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Class-Independent Switching

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October 12, 2000

Introduction

Integrating the world's voice and data communications infrastructure is among the biggest opportunities facing new entrants and established service providers alike. But convergence solutions to date had critical limitations. They lack the combination of flexibility and scalability that is required to deliver convergence solutions in today's competitive and deregulated environment. The answer for tomorrow's network is SALIX class-independent switching, a comprehensive portfolio of products and services from Tellabs, a world leader in communications.

Class-independent switching is the next evolutionary step in the transition from legacy approaches for delivering telephony services, to the creation of a new public network designed to deliver converged network services. SALIX class-independent switching defines a new family of next-generation switching products from Tellabs that delivers complete end-to-end solutions that serve both long-haul/interexchange and local access applications. A new generation of converged carriers will bring to voice transport the huge cost performance improvements experienced by data transport, while adding a wide range of new services. Converged access providers will realize the true potential of broadband access by integrating voice and data. And today's established service providers, already well established in the voice or data networking services markets, can leverage Tellabs' class-independent switching to meet new competition and protect their installed base. Tellabs is the only global provider of communications solutions that is delivering total end-to-end, next-generation switching solutions to customers today.

The Convergence Opportunity

Despite many years of developing voice over Internet protocol (VoIP), voice over asynchronous transfer mode (ATM) and other media conversion technologies, the world's voice and data networks remain largely separate. The resulting parallel voice and data infrastructures create duplication in equipment and expertise, greatly increasing the costs borne by network operators. And telephony traffic is unable to benefit from the efficiencies of packet-based transport (IP or ATM cells) enjoyed by data.

Moving from a circuit-switched infrastructure to a packet-based infrastructure can save up to 70 percent in operating costs. The impact of these savings can be seen from the major share of revenues that voice services continue to generate. As shown in *Figure 1,* although the volume of data traffic on the world's networks now exceeds that of voice, the majority of revenues continue to be derived from voice services.

And cost saving is only one of the benefits of convergence. A converged voice/data infrastructure would make it much easier to deliver a wide range of new services that transcend the voice/data boundary — services such as unified messaging, personal assistant services, voice-enabled e-commerce and web-enabled call centers.

The compelling benefits of convergence will drive many network operators into a new category. Whether they are emerging or established carriers, wireline or wireless operators, or focused today on voice or data services; they will become converged network carriers (CNCs). For new entrants and data-centric operators, becoming a CNC is an opportunity to leverage their efficient packet-based networks to grab revenue and market share from incumbents. For incumbent telcos such as LECs and IXCs convergent networking is a threat to their installed base; repositioning themselves as CNCs brings an opportunity to fight back. Wireless operators experiencing rapid growth can lower operating costs and expand their service portfolios by completing their network build-outs using class-independent switching technology.

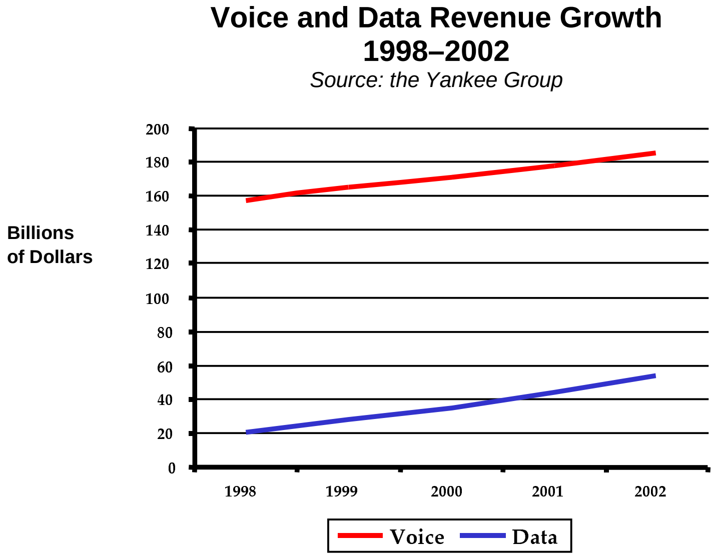

Figure 1: The convergence opportunity: operator revenues by service type

Challenges of Convergence

The fact that network convergence has not yet taken place, despite the financial incentives, indicates the extent of the challenges convergence brings. Some of the challenges are technical:

- Voice is much more demanding of network quality than data. While voice-over-packet technology is mature, it does not easily scale to the levels required by national and international operators.

- Voice communications take place within a fully interconnected global network — voice services cannot compete in the mainstream voice market unless service users can participate fully in this global network.

Compounding these technical challenges is the difficulty in predicting what capabilities the converged network should have in it. It is clearly not sufficient to replace legacy voice networks with similar services on a packet- or cell-based infrastructure. Legacy telephony networks were built in an era when competition was limited, and the types of services each market participant could offer were tightly constrained by regulation. As a result, they are based largely on a class hierarchy mandated by the separation of long-distance and local calling services.

In today's competitive, largely deregulated environment, every market participant must be free to offer a wide range of services, which means leaving behind the regulation-driven class hierarchy of the past. To be successful, a CNC must be able to tailor service packages to the needs of different customer segments, and rapidly adapt its service portfolio to meet customer requirements, market opportunities and competitive threats.

Class-Independent Switching

Now a new architecture, known as class-independent switching, addresses all of these challenges. Class-independent switching provides media processing, network interconnection, signaling, enhanced applications support and all switching functions for any call-based traffic.

Class-independent switching enables network convergence because of the following three key properties.

- It enables media conversion technology and associated services to be deployed on a very large scale.
- It provides complete integration between packet-based voice, data and fax, and their telephony equivalents.
- It allows operators to offer any mix of services to any subset of users, and to easily extend and adapt these service packages as needs change.
- With a class-independent switching approach, new telephony service platforms can provide all of the services of a Class 4- or Class 5-telephony switch in any combination, as well as new services unknown in the legacy telephony environment. A class-independent switch is illustrated in *Figure 2*.

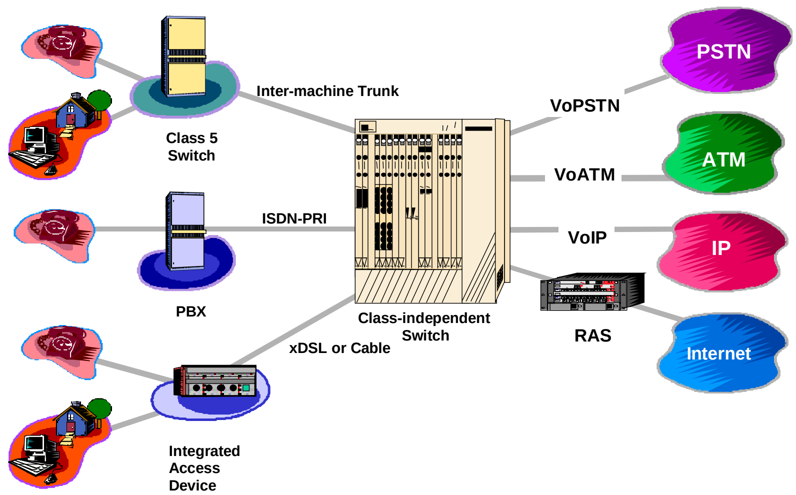

Figure 2 — A class-independent, next-generation switch.

Application Needs and Operational Requirements

The specific requirements of a convergence solution vary from operator to operator, depending on heritage, mission and competition. For many new entrants and data-centric operators, convergence is an opportunity to add telephony traffic to their core data business, taking revenue and market share from incumbents. For wireless operators, convergence is already a reality, as customer demand for integrated voice, messaging and web service grows. Other new wireline entrants will become CNCs from day one. Incumbent telcos such as local exchange carriers (LECs) and interexchange carriers (IXCs), will turn to convergent networking to maintain competitiveness with converged new entrants, and to take market share from their traditional competitors.

For all market participants, the convergence opportunity brings some common requirements. In this deregulated world, operators must be free to follow customer needs and market opportunities. They cannot afford to be constrained by their chosen implementation — the old rigid segmentation of different services to different classes of operator has gone for good.

To grasp their convergence opportunity, each operator must successfully address the technical and operational challenges of their core applications while providing the flexibility to respond to market development. They must also have the tools to migrate from where they are today into the converged future.

Wide-Area-Network Applications

The long-haul telephony infrastructure is built from a network of tandem switches interconnected by dedicated trunks. The starting point for a converged network is to replicate this solution with a packet or cell infrastructure at the core. This is accomplished by using next-generation switches as virtual tandem switches in place of the tandem switches of the traditional solution. This configuration is shown in *Figure 3.*

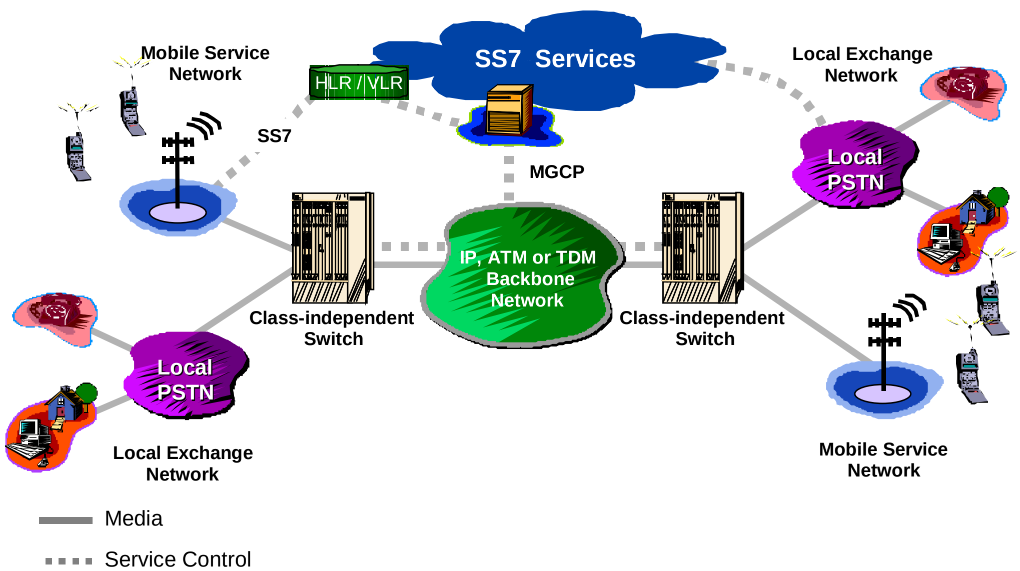

Figure 3 — A converged solution for long-haul or tandem networks.

These next-generation switches have two types of function:

- They convert each telephony call into the appropriate packet or cell format to transit the infrastructure.
- They perform the switching functions of the tandem switch.

However, while these functions allow the replacement of the traditional long-haul network, they do not meet the all the needs of the emerging generation of converged carrier.

Value-added services

In the past, regulation imposed restrictions that limited the ability of long -distance carriers to offer many types of value-added services to individual users. However, all service providers in the current environment — local and long distance, as well as wireline and wireless — need to offer a full array of value-added services to remain competitive. Many of the features needed to support them — including dynamic trunk bandwidth management, Class services and integrated messaging support — are beyond the scope of a traditional Class 4 or toll-tandem switch.

Mixed media

Traditional telephony networks connect similar devices: telephone to telephone, fax machine to fax machine, etc. However, the converged world will bring demand for more complex interactions. The major new factor is the origination and termination of voice and fax calls on personal computers (PCs) and other IP terminals. Examples include a voice and web connection from a 3G mobile phone or multimedia PC, and connecting calls from standard telephones to IP-based call-center switches.

Ingress switching

A significant proportion of voice and fax calls received by an IP or ATM network operator will be switched to the public-switched telephone network (PSTN) rather than transported across the operator's packet or cell network. The reason is that even the most aggressive packet network deployment plans will take years achieve the level of ubiquity that exists in today's PSTN. Until full, global coverage is achieved, calls destined for locations not yet served by the packet network, will be switched onto time-division multiplexed (TDM) network facilities requiring any viable solution to fully support TDM switching as well as packet services.

Access Applications

Internet call bypass

Most telephony access continues to be over conventional local loops terminated in a Class 5 switch. However, most of the growth in capacity is being used for Internet access modem connections. The goal of a convergent solution is to take this data traffic off of the voice access equipment at the earliest possible point.

The approach is to drop modem traffic directly into a next-generation switch that converts it to media format. This solution is illustrated in *Figure 4.* This solution can be deployed either by the local exchange carrier, or by a co-located competitive local exchange carrier (CLEC) offering local bypass services.

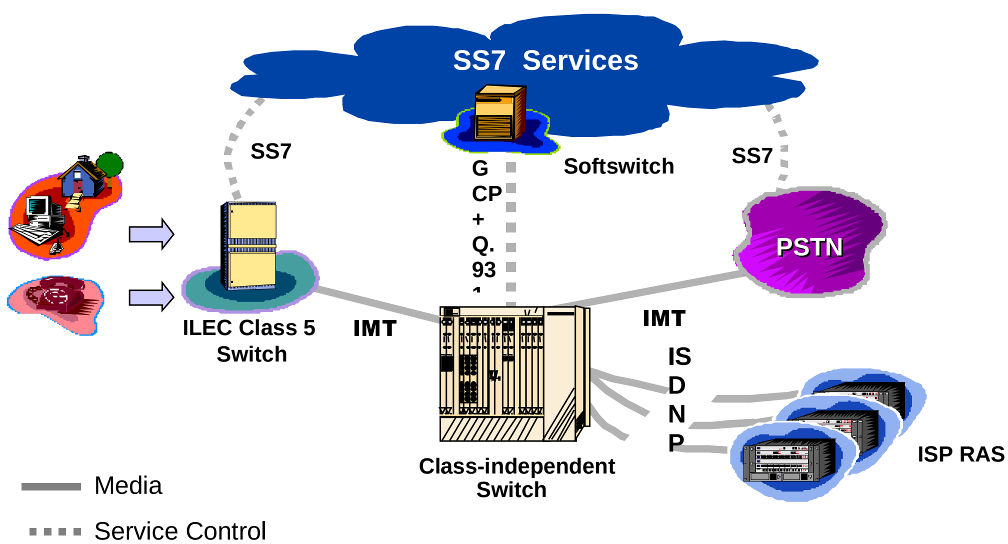

Figure 4 — Internet call bypass.

Converged broadband access

Operators face the opposite problem with the other forms of network access that are being deployed in large numbers: digital subscriber line (DSL) and cable-modem access connections. Today, these are largely limited to data services. In these cases, the goal of a convergent solution is to allow this access infrastructure to be used for voice as well as data by interconnecting it to the voice network and providing the services required. This solution is illustrated in *Figure 5.*

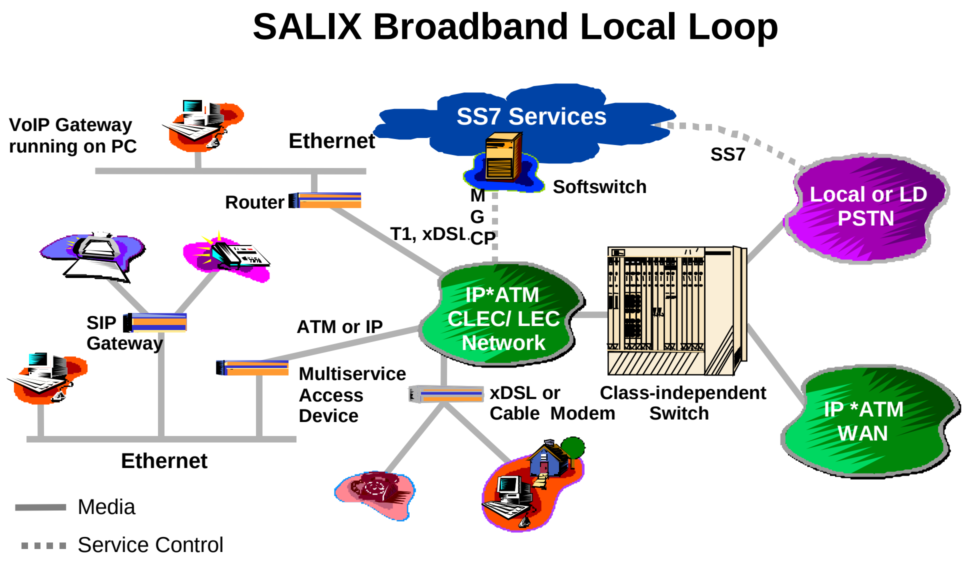

Figure 5 — Converged broadband access.

Application needs

Both of these access applications require the integration of packet and telephony facilities, and demand that the next-generation switch be media agnostic. Also, to avoid performance penalties, each traffic type must be switched in at wireline speeds to preserve quality of service.

The ultimate goal in these local access applications is to completely eliminate the Class 5 telephony switch for all voice traffic entering the network through digital access connections such as DSL and cable-modem links. Only by using class-independent switching can the goals of low cost and high performance be met, while at the same time enabling the delivery of high-margin, value-added services.

Services

The growing need for value-added services

In and of themselves, the core communications services of voice and data transport provide little opportunity for differentiation. The result is the promotion of these services as if they are commodities, resulting in intense price pressure, reduced margins and high customer churn. In the case of telephony services these pressures are being experienced in the pre-converged market, and will be exacerbated as convergence enables more carriers to compete in the market.

The best defense against this "commoditization" is the introduction of value-added services, such as messaging (voice or unified), single-number services, virtual private voice networks, three-way calling, integrated mobile and fixed wireless services, and so on. Value-added services can generate incremental revenue, stimulate additional network usage and slow price erosion. And several operators found that loyalty is greatly increased among customers with three or more services.

Some services can also help to reduce costs. Examples of these are self-service provisioning, automated directories, self-service conference calling and online billing.

Challenges of providing value-added services

While value-added services promise many benefits, they also bring a large number of challenges. Many of these arise from the large number of services that will be required by at least some customers, coupled with the speed at which new services are being developed.

As the number of services grows, so do the overall complexities and the potential impact on scalability. With so many variables, growth in customer demand for each service is nearly impossible to predict, making flexibility in provisioning essential. And with large numbers of services, they must be easy to manage and maintain.

A further challenge arises from the marketing requirement to deploy value-added services in the form of tailored packages for each group of users, with the groups of users defined by need rather than physical location, and not limited by trunk group or subnet. For example, it must be possible to offer employees of a large corporation a customized package of services whether they are located at an enterprise site, are telecommuting from home, or traveling on business.

The service provisioning interface

Softswitches and media switches or gateways that can come from a diverse set of companies define services in converged networks. Class-independent switches interface to softswitches via an open-protocol service-provisioning interface (SPI). The key to meeting the scalability and flexibility requirements of value-added services is this interface.

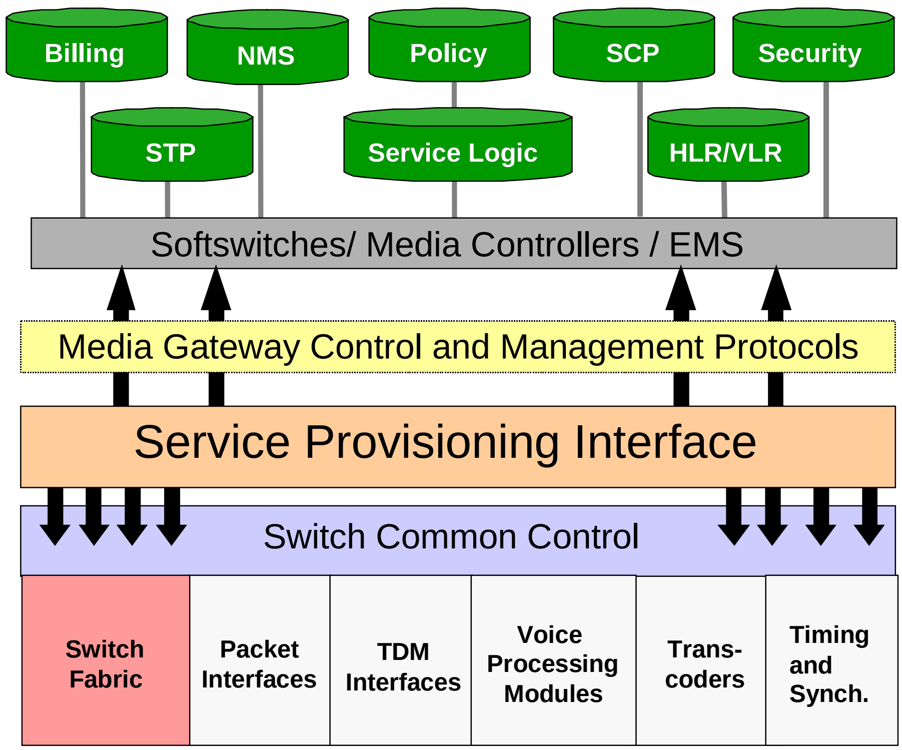

Figure 6 — The role of the service-provisioning interface.

As with many areas of communications, the key to avoiding scalability and flexibility traps is standards. In this case, the next-generation switch must support the key interface standards in use today, and be extensible to support new standards as they emerge.

Vendor-specific or application-specific interface implementations should be avoided because they cannot adapt to changing needs. And implementations where the next-generation switch provides an “open” application-specific interface (API) are very risky, because the service provider has to take the leap of faith that softswitch and next-generation switch developers will choose to support it.

Operational Requirements

In addition to the application-specific requirements described above, there are a number of requirements common to all converged applications.

Scalability

Scalability is perhaps the defining requirement of communications networks. In no other information system do services support tens of millions of users, or share a common infrastructure with hundreds of millions of others. Over the years, telcos and their suppliers developed ways of delivering solutions on a very large scale with utility-class reliability.

One of the biggest challenges of convergence is moving solutions from the lab or small-scale pilot to a telco-scale deployment. Technical choices that are acceptable in a private data network will often fall at the scalability hurdle, and scalability has been a fundamental limitation of some of these new switches.

A critical test of scalability is how a system grows as users or services are added. A good solution scales linearly — a bad solution scales exponentially. One example of this is the choice some next-generation switches made to use dual buses, one for each type of traffic. This solution works fine in a small environment, but does not pass the scalability test. Another example is the integration of signaling, call control, switching and media adaptation into single network elements, as opposed to the distributed approach utilized by class-independent switches. Again, it works fine in a small environment, but does not pass the scalability test.

Migration

Service providers building a converged network are rarely starting from scratch. Most have large networks supporting existing applications for their current customers. These existing networks represent substantial investments, not only in hardware and software, but also in trained staff and support systems.

When moving toward a converged network, a key requirement is to preserve the investment in the existing infrastructure by enabling its continued use. This need for investment protection during migration introduces two requirements for the converged solution:

- It must interoperate fully with legacy telephony and packet services — not just at a transport level, but also at a service level.
- It must be very flexible and easily adapt to the new functions required as the migration progresses.

These requirements will vary from location to location as well. For example, the solution must be able to coexist with legacy telephony switches in some locations, while completely replacing them in others. And the solution must support the extensive call processing and interconnection requirements needed to support existing intelligent network (IN) services such as 800 and 900 call routing.

Flexibility

The only certain thing about the future of communications is that it is uncertain. Technology and innovation are progressing at a very rapid pace. Undoubtedly applications that are virtually unknown today will be in common use in five years. Internet-based application service provisioning may revolutionize corporate computing, and integrated mobile wireless services may revolutionize personal communications.

In planning their infrastructure, service providers must prepare for change driven by customer requirements, and market developments and competitive pressures, without knowing exactly what form they will take. The only course is to choose modular solutions tied together by standard interfaces, to choose open architectures that are not locked to the specific applications built on them today, and to choose solutions that will scale as new requirements bring demands beyond those anticipated today.

Common solution

For all the challenges they faced in the past, most network operators operated a fairly homogeneous service. However, in the developing competitive service market, homogeneity will be the exception.

Not only is there a growing number of services that have to be packaged for different user groups, but the complexity is further increased as operators move into each others' territory. As mobile operators expand their service offerings and coverage areas, long-haul carriers offer broadband access services to leverage their optical backbones, and local service providers enter the long-distance market with integrated voice and data services. Each of these types of service providers has new sets of challenges to meet the service demands of new groups of customers. And into this mix is added a technology migration that is putting different demands on different network components at different times.

But operators cannot afford multiple solutions to meet these different application needs. Each solution introduced incurs a substantial overhead in training, developing operating procedures, integrating management and billing systems, sparing, and so on. To keep these overheads from spiraling out of control, it is absolutely essential that operators introduce a reliable architecture designed to address the broadest possible range of applications.

The First Next-Generation Switch with Class-Independent Switching

Tellabs' SALIX family is the first next-generation switching product portfolio to implement class-independent switching and, by so doing, to address the full range of convergence requirements described in this paper. The SALIX family achieved this by utilizing a number of unique technologies, some of which are described below.

FleXchange™ unified switch fabric

Most converged network applications require switching of both conventional and packet-based telephony. First-generation packet gateways switches use two approaches to meet this need.

Some switch only one of the two traffic types, relying on media conversion to adapt other types of traffic to the formats they can handle. However, unnecessary media conversion adds latency and jitter, and has a direct negative impact on service quality.

Others provide two buses — one for telephony traffic and the other for packet traffic. While this approach avoids quality problems, it brings different penalties. First is a cost penalty, since every module must have duplicated bus interfaces. More critically, this approach brings major scalability problems, since every path between modules must be duplicated, and this need increases exponentially as the network grows.

The Tellabs SALIX 7720 and 7750 switches overcome these problems with unique switch fabric technology that allows all media to be switched in their native modes, eliminating the need to reformat traffic before switching. By implementing FleXchange technology into the SALIX switching family, all traffic receives the best possible service quality and the cost and scalability problems are avoided.

Dynamic call-processing and traffic management

A next-generation telephony switch must provide each traffic flow with a set of services and the bandwidth necessary to deliver the service. As the set of potential services has become very large, some vendors approached this by retrofitting their legacy systems with packet telephony gateway modules. The approach has multiple problems:

- Legacy switch control programs lack the capability to adjust dynamically to different media processing requirements.
- Utilization is inefficient because excess capacity has to be provided for every potential class of traffic that transits the switch.

- Utilization is inefficient because resources can’t be easily shifted to meet variations in traffic patterns through the day
- Changing traffic flows that need bandwidth to different locations can be economically accommodated.

SALIX class-independent switches eliminate these restrictions and are unique in their ability to support the dynamic programming of all requested call processing functions “on the fly.” By implementing innovative modular signal processing technology and active traffic management capabilities, such as multihoming and switched virtual circuits, Tellabs allows switch and network capacity to be optimized and reduces management complexity.

Multistandard service provisioning interface

Many next-generation switches either provide a vendor-specific or application-specific media controller implementation, or publish an “open” API that depends on the softswitch or media controller vendor to write to that API. Both of these approaches limit flexibility and limit the choice of media controllers and, hence, of services.

SALIX class-independent switches provide a standards-based service-provisioning interface for connection to Tellabs’ and/or a third-party’s softswitch and applications platforms. Tellabs’ switches support the most widely implemented standards in current use, including the media gateway control protocol (MGCP), the simple gateway control protocol (SGCP) and Internet protocol device control (IPDC). Interfaces are designed so new standards can be added as they are needed.

Summary: Unlocking the Convergence Opportunity

Convergence of voice and data networks onto a common infrastructure is one of the biggest opportunities facing network operators today. But although media conversion technologies are mature, many packet telephony solutions today have critical limitations. These limitations include the inability to support multiple media types efficiently and to dynamically manage network resources, the retention of restrictive classifications of functionality from the legacy voice world, the rigid association of services with hardware, and non-standard interfaces to softswitches and enhanced service platforms.

By facilitating class-independent switching, Tellabs’ SALIX family overcomes these limitations, bringing network operators a wide range of market opportunities and financial benefits. New entrants can easily offer voice as well as data applications with a rich array of services. Mobile operators can build out new broadband network infrastructures capable of supporting current and third-generation services. Local carriers can move into enhanced long-distance applications; long-distance carriers can deliver local access services. The SALIX family from Tellabs gives converged network carriers the flexibility to define service packages to meet their customer, competitive and business requirements.

Best of all, class-independent switching brings the flexibility to interoperate with existing network services and to address the full range of new convergence opportunities. Network operators will no longer have to deal with the costs and operational headaches of using different classes of switches in different parts of their network.