“The industry is approaching an inflection point where the relative investment allocations to telecom hardware and software will shift dramatically. Communication software will present one of the most opportunistic areas for investment over the next five years.”

“Carriers around the globe desperately need to invest in a new generation of software that can create, deploy, manage, and maintain new packet-based services inexpensively and efficiently. The market for communication software is still emerging.”

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Despite a decline in service provider capital expenditures (capex) spending in 2001 and the lack of near-term visibility for most players in the telecom world, the communication revolution will still take many more years to unfold. In the underpinnings of a highly competitive and progressively open (deregulated) service provider marketplace, incumbent and insurgent carriers are under intense pressure to deliver high-margin services to their residential and business customers and lower operating costs.

Carriers spent $1 trillion in building the Public Switched Telephone Network (PSTN) over the past 20 years to keep up with the growth in voice traffic; and will have little choice but to spend a comparable amount to build out the broadband network and deliver advanced Internet Protocol (IP) services.

According to a recent report by Sanford Bernstein, service providers have spent significant amounts on network expansion — nearly $225 billion has been invested by U.S. carriers since 1995. While this investment has delivered massive increases in bandwidth, it has done little to enhance functionality and operational flexibility. The reality is that, in addition to purchasing optical transport, switching, and access equipment, carriers around the globe need to invest in a new generation of software to enhance and simplify Operations, Administration, Maintenance, and Provisioning (OAM&P) functions in new IP-based network services, in an inexpensive and efficient manner.

The explosive growth of the Internet and applications based on the World Wide Web have created a strong incentive for carriers to deploy feature-rich and software-rich IP network services that leverage the global reach and simplicity of IP networks. The draw of these technologies — coupled with the ever-increasing pressure to stay competitive and at the leading edge — will force carriers to continue to make investments in broadband networking and services delivery infrastructure, albeit at a slower pace.

Rapid response to the service needs of customers is core to a service provider’s success. As the market develops, the key objectives reflect a “more for less” approach: faster service introduction, improved Quality of Service (QoS) at a lower cost, and interoperability of new operations support system (OSS)/OAM&P capabilities that are required for new services within the carrier’s existing infrastructure. Achieving all of these objectives requires a strong, automated linkage between the management of customer service offerings and the underlying networking assets and enterprise applications.
Unfortunately, the level of automation and integration in the current environment of most service providers, both existing and new, is significantly less than what is needed to compete. Many of the existing service providers facing new competitive pressures or facing restructuring are now actively engaged in reengineering their business processes toward integration and automation, thereby decreasing costs and improving customer-perceived value and performance.

With the growth of data services, service providers need to expand traditional measures of quality and introduce offerings such as service personalization, service self-selection, rapid service activation, proactive service management, and interactive customer care. The directory-enabled network services (DENS) model, slated for widespread adoption by both the networking vendor and service provider communities in the near future, is designed to offer all these enhanced service delivery capabilities. The front-end is a simple and intuitive (online, GUI-based) service portal to enable rapid, XML-based service presentation, point-and-click service self-selection, and service personalization. The user service profiles are activated in an on-demand basis across networking platforms, and are managed at the individual services layers instead of the underlying networking layers.

Service providers also need to provide their customers with some assurance about the quality of services being sold to them. Therefore, for service providers, managing faults in the network is not enough — predicting and preempting faults and delays before they occur, both at the services and networking layers, is essential. Service providers need to optimize their network architecture using a sophisticated set of traffic engineering and load balancing functions in order to eliminate hot-spots and ensure critical applications meet their required Service Level Agreements (SLAs). In effect, the concept of service assurance is moving into a customer-driven environment through SLAs.

Traditional software used to manage the network; new software will respond to and (in many cases) manage the service provider’s total relationship with the customer. When the customer contacts a carrier to arrange for a new service, service activation will occur within hours, and eventually within seconds, instead of weeks or months. Moreover, the service provider can use new customer relationship management (CRM) systems to recommend additional services to increase both revenue and customer satisfaction.
EXECUTIVE SUMMARY

Historically, when service providers added new applications or deployed new equipment from different vendors they had to dedicate enormous resources toward OAM&P capabilities. Today, service providers are looking for automated, real-time control of a multi-vendor, IP infrastructure with end-to-end service activation and management through multiple technology layers including IP, Asynchronous Transfer Mode (ATM), Multiprotocol Label Switching (MPLS), and Dense Wave Division Multiplexing (DWDM). These capabilities allow them to deploy a variety of advanced network services and deliver consistent, high-performance service to end users with highly simplified and innovative service definition, subscription, activation, and management capabilities.

The decreasing revenue-to-capex ratio experienced recently by service providers will force them to achieve the highest incremental value per network dollar invested. According to various research estimates, communication software has the highest return of any capex dollar spent. However, communication software has represented only about 7 to 10 percent of service providers’ total cumulative capital expenditures over the past five years. The industry is approaching an inflection point and the relative allocations of investment to telecom hardware and software will shift dramatically. This will translate into a huge opportunity for the communication software market. According to RHK, the market for service fulfillment, service assurance, and billing and customer care will be in excess of $24 billion in 2003.
WHAT'S FUELING COMMUNICATION SOFTWARE?

The communication software market is set to undergo radical change over the next few years and presents attractive investment opportunities. Several factors are driving the demand for communication software solutions:

**The Internet is still growing**

With the growth of the Internet, service providers must now manage a more complex set of services and network technologies in order to remain competitive. According to RHK, the volume of network elements expected to comprise the public network and the Internet will grow by a factor of 10 over the next five years.

**Convergence of legacy voice/data and IP networks**

The convergence of legacy voice/data and IP networks, and the gradual move toward a ubiquitous IP network will no doubt increase the demand for next-generation software. The move to IP can be attributed to several factors, including the following:

- IP is an open standard; it has no proprietary ownership.
- Packet-switching (using routers instead of PSTN switches) is faster than circuit-switching; and packet-switched networks can be scaled more quickly than the PSTN.
- Equipment costs are lower than in circuit-switched networks, which means significant purchase and operational savings are possible.
- IP transports voice across data infrastructure very economically, and allows enhanced web-based applications using application servers.

**Integrating middleware capabilities in services**

Incorporating and effectively integrating middleware server platforms and service mediation capabilities into the OSS/NMS (operations support system/network management system) enables service providers to leverage their network services delivery infrastructure. This is especially relevant in the context of end users accessing application service provider (ASP) and enterprise network applications. Key middleware capabilities can enhance services and generate additional revenue for the service providers including:

- Flexible and dynamic (end-user and merchant initiated) billing and e-commerce mediation
- Monitoring of network service performance (for example, SLA) and web-based reporting/charting options
- Fraud and fault monitoring and alerting
- Brokering enterprise resource planning (ERP) as well as CRM and other emerging ASP applications
- Data mining (physical through application layers) and real-time/historical snapshots of network capacity and customer network and services usage patterns
Emergence of Directory-Enabled Network Services

The DENS model is emerging as a cross-platform, systematic approach to defining, activating, and managing a variety of IP network services. Deploying next-generation IP network services requires intelligent, application-aware packet processing capabilities in the network. This in turn requires that service requirements be turned into complex configuration/provisioning commands for multiple network elements, in order to deliver a comprehensive suite of managed and scalable end-to-end services.

The software-intensive DENS model for rapid service creation and management is widely anticipated to dramatically improve service velocity (the entire service fulfillment process), significantly lower OAM&P costs, and ultimately help to ensure the long-term profitability and revenue growth of IP-based network service providers. Based on a modular and systemic design a state-of-the-art DENS system includes:

- Service definition based on XML and directory-based schema for subscriber service profile creation and customization
- Web-based service portal for services self-selection, provisioning, and customer care
- Standards-based APIs (for example, CORBA and JAVA RMI) for cross-platform service installation
- Network and service-layer management, performance monitoring, fault alerting, and reporting capabilities

Auto everything

One of the biggest contributors to the service provider’s cost of delivering network services is the cost of OAM&P. This life-cycle cost — in addition to the cost of first-time service activation and 24x7 customer care — is often the major cost factor that service providers seek to minimize, especially in the new, highly competitive and deregulated carrier environment.

Both network equipment vendors and service providers, especially the larger carriers, are responding to the challenge of significantly reducing OAM&P costs by investing in R&D efforts that will eventually result in auto everything. What this term means is automated service presentation to customers when new services become available; auto network services provisioning, auto network and services-layer architecture healing (near real-time), auto network and services-layer management, auto fault/fraud reporting, and auto networking and server equipment troubleshooting and repair.

Service creation at the edge of the network

Equipment vendors are increasingly designing network systems that utilize the edge of the service provider’s network for service creation instead of legacy customer premises equipment (CPE). This network-based approach follows a utilitarian model for delivering traditional CPE- and PC-based network and desktop application software as managed network services. There is tremendous interest and R&D activity from both public and startup vendor companies to create advanced services gateway systems that leverage the network edge in order to deliver a comprehensive suite of IP network services.

Electronic bonding (EB)

With the Telecommunications Act of 1996, service providers are mandated to open their networks to potential competitors and provide them with access to unbundled network elements (NEs), billing information, etc. The task of integrating billing, activation, and trouble management across multiple legacy OSSs, given the complexity of today’s service offerings, is a daunting challenge. Electronic bonding software allows fully automated integration so orders entered by CLECs are automatically loaded into the RBOC system.
INTRODUCTION

The big picture
We are in the midst of a massive transformation of the telecommunications industry. Governments worldwide are deregulating and privatizing telecom services. Hundreds of new companies are springing up, building dozens of new networks — local phone systems, urban fiber rings, high-speed long-distance networks, and wireless data pipelines. Usage is shifting from wired networks to wireless ones; connections are morphing from narrowband to broadband; and, perhaps most significantly, the Internet revolution has resulted in continuous streams of data overtaking voice traffic on systems that were built for five-minute phone calls. These public networks will soon need to support voice, data, and video-based applications.

Carriers are grappling with how to translate the explosion in data traffic — it doubles every three or four months — into explosive revenue and profit growth. The explosion of the Internet has created a virtuous cycle in which carriers need more capacity, which fuels demand for new equipment. New equipment makes networks more robust and reliable, which spawns new applications and drives more customer demands, which then drives the need for even more capacity.

The investment landscape
Crescendo is focused on capitalizing on this tight coupling between emerging new services and the enabling infrastructure. Crescendo strategically invests in a landscape of complementary and synergistic industry sectors. Each portfolio company addresses a specific network issue. Thus, as a group, the Crescendo companies form a powerful force that drives the next generation of communications networks.

As such, the Crescendo Ventures investment landscape is divided into 14 industry sectors: 8 in services and 6 in infrastructure as shown in Figure 1. This is one of a series of research reports that analyze the key sectors and highlight the issues, trends, and investment opportunities.
Today, communication software is becoming a necessity for service providers wanting to efficiently deploy and manage more complex services in their converging voice and data networks. Faced with ever-increasing competition and a market that is experiencing dramatic change at an unprecedented rate, incumbent service providers, and new entrants alike, urgently require well-automated operating processes. Many are struggling to move from a manual-intensive, inconsistent, inflexible environment to one that provides significant improvements in customer focus, service quality, costs, and time-to-market. They have to pervasively do business electronically with trading partners, suppliers, and wholesale and retail customers.

For the growing IP services and wireless markets, these service providers are focused on quickly provisioning new customers and supporting service-quality issues. For all service providers the drive to introduce new value-added services while also dramatically improving customer care is intense. Over time communication software will manage not only the network but the end-customer relationship as well. Therefore, communication software can be defined as software that allows service providers to:

- Increase revenues through rapid deployment of IP based services.  
  (For example: Software based applications, IP-VPN, storage software, etc.)
- Reduce operating costs by integrating and automating the three key functions within a service provider network. Including Service Fulfillment, Service Assurance and Billing & Customer Care.

For the purposes of this report, we have chosen to focus on the second category.
Setting the Stage: What is Communication Software?

Background

The communications industry has embraced the Telecommunications Management Network (TMN) model shown in Figure 2. This model logically demonstrates how the business of a service provider is managed. The TMN model consists of five layers, which can be represented by a triangle or pyramid. Business management is at the apex; service management is the second layer; network management is the third layer; the fourth layer is element management; and the physical network elements are represented in the bottom layer.

The concept suggests that management decisions at each layer are different, but interrelated. For example, detailed information is needed to keep a switch operating (at the element management layer), but only a subset of that information is needed to keep the network operating (that is, the switch operating at full capacity). Working from the top down, each layer imposes requirements on the layer below. Working from the bottom up, each layer provides capabilities to the layer above.

Figure 2. The Telecommunications Management Network pyramid. (Source: CE Unterberg Towbin)

In more detail, here are the five layers of the TMN architecture:

**Business Management Layer** — The top layer deals with non-telecom functions that apply to any business, such as planning, finance, and relationship management. Companies like SAP and PeopleSoft are examples of players in this arena, although they have a very small presence in the telecom space.

**Service Management Layer (SML)** — This layer is responsible for all customer to service provider and service provider to service provider transactions. Billing, customer care, ordering, provisioning, and workforce management are the components that constitute this layer. Companies like MetaSolv, Portal Software, and Amdocs are players in this area.

**Network Management Layer (NML)** — The NML is responsible for the same types of activities as the EML, but exceeds the coverage to handle EMS domains from multiple vendors and multiple functional systems, as well as the pieces of the network beyond the network elements (that is, the paths, spans, and links). Micromuse is an example of a player in this area.

**Element Management Layer (EML)** — This layer is responsible for managing the information associated with a specific set of NEs. Element management systems (EMS) help service providers perform OAM&P activities on the NEs. Today, most vendors like Cisco, Nortel, and Lucent have this functionality incorporated in their devices.
Network Element Layer (NEL) — This layer represents the network elements (NEs) that make up the network, including digital switches, transport/access systems, signaling network elements, and routers. Companies like Cisco, Lucent, Nortel, and Sycamore are examples of players in this area.

Using the TMN model as a foundation, the Telecommunications Operations Map (see Figure 3) addresses operations support and management for any communications service from a top-down, end-to-end process, and customer-oriented standpoint.

Market segmentation
The objective of service providers is to automate their processes to deliver value to their customers. Therefore, the most critical process work is the design and definition of the end-to-end process flows for providing services to customers. According to The Telecommunications Operations Map in Figure 3, there are three basic end-to-end processes common to any service-oriented business:

Service Fulfillment — timely and correct provisioning of what the customer ordered.
Service Assurance — timely response and resolution of customer- or network-triggered problems; tracking, reporting, managing, and taking action to improve performance for all aspects of a service.
Service Billing and Customer Care — timely and accurate billing, knowledgeable and responsive billing inquiry support, timely adjustment handling and payment collection.

The network inventory management and network data management boxes overlap into two areas to represent their significant role in both end-to-end processes. For example, network inventory management, which includes physical implementation activities in the network, is important to both the fulfillment and assurance processes for final installation of a service as well as restoration and repair of the service.

Figure 3. The Telecommunications Operations Map. (Source: Telemanagement Forum)
Market Size

According to RHK, the North American telecom software market (excluding integration services performed by third-party integrators) was approximately $8 billion in 1999 and is expected to grow to $22.6 billion in 2003 (see Figure 4).

Figure 4. North American telecom software market. (Source: RHK)
SERVICE FULFILLMENT

Definition
Service fulfillment is a combination of all of the processes within a telco that are needed to initiate, plan for, and implement new service. The process starts with presales activity and ends with the information required to manage a Service Level Agreement (SLA) and produce an accurate bill.

The Process
The step-by-step process that is typically involved in service fulfillment includes:

Sales
The sales process includes a thorough needs analysis for each customer which leads to an informative sale describing the services available to meet those needs. It includes working to create a match between the customer’s expectations and the service provider’s ability to deliver. Request for Proposal (RFP) management and negotiation, including SLA negotiation, are results of this process.

Order handling
The order handling process includes all the functions of order taking, tracking, customer updates, and notification when the order is complete. The process ends with sufficient information to build or update a customer account record in trouble/problem handling, performance reporting, and billing processes and systems.

Service planning and development
The service planning and development process encompasses several steps including:

- Designing technical and non-technical capabilities to meet specified market needs at a desired cost. This could be related to a new service, new feature, service enhancement, upgrade, or maintenance.
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- Negotiating joint service arrangements. For example, SLAs with other providers, mobile-service roaming agreements, and interprovider peering agreements.
- Initiating appropriate processes and new methodologies to ensure that the service (product) can be properly implemented, managed, and billed.
- Assuring the necessary levels of operations personnel are provided to support growth of new services, new features, and enhancements.
- Initiating any modifications to the underlying network or information systems to support the service requirements.
- Forecasting capacity based on extracted usage behavior information from network monitoring equipment.

Service configuration

The service configuration process encompasses the installation and/or configuration of service for customers including the installation/configuration of customer premise equipment. It also supports the reconfiguration of service (due to customer demand or problem resolution) after the initial installation. The service configuration process interacts with the network provisioning and network inventory management processes to perform physical implementation or installation work on the network.

Network planning and development

The objective of network planning and development is to design, develop, and deploy a low-cost network and information technology infrastructure that meets the requirements of the services delivered across it. This process includes the following steps:

- Define the rules for network including planning, installation, usage monitoring and analysis, and maintenance.
- Design the network capabilities to meet a specified service needs at the desired cost. For example, the introduction of a new platform to support new services, features, or enhancements.
- Steps are taken to ensure that the network can be properly implemented, managed, and billed.
- Based on the required network capacity, issue orders to suppliers or other network operators. Site preparation and installation orders are issued to network inventory management or a third-party network constructors.
- Design the logical network configuration.

Network and services provisioning

Network and services provisioning is anything having to do with the physical network and the OAM&P of the equipment. This process is responsible for the installation and acceptance of equipment, the physical configuration of the network resources, management of the spare parts and parts return/repair sub-processes, and software upgrades. The process starts with a work order request for the installation or implementation required by a network problem. It can also start as a result of the administration of the repair, faulty part, or spare parts sub-processes. It ends with a successful installation or implementation in the network.

Example

As shown in Figure 6, the service fulfillment process involves a sequence of activities. Interfaces with the customer are shown, as well as the output interfaces required to support service assurance and
billing processes. Interfaces with other service providers or network operators are required when there are joint service arrangements. Security is critical and applied at every interface. Security, like test management, can be applied across the entire Telecommunications Operations Map framework, or be managed as part of a specific process within the framework.

Figure 6. This figure shows the complexity of provisioning a service within a carrier's network. (Source: Telemanagement Forum)

**MARKET SEGMENTATION**

The service fulfillment market can be divided into four main areas: provisioning (flow-through and DENS), OS interconnect, engineering and operations, and traditional provisioning.

I. Flow-through provisioning

At a minimum, the fulfillment process must support provisioning and activation. Provisioning systems allocate bandwidth and specify what pieces of equipment are needed over which parts of the network; these systems are closely tied to the engineering design function. Attempts are being made to integrate modern provisioning systems with the ordering, billing, and activation system, so that provisioning is “flow through.” With this approach, all of the processes involved in taking an order, checking inventory, specifying of equipment, allocating bandwidth, activating the service, and billing are automated. The provisioning of a standard phone line is typically automated, but even a simple phone line can involve from 25 to 40 separate tasks between the order taking and activation.

Activation refers to the actual turning on of the specified service. This means technicians are dispatched and to install equipment. Once the equipment is installed and available, a modern activation system interfaces directly with element management systems, or the relevant network elements, to issue the appropriate commands to activate service. For end-to-end service requirements across a nationwide network, an activation system may need to issue commands to ATM or circuit switches to provision PVCs or circuits, to SONET terminals to allocate bandwidth, and to a wide array of access devices such as DSLAM/DLC or cable modem devices to turn on service. As new network elements appear in the network — such as call agents, policy servers, and new hybrid devices.
— the complexity of an activation system increases dramatically. Also, tight integration between service activation and de-activation is essential to optimize network utilization.

The main driver for flow-through provisioning is the rapid rollout of broadband connections and the introduction of many new value-added services, such as virtual private networks (VPNs) and voice over broadband (VoBB). In addition, customer demand for a web-enabled interface, such as the one offered by Cygent (a Crescendo portfolio company), to automatically provision new services or reconfigure existing services.

Another approach to service provisioning: Directory-enabled network services

As previously described, the emerging directory-enabled network services (DENS) model is establishing itself as a powerful, platform-independent capability that offers highly simplified and feature-rich service customization, self-selection, activation, and management capabilities across network equipment and server platforms. This is evident from commercially available DENS provisioning server-based platforms available from leading network equipment vendors. The DENS approach to service provisioning is based on a modular approach and is summarized below:

**XML for services definition**

XML provides a flexible, open, interoperable, and common format to represent services-layer attributes and data across heterogeneous network systems. Each system publishes service-specific information into a common database and appropriately subscribes, and/or selects, pertinent information from the database. Complexity is significantly reduced in XML-based parameter passing because the source and recipient do not need to know each other or their respective locations.

XML is widely anticipated, in both service provider and vendor communities, to play an important role in rapid service definition, subscription, and self-selection—typically via a highly intuitive, online, GUI-based service portal. For example, XML-based vocabularies will assist in enabling business-centric, on-demand IP services such as videoconferencing, content hosting, and ASP software rental. Services can be created and bundled for presentation to end users based on many factors including bandwidth, priority, time of day, session duration, user demographics, or service plan. The common XML-based framework also enables the service definitions to be easily exchanged among service providers, businesses, content providers, and ASPs. This sets the stage for realizing a viable wholesale/retail/end-customer model for delivering advanced IP network services.

**Service presentation and service self-selection**

The XML-based service definitions can be presented to end users via a highly intuitive, online GUI-based service portal. The service portal approach to service presentation serves the following purposes:

- It empowers the end user with adequate description, real-time performance charting, visual/audible alerts, and pricing information about new service offerings.
- Services can be self-selected by end users, often with a point-and-click method. This appreciably reduces the service provisioning costs and first-time service activation costs. The XML-based service tags enable service providers, ASPs, third-party billing providers, and content providers to efficiently and quickly exchange information regarding various customer and service-specific attributes. This information exchange is required for activating the service sets selected by the end users.

**Directory-based service profile retrieval and activation**

The service portal allows both end users and network administrators to rapidly activate new services on a large scale via the point-and-click GUI. This has a direct impact on reducing the overall service provisioning resources and costs of activating new IP network services. Underneath the service por-
The directory server stores all the customer service profiles using hierarchical object definitions and object inheritances based on a standard Lightweight Directory Access Protocol (LDAP) schema. Fast and lightweight directory server access technologies, such as LDAP, are often used to query various objects of the service profiles archived in the directory server.

The directory-based service provisioning model therefore allows for quick and efficient assignment of service sets to any logical group — from large service domains to local/metro areas, buildings, and individual businesses, or directly to an individual end user.

Industry-standard APIs, such as CORBA and JAVA RMI, are used in conjunction with the XML-based service attribute definitions to provision the user/administrator-selected service profile retrieved from an LDAP-enabled directory server. The requested network service is provisioned across network equipment and application server platforms and transcends spatial location and access/transport methods. This enables service models to be driven by business goals rather than the available network or services delivery technology, thus reducing service OAM&P costs.

II. OS interconnect

The global nature of today’s emerging telecommunications services is not only multinational, but is also becoming multi-corporation—as companies extend their reach to serve larger geographical areas or to increase the range of services they can offer their customers. Though one route to accomplish this extended reach is through direct expansion of networks and development of new service capabilities, another route is through formal or informal relationships with other providers such as ILECs, CLECs, DLECs, IXPs, ISPs, and ASPs. Electronic interconnection allows e-business connections between service providers to automate the exchange of service orders, share user databases, and keep track of ported phone numbers and allow for billing. For example, CLEC-ILEC ordering for services such as local number portability (LNP).

Today, interconnection is a frustrating barrier for most service providers because of the inflexible legacy systems of the ILECs, complex proprietary interfaces, and a reliance on manual intervention. For the incumbents, escalating demand and operational costs are major concerns as a growing number of competitors request access to operating systems and network facilities. Whatever the cause, shortcomings in interconnection lead to delays, lost orders, and dissatisfied customers. Service providers of all sizes share a common near-term goal of lowering the cost of interconnection.

III. Engineering and operations

Engineering and operations covers tools used to design, build, and operate networks, and includes engineering tools for outside plant design and documentation. This is not generally viewed as a high-growth area for new investments. Telcordia has the biggest market share. Most equipment vendors, including Lucent, Nortel, and Alcatel, offer tools in this area.

IV. Traditional provisioning (ILEC provisioning)

Traditional provisioning includes traditional circuit-switched provisioning; for example, switching, access, and transport provisioning. Traditional provisioning is not generally viewed as a high-growth area for new investments. The emergence of the IP-based network has decreased the demand for provisioning TDM networks. This area includes switch activation tools, such as Lucent ConnectView and Telcordia SWITCH. This market is growing very slowly because of the slow growth in switched lines.

1 This is in sharp contrast to existing OSSs, which are inflexible and slow to provision and manage new services. This is primarily attributable to the pair-wise APIs required for communication between each OSS application, often leading to complex software and systems integration.
Major players

1. Flow-through provisioning/convergent networks
   - MetaSolv, Syndesis, Nortel/Architel, Lucent, Alcatel/Newbridge Service,
     Cramer Systems (Bath, U.K.)

2. OS interconnect
   - Telcordia, DSET, Quintessent, NightFire

3. Engineering and operations
   - Telcordia, CSG systems, MapInfo

4. Traditional provisioning
   - Telcordia, Lucent, Nortel

Overview of areas for investment

Directory-enabled network services
DENS instantiation and management software will enable service providers to deliver a variety of IP
and voice network services with simplified service provisioning, services self-selection (via a service
portal GUI), directory-enabled service profile activation, and service-layer management.

Real-time inventory management
Automated, real-time inventory management will help service providers get the most out of their
transport networks. Although DWDM adds tremendous capacity to the wide-area infrastructure,
many experts believe that networks will still be congested on certain high-traffic routes. By
maintaining up-to-the-millisecond records of bandwidth utilization, real-time asset management will
ensure that each wavelength is used as efficiently as possible without the agonizing delay of
manual procedures.

Automated provisioning software for intelligent optical networks
The network of the future is transitioning toward an all-optical network, with conversion to
electronics performed only at the edge of the network. This approach impacts the architecture,
network elements, and signaling of the network. Communication software that supports new optical
networks must be able to provision, bill, manage, and monitor wavelength and optical signaling at
very high speeds.

In addition, technologies such as MPLS enable IP service flows at various levels of granularity, to intel-
ligently control bandwidth in the wavelength domain, thus satisfying even the most stringent QoS
criteria and SLAs. However, as compelling as the IP-over-DWDM vision is — streamlined
operation, bandwidth on demand, guaranteed QoS, customer self-management — none of it works
without automated provisioning. Without automated provisioning, service activation will still be slow
and unreliable. Network operators will still have to configure every switch and router one by one —
specifying ports, allocating lambdas, assigning addresses, and so forth. Manual provisioning will
remain a stumbling block, and the full potential of IP-over-DWDM will never be realized.

With automated provisioning in place, everything will be different. Network providers will define
services in advance. When a customer requests a new service, an operator will merely select the
appropriate service profile and add customer-specific information such as incoming port number or
bandwidth level. The provisioning system will translate the profile into configuration commands for each device in the service path, send the commands to the network, and then automatically integrate into the billing system of the carriers.

**Scalable communication software for managed IP VPN**

Service providers are increasingly offering managed IP VPN services to their corporate customers. However, today’s providers are typically struggling with a dearth of tools and systems to manage modern IP VPN capabilities resulting in labor-intensive processes that cannot scale. There is a need for software that offers automation, scalability, customer self-management, and multi-vendor interoperability for managing IPSec and QoS configurations for IP VPNs.

**Backwards provisioning**

Next-generation networks promise to push control of the network as well as on-demand choice of services out to the end user. To accomplish this requires the ability to backward provision — to create and uncreate, or provision and unprovision, service requests with equal speed and accuracy. Therefore, service providers need to be able to manage automated setup and tear-down commands of broadband service applications, which must interface with millions of lines of code from legacy billing, customer management software systems, and the applications.

**SERVICE ASSURANCE**

![Figure 7. Service assurance activities. (Source: Telemanagement Forum)](image)

**Definition**

The service assurance process starts with registering SLA terms by specific customer and updating trouble/problem management systems for specific service and customer instance. The process ends with the identification of an SLA or QoS violation, reporting, managing improvement, and providing information to billing if there is a bill impact.
The Process

The step-by-step process that is typically involved in service assurance is described below.

Problem handling

The problem handling process is responsible for receiving service complaints from customers, resolving problems, and providing status on repair and/or restoration activity. The goal is to have the majority of problems proactively identified and communicated to the customer, to provide meaningful status, and to resolve the problem in the shortest timeframe, preferably with no customer impact. The proactive part of the process begins with a network or technology-generated problem and creation of a trouble ticket. The process is completed when information is logged and output to support SLA reporting.

Customer QoS management

Customer QoS management encompasses monitoring, managing, and reporting on Quality of Service, as defined in SLAs. The process begins with receiving performance information from the physical service infrastructure, as well as receiving individual process and/or sub-process performance information. It is completed when performance and quality reports are sent to internal management and to the customer, updates to problem handling, and SLA violation information to billing for credits.

Service problem management

Service problem management encompasses reporting on service problems and trouble performance, isolating the root cause of service-affecting and non-service-affecting failures, and acting to resolve them. Typically, failures reported during this process affect multiple customers. Actions may include immediate reconfiguration or other corrective action. Longer-term modifications to the service design, to the network, or information technology components associated with the service may also be required.

Service quality management

Service quality management involves monitoring, analysis, and reporting of service levels to meet SLA commitments.

Network inventory management

Network inventory management involves installation and administration of the physical infrastructure. The process starts with a work order request for installation or implementation. It can also start as a result of the administration of repair, faulty part, or spare parts sub-processes. It is complete with the successful installation or implementation in the network.

Network maintenance and restoration

The network maintenance and restoration process starts with an infrastructure-identified problem, a customer-identified problem provided via the service management layer, or analysis of infrastructure information and monitoring. The process ends with appropriate action being taken to maintain the physical infrastructure and/or to fix a specific problem.
Example

Figure 8 shows a possible sequence of activities in response to a network-detected problem. The problem could be non-service affecting because of inherent “self healing” capabilities in the underlying network and information technology infrastructure. For example, SONET/SDH networks have fast restoration (~50ms) capabilities. The figure shows two ways a potential service-affecting problem could be identified; that is, either by an “alarm event” or by synthesis of network data through network data management. Neither is exclusive. Network data management collects and processes both performance and traffic data, as well as usage data. The usage data is then used in the billing process.

Most service providers are driving their service assurance processes to become primarily proactive, meaning triggered by automation rather than by the customer. This is important for improving service quality and the customer’s perception of service, as well as for lowering costs. With the growth of IP services, interactive customer-enabled service gives customers the ability to see and act on service performance, or the performance of “their network.” Service providers need to recognize the value of customer-provided information at each customer interface point. They are capturing that information for use in other ways across the enterprise—for example, to customize offers to customer needs, to relate to the customer in future interactions, and so on.
MARKET SEGMENTATION

The service assurance space can be divided into four main areas: Assurance of SLAs, frameworks, performance verification (testing), and voice traffic and fraud management.

I. Assurance of Service Level Agreements

The concept of Service Level Agreements came out of the notion that customers were buying a measurable level of service, not just bandwidth. The components of an SLA include a specification for Quality of Service that may consist of bounds on packet loss, jitter and latency, CIR (committed information rate), and burst threshold, as well as the usual metrics like system availability, performance, price, and serviceability.

The SLA market is fueled by the need to extend intranets to several locations. Since IP traffic can be carried seamlessly across several networks, enterprise customers find this to be a convenient mechanism to avoid the heavy cost and time required to set up a leased network. However, enterprise customers are also aware of potential problems of traffic carried over the Internet, such as achieving the availability and throughput required for their applications. Since Internet traffic can be carried over diverse paths with diverse latencies, customers are demanding some bounds to the limits—hence Service Level Agreements. Such requirements are being enforced and verified at several points in the network; for example, from an ASP to an ISP, from an ISP to another ISP, and so on. The SLA market covers service monitoring, service control and service security.

The SLA market is expected to grow quickly in the coming years because service providers, especially ISPs, can easily deploy available products. These products are the only tools available today to allow service providers to qualify (via monitoring) and enforce (via control and security) SLAs. These products also permit service providers to deploy a simple point solution to control a customer or class of customer, thereby making network connections more efficient. According to RHK, this space was a $1 billion market in 2000, growing at 39 percent CAGR for the next five years.

II. Frameworks

The frameworks market is evolving from fault management systems to open integration products. This market in 2000 was $1 billion, and is expected to grow at a 12 percent CAGR over the next five years. Multi-function, fault management products consolidate information from multi-vendor, multi-technology networks. The market covers OEM sales and vendor-independent sales to service providers of network management products.

Application integration frameworks used in the integration of service level applications, such as order management and inventory management, are a high-growth area. According to RHK, the application integration framework space has revenues of more than $300 million, with an expected growth rate of 60 percent over the next five years. Figure 9 shows an example of KPMG’s application integration framework.
Application integration services are very expensive. Service providers are always looking for technologies that can cut down on integration costs. It is generally reported in the industry that application integration frameworks can cut project costs by as much as 50 percent over hand-coded efforts.

III. Performance verification

The performance verification (testing) market includes voice, IP applications, IP network services, server platforms, optical networking, and broadband access (xDSL, cable, and wireless).

Growth in this market is dominated by optical and DSL testing. It is fueled by the need to expand the Internet infrastructure to the copper lines going to residences. The DSL test market and the optical test market had a healthy growth rate of 50 percent in 2000. The DSL test market is dominated by a few players and is likely to stagnate as the industry realizes the importance of application testing, which currently is small but rising quickly. The voice market is expected to remain steady as new voice infrastructure softswitches begin to be deployed.

IV. Voice traffic and fraud management

This market includes management of voice traffic that is collected from Class 5 switches and SS7 STP/SCPs. The market is dominated by Lucent and Telcordia from the Class 5 perspective, and by a few players such as Agilent, Inet, and Tekelec from the SS7 perspective.

Major players

1. Assurance of Service Level Agreements
   - Visual Networks, Concord, Micromuse, CrossKeys, Mantra

2. Frameworks
   - Hewlett-Packard, Sun, Telcordia, BEA, Vitria, Tibco

3. Performance verification
   - Hekimian, Turnstone, Minacom, Agilent

4. Voice traffic and fraud management
   - Telcordia, Lucent, Agilent, Inet
Overview of areas for investment

Assurance of Service Level Agreements—from QoS to LoS for IP services

Many network equipment vendors are incorporating IP-based QoS technologies in their services delivery systems. IP QoS technologies are readily amenable to modularization and hardware implementation. The key components of IP QoS technologies that are the subject of R&D efforts include traffic flow classification (from physical layer to applications layer), priority queue-based scheduling (using technologies such as weighted fair queuing) deficit round robin (DRR), traffic congestion and bandwidth management, and end-to-end differentiated Classes of Service (CoS) using DiffServ.

To ensure wire-speed performance, especially at optical interface data rates (e.g., OC-3 and higher), vendors are implementing these modular IP QoS technologies directly in silicon (custom ASICs) or network processors. Service providers are primarily interested in mapping the underlying sophistication in IP QoS technologies to simple service classes or Levels of Service (LoS) that can be clearly defined, monitored for conformance, and billed on a differentiated pricing basis. Typical service levels that are reasonable to define, as part of an SLA, and enforce on a per-user basis include:

1. Platinum
2. Gold
3. Silver
4. Bronze
5. Best Effort

Service providers are also interested in integrating the QoS classification rules with a higher-level subscriber QoS and/or LoS policy that can be presented to end users via a service portal and billed on a per-user basis. The QoS/LoS policy server is a part of the service provider’s overall directory-enabled, network management system infrastructure.

Application integration frameworks

This area is expected to continue to grow as application integration frameworks replace traditional fault management systems and find inroads into the service provider business-to-business interconnection market. Service providers tend to purchase integration frameworks when the manual tasks required to make their business function become a bottleneck to business (order taking activation, revenue collection, etc.). Companies like Vitria, Tibco, and BEA have proved their application integration frameworks in the enterprise and financial services markets are scalable and reliable, and are rapidly moving into the telecom market.

Root-cause reporting

Root-cause analysis tools show much promise in solving the overall management problems of multivendor IP networks. Root-cause tools prevent the flooding of network operations center (NOC) screens with useless alarms that are generated when a core piece of equipment fails or malfunctions. These tools go far beyond presenting a single alarm for multiple events and actually narrow down the cause to a manageable problem set so network managers can efficiently resolve the issues with limited resources. Also, because IP lacks complex management features, many people have turned to adopting SNMP-based tools. Root-cause analysis products help managers take a proactive stance in detecting and addressing failures.
BILLING AND CUSTOMER CARE

**Definition**

The billing and customer care segment encompasses customer-facing rather than network-facing software. The process starts with creating and updating customer accounts, as well as registering SLA terms by specific customer. The goal is to keep a satisfied customer, as well as the following:

- Correct and timely creation of invoices, including application of outage credits and SLA violation credits.
- Customer account or billing inquiry support.
- Timely and accurate bill adjustments.
- Management of accounts receivable, including payment collections from customers.

Customer care manages the entire customer interaction process, which encompasses issues such as billing inquiry and service changes.

**The Process**

The step-by-step billing processes typically involved are invoicing and collections, rating and discounting, and network data management.

**Invoicing and collections**

The invoicing and collections process encompasses sending invoices to customers, processing their payments, and performing payment collections. In addition, it handles customer inquiries about bills, provides billing adjustment status, and is responsible for resolving billing problems.

**Rating and discounting**

The purpose of rating and discounting is to apply charges and rate usage in order to correctly apply discounts, promotions, and credits. The process starts with registration of a specific customer’s identifiers for matching to usage and appropriate discounts, charges, and/or credits and ends with an accurate invoice.
Network data management

Network data management encompasses collecting usage data and network and information technology events and data for the purpose of network performance and traffic analysis. This data may also be input to billing (rating and discounting) processes at the service management layer, depending on the service and its architecture. The process must provide sufficient and relevant information to verify compliance/ noncompliance to SLA and QoS levels. The SLAs themselves are not known at the NML. In the service and network development processes specifications for monitoring must translate service requirements into what needs to be monitored (including the thresholds) in the infrastructures. The process must also provide sufficient usage information for rating and billing, per translated service specifications developed and implemented in the service development and network development processes.

Example

Figure 11 shows a typical sequence of activities to generate a bill that has flat-rate elements (e.g., one-time installation, monthly recurring charges), usage charges, and possible SLA adjustments. Service providers may also apply discounts or rebates (for outages and/or SLA breaches) to a specific customer’s bill based on service type, promotion, customer relationship, company policy, or customer contract. When a service is provided by a combination of different service providers, usage and/or other billing data may be aggregated by the main service provider from input by secondary service providers — then one bill is presented to the customer. This is a trend, but depends on the service provider’s billing strategy, the customer’s wishes, the actual service arrangement provided, and/or the service provider’s process capability and policy.
MARKET SEGMENTATION

A recent study by Northern Business Information, a McGraw-Hill telecommunications market research firm, predicts that in 2001, more than 50 percent of communication software spending in the United States will be for billing and customer care. This segment includes the entire process of preparing a service to be billed and collected. The main goal is to provide service providers with a complete set of business processes to effectively activate and bill for services.

Billing systems need to be revamped because of the need for service bundling, flexibility, and the desire to reduce billing costs. These systems collect information from the network in order to create a bill for the customer. Traditionally, such systems interfaced with a few different network elements to bill for a limited number of service types, all of which were circuit-based. Today, billing systems need to interface with more than 100 different network element types before presenting to the customer via a web interface. Increasingly, this customer interface is seen as an initial contact point to offer additional services, as well as a means for profiling customers to better understand their needs.

The costs associated with calculating customers’ bills and sending them out have traditionally been the most expensive part of a service provider’s operation. Costs are in the range of several dollars per billing transaction, which accounts for the handling of paper bills mailed to customers and the management of payments received. The drive to reduce operating costs while increasing revenue is causing providers to integrate multiple billing systems, which in the past have been used to separately handle new services in the form of IP, wireless, and long-distance services.

In the new IP world, the criteria for billing is changing and is still uncertain. Rather than billing in batches for bandwidth on a monthly basis, service providers need to explore other ways to bill customers, such as billing on a per-user basis, per-application basis, per-packet basis, or based on distance. Also, this process must integrate with the necessary QoS parameters within a near real-time billing collection environment. The need for flexibility is also driving the need for upgraded billing systems for any service provider wanting to include usage-based IP services in its portfolio.

Major players

Billing and customer care


Overview of areas for investment

Billing mediation products

Billing mediation products are used to assemble information from various network elements for input into billing systems; for example, Internet Protocol Detailed Records (IPDR). In traditional systems, all the necessary billing information came from a switch that was downloaded from tape once a day. All that was needed was information detailing the call origination, termination, length of time, and party to be billed. With IP services, the billing records require much more information, so IPDRs have to somehow be constructed.

End-to-end billing solutions

End-to-end billing of IP services may involve multiple peering arrangements with agreed-upon administrative policies. As IP services move beyond a simple flat-rate billing arrangement, these peering arrangements will no doubt become more complex than the typical ISP transit arrangements that permit each service provider to bill its own customers, while offering transit arrangements.
Electronic bill format and payment
As electronic billing via the web becomes a necessary competitive tool, more service providers are using electronic billing as a starting point for customers to do business online. Service providers are beginning to view electronic billing via the web as just one piece of a strategy that could leverage customer interaction to improve revenue and reduce costs. A complete strategy would use the web and e-commerce to manage relationships with business customers — integrating bill format, payment, call analysis, customer service, trouble ticketing, order management, and provisioning.

CRM market for the telecommunications industry
Information about customers, their preferences, payment records, addresses, and so on, are all included in a billing and customer care system. A broader term that encompasses everything that a customer may want to do with a service provider is customer relationship management (CRM). CRM has been a huge opportunity in the enterprise market, as businesses begin to use web interactions with customers to automate call centers, build databases of user preferences, link to sales and marketing, link to e-commerce functionality — basically anything that will help businesses better understand the needs of and serve their customers.

Figure 12. North American CRM market in the public network. (Source: Yankee Group)

According to the Yankee Group, the telecommunications and energy industries have been the slowest by far to adopt CRM software. In the future, service providers will seek CRM applications that assist call center agents, field agents, and the sales force in order to get a common view of the customer. These applications will help service providers identify and retain high-quality customers.
Service Fulfillment

MetaSolv

Background

MetaSolv, Inc., is a leading provider of software designed to simplify the process emerging competitive communications service providers take, manage, and fulfill orders for service from their customers. These providers offer a full array of communications services — often as a bundled offering — including local and long-distance telephone services, high-speed data services, and Internet services.

Products

- Telecom Business Solution (TBS). The company derives most of its revenue from the sale of licenses, related professional services, and maintenance and support of its TBS packaged software to convergent communications service providers. Major functions provided by MetaSolv’s TBS include the following:
  - Order management
  - Service provisioning
  - Network inventory and design
  - Customer care
  - Trouble management
  - Work management
  - Data management

Orchestream

Background

Orchestream is a provider of policy-based, IP service and network management software. The company’s policy-based solutions allow network managers to use a series of rules to determine who or what gets access to various service levels on a network.

Products

- Orchestream/Provider. This product offers service providers a scalable system for facilitating the rapid configuration of MPLS-based IP VPNs with different service classes.
- Orchestream/Enterprise. A flexible, rules-based interface allows network managers to set up dedicated classes on an IP WAN for different applications. The software is a vendor-independent solution that can be deployed on an enterprise’s existing IP network without any forklift upgrades to network hardware or software.
Syndesis

Background

Syndesis is one of the leading providers of service fulfillment solutions for next generation networks. The company’s software suite gives communications providers the ability to deliver high-margin, value-added services quickly, reliably, and profitably.

Products

- NetProvision. This software suite addresses every step in the fulfillment process; service and policy management, service provisioning, service activation, inventory management, customer care, network maintenance, and service and network reporting. Designed for multi-vendor, multi-technology networks, NetProvision provides complete top-to-bottom, automated control over applications, policies, and services — including value-added IP, VPNs, etc.
Service Assurance

**CrossKeys**

**Background**

Founded in 1992, CrossKeys develops and supports carrier-scale software that enables the world’s largest service providers to manage the equipment and traffic on their telecom networks globally. CrossKeys uses the TMN model to develop performance management software products and services.

**Products**

CrossKeys Resolve. This portfolio of network and service management applications allows service providers to understand how their customers and operations are affected by network problems so they can react accordingly.

CrossKeys NetworkWare. This is a line of interoperable network management products for the Newbridge 46020 MainStreet platform. These products provide advanced reporting and billing capabilities to help gain competitive advantage and maintain peak performance.

CrossKeys CrossControl. This software extends the control and benefits of the network management system to include multi-vendor network elements.

CrossKeys Access. Broadband access management software monitors and shapes broadband IP traffic, allowing service providers to deliver on QoS obligations without an overbuilding infrastructure.

**Micromuse**

**Background**

Founded as a network management solutions reseller, Micromuse provides real-time fault and service-level management software. Its tools help telecommunications and Internet service providers ensure the uptime of network-based customer services and applications.

**Products**

The Netcool Suite helps telecommunications firms, ISPs, and business-oriented enterprises maintain the uptime of network-based customer services and applications. It monitors larger-scale networks in real time, allowing network operators to quickly identify and address problems before they lead to trouble. The suite includes the following:

- **Internet Service Monitor.** Provides real-time Internet availability and response-time information for 18 Internet protocols and applications.
- **NT Service Monitor.** Maintains the availability of Microsoft Windows NT software–based resources.
- **Netcool Fusion.** Bridges the service level management gap between IBM mainframe environments and the global network operations center.
- **Netcool Reporter.** This query and reporting tool interacts with Netcool data archived in Informix, Oracle, Sybase, or Microsoft SQL Server databases.
- **Netcool Impact.** Provides impact analysis and facilitates policy-based management of real-time events by leveraging data from different sources and uses it to define and enforce policies.
- **Netcool Firewall.** This real-time security application helps managers in secure operation sectors resolve network-related events before they disrupt business services or cause a security breach.
**Trendium**

**Background**

Founded in 1998, Trendium provides Service Quality Management (SQM) software that allows service providers to offer assured service levels to their customers and to integrate the management of QoS with existing or new business systems and processes.

**Products**

- **ServicePath.** This software platform enables telecom service providers to develop, monitor, and verify SLAs, provide QoS monitoring and analysis, proactively optimize QoS through traffic management techniques, and offer customer access to service management.

**Visual Networks**

**Background**

Visual Networks designs, manufactures, and sells WAN service-level management solutions for new-world networks. It provides a reliable network infrastructure for the Internet and IP corporate networks that are running on frame relay, ATM, IP, VPN, or any other transport technologies.

**Products**

- **Uptime.** This is a complete support system for effective WAN service level management.
- **IP InSight.** Comprises three new powerful application suites that let IP service managers effectively provide and monitor SLAs and monitor end-to-end network performance.
Billing and Customer Care

**Amdocs (Solect)**

*Background*

Amdocs is a provider of software products and services for the telecommunications industry — primarily customer care, billing, and order management systems for wireline, wireless, data, and multiple-service network operators and service providers.

*Products*

- *Ensemble*. This is a platform for customer care, billing, and order management solutions in voice and data environments. It supports convergent multi-service operations, including local, cellular, data, paging, long-distance, international broadband, Internet, and IP services.
- *Directory products*. These provide directory publishers and telecoms with a complete set of automation systems for listing management, for the printed and electronic directory, and for e-commerce solutions.

**Convergys**

*Background*

Convergys Corporation enables companies to create greater value from their customer relationships through the application of its billing solutions and interactive customer care.

*Products*

The Convergys suite of customer care and billing offerings currently includes:

- *Atlys*. The global convergent solution for wireless voice and data providers.
- *Catalys*. The global convergent solution for IP service providers.
- *ICOMS*. The global voice, video, and data solution for cable, broadband, and satellite providers.
- *WIZARD*. The comprehensive solution for multichannel subscription television operators.

**NARUS**

*Background*

NARUS IBI solutions provide detailed, real-time intelligence about customer and service usage enabling service providers to target customer segments, define and deliver new services, manage them effectively, and price them creatively. This transforms provider networks into intelligent platforms for deploying increasingly specialized services that target the most profitable market segments.

*Products*

Using a three-tiered architecture, the NARUS IBI platform deploys:

- NARUS Analyzers. Captures IP session information.
- NARUS LogicServer. Software to transform session information to meaningful business.
- NARUS Application Services. Provide mediation for OSS/BSS applications.
THE LAY OF THE LAND: WHO ARE THE PLAYERS AND WHERE DO WE STAND?

**Portal Software**

**Background**

Established in 1985, Portal Software develops, markets, and supports real-time, scalable customer management and billing software for providers of Internet-based services.

**Products**

The company has several products that present a real-time, flexible solution for the management of Internet and emerging next-generation communications services.

- Infranet Cable. This product is a highly extensible and scalable platform for the carrier-grade, real-time management of advanced cable services, including support for high-speed Internet access, VoIP over cable, and more.
- Infranet ICP. A comprehensive solution for integrated communications providers.
- Infranet IPT. This product is a flexible, scalable platform for the real-time management of IP telephony services.
- Infranet FreeServ. This product is a customer management solution for providers of free Internet-based services.

**Telcordia**

**Background**

Telcordia Technologies is the leading developer and supplier of OSS solutions for the telecommunications industry.

**Products**

The company’s OSS solutions are bundled into integrated suites, each supporting a specific functional area:

- Network Design and Inventory
- Service Provisioning and Activation
- Service Assurance
- Customer Care and Billing
- Work and Force Management
- COMMON LANGUAGE products

**Crescendo portfolio**

**Cygent**

Cygent offers software that focuses on problems particular to telcos, such as account management, service ordering, and network configuration. Cygent purports to link a provider’s OSS data for billing, provisioning, customer care, ordering, marketing, and trouble management to customers on the web. While Cygent does not attempt to automate processes for the service provider, it provides a front-end interface on the web for such processes to interact with customers.

**NetCentrex**

NetCentrex enables converged voice-data networking and next-generation applications by providing a carrier-class call control switch, a services (applications) creation platform, and prepackaged
services modules to allow quick application creation for multimedia call centers, sophisticated web/call center interactions, corporate VPNs, and more. NetCentrex targets its products primarily to carriers, next-generation ISPs, and ASPs who in turn will deliver solutions to the top-tier, end-markets (consumer broadband, e-commerce, and corporate communications).

**Broadsoft**

Broadsoft’s flagship product, BroadWorks, is a service delivery system that enables integrated communications providers (ICPs) to rapidly and economically design and deploy web-enabled enhanced telephony services to their customers. BroadWorks addresses the limitation of the PSTN and leverages the emerging packet-based, broadband networks with the first open software platform for enhanced communication services.
**RISKS**

**Lack of common standards**
The plethora of signaling protocols and interfaces, combined with the lack of standards in provisioning and management, makes it extremely challenging for communication software vendors to develop a robust solution that scales throughout the network. Though some standards bodies are addressing these issues, more cooperation is needed among major vendors and innovation in the software is necessary if these challenges are to be met.

**Integration issues**
The integration of new communication software modules with old legacy systems is very time and resource consuming. Also, it often requires expensive gateways, particularly given the need for new carrier access to legacy OSS systems. In addition, integrating current (for example, SDH/SONET and ATM) and new technologies (for example, IP/DWDM) is a very challenging and arduous task.

**Impact of the declining CLEC market on communication software vendors**
While concern over CLEC spending and financial health has been the primary topic of investor focus in the past several months, CLECs accounted for only 7 percent of the cumulative $225 billion of total spending since 1995. Incumbent service providers still control much of the field, as they control access to many of the end customers. The CLECs may be the innovators, but the incumbents are likely to be the ones doing most of the execution in the near term. However, the relatively long sales cycles into incumbents presents a huge challenge for startup companies.

**Shortage of skilled talent**
The shortage of skilled communication software engineers, IT staff, and network managers is one of the major hurdles facing the industry. It is estimated that there currently is a need for skilled personnel in the following areas of communication software:

- Software design/development and management of directory-enabled network services provisioning and services-layer management
- CORBA, JAVA RMI, JavaBeans, and other API and XML programming
- Software resilience technologies
- IP and DWDM control plane integration software
Many network equipment manufacturers offer element or domain network management for their own products. But a typical IP-over-DWDM infrastructure includes devices from several suppliers — DWDM gear from one company, routers from another company, DSL boxes from a third source, etc. To create an end-to-end service, the network operator has to match up port assignments, coordinate virtual circuit identifiers, synchronize bandwidth levels, and so forth, among different manufacturers’ devices — a slow, expensive, error-prone process. To yield maximum benefit, therefore, an automated provisioning system must be complete — reaching every device in the service path and including optical resources as an essential ingredient.

Therefore, an automated provisioning system is one that spans multiple technologies and multiple vendors; and a single touch activates a complete, end-to-end service — instantaneously and error-free. And by imposing a layer of abstraction between service profiles and specific technologies, the provisioning system lets each service provider offer consistent services throughout its infrastructure, and maintain this consistency as the network evolves.

By adding a web interface to its order entry system, a service provider can even open its network to customer self-provisioning. Based on predetermined policies, customers can order new services, increase bandwidth allocation, or modify QoS parameters on their own. Their requests pass automatically from the order entry system to the service activation system, with zero paperwork and zero involvement by network operators — that is, “zero touch provisioning.” Of course, this requires the infrastructure to be extremely robust so as to avoid a single user to bring down the network.

Incorporating and effectively integrating middleware server platforms and service mediation capabilities into the OSS/NMS enables service providers to efficiently mine their network services delivery infrastructure for additional sources of revenue. This is especially relevant in the context of end users accessing ASP and enterprise network applications. Key middleware capabilities that can enhance services and generate additional revenue for the service providers include:

- Billing and e-commerce mediation
- Web-enhanced customer care
- Network/services-layer performance and fraud/fault monitoring, alerting, and reporting
- Network-based application services (e.g., ERP, CRM, HR, desktop) brokering
- Data mining at all protocol stack layers and graphical presentment
- Real-time and long-term customer usage behavior analysis and modeling

Tightly integrating these middleware features to a variety of IP network services offerings also helps in creating an inherent stickiness in the ISP/NSP to end-customer and ASP to end-customer relationships, thus generating sustained long-term revenues for the service provider.

Control plane software

Control plane software would allow service providers to unlock new revenue from multivendor, multi-technology networks through a unified, distributed control paradigm of the network, both at the switch/router/optical layer and the services layer. The goal is to support dynamic control, optimization, and fault protection switching for DWDM network elements — with the ability to dynamically evolve the optical logical topology to meet the needs of higher-layer functions. This would form the bridge between the IP services domain and the optical domain and allow service providers to deploy optical capacity on demand, in order to meet the needs of IP services.

Software resilience

Startup companies such as Rainfinity are developing software clustering technologies that glue multiple computational nodes together to support highly scalable, fault-tolerant, and continuously
available IP network applications. Software resilience technologies also incorporate traffic management, intelligent server load balancing, and security features. Popular Internet applications that benefit from resilient software server platforms include firewalls, web servers, ASP application servers, FTP servers, and e-commerce servers. Service providers, looking for high-margin, revenue-generating services are increasingly offering these computationally intensive and load-sensitive applications to their business and small office, home office (SOHO) customers as premium network-based services.

Flexible and dynamic billing
Service providers are investigating novel third-party and merchant-initiated billing mechanisms to deliver premium IP services to their customers. We foresee innovations and investment opportunities in flexible and dynamic (pay-per-service-usage) billing software technologies spurring rapid adoption of new network services. This is especially relevant in the context of new service concepts that enable merchants such as ASPs, online brokerage firms, and Internet retailers to provide a consistent, high-quality online experience to their customers.

Auto everything
As previously described, both equipment vendors and service providers are investing in technologies that significantly reduce OAM&P and customer-care costs. This implies auto everything and encompasses auto new service presentation, auto services provisioning, auto network and services-layer architecture healing, auto network and services-layer management, auto fault/fraud reporting, and auto network infrastructure troubleshooting and repair.
We are in the early stages of the communication revolution. Internet traffic is growing at approximately 111 percent year over year. The dramatic growth of the Internet has created the need for more robust, scalable, and secure software that can efficiently capitalize the underlying network. There is a fundamental shift toward bandwidth-intensive and isochronous network applications.

Current software technology is not designed to meet the ever-increasing demands of today’s public and private network applications. The software-intensive DENS model could allow service providers to provide a robust, extensible foundation for building network-centric applications with network-wide service creation, provisioning, and management.

Service providers have realized that Internet connectivity revenues will continue to decline and they will need to offer advanced IP services such as VPNs, QoS, network-based firewalls, ASP performance monitoring, dynamic bandwidth provisioning, and so on, with policy-based service personalization functionality and software-rich feature capabilities. In addition, new definitions for these advanced IP services — such as SLA and conformance criteria, and service-level management and monitoring — will be key issues that service providers will need to address to successfully compete.

Software in all-optical DWDM networks will be needed for routing, signaling, wavelength assignment, resource allocation, restoration, and monitoring.

Control plane software will dynamically evolve the optical logical topology to meet the needs of higher-layer functions, and link the IP services domain with the optical domain.

The industry is still in its infancy, and we expect much innovation over the coming years. To properly capitalize on the opportunities, a deep technical understanding of the underlying network will be required.

As with any rapidly growing industry, there will be volatility in the public and private markets. However, we expect this area to present significant investment opportunities for the patient and disciplined investor.
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</thead>
<tbody>
<tr>
<td>ASR</td>
<td>access service request</td>
</tr>
<tr>
<td>CIR</td>
<td>committed information rate</td>
</tr>
<tr>
<td>CLEC</td>
<td>competitive local exchange carrier</td>
</tr>
<tr>
<td>CNM</td>
<td>customer network management</td>
</tr>
<tr>
<td>CRM</td>
<td>customer relationship management</td>
</tr>
<tr>
<td>DENS</td>
<td>directory-enabled network services</td>
</tr>
<tr>
<td>DLC</td>
<td>digital loop carrier</td>
</tr>
<tr>
<td>DLEC</td>
<td>DSL-based local exchange carrier</td>
</tr>
<tr>
<td>DRR</td>
<td>deficit round robin</td>
</tr>
<tr>
<td>DSLAM</td>
<td>digital subscriber line access multiplexer</td>
</tr>
<tr>
<td>DWDM</td>
<td>dense wave division multiplexing</td>
</tr>
<tr>
<td>E911</td>
<td>enhanced 911 service</td>
</tr>
<tr>
<td>ERP</td>
<td>enterprise resource planning</td>
</tr>
<tr>
<td>FAB</td>
<td>fulfillment, assurance, billing</td>
</tr>
<tr>
<td>GUI</td>
<td>graphical user interface</td>
</tr>
<tr>
<td>ILEC</td>
<td>incumbent local exchange carrier</td>
</tr>
<tr>
<td>IP</td>
<td>internet protocol</td>
</tr>
<tr>
<td>IPDR</td>
<td>internet protocol detailed records</td>
</tr>
<tr>
<td>LDAP</td>
<td>lightweight directory access protocol</td>
</tr>
<tr>
<td>LOS</td>
<td>level of service</td>
</tr>
<tr>
<td>LNP</td>
<td>local number portability</td>
</tr>
<tr>
<td>LSR</td>
<td>label switch router</td>
</tr>
<tr>
<td>MPLS</td>
<td>multiprotocol lambda switching</td>
</tr>
<tr>
<td>NE</td>
<td>network element</td>
</tr>
<tr>
<td>OAM&amp;P</td>
<td>operations, administration, maintenance, and provisioning</td>
</tr>
<tr>
<td>POTS</td>
<td>plain old telephone service</td>
</tr>
<tr>
<td>PVC</td>
<td>private virtual circuits</td>
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<tr>
<td>QoS</td>
<td>quality of service</td>
</tr>
<tr>
<td>SNMP</td>
<td>simple network management protocol</td>
</tr>
<tr>
<td>SONET</td>
<td>synchronous optical network</td>
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<tr>
<td>TL1</td>
<td>transaction language 1</td>
</tr>
<tr>
<td>VoBB</td>
<td>voice over broadband</td>
</tr>
<tr>
<td>VPN</td>
<td>virtual private network</td>
</tr>
<tr>
<td>WFQ</td>
<td>weighted fair queuing</td>
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</tbody>
</table>
Crescendo Ventures is a global venture capital firm that accelerates the growth of companies by providing seed and early-stage funding in communications and Internet infrastructure. A new breed of venture capital firm, Crescendo Ventures collaborates with and supports entrepreneurs, using its industry expertise and personal approach to nurture promising ideas and companies to their full potential. Founded in 1993, Crescendo Ventures is headquartered in Palo Alto, California with offices in Minneapolis and London.

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