White Paper

Telecom
Network Management
AdvancedTCA

Network Management Systems Today

Meeting the Challenges of Complexity, Flexibility, and Customer Assurance with AdvancedTCA Technology

Executive Summary

Service providers today face many challenges. Network topologies are growing more complex, new technologies for IP-based service delivery must be integrated into their networks, and customers are more demanding and fickle than ever before. One of the most important requirements for assuring the timely delivery of services without interruption is a network management system that is flexible enough to provide visibility within a complex network while anticipating network issues before customers become aware of them. Because today's network management systems require improved price/performance, high density and low power consumption, programmability for flexibility, modularity for scalability, and carrier-grade availability, modular communications platforms and AdvancedTCA* (ATCA*) technology are ideal vehicles for such systems.

Table of Contents

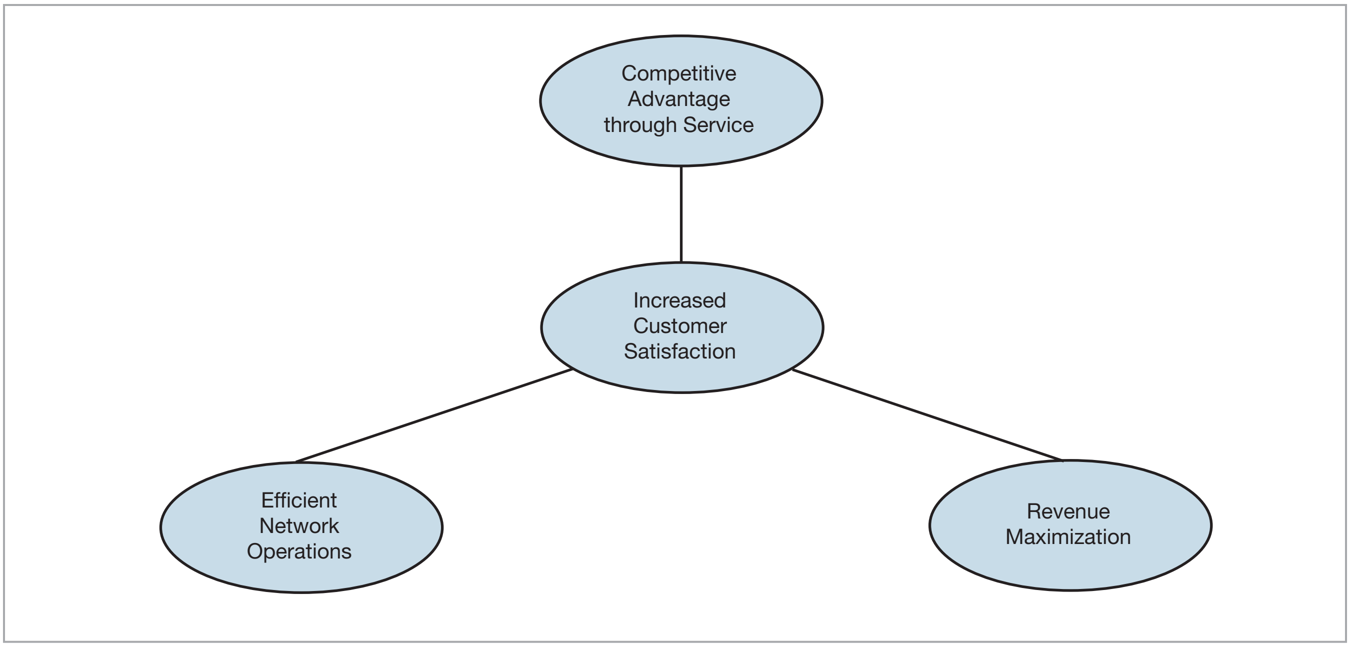
Network Management Challenges Today

Today, telecommunication industry consolidation is very much in the news as fixed and mobile service providers strive to gain market segment share and wrestle with the opportunities and challenges that convergence presents. Service providers are also working feverishly to bring to market IP-based services that promise to increase average revenue per user (ARPU) and bolster customer satisfaction to encourage loyalty and discourage churn.

One of the most important challenges in light of today's highly competitive environment, rapid network consolidation, and increased customer focus is designing systems to manage the modular network in which service providers are currently investing. Such systems must not only bring together disparate network topologies seamlessly but also have the flexibility to embrace new service deployment technologies such as the IP Media Subsystem (IMS), which was designed specifically for IP-based service delivery. How can all these challenges be met with a network management system that is also intelligent enough to recognize and resolve service availability issues before a single customer becomes aware of them?

Keen competition is also forcing service providers to streamline their operations, which precipitates investment in network management. Efficient network management facilitates an improved revenue stream since network resources are used more efficiently. The resulting savings can then be used to fund the implementation of more new and improved services. See Figure 1 for a simple illustration of how meeting today's service challenges increases customer satisfaction, which is a network operator's ultimate goal.

Figure 1. Challenges Lead to Ultimate Goal of Customer Satisfaction


Competitive Advantage through Service
Increased Customer Satisfaction
Efficient Network Operations
Revenue Maximization

What Is a Network Management System?

A network management system (NMS) provides operational and maintenance capabilities at various levels in a network by interfacing with the many different types of devices in today's network.

Service providers rely on their NMS to provide information that allows the following:

- **Peak Optimization** — Ensures the network is optimized for highly efficient performance under all load conditions
- **Service Support** — Configures network equipment to support the services offered to customers by the service provider at all times
- **Usage Monitoring** — Ensures that network usage is monitored for availability and that data is collected for billing purposes
- **Continuous Operation** — Identifies network problems related to the operation of the network equipment, facilities, and communications protocols that could compromise reliable service delivery
- **Proper Access** — Protects the network, its equipment, and data from unauthorized access or fraudulent use and by extension, protects customer information and privacy

Understanding Network Management

The Telecommunications Management Network (TMN) is a network management model defined by the Telecommunications Standardization Sector of the International Telecommunications Union (ITU-T), and is summarized here to provide a framework for discussion. TMN describes telecom network management from several view-points and facilitates a comprehensive understanding of a complicated subject. For additional details, see ITU-T Recommendation M.3000.

Layers in the TMN Framework

The TMN consists of five logical layers:

- **Network Element Layer (NEL)** — Comprised of the most elementary components in the network, which are generally called Network Elements (NEs). They provide switching and transport functions and perform basic network operations. Traditionally each NE has its own, often proprietary, element management system.
- **Element Management Layer (EML)** — Consists of modules that manage and monitor the lowest-level components or NEs, normally in groups. These devices are called Element Managers (EMs). Functions at this level generally include management, backup, problem logging, and hardware and software maintenance.

- **Network Management Layer (NML)** — Contains functionality to manage and monitor the EMs and the network connecting the NEs. Functions on this level generally include resource management, network provisioning, configuration, fault management, optimization, and control.
- **Service Management Layer (SML)** — Consists of functionality directly related to managing the delivery of services. Functions on this level generally include Quality of Service (QoS), customer provisioning, administration, and billing.
- **Business Management Layer (BML)** – Contains functionality that is used to manage business functions such as planning, budgeting, trends analysis, and financial reporting.

These logical layers refer to specific functionality at each level, but similar functions can be executed at many levels. Implementation depends on the goals of that layer, from business overview to highly granular network operation.

A Note on Network Probes

Recently "network probes" have become an increasingly important part of managing network fault management. These hardware devices passively collect data in real time and present information in a variety of GUI-based structured formats such as tables and charts. Data can be searched, sorted, and filtered to monitor protocols, hosts, and network interfaces.

Probes gather data essential to the construction of network history and trends, allowing network professionals to make timely, informed decisions during a network crisis or failure, and work proactively to prevent a problem. Probe data also provides a solid basis on which managers can make network upgrade and enhancement decisions.

Types of Management

Along with the layers of management, understanding the types of management that take place at each layer is also important. These types have been codified as fault, configuration, accounting, performance, and security management, generally known in the industry as "FCAPS." These have also been thoroughly studied in recommendations published by the ITU-T.

Because of the constant interaction between layers, each type of management is effective at many different management layers.

Fault Management

To provide high availability and "five-nines" reliability, fault management must be able to detect, log, notify users of, and automatically fix network problems when desirable in order to keep the network running effectively whenever possible. Since faults can result in downtime or unacceptably degraded network response, fault management is one of the most important network management functions.

Fault management involves the following steps:

1. Detect symptoms.
2. Diagnose the problem.
3. Isolate the problem.
4. Devise a solution.
5. Test the solution on all important subsystems.
6. Implement the solution.
7. Record data about how the problem was detected and resolved for reference.

Configuration Management

Configuration management tracks the various versions of hardware and software elements within the network and manages the affects of these variations for functionality and performance. Among the elements tracked are operating systems, Ethernet interfaces, TCP/IP software, and many others.

Version information is normally stored in a database that is optimized for easy access when a problem arises.

Accounting Management

Accounting management measures network utilization parameters, allowing users appropriate access. Such measurement is also critical for internal staff or external customer billing.

The methodology for accounting management is similar to that for performance management.

1. Measure utilization of all important network resources.

2. Analyze results for current usage patterns.

3. Set usage quotas and correct when necessary for optimal access.

Once the methodology is in place, resource usage data can be sent to billing systems on an ongoing basis.

Performance Management

Performance management monitors network performance variables to ensure that it is maintained at an acceptable level. Network throughput, user response times, and line utilization are good examples of variables that are monitored.

Performance management involves three basic activities.

1. Data is gathered on variables of interest to network administrators.

2. Data is analyzed to determine acceptable performance levels.

3. Thresholds are determined for each important variable.

When a performance threshold is exceeded, an alert is generated and sent to the network management system.

Performance management can also be made proactive through simulation that studies the affects of different variables on various performance metrics, and action can be taken before performance problems arise.

Security Management

Controlling access to network resources through security management has become increasingly critical. Protecting a network from sabotage and guarding sensitive information (including customer information) from unauthorized access requires constant vigilance.

Generally security management is handled as a set of subsystems that perform several functions.

- Identify sensitive network resources.

- Distinguish among groups of users who can access particular resources.

- Monitor access points to network resources and block inappropriate access.

One subsystem, for example, can control access to a network by authenticating the user codes presented when someone is logging into the network.

Operational Considerations

Although it is important to understand the concepts of network management, service providers must also focus on the immediate operational aspects. These are usually implemented in the Operations Support System (OSS), which can be defined as the methods and procedures that directly support the day-to-day operation of a network.

Although carriers may have hundreds of OSSs in place, three major functions are key: fulfillment, assurance, and billing.

- **Fulfillment** — Adds or increases existing network services to satisfy actual customer service orders.

- **Assurance** — Manages existing infrastructure to operate and perform at a particular level, which is usually set based on strategic business decisions. Multiple technologies are employed to ensure availability, response time, and required throughput.

- **Billing** — Processes customer charges and enables revenue collection for network usage and services.

As service providers build out their 3G, broadband, and converged networks, they are moving to a business model that makes the quick introduction of new services of primary importance along with the need to fully exploit the full revenue potential of these new services and networks. Because traditional OSSs are not optimized to deploy services quickly nor are they flexible enough to accommodate easy scaling, new versions are required to fulfill changing service provider needs in network management.

Hardware Requirements for NMS

In order to perform all the functions required for network management, NMS platforms must meet a challenging set of requirements. These requirements underpin a growing need for robust network management in increasingly modular network systems, especially as IP-based service delivery gains momentum. Key requirements include:

- **Price/performance** —In a highly competitive, service-driven market, service providers need systems which allow them to serve large numbers of subscribers profitably and cost effectively. NMS platforms must handle increasingly large amounts of traffic over time with additional throughput and protocol processing capacity while effectively controlling ever more demanding cost pressures.

- **High density and low power consumption** — To cope with increasing traffic and service delivery, solution providers need systems that scale in both performance and density, without the added expense of increased power consumption.
- **Programmability for flexibility** — As technology standards for NMS continue to mature, a flexible, programmable platform that can evolve with the technology is highly desirable. Programmability eases the task of changing features and functionality in an NMS, shortening time-to-market for services.
- **Modularity and scalability** — The ability of systems to scale cost effectively as traffic increases provides significant revenue and time-to-market advantages. A modular approach to network element design significantly enhances the ability to meet this need. When designed properly, such systems can effectively add more computing, protocol processing, or I/O functions independently without requiring an entire system upgrade or replacement.
- **Carrier Grade** — An NMS must be designed to provide carrier-grade reliability since the network must meet or exceed the industry benchmark of "five-nines" availability and must incorporate multiple safeguards to ensure uptime. Redundant components, failover, preventive diagnostics, and distributed design are just a few of the techniques that can be used.

Meeting NMS Requirements with Modular Communications Platforms

Modular communications platforms (MCP) are industry standards-based telecommunications infrastructure platforms that enable efficiencies through the entire value chain, including solution flexibility, faster time-to-market, vendor choice, and cost benefits. Through a growing ecosystem of standards-based suppliers, modular communications platforms provide network equipment providers with reusable development and deployment platforms and an avenue to product, and in turn, service innovation.

Modular platforms are ideally suited for next-generation communications applications such as NMS. Platforms based on Intel® technology are today providing the telecommunications industry with flexible, cost-effective, high-performance carrier-grade capabilities. Resulting solutions enable carriers and service providers to speed time-to-market for new, revenue-generating services.

These solutions are based on industry standards including Advanced Telecom Computing Architecture (AdvancedTCA) and Rack Mount Servers (RMS) as well as Intel processors.

The chief benefits of a modular approach include:

- **Lower development costs and faster time-to-market** — TEMs can focus on platform differentiation, cutting development time, and delivering solutions with increased value-add.
- **Supply chain flexibility resulting from a broad vendor ecosystem** — Hardware and software products can be delivered at every level of integration.
- **Solid platform strategy** — Building with industry-standard components enables flexibility and easy scalability.

Two technologies in particular can help equipment manufactures capitalize on the benefits of MCP, while meeting the demanding requirements of NMS: AdvancedTCA and the Linux* operating system.

AdvancedTCA

AdvancedTCA is an industry initiative developed by the PCI Industrial Computer Manufacturers Group (PICMG*). It is designed to meet the needs of both network equipment manufacturers, who require platform reuse, lower costs, faster time-to-market, and multi-source flexibility, and carriers and service providers, who require reduced capital and operational expenditures. AdvancedTCA meets these needs by defining a standard chassis form factor, intra-chassis interconnects, and platform management interfaces suitable for high-performance, high-bandwidth computing and communications solutions.

AdvancedTCA also provides higher component density, improved thermal and cooling characteristics, and more flexible, higher bandwidth interconnection topologies than previously defined specifications, and, as such, provides a platform with room for significant upgrades as technology improves and requirements increase.

For the network manager, higher component density is especially important and can result in significant operational benefits through server consolidation. Fewer individual servers are needed because one platform can support multiple functions.

Today, AdvancedTCA is rapidly gaining momentum in the industry. Numerous major worldwide equipment providers have started shipping products based on the standard and service providers have made public announcements on their AdvancedTCA deployment plans. As well as supporting the standards, Intel offers numerous AdvancedTCA products and has a strong, robust roadmap. Many vendors in the telecom industry are also offering AdvancedTCA products featuring Intel® Architecture based components. Through the Intel Communications Alliance, Intel is also working to enabling a flexible supply chain through a collaborative ecosystem of suppliers.

Linux Operating System

Linux provides a cost-effective operating system solution, while supporting all the security and management functionality required by a carrier-grade platform. Choosing an open, standards-based operating system allows NMS developers to offer a critically secure and full-featured solution, while delivering cost-effective platforms to service providers.

Next Steps

As new network topologies coupled with new service requirements create both challenges and opportunities, it is important for service providers to stay informed about the latest products and technologies. The following sections of the Intel website can provide such information:

AdvancedTCA
http://www.intel.com/go/atca

AdvancedTCA Products
http://www.intel.com/go/atcaprod

Intel® Communications Alliance
http://www.intel.com/go/ica

Acronyms

ARPU	Average Revenue Per User
ATCA	Advanced Telecom Computing Architecture* (AdvancedTCA)
BML	Business Management Layer
EM	Element Manager
EML	Element Management Layer
FCAPS	Fault, Configuration, Accounting, Performance, and Security
IMS	IP Multimedia Subsystem
ISO	International Standards Organization
ITU-T	International Telecommunications Union (Standardization Sector)
MCP	Modular Communications Platform
NE	Network Elements
NEL	Network Element Layer
NML	Network Management Layer
NMS	Network Management System
OSS	Operations Support System
PICMG	PCI Industrial Computer Manufacturers Group
QoS	Quality of Service
SML	Service Management Layer
TEM	Telephone Equipment Manufacturers
TMN	Telecommunications Management Network

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