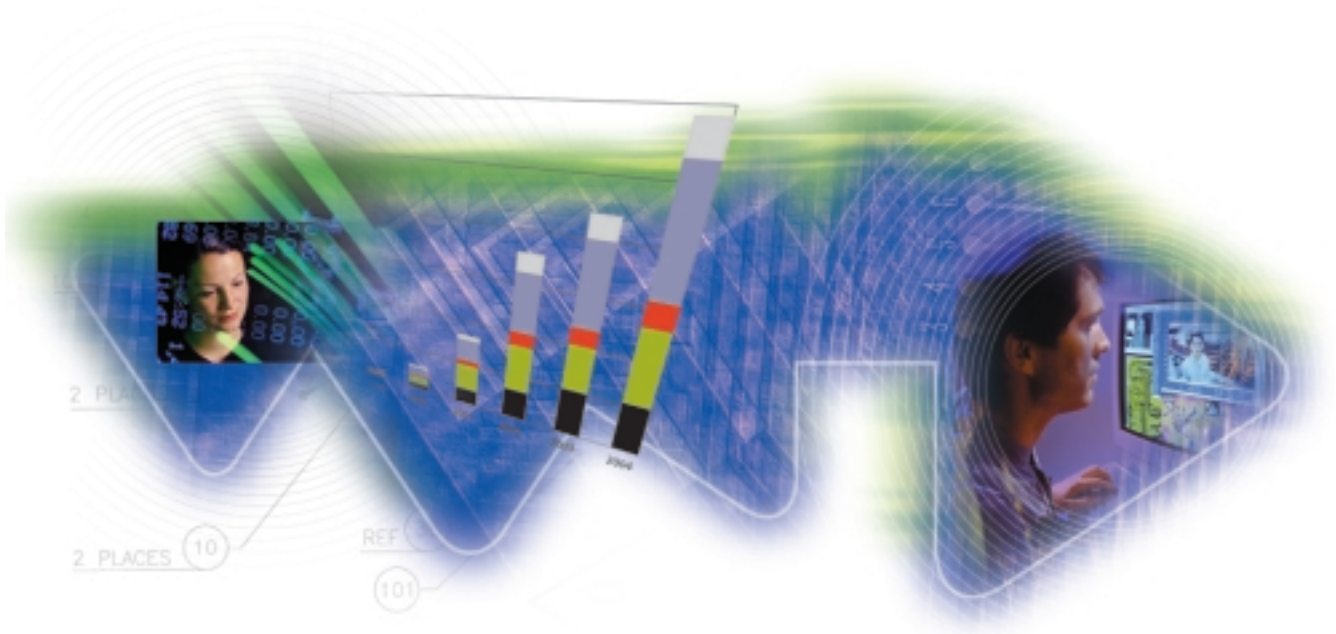


TECHNICAL PAPER

---

# Network and Service Management in a Broadband World

DECEMBER 2000



ARCHITECTS OF AN INTERNET WORLD

## TABLE OF CONTENTS

---

- 1 Introduction**
  - 2 Scalability
  - 2 Interoperability
  
- 2 DSL Broadband Network from a Management Perspective**
  
- 2 Broadband Management: Key Management Functions**
  - 2 Network Management
  - 3 Service Activation
  - 3 Billing
  - 3 OSS Integration
  
- 3 NSM Strategy and Supplier Selection**
  - 3 Option 1: Source Individual Management Applications from Various Suppliers
  - 4 Option 2: Select a Single EAI Solution Supplier
  - 4 Option 3: Select a Systems Integrator
  - 4 Option 4: Select a Prepackaged NSM Solution
  
- 5 Startup Phase Management Implementation**
  
- 6 Sustained Growth Phase**
  
- 7 Conclusion**

## Introduction

Operating a next generation broadband network can be expensive. Some service providers report spending over 50 percent of their network operations budget on provisioning subscribers, assuring the service and issuing bills.

Integrating all the systems required to perform these basic functions will consume most of the initial IT capital development budget. The investment required to achieve integration from scratch is also likely to affect the initial bottom line “cost per service in operation” by so much that the service may turn out not to be viable in a competitive market. So, what are the choices? Integration reduces the overall complexities of providing and operating a service, but can the costs be kept under control? The answer lies in focusing on the key priorities that will ultimately provide the greatest return on the system investment, and use these to drive forward the degree of integration and automation.

Scalability and “flowthrough” interoperability between back-office and network-facing systems and the strategy adopted to achieve both (e.g. partner vendor selection) will either make or break the business.

## Scalability

When a new service succeeds, an initial deployment phase is usually followed by a sustained period of significant growth, sometimes peaking with up to thousands of new subscribers signing up each day. The management systems must not only be able to cope with a high volume of initial network deployment activity, but also with the subsequent rapidly accelerating increase in the load, which is usually associated with increasing subscriber numbers.

During the initial phase, direct support for a typically delicately balanced startup business case demands that investment in the Network and Service Management (NSM) solution be predictable, with no major surprises.

The business challenge for the network supplier then shifts to one of ensuring that consequential NSM investments are kept in proportion with the fragile revenue streams during the subscriber rampup phase. This demands an unswerving focus on investment propositions, centering on robustness, operational stability and improvements in the efficiency of service uptake. Always present is the need to resist the temptations of “nice-to-have” functionality.

## Interoperability

Broadband networks rarely exist independently of the existing infrastructure. Also, a service provider’s back-office systems (e.g. billing, order management, work force management, etc) are often shared across multiple legacy service infrastructures. Traditionally, any improvements made in any back office system leads to significant overall operational cost improvements as a result of the multiplicative effects across the various business streams they support.

Integration of these systems with network-facing broadband management systems, however, represents a huge step forward. Not only is the back office now able to “talk” with the new broadband network infrastructure, but also the additional quantum leap is that, in theory, the legacy services will ultimately converge to the new broadband service infrastructure and the ageold problem of synchronizing back-office and network information will be resolved in the future.

Take, for example, broadband Digital Subscriber Line (DSL) networks. In this case, the provider must be able to order copper pairs from the Incumbent Local Exchange Carrier (ILEC). Once these pairs have been made available by the ILEC, loop quality tests must be performed.

Generally, these two provisioning steps occur early in the initial service provisioning sequence. Transactions can be separated in time by periods ranging from hours to weeks. End-to-end tracking of both activities under a single integrated management environment is essential, especially where a provider’s business case calls for thousands of customers to be added within a single day, involving transactions varying from hours to weeks. In this situation, an integrated network to back-office management systems environment is fundamental.

Considerable benefits arise when the same integrated DSL loop ordering, testing and network-facing systems can be reused to swap existing subscribers (connected to legacy networks) to the newer, integrated broadband DSL infrastructure. Once integrated, these same systems are used to add a voice or video subscriber over the DSL infrastructure. The age-old problem of combining provisioning for both voice and transmission based services has been solved! Many similar scenarios are emerging from the industry-wide race to deploy broadband services rapidly, calling for what is tantamount to “off-the-shelf” integration technologies specifically aimed at integrating management systems.

In the long run, direct machine-to-machine, or “flowthrough”, integration between the network management and back-office systems is the only sustainable solution for service providers and network suppliers alike.

### DSL Broadband Network from a Management Perspective

So, from a management perspective, what are the elements that comprise, say, a DSL broadband service?

Figure 1 shows a typical residential Asymmetric Digital Subscriber Line (ADSL) deployment for Internet access. The ADSL links from multiple residences (DSL Customer Premises Equipment; DSL CPE) are terminated by the Digital Subscriber Line Access Multiplexer (DSLAM) and the traffic forwarded to the aggregation device, typically an Asynchronous Transfer Mode (ATM) switch. This switch then forwards the aggregated traffic to a Broadband Remote Access Server (BRAS), which performs format conversion, subscriber authentication and other functions before forwarding Internet Protocol (IP) traffic to and receiving it from the Internet.

All the equipment between the subscriber’s PC and the Internet knows about the subscriber, either directly or indirectly. This includes the ADSL CPE, the DSLAM, the BRAS and even the ATM switch. Much of the effort

in operating a broadband network is devoted to subscriber configuration, status and accounting, so an integrated management systems environment plays a crucial role in gathering and distributing the relevant information provided by these network elements.

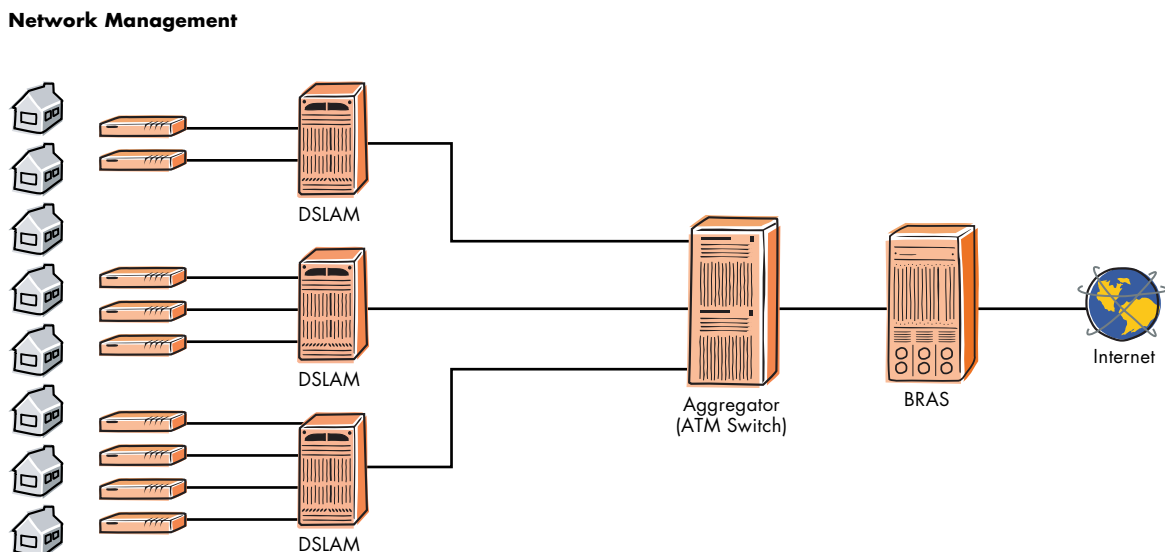
### Broadband Management: Key Management Functions

The management infrastructure for a broadband network performs numerous functions. Among the key functions related to basic operation and revenue generation are: network management, service activation and billing. Integration with back-office Operations Support Systems (OSS) can accelerate subscriber rollout.

### Network Management

This encompasses provisioning, monitoring, testing and control of all the network elements: equipment, links, connections, etc. network management system must discover the elements in the network, manage the configuration of all these elements, monitor them continuously and flag any abnormalities to the operations staff. Depending on the level of integration and automation, the network management system might also collect usage data from the network elements and make it available to other systems, as required.

▼ Figure 1: Residential broadband Internet access network solution



## Service Activation

This function ensures that all the network elements (e.g. CPE, DSLAM, BRAS) have enough information to provide a service to a subscriber. This information includes:

- ▼ Amount of bandwidth available to the subscriber.
- ▼ Quality of Service (QoS) assigned to the subscriber.
- ▼ Authentication information that might be required by a terminating subscriber access protocol, such as Point-to-Point Protocol over Ethernet (PPPoE) or Radius.
- ▼ Explicit virtual path and virtual circuit identifiers to use for subscriber connections.
- ▼ Explicit backbone network connections, which must be in place before a subscriber is added.

Although this information is present in many different network elements, the only satisfactory way to ensure that it is consistent is for it to originate from a single service activation system.

## Billing

Billing is the lifeblood that ensures that a service provider receives revenue from its services. The billing system takes service usage information and produces bills which are delivered to subscribers. Usage can be based on the exact amount of data a subscriber transfers, the duration of the connection or simply a flat charge for the number of times a subscriber accesses a particular service. In all cases, the raw information is collected and made available to the billing system by the NSM system. Finally, the billing system must address the bill correctly. In some cases it will go directly to the subscriber, in other cases to the user's employer. Again, this location information must be made available to the billing system.

## OSS Integration

To automate the business and network operating processes, open interfaces are used to facilitate the integration of the corresponding management software components. In the context of the NSM infrastructure, open interfaces allow application management processes (e.g. service activation) to control or be controlled by other software.

These interfaces are based on industry standards, such as Common Management Information Protocol (CMIP), Common Object Request Broker Architecture (CORBA) and eXtensible Markup Language (XML).

Over time, it is expected that industry standards will emerge for synchronizing policy data across multiple backend systems. Several protocols currently exist, but the industry has not yet universally adopted one of these.

## NSM Strategy and Supplier Selection

When building an NSM environment for a broadband network, the adopted approach must reflect the business priorities of the service provider. In the case of an Internet access business model, priority is usually given to rapid equipment deployment and rapid subscriber activation, while minimizing capital expenditure. The first is important to capture market share, while the second starts revenue flowing to ensure the service is financially viable as early as possible.

The service provider usually has a limited number of choices as to how to acquire an NSM infrastructure. The most common options are:

- ▼ Option 1: Source individual management applications from various suppliers.
- ▼ Option 2: Select a single Enterprise Application Integration (EAI) solution supplier.
- ▼ Option 3: Select a systems integrator.
- ▼ Option 4: Select a prepackaged NSM solution from an equipment supplier or system integrator.

By comparing these approaches in the light of the business priorities listed above, it is possible to get a clear idea of the advantages and disadvantages of each.

### Option 1: Source Individual Management Applications from Various Suppliers

Sourcing individual applications from a variety of suppliers provides little, if any, integration between systems. It is generally agreed that a significant manual effort would be needed to copy subscriber data between the systems, requiring a large number of operations staff. The result is painfully slow subscriber activation.

The lack of integration also means that the service provider will need extensive inhouse IT skills to ultimately correct the problem by attempting to partially integrate the applications. There is also a considerable (and usually unstated) risk as the service provider has no guarantee that integration will be successful.

**Option 2: Select a Single EAI Solution Supplier**

The chosen EAI solution supplier will provide a framework and integration services. If the option can be viewed in a riskfree way (i.e. no risk to time to market or large upfront cost), the resulting comparatively “luxurious” management environment is very attractive.

In general, as the business matures, EAI frameworks become more than a luxury. The efficient integration of core business applications becomes an essential strategy for minimizing the errors that would otherwise occur among provider organization work groups. The cumulative effect of these has a dramatic impact on business, which usually shows up in key performance indicators such as customer churn, uptake of loyalty programs and retention of operations provisioning staff.

**Option 3: Select a Systems Integrator**

By selecting a systems integrator at the outset, the service provider can obtain exactly the systems it needs, with the added benefit of being able to share some of the risk of integration with the integrator. Rigorous requirements definition and architectural design techniques, undertaken by the systems integrator, are generally intended to result in a system that meets the service provider’s integration and systems performance/scalability needs. The integrator usually offsets the risk by running this rigorous process and by recommending “tried and proven” systems.

Integration projects following this approach can be costly (up to 20 to 30 percent of network equipment capital spend), and can often result in lengthy delays. These delays often become painfully apparent to all parties during the requirements definition phase, which is specifically intended to identify the functional gaps between a candidate system (widely deployed in the past) and the emerging requirements.

Such delays can result from the need to retender for the final systems or wait for the systems to undergo fundamental architectural changes. The underlying culprit here is that technology shifts giving rise to the new services are accompanied by unforeseen complexities in handling the intricacies associated with more advanced, complex service types.

The “tried and proven” systems, often shortlisted during a shortened systems integration evaluation process (to meet the provider’s schedule), have often been driven by a set of network behaviors that have changed fundamentally as a result of advances in network technology.

**Option 4: Select a Prepackaged NSM Solution**

In this final case, the adoption of an equipment supplier’s prepackaged solution offers rapid deployment, pretested integration and a low risk scaling-to-meet-growth alternative. In general, the deployment risks (time to market, upfront costs) are significantly reduced if the network equipment supplier undertakes to certify that systems integration development and testing have already been successfully undertaken (i.e. prior to the provider’s deployment).

This is possible if the supplier has implemented a partner program among IT systems suppliers, which calls for relationships to be formed around agreed integration responsibility and systems architectural boundaries. Integration testing prior to, and independently of, the service provider’s rollout significantly reduces time-to-market risks.

Scalability risks are also minimized as the network equipment supplier has a vested interest in being able to scale up network equipment from small initial volumes to very large network sizes. Where a network supplier is able to offer an integrated network equipment management systems solution, it is also has a responsibility to ensure that both the network equipment and management systems can be scaled up to support the future network loads. Furthermore, the timing of any expansion can be synchronized by a single network supplier in terms of both network and management features/functionality.

Benefits aside, the approach does have its limitations with regard to the equipment supported and the functionality. Generally, suppliers of prepackaged solutions are willing to disclose any limitations to the customer (service provider), because these limitations are clearly defined, as a result of the pretesting. Hence the equipment supplier can more tightly “scope and certify” the solution.

Using this approach, the service provider would also be diligent in ensuring that any prepackaged solution has the open interfaces that are needed to facilitate future network evolution and/or the integration of products from third parties. This is important to the service provider as it prevents the notorious equipment supplier “lock-in” syndrome.

### Startup Phase Management Implementation

In view of the advantages and disadvantages of the approaches considered above, there is a strong incentive for a service provider to select an integrated management solution. This would ideally provide an operationally proven, certified set of tightly coupled applications, focused on the fundamental business and operational requirements. Key applications provided by a prepackaged solution must at least include: order entry, service activation, network management and billing integration.

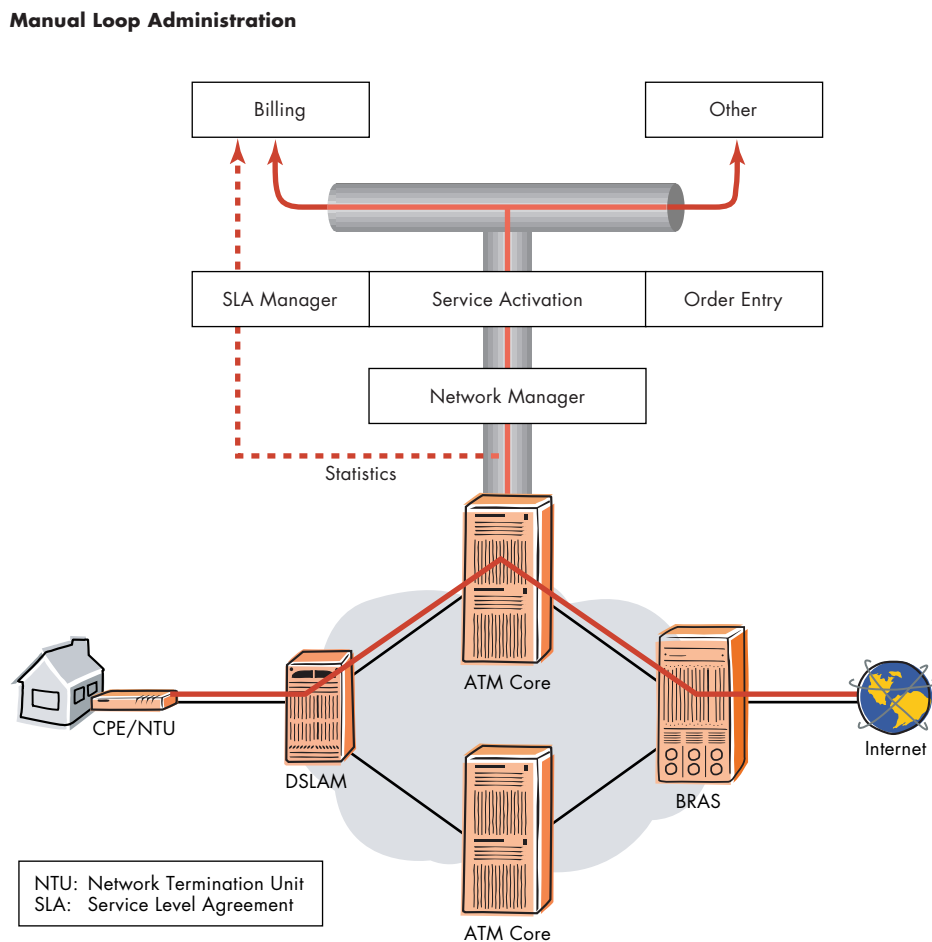
In the startup phase, while subscriber numbers are low, loop ordering and testing can be manual processes that are performed by the operations staff before a service is activated for a subscriber. However, in view of the large number of network elements involved in providing a single service (see Figure 2), service activation must be automated.

A scalable solution should require the operations staff to enter, at most, details of the end-points. The activation subsystem must then configure all of the network elements correctly.

Most importantly, even though the network is in the startup phase, the service provider must be able to charge subscribers for their services. Usage data exported from the NSM system can provide enough information for an integrated billing system to generate the bills that are required to maintain the flow of revenue.

Although not strictly required for the startup phase, an open interface is the key to progressing to a phase of sustained growth.

▼ Figure 2: NSM infrastructure for the startup phase



## Sustained Growth Phase

The second phase of a typical NSM rollout strategy involves focusing on adding features, improving efficiency and, most importantly, keeping up with growth.

In this phase, the network is proving successful, enabling the service provider to justify incremental investment as more subscribers are added. Keeping up with an increasing number of new subscribers and the growing demand for new services from existing subscribers, requires an increase in the capacity of the integrating infrastructure. In addition, the increasing demand for services from a growing subscriber base requires closer integration of as many business processes as possible. Two processes that are prime candidates for automation through integration are:

- ▼ subscriber service order capture;
- ▼ subscriber loop ordering (by the service provider).

In both cases, eliminating manual operations frees up staff to handle many more subscribers while reducing activation times and minimizing errors associated with having to copy data.

An EAI framework is usually required to facilitate automation. The focus here is on ensuring the robustness, scalability and integrity of the business process embedded within the resulting systems.

Synchronization of the complex transactional messaging environment between the network and back-office systems is a nontrivial undertaking which requires a specialized transactional infrastructure. Fortunately, such frameworks have started to emerge as the Internet economy grows, and several are now commercially available.

An open interface for the startup phase NSM infrastructure, in most cases based on the CORBA standard, is used for integration within the EAI framework, and is a key to improving the NSM infrastructure.

As can be seen from Figure 3, a number of new functions are added in the second phase, including loop ordering, loop testing and inventory management.

Inventory management automates tracking of the assets of what is, by this stage, a large network. The need to consolidate the various lists and tables of equipment into a single location is fundamental. Loop ordering typically calls for direct connectivity between a service provider's

NSM infrastructure and the order entry systems of, for example, a US ILEC(s) exchange carrier. (In the US, a competitive service provider typically obtains copper pairs by placing an order directly on the ILEC's loop ordering system.)

The test function requires integration of the NSM infrastructure with the service provider's loop testing system.

Bringing it all together, integrating the loop ordering and testing systems with the NSM infrastructure and using the existing "initial" phase activation functionality, enables orders to "flow through" the system without human intervention once the order has been captured.

In subsequent phases, order entry functions are usually moved to a more sophisticated backend IT system. This will require significant IT investment, which can now be supported because of the improved revenue streams. This more sophisticated system is designed to handle the complexities of more extensive business partnerships (e.g. Internet service provider and access provider interconnect settlements, resellers relationships, equipment distribution). Such systems can handle not only web-based customer self-subscription, but also online electronic orders from business partners.

The results of this overall strategy, including a controlled improvement in the degree of integration, include:

- ▼ Improved productivity.
- ▼ Increased direct revenues through service bundling.
- ▼ Increased user satisfaction as a result of reduced provisioning times.
- ▼ Reduction in human provisioning errors.
- ▼ Significant reductions in the costs of capturing and activating new subscribers.

Integration of the network-facing and back-office systems to support the early stages of growth, requires a systems integration supplier that uses well defined OSS interconnection gateways from network equipment suppliers.

With this strategy, the systems deployed during the startup phase are preserved, and development is based primarily around the "south-bound" (towards the network) certified, open programming interfaces. This minimizes integration times and costs since established work practices and processes are simply refined, rather than being extensively reengineered.

Given that the second phase takes place when the network is proving successful, upgrading involves some risk, especially with regard to crucial functions (i.e. order entry) as they are transferred from the initial system to the final IT back-end environment. The key to minimizing this risk is the expertise of the system integrator, together with the provisions made for evolution by the supplier of the prepackaged solution.

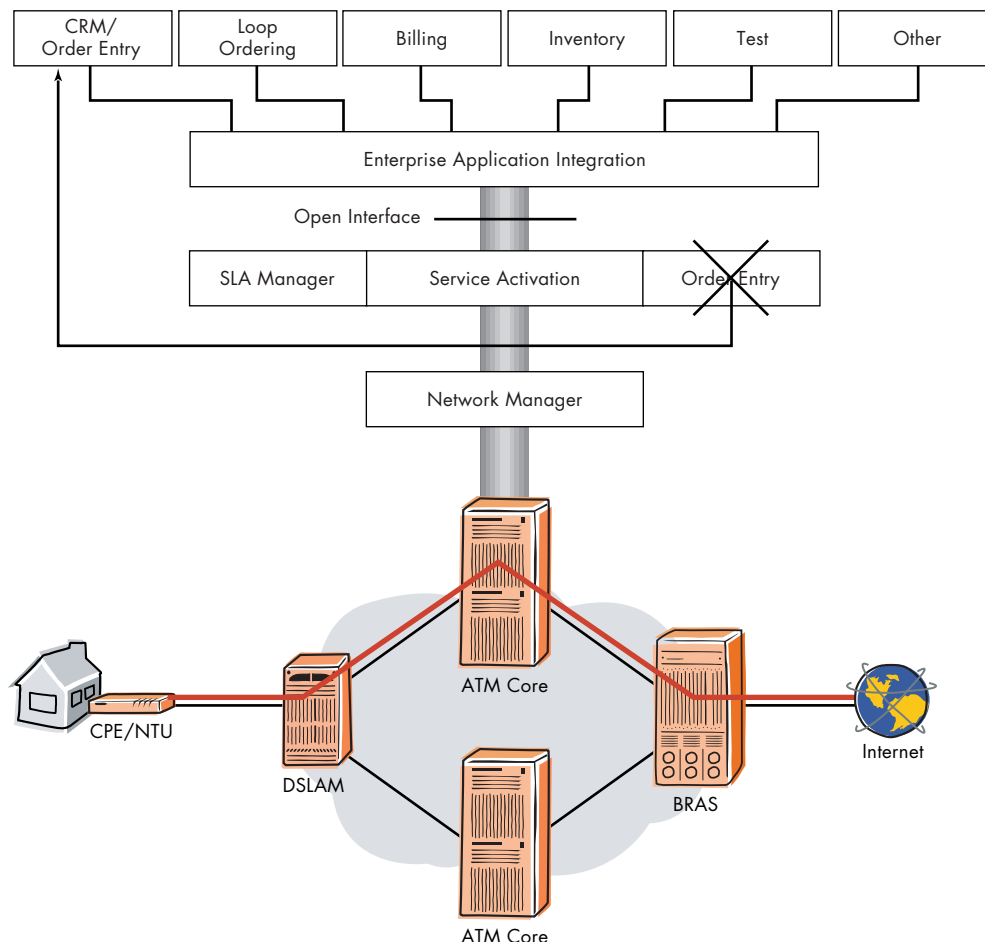
### Conclusion

Given the business objectives of rapid equipment deployment, swift subscriber activation and minimum capital expenditure, a two-phase implementation of the NSM infrastructure offers significant advantages to a service provider. The two-phase approach allows the service provider to minimize the operational risks by leveraging established and formal partnerships.

These relationships provide the service provider with precertified interoperability between components and thus eliminate one of the largest sources of risk. Financially, a two-phase approach allows the service provider to keep its spending in line with revenues, while having sufficient capabilities to enable its revenue to grow. Such a “self-funded” model for the NSM infrastructure represents a significant contribution to the profitability, and thus the long term success, of a service provider. The use of a prepackaged solution also provides a significant time-to-market advantage without compromising on key functions.

Careful selection of a solution provider will ensure that the chosen prepackaged solution offers the openness that is required to facilitate integration with a more sophisticated or alternative infrastructure.

▼ Figure 3: NSM infrastructure for sustained growth



For more information: [www.cid.alcatel.com](http://www.cid.alcatel.com)

Alcatel and the Alcatel logo are registered trademarks of Alcatel.  
All other trademarks are the property of their respective owners.  
Alcatel assumes no responsibility for the accuracy of the information  
presented, which is subject to change without notice.

© 2001 Alcatel. All rights reserved. 10690  
3CL 00469 0115 TQZCA Ed.01



ARCHITECTS OF AN INTERNET WORLD