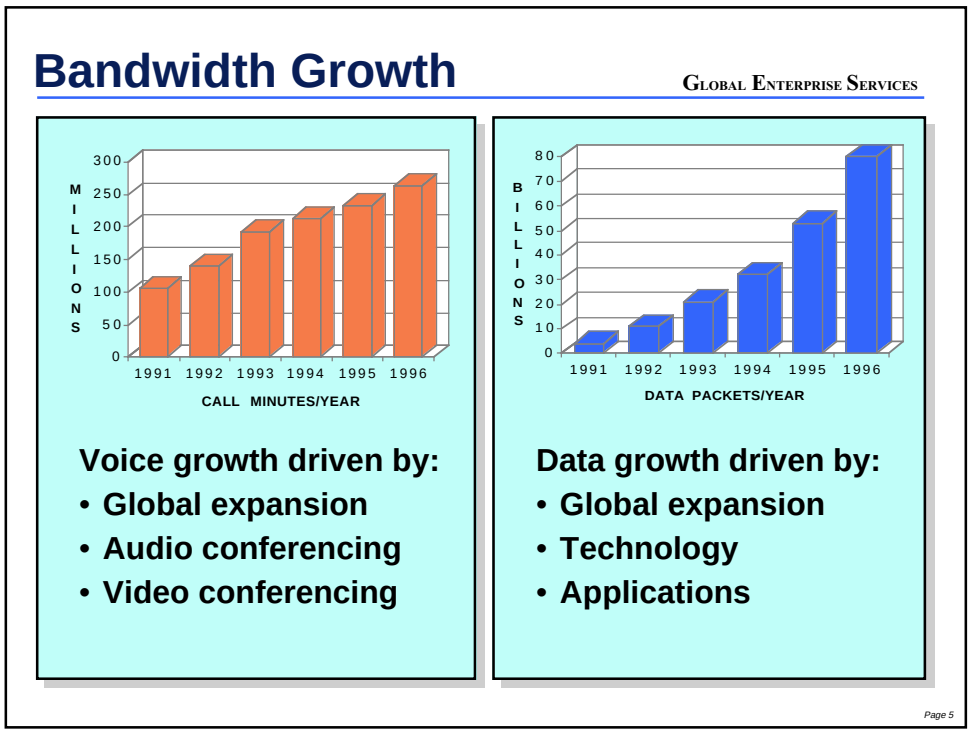
In the past, the enterprise networks would respond to an application requirement by adding the required network functionality or by adding bandwidth, but this took time.

GES wanted to be in the position of anticipating these requirements and being able to respond rapidly. This would then provide the support for the emerging applications, which in turn would support Nortel business re- engineering efforts.

In effect, the enterprise network becomes a competitive advantage.

The current application direction is to include more visual content, embedded speech and image, workshop collaboration, synchronized distributed databases, enterprise servers, and remote systems management.

All of which require more bandwidth.



GES Bandwidth requirements

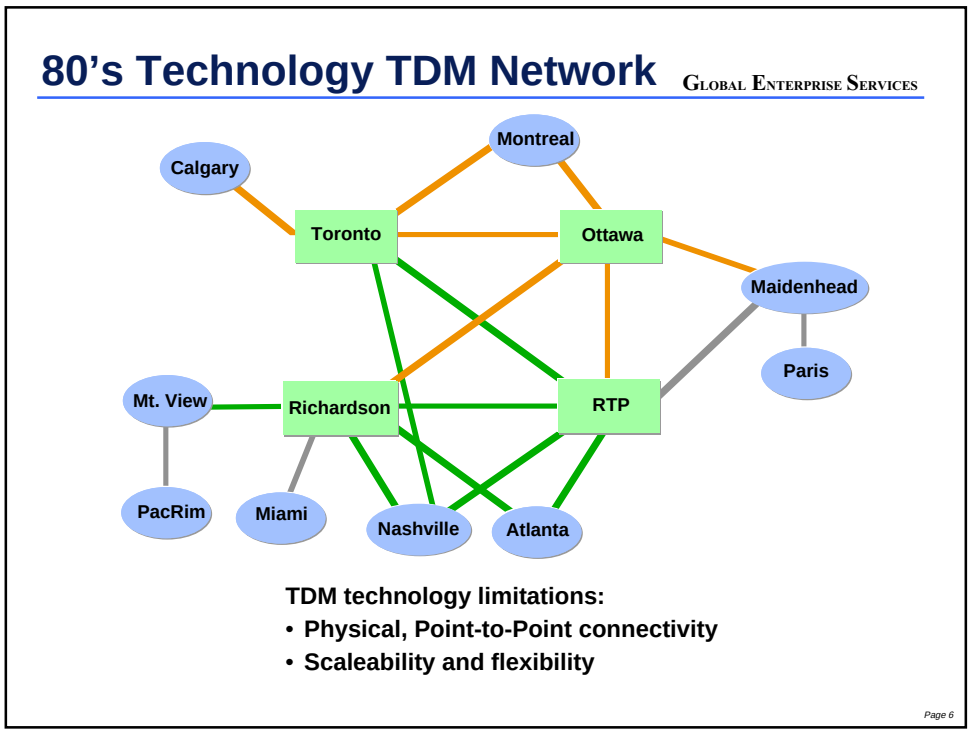
An historical look at the various traffic statistics over the past five years for the GES network shows that growth rates vary by traffic type.

For example, voice is growing at a steady rate of 15 to 20% per year, which is driven by Nortel's growth rate and global expansion.

The data growth is much more dramatic, almost doubling each year and is being driven by PC deployment, and client/server architecture which is enabling new applications.

Another area that is exploding is that of video conferencing, which is expected to continue to grow as the technology evolves.

The bottom line is the need for more bandwidth.



The TDM technology:

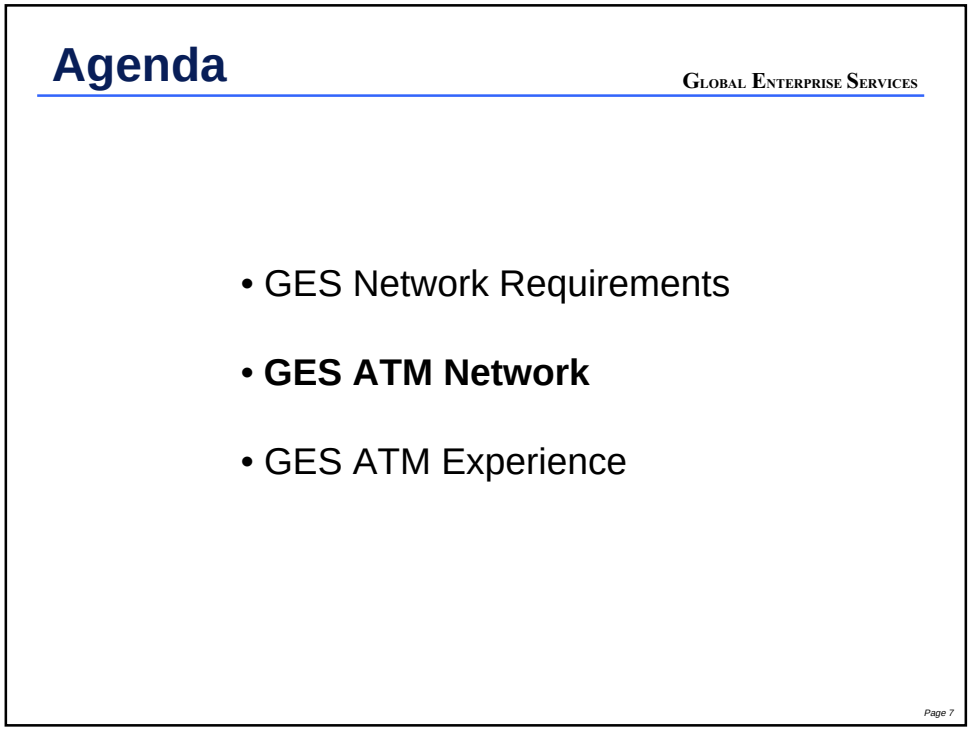
The GES TDM network has been serving the major Nortel locations for many years. Several types of T1 multiplexors have been deployed and used to connect T1 facilities between locations.

This technology basically provides a point-to-point physical connectivity at T1 speeds. This was fine when applications required T1 or subrate T1 speeds, but new applications require more bandwidth. In addition, the TDM technology does not provide the scalability and flexibility required in today's enterprise networking environment.

GES networking environment summary:

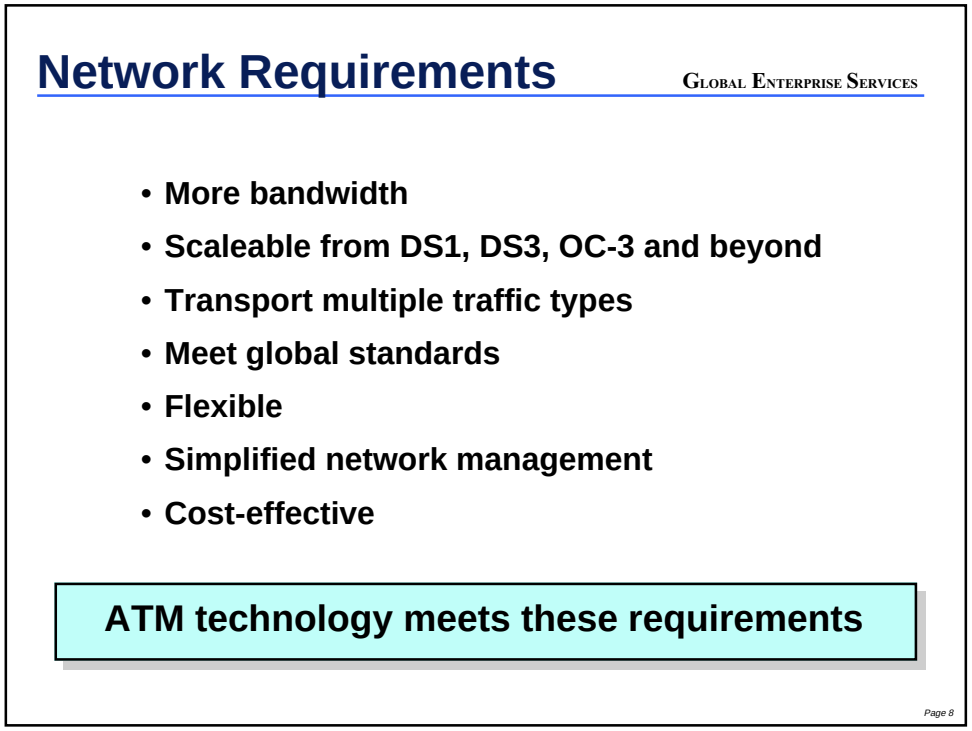
The GES challenge was that the existing TDM network environment was straining to meet the users' expectations and in responding to the constantly changing business needs.

In late 1994 ATM technology was still in its infancy but it had the potential attributes to meet this challenge.



The GES ATM network:

The presenter will now discuss the ATM network in more detail—why ATM was chosen, what was the business case, the scope of the deployment, and the achievements.



Network requirements and why ATM

From the previous section, the need for more bandwidth has been established to accommodate growth, and new applications.

Scalability was required to allow an upgrade to the next bandwidth, eg. OC-3, to be achieved easily and quickly without having to redesign the network.

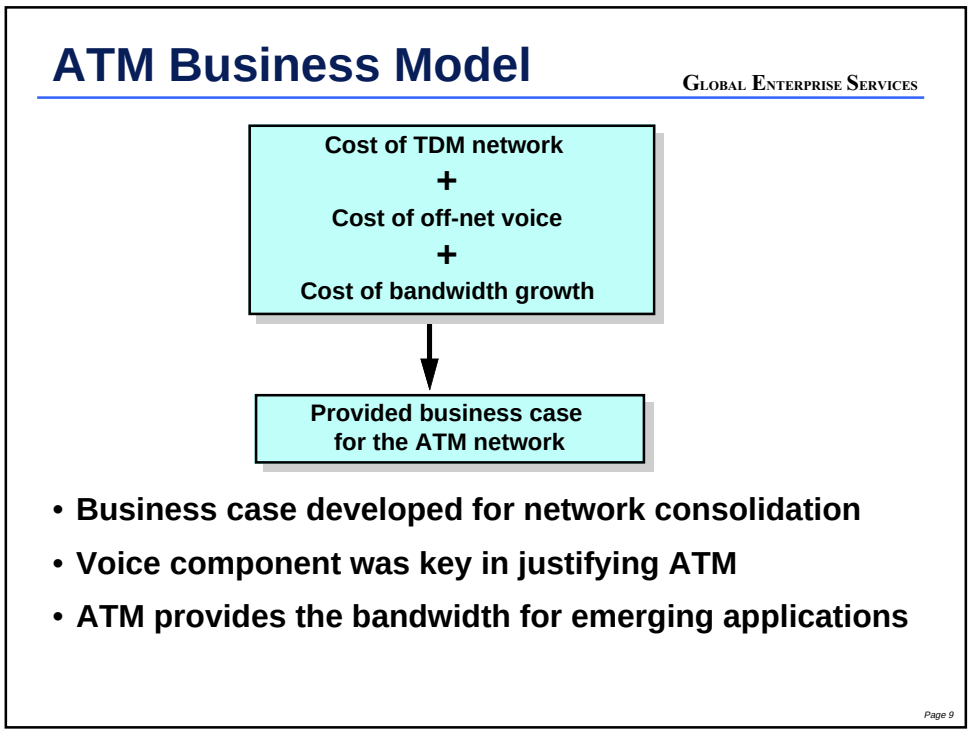
The network had to be capable of handling the different traffic types and their various characteristics, so network consolidation could be accomplished effectively.

The need to conform to global standards is based on the requirement for any-to-any connectivity for all applications. The days of proprietary protocols have gone.

Flexibility is required to allow changes to be made quickly, if possible, under software control, and provide the ability to connect any location to any other location.

Of course any network has to be cost effective. The cost of bandwidth continues to fall and as we move towards a SONET environment the costs are expected to fall further. The network management system is another key to driving the network operating costs down.

ATM technology meets these requirements!



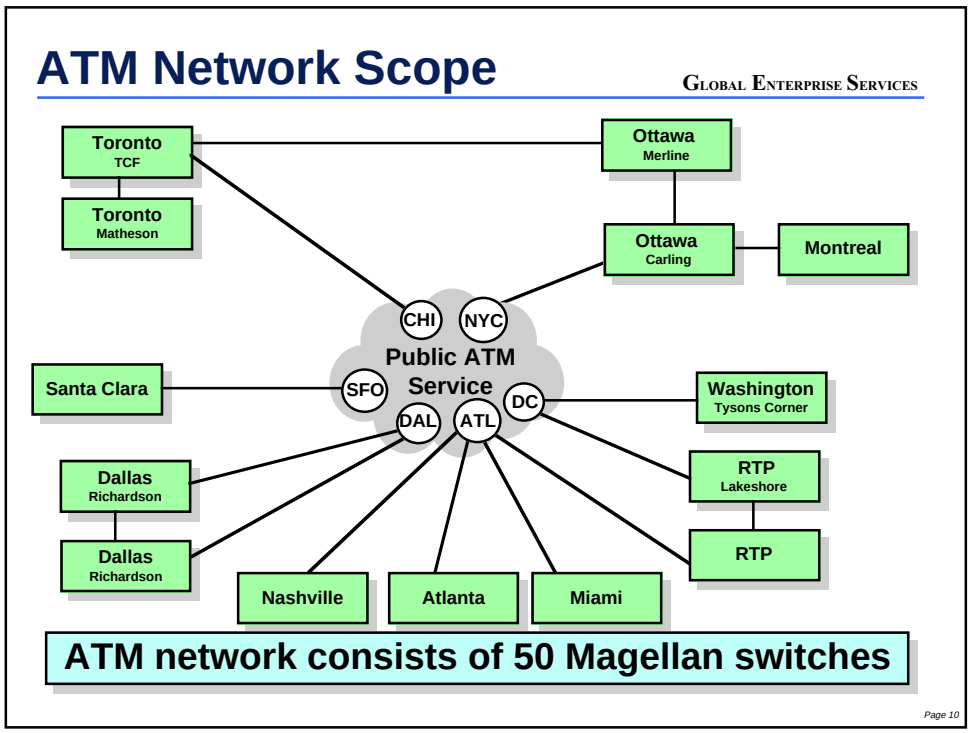
What was the business case for ATM?

The enterprise networking model of the 80's was to provide a private network for the data traffic, while voice was either carried "free" on the excess private bandwidth or went off-net.

When the business case for the ATM network was initiated, we realized that more than 60% of the bandwidth was used by voice traffic. This formed the basis for the business case for the ATM.

In effect, the voice component, plus the existing TDM costs, provided the business case for proceeding with ATM. This enabled GES to start an ATM network implementation while the requirements for more bandwidth for the video and data applications were emerging.

Following the completion of the ATM network, a shift in bandwidth utilization is already occurring. Data traffic is taking a larger percentage of the total bandwidth, and the voice traffic volumes are dropping below the 50% level.



The ATM network

An extensive wide area ATM network has been deployed and is fully operational carrying a substantial amount of Nortel's voice and data corporate traffic. This deployment covers 14 locations, nine in the U.S. and five in Canada, and is based on 50 Magellan ATM switches.

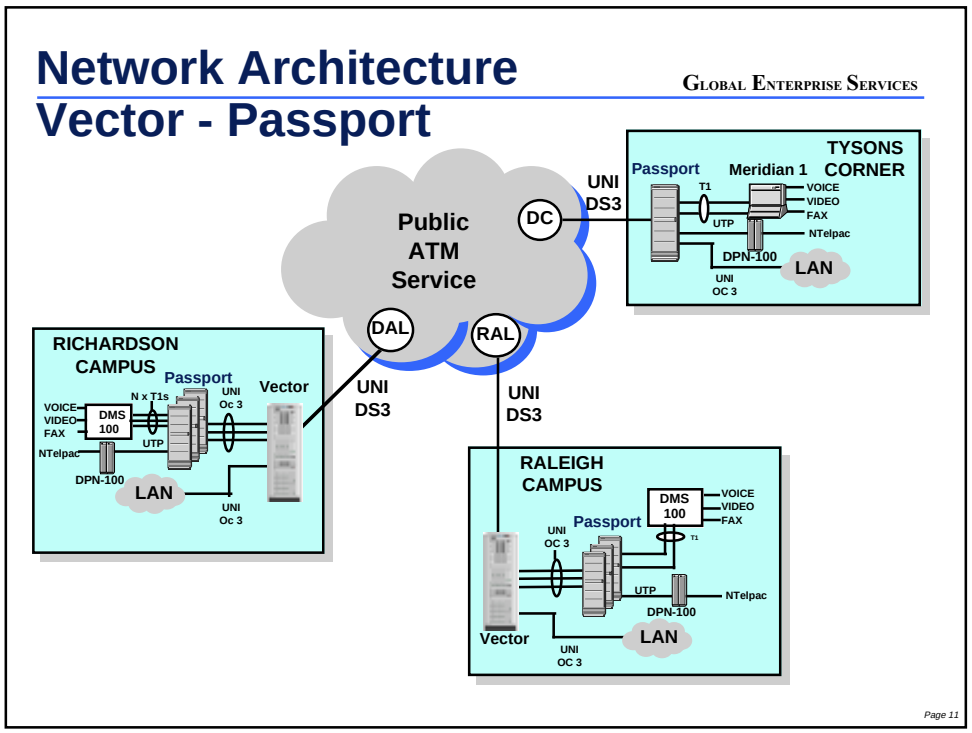
In Canada a DS3 leased line solution has been deployed while in the U.S. a DS3 ATM UNI service is provided from an IEC. Two cross border DS3's are in place to provide for diversity and survivability.

To make the deployment more manageable, the project was organized into three phases:

Phase 1 consisted of five U.S. sites

Phase 2 consisted of four Canadian sites

Phase 3 consisted of the remaining five sites



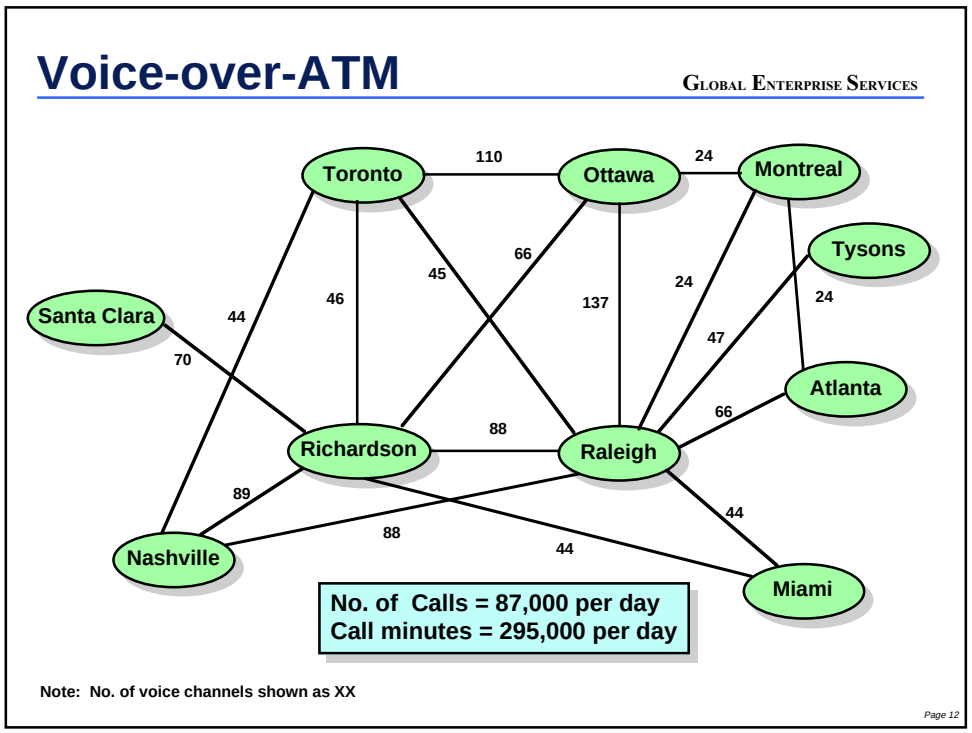
The ATM Network Architecture:

At the present time, GES is in the process of migrating to the above architecture, which is scheduled for completion in third quarter 1996. The current ATM network also includes the predecessor to the Vector product, which is being redeployed lower in the architecture.

The Passports are located on the Nortel premises and are used extensively throughout the network to provide the adaption layers of the ATM environment.

The Passports convert the various traffic types, e.g: voice, data, and video, from their native protocols to ATM. The Passports then either connect directly to the ATM cloud using ATM UNI or connect directly to a Vector.

The Vectors are also located at the major Nortel campus sites and are deployed to concentrate the various ATM streams generated at the site. The Vectors will provide the higher performance that will be required as bandwidth needs continue to explode.



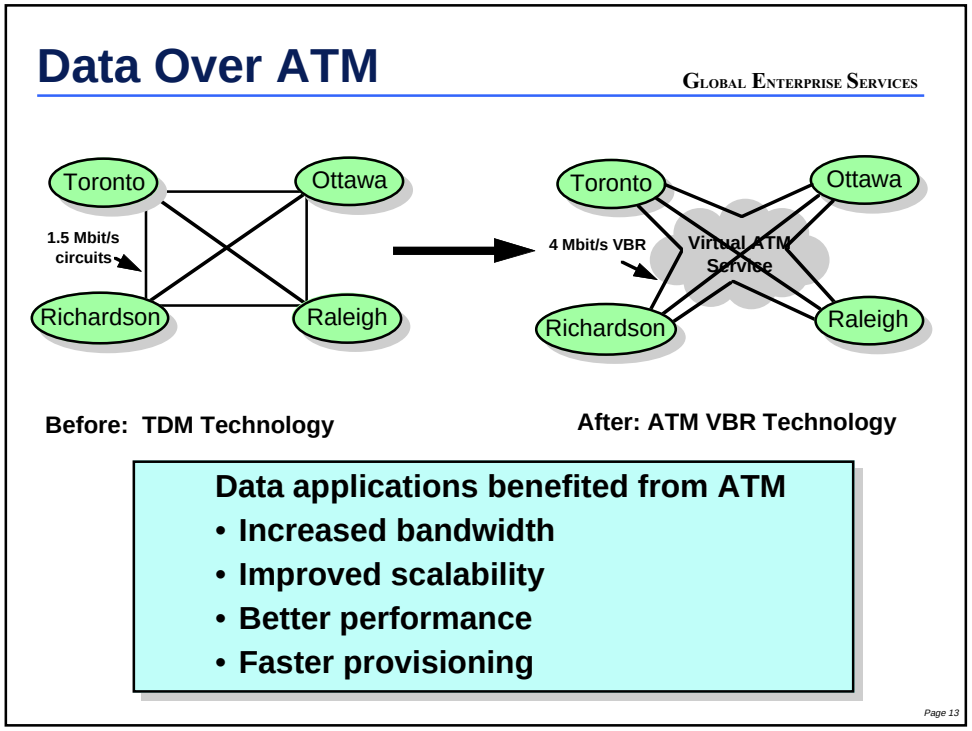
Voice over ATM

An extensive voice-over-ATM network has been deployed and a substantial amount of traffic is being routed over the ATM network.

As of March 1996, the number of voice calls over the ATM network were 87,000 per day, on average, and the call minutes were 295,000 per day. The ATM network is the first choice route and the TDM network has been removed.

The initial deployment used DS1 emulation and replicated the TDM network. Plans are in place and the migration to a VBR implementation is underway. The voice engineering functional group is reviewing the routing and plans to move towards a more fully meshed network.

The voice channels are configured using 2 to 1 compression with silence suppression turned on.



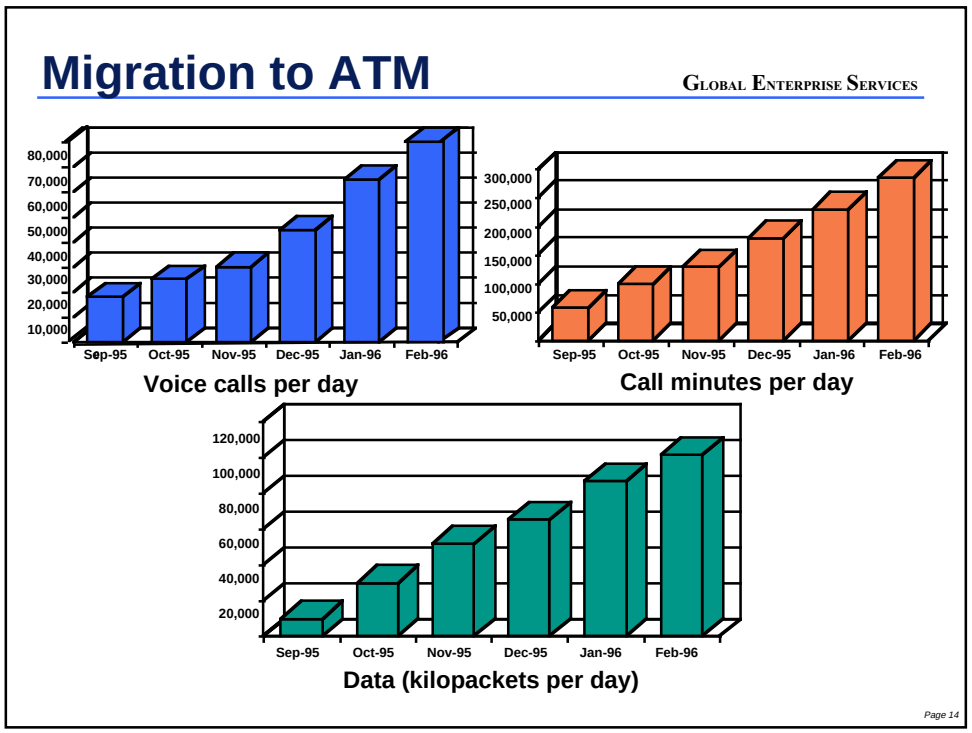
Data over ATM

Implementing voice-over-ATM on such a large scale was an exciting achievement and proved that ATM could effectively handle the voice requirements. However, ATM's potential for handling the data traffic is even more exciting.

Rather than show the entire data overlay, this slide concentrates on the four major Nortel campuses, were the largest community of interest lies. It should be pointed out that each of the 14 ATM sites do have data connectivity.

In third quarter 1995, the ATM deployment for data focused on DS1 emulation. This was to prove the viability of ATM in a production environment and develop the expertise. In first quarter 1996, the ATM network was re- engineered to provide larger PVCs (4 Mbit/s to 10 Mbit/s) using VBR quality of service, and all production traffic has been migrated.

Plans are already in place to increase the VBR's bandwidth even higher. This can be done quickly and easily under software control, as the applications' requirements demand more bandwidth.



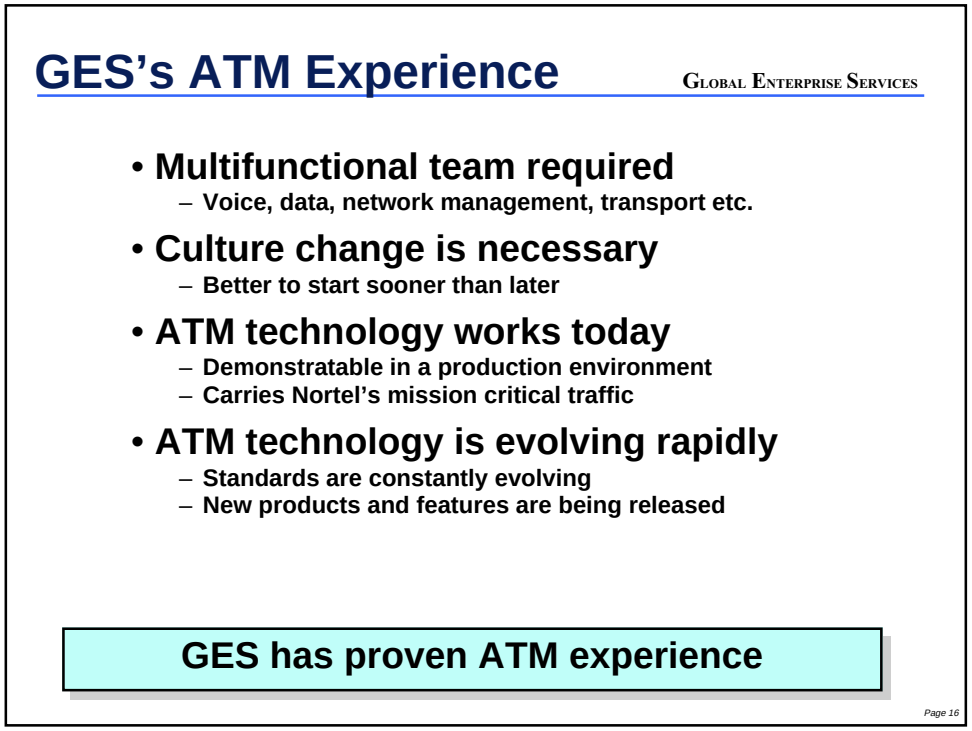
Migration to ATM

From the above graphs, it is apparent that once the traffic migration commenced in September 1995 it proceeded very aggressively. This was the result of the confidence that existed in the stability of the new network and in the ATM technology.

This confidence was established prior to the start of the migration as a result of a significant amount of testing that had been carried out. This testing was in several phases and included, the acceptance of service from the IEC, the testing of the wide area service, and end-to-end testing of the voice and data applications.

Agenda

- GES Network Requirements
- GES ATM Network
- **GES ATM Experience**



GES's ATM experience

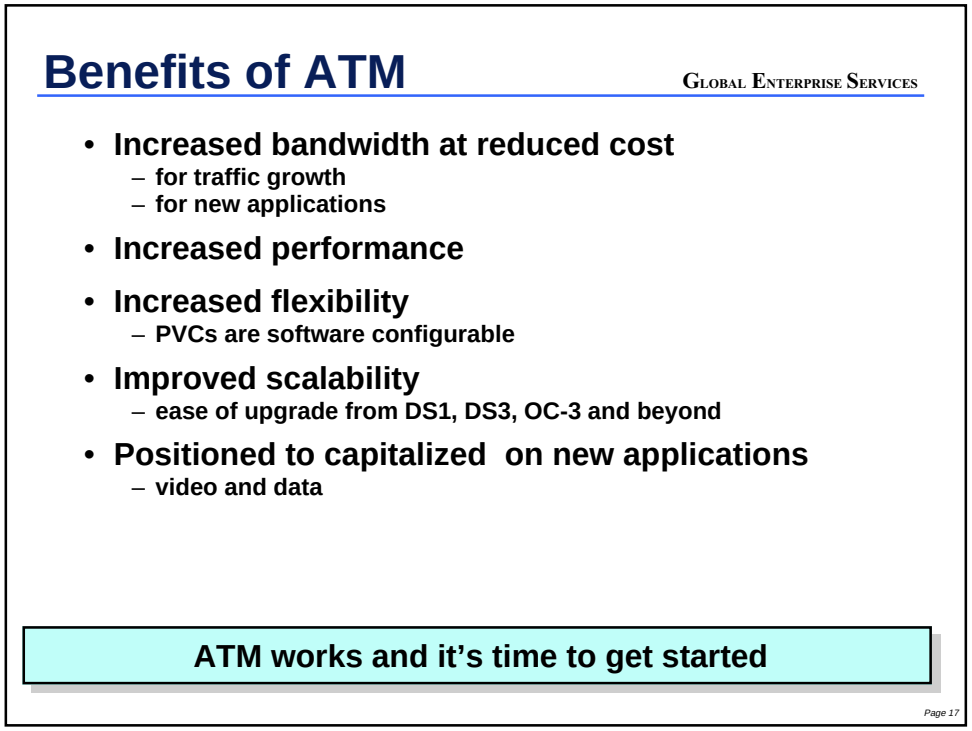
GES now has some 12 to 18 months experience in ATM, covering design, deployment, testing, migration, operations and project management.

In order to successfully implement the project it was critical to form an experienced team, covering all aspects, i.e. design, WAN, LAN, voice, NTelpac, carrier, network management, finance and project management.

Several aspects emerged that required a culture change in the organization—beginning with the aspect of managing a logical, fully meshed network versus the physical point-to-point TDM. Engineering an ATM network introduces some new challenges such as delay, quality of service, and survivability.

ATM really works well and is stable. It is working today in the WAN environment and is carrying Nortel's mission critical traffic.

The standards, technology and products continue to evolve rapidly. GES's approach is to be on the leading edge and be ready to take advantage of new technology as it becomes available.



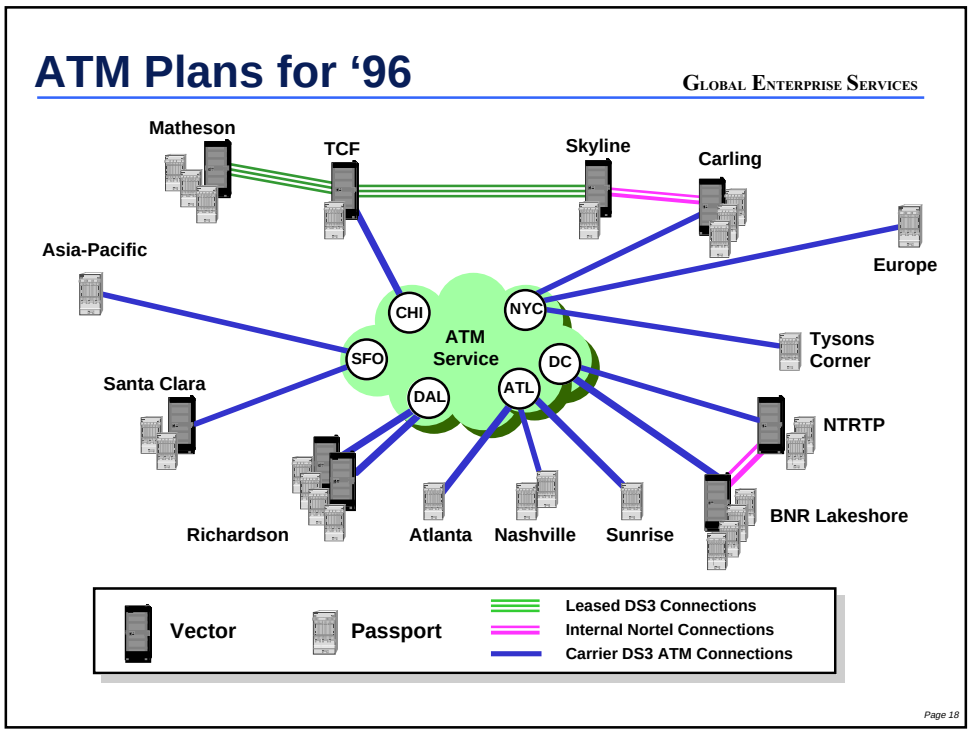
The benefits of ATM

The first benefit realized is increased bandwidth at reduced costs. All of the voice traffic to/from the ATM locations is now routing over ATM. This includes traffic that was previously routing off-net and the tandem traffic. The TDM network is dismantled. Additional DS3 bandwidth capacity is available to meet growth and new application requirements.

Data applications are realizing an improvement in performance from the increased speed and bandwidth. The capability of an application to use available bandwidth with ATM technology, allows for over-booking of bandwidth resulting in improved performance and improved bandwidth efficiencies.

The capability of making changes via software control means that a new circuit (PVC) can be added in hours versus weeks.

ATM also has the advantage that when the need for additional capacity is required, the connectivity can be upgraded from DS3 to OC-3 comparatively easily. Then, under software control, a new PVC can be added or an existing one changed.



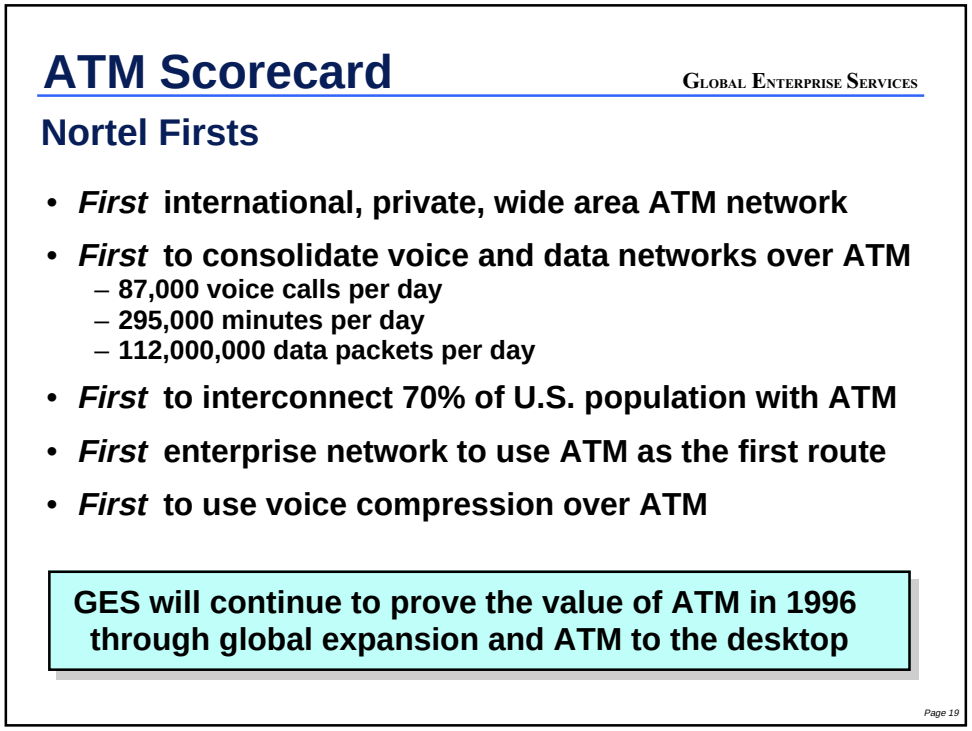
GES's 1996 plans

The GES 1996 ATM plans continue to be very aggressive. This is in line with the GES vision of demonstrating leadership in enterprise networking.

The plan is to complete the migration to the Vector and Passport ATM topology shown above. This is well under way and completion is scheduled for third quarter 1996.

The next step is to take ATM globally by deploying it to/in Europe and Asia-Pacific. This will form the basis of the global ATM network.

In addition to these activities, design work is in progress that will bring ATM to the desktop.



Nortel's achievements

In 1995 Nortel, through GES's use of the Magellan products, achieved a number of firsts in the industry.

GES is firmly convinced that ATM is the right technology for the enterprise network, and it is important to get started now.

GES is also committed to establishing leadership in deployment of ATM technology in the internal network, and being in the position of demonstrating ATM's capability to Nortel's customers.

GES would welcome the opportunity to assist you in the planning and implementation of your transition to ATM.