Ensuring ESA Capabilities during Network Transformation

An Aztek Networks™ White Paper
In Conjunction with

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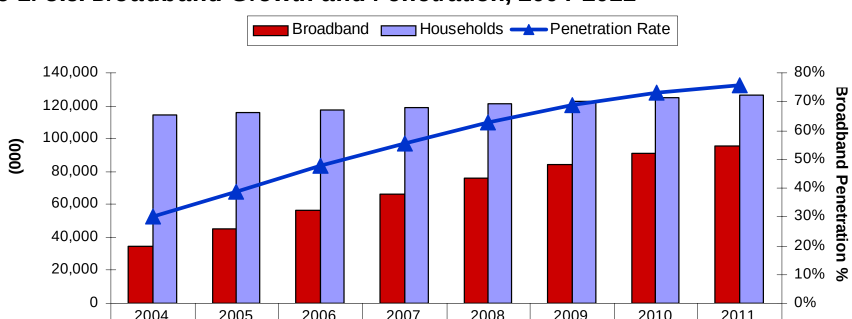
Executive Summary

For many operators, the need to reduce operating costs, while optimizing network infrastructure to offer new value-added, bundled service has taken on escalating importance as competition intensifies. As such, many operators are implementing network transformation projects that will enable them to support the delivery of both traditional and next-generation services over simplified, flexible network architectures. A key driver for many of these projects has been the growing demand for broadband services, combined with the declining demand for traditional voice. As operators begin to implement PSTN transformation through a combination of central office consolidation, switch collapse and MSAP deployment, it will be critically important to guarantee network survivability and emergency access via emergency standalone capabilities throughout this transformation.

Broadband Accelerates the Need for Network Transformation

The impact of broadband to the telecommunications industry has been nothing short of phenomenal. Not only is broadband changing the way consumers utilize their services, it is also having a profound impact on the network, business models and practices of telecommunications service providers. Demand is expected to remain robust over the coming years, as broadband availability nears 100 percent. At present, there are over 61 million broadband subscribers in the U.S. This is expected to reach nearly 96 million by 2012 with a household penetration of 76 percent, as shown in Figure 1.

Figure 1: U.S. Broadband Growth and Penetration, 2004-2011



	2004	2005	2006	2007	2008	2009	2010	2011
Broadband	34,533	44,941	56,101	66,199	76,129	84,503	91,264	95,827
Households	114,300	115,800	117,537	119,300	121,090	122,906	124,749	126,621
Penetration Rate	30%	39%	48%	55%	63%	69%	73%	76%

Source: broadbandtrends.com

In addition to providing end-users with a wealth of new services and applications, broadband adoption has become a key element for economic development both here in the U.S. and abroad. Many states are quickly implementing "Connect" programs that accelerate the availability and use of technology with the aspiration of creating a better business environment, more effective community and economic development, improved healthcare, enhanced education, more efficient government and improvement in the overall quality of life for its residents.

Network Transformation Projects and the Move to IP/Ethernet

Network operators are faced with a number of ongoing challenges including declining voice revenues, access line loss, pricing erosion, and a strong competitive environment which has resulted in customer churn. As such, incumbent operators are in search of ways to retain customers, reduce costs and grow revenues.

Operators have acknowledged that their future success will require them to build flexible, intelligent, IP-based networks that will enable them to deliver converged communication and multimedia services that customers demand now and in the future. These new networks must be able to allow for faster introduction of new services; operate at reduced costs while increasing efficiencies, bandwidth, scalability, intelligence and availability of services. As such, most operators will take a phased approach to their network migration, with particular focus on two key areas: PSTN Transformation and Access Network Transformation.

PSTN Transformation

PSTN Transformation allows a service provider to migrate its TDM network to VoIP, both at the transit level (Class 4) and at the access level (Class 5). In many cases, operators are able to leave their existing PSTN network in place and utilize VoIP technology only for network expansions, allowing them to leverage their current TDM assets. This is particularly important in the Class 5 portion of the network, where operators have invested significant amounts of money. According to data from the FCC, the local switches (Class 5) account for 96 percent of the total switch market in the U.S.[1].

As such, operators are implementing a variety of strategies for PSTN transformation including Cap and Grow, Class 5 Migration and Class 5 Replacement as shown in Table 1.

Table 1: PSTN Transformation Strategies

Cap & Grow	Class 5 Migration	Class 5 Replacement
▸ Overlay Existing Network with VoIP ▸ Add new Trunks and Lines to IP Network	▸ Add IP interfaces to existing TDM infrastructure ▸ New growth on VoIP	▸ Replace existing TDM infrastructure with VoIP

Source: broadbandtrends.com

Decisions to implement a PSTN transformation strategy is dependent on a number of factors including, by not limited to the following:

- Capabilities and capacity of current switch platform
- Current switch vendor support
- Market specific service/feature opportunities
- Impact on BSS/OSS infrastructure
- Regulatory requirements (CALEA, Equal Access, LNP, etc.)
- Strategic direction of service provider
- Depreciation of current assets
- Move from proprietary towards opens standards
- Transition from circuit to packet infrastructure

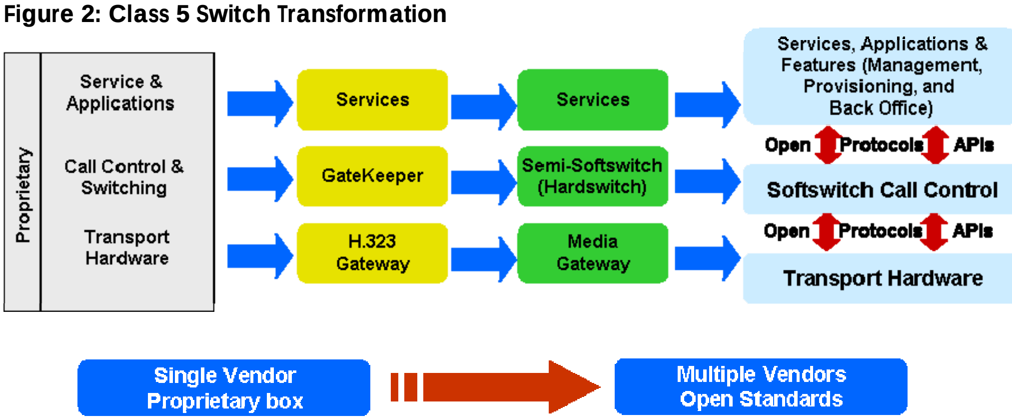
[1] FCC ARMIS Database, Report

Other factors that must be taken into consideration is the ability to preserve the current revenue streams, utilizes current methods and procedures, leverage some of the current infrastructure, including legacy equipment, as well as support existing features and capabilities such as CLASS features and emergency access.

Class 5 Transformation

Similar to network transformation, the Class 5 switch platform has gone through its own transformation over the last decade. Innovations in call processing and semiconductor technology as well as an industry wide adoption of IP technology and open standards, has led to a complete paradigm shift in how operators deploy and manage their switching infrastructure. Figure 2 illustrates the transformation of the Class 5 switch over time.

Figure 2: Class 5 Switch Transformation



Source: broadbandtrends.com

Class 5 switches have moved beyond monolithic, proprietary platforms, towards distributed, open platforms that enable wide-scale vendor interoperability and the ability to leverage 3rd party applications.

This transformation in the switching platform has resulted in both CAPEX and OPEX savings as smaller footprints and higher densities allow for a reduction in space and power requirements. Standards-based technology allows operators to move away from proprietary solutions allowing for "mix and match" vendor deployment and "off-the-shelf" hardware. The introduction of IP enables a reduction in transmission and bandwidth requirements, allowing for easier and more economic network management.

Finally, these new platforms form a technology synergy with broadband access platforms, particularly Multi-Service Access Platform, that support not only IP-based multimedia services, but also traditional voice services. In addition, these platforms may be deployed as a line access gateway, allowing for packetization of voice services at the edge of the network with no impact to the end user. We will discuss the role of the MSAP later in this paper.

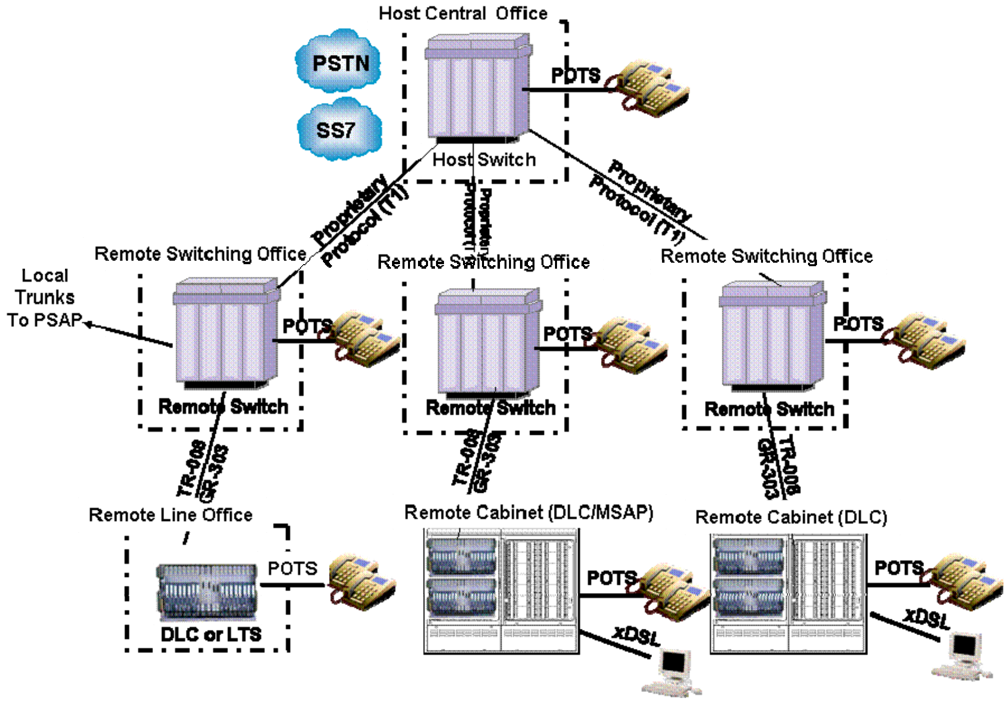
Host-Remote Architectures

In North America, many operators have deployed their Class 5 switch network in a Host-Remote architecture. In general, a host-remote network comprises of a primary Class 5 switch in the main office (the “host”) as well as a number of remotes, which might consists of any of the following:

- A remote switch, in a satellite switching office.
- A line termination shelf, in a remote line switching office.
- A digital loop carrier “remote terminal” in a cabinet or smaller remote office.

An example of this architecture is shown in Figure 3.

Figure 3: Typical Host-Remote Switch Architecture



Source: broadbandtrends.com

Remote Switch Units and Remote Line Shelves

A remote switch operates under the control of the host in normal operation, but typically is a fully featured Class 5 switch offering Analog line termination, upstream trunking, Off-switch or “hair-pin” trunking, as well as Emergency standalone capabilities.

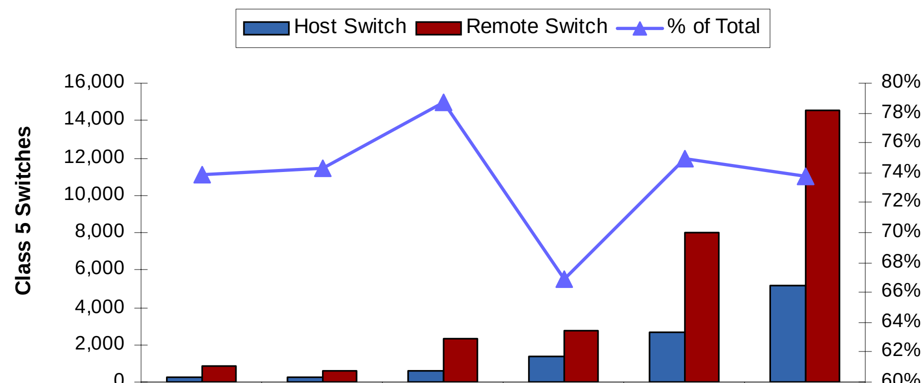
While fully feature, the biggest drawback to remote switches is the proprietary connection between the host and remote switch, requiring both components to be purchased from the same vendor. This type of closed system often results in lack of technological innovation as well as high maintenance, upgrade and licensing fees.

A remote line shelf terminates analog lines and operates under the control of its upstream switch (either the host or a remote switch). The remote line shelf has emergency standalone switching capability but it does not have any trunking capability.

The fact that these remote units are able to perform standalone switching operations is a fundamental test for the National Exchange Carrier Association (NECA) categorization of a network purchase as a switch (and not simply a line termination device) – which has commercial implications for NECA members.

At the end of 2006, there were nearly 15,000[2] remote switches or remote line units deployed in the United States as shown in Figure 4.

Figure 4: U.S. Class 5 Host-Remote by Operator, 2006



	BellSouth	Qwest	ATT	VZ	IOCs	Total
Host Switch	297	216	620	1,383	2,676	5,192
Remote Switch	839	626	2,291	2,787	8,027	14,570
% of Total	74%	74%	79%	67%	75%	74%

Source: broadbandtrends.com

Digital Loop Carriers

Similar to remote line shelves, a digital loop carrier (DLC) terminates analog lines and converts them to digital signals (TDM) under the complete control of the host switch, connecting to the switch via various standard protocols, such as TR-008 and GR-303 (V5.2 outside of North America.) Typically these platforms do not support any standalone switching capability.

Operators in the United States have long deployed digital loop carrier (DLC) platforms as a cost effective means of providing voice services beyond the standard carrier serving area (CSA) of 12,000 ft. At the end of 2006, 53 million access lines, representing 34 percent of total access lines were supported by Digital Loop Carrier platforms. [3] Although many DLC platforms have evolved over the years to add broadband capabilities, they remain primarily a vehicle for voice services.

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[2] NECA, FCC
[3] ARMIS, broadbandtrends.com

The Significance of Line Termination Functionality

In today's market, all circuit-based Class 5 solutions support line-side termination (also referred to as analog termination). In other words, a customer's line can be directly terminated to the switching platform. Service providers have the following three options when addressing line termination:

- Direct termination at the central office
- Termination at a remote switching location
- Termination on a digital loop carrier

Unfortunately, due to the disaggregated nature of next-generation switch platforms, many do not support this capability. Instead the majority of NG switch vendors have chosen to utilize MSAP platforms to act as line gateways that not only support POTS termination, but also video, data and VoIP, as well as call control interfaces such as H.248, SIP and MGCP.

Access Network Transformation

If we look historically at the most widely deployed access platforms, we find two main product categories: digital loop carriers (DLCs) and Digital Subscriber Line Access Multiplexers (DSLAMs). As discussed earlier, DLCs have been deployed primarily to offer voice services, while DSLAMs have been deployed to offer broadband services. Neither platform was purpose built to support multimedia services such as video, especially over an IP/Ethernet infrastructure. Table 2 provides a quick look at the advantages and disadvantages of these legacy access platforms.

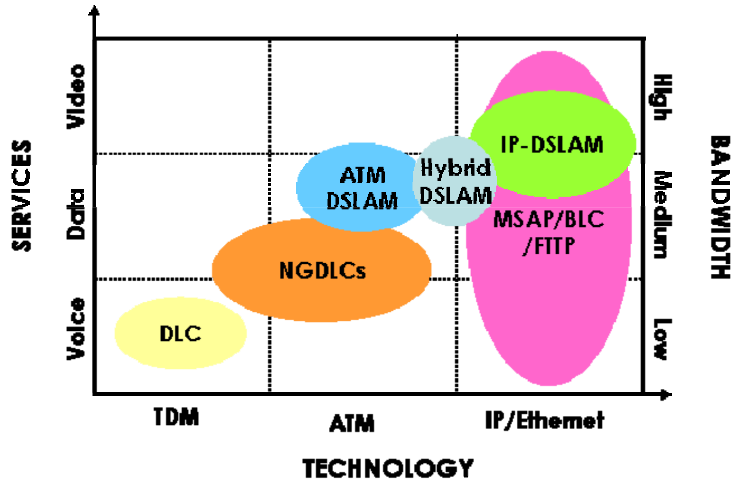
Table 2: Legacy Access Platform Advantages/Disadvantages

	Advantage	Disadvantage
DLC	▪ Optimized for OSP deployment ▪ Multiple Form Factors ▪ Widely Deployed ▪ NG-DLCs can offer limited amounts of Broadband Data Services	▪ Optimized for TDM voice only ▪ Limited Broadband Data Capability ▪ Limited or no Video and Multicast Capability ▪ Limited backhaul transport using SONET/SDH and ATM ▪ No native VoIP support
DSLAM	▪ Next-Generation Platforms are Ethernet Based ▪ Widely Deployed ▪ Many support GigE uplinks	▪ Optimized for data only ▪ Limited investment opportunity for ATM-based platforms ▪ Limited or No Voice Capability ▪ Limited Video and Multicast Capability ▪ Traditionally CO-based ▪ Lack of QnQ, multi-tiered QoS and native VLAN capability

Source: broadbandtrends.com

Although many DLCs and DSLAMs have evolved beyond their original capabilities, operators are finding these platforms can not adequately support the stringent requirements necessary for converged, multimedia services. This has resulted in the need for a new class of access platforms that have been purpose built for the delivery of high-bandwidth triple-play services: the Multi-Service Access Platform, as illustrated in Figure 5.

Figure 5: Access Platform Evolution



Source: broadbandtrends.com

The Role of the MSAP in Network Transformation

MultiService Access Platforms (MSAPs) will play a key role in helping network operators' transition to next-generation access networks. A single platform can be deployed to support mixed topology networks over copper, fiber or even the air using a variety of different technologies such as DSL, FTTX and WiMAX. These platforms not only offer operators the ability to introduce new, more advanced services on a customer by customer basis, they also allow the continued delivery of legacy services. Key characteristics of the MSAP are found in Table 3.

Table 3: Key MSAP Characteristics

Technologies	Topologies	Applications
▪ xDSL ▪ FTTX (xPON and/or Active Ethernet) ▪ GigEthernet/Fast Ethernet ▪ WiMAX	▪ Point to Point ▪ Point to Multi-Point ▪ Fiber-to-the-Node (FTTN) ▪ Fiber-to-the-Curb (FTTC) ▪ Fiber-to-the-Home (FTTH) ▪ Fiber-to-the-Building (FTTB)	▪ IPTV (IGMP) ▪ TDM Voice ▪ PSTN Transformation (SIP, H.248, MGCP) ▪ Data Services ▪ Business Services (Ethernet, T1, etc.) ▪ QoS per user, per service

Source: broadbandtrends.com

MSAPs not only enable new, high revenue generating services, such as video, but still provide support for legacy voice services. By deploying a platform that not only supports voice packetization on a per line basis, but also native POTS and ISDN line terminations, operators are able to implement PSTN transformation on gradual basis, where and when it makes sense. Features such as GR-303/V5.2 as well as integrated H.248 and SIP signaling gateways for interface to an NGN softswitch, enable voice migration without a necessary change in the end points.

Ensuring ESA during Network Transformation

The pace of network transformation will vary from operator to operator and even from market to market. As such, it will be necessary to ensure that network survivability, particularly emergency access services remain functioning throughout network transformation.

Why is Support for Emergency Stand Alone Necessary?

The importance of support for Emergency Services capabilities, primarily through the use of 9-1-1, cannot be overlooked or undervalued. According to NENA (National Emergency Number Association), over 200 million 9-1-1 calls are made each year in the United States, utilizing the services of more than 8,000[4] PSAPs (Public Safety Answering Points) and 3100 counties. The ability to maintain 9-1-1 service during natural disasters, severe weather, major power outages, telecommunications cable cuts, and other such events, is vitally important.

Emergency Stand Alone capability allows for backup switching functionality in the event of a network failure. By enabling this capability in a remote node, such as a remote switch or other line termination device, callers are able to maintain localized calling functionality, including support for 9-1-1 services.

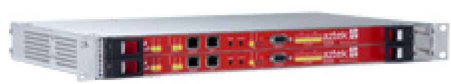
New Solutions Address Operator Concerns

Although operators have expressed strong interest in consolidating their switching network by replacing remote switch units with MSAPs, the lack of ESA functionality has given many operators reasons to defer and delay these decisions.

However, the recently introduced Emergency Standalone Switch (Figure 6) offered by Aztek Networks, provides a low-cost, compact, distributable, scaleable and open-standards based solution to address this issue.

Not only is an operator able to guarantee emergency access services to subscribers in the event that communication with the host switch has been lost, but offers a new level of flexibility not found with legacy switch remote. This flexibility allows operators to deploy ESA in a layered approach to make sure that no subscriber is without emergency access, no matter how rural the community.

Figure 6: Aztek Networks 5000S ESA



Aztek 5000S Features

- True ESA switching
- Based on standard GR-303
- Works with legacy DLCs or new BLCs and MSAPs
- Compact design
- Environmentally hardened
- IP ready
- Ideal solutions for switch collapse or replacement of proprietary RSUs

Source: Aztek Networks

[4] FCC PSAP Registry September 2007

The 5000S ESA Switch is a 1RU, fully hardened unit that can act as a back-up switch to any host with GR-303 or IP interfaces. Additionally, the 5000S can support multiple access systems (including both legacy DLCs and MSAPs) from different vendors within the same network.

Phases of Network Transformation

Due to the varied requirements of each network, operators will likely take a phased approach towards network transformation depending on the desired goals and the state of their current network. In many scenarios, operators are likely to transform the access network first, followed by the PSTN network. Network Transformation Phases are summarized in Table 4.

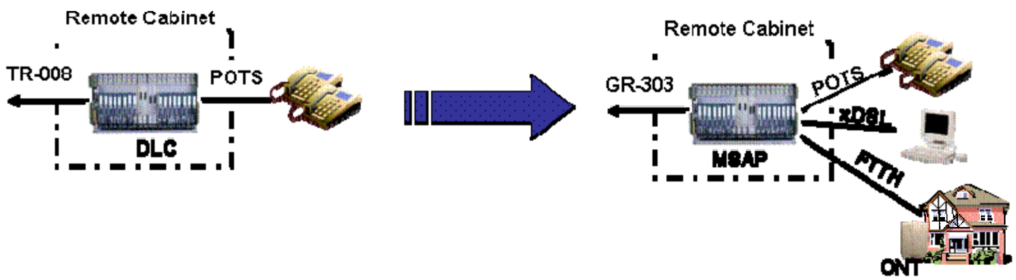
Table 4: Network Transformation Phases

	Phase 1	Phase 2	Phase 3
PSTN Network	▸ No Changes	▸ Eliminate Remote Switch Units	▸ Replace circuit switch with NGN switch platform
Access Network	▸ Replace old voice only DLCs with MSAPs	▸ Deploy MSAPs	▸ Upgrade switch interface from GR-303 to IP
ESA Functionality	▸ No Changes	▸ Add ESA server to MSAP	▸ No Changes

Source: broadbandtrends.com

Phase 1 allows an operator to position the network for the delivery of broadband services. It is assumed that ESA functionality continues to be provided by either a host or remote switch unit. An example is shown in Figure 7.

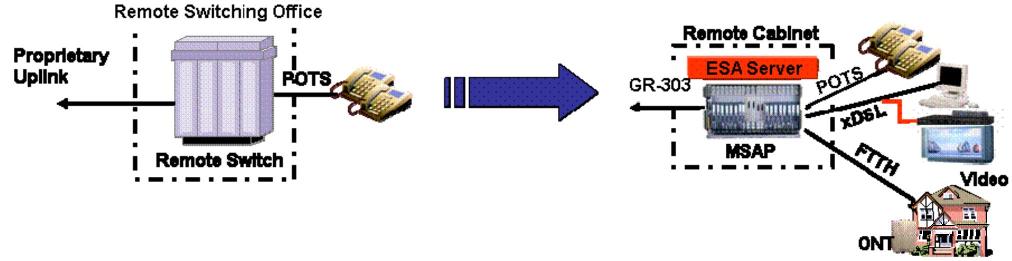
Figure 7: Phase 1 Example



Source: broadbandtrends.com

Phase 2 allows an operator to replace outdated monolithic remote switch units with multi-media capable MSAPs. The addition of a compact, single rack-unit Emergency Standalone switch provides continuity of emergency services. An example is shown in Figure 8.

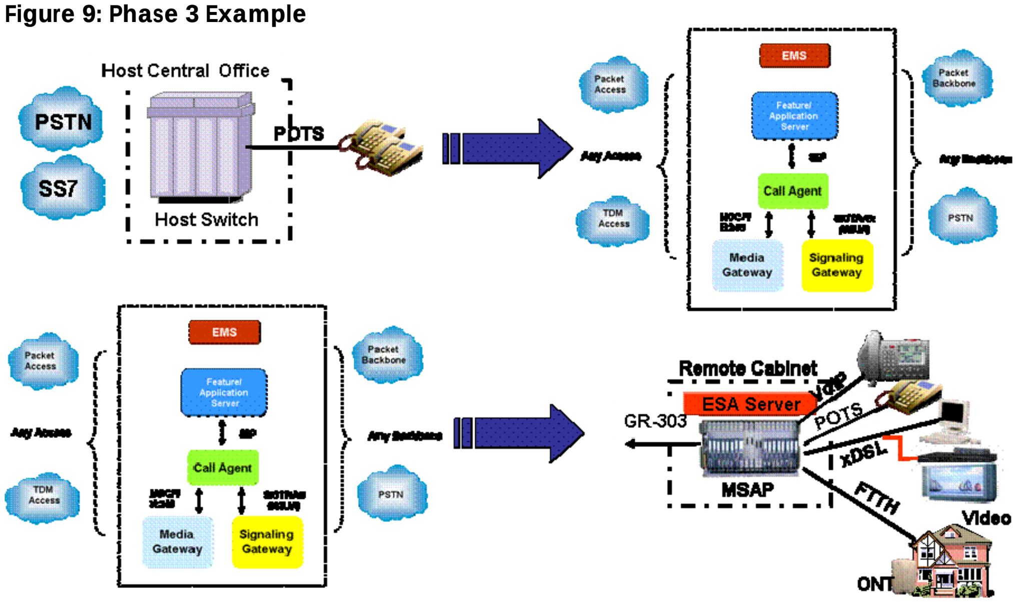
Figure 8: Phase 2 Example



Source: broadbandtrends.com

Phase 3 allows an operator to make a complete PSTN transformation, replace all circuit switches with NG switching platforms with little impact to the investment in the access network. An example is shown in Figure 9.

Figure 9: Phase 3 Example



Source: broadbandtrends.com

MSAP + ESA = The Best of All Worlds

The combination of an MSAP with ESA functionality provides operators with the best of all worlds. Not only does it allow for PSTN transformation, through the consolidation of switching platforms, but also access transformation, through the deployment of multimedia capable broadband platforms. A comparison of remote solutions is shown in Table 5.

Table 5: Comparison of Remote Solutions

Features	RSU	RLC	DLC	MSAP
Analog Termination	✓	✓	✓	✓
DSL Services	×	×	✓	✓
FTTx Services	×	×	×	✓
Triple-Play Services	×	×	×	✓
Emergency StandAlone	✓	✓	**w/ESA Server**	**w/ESA Server**

Source: broadbandtrends.com

Conclusion

The introduction of Multi-Service Access Platforms combined with the Aztek Networks 5000s Emergency Standalone switch allows operators to begin network transformation with the full assurance that emergency services will be guaranteed for all subscribers. By inter-working with both legacy and next-generation access and switching platforms, the 5000S ESA allows operators to selectively deploy transformation solutions where and when it makes the most economical sense, while still leveraging its legacy infrastructure. By deploying ESA capability directly with the MSAP, operators can eliminate the need for expensive remote switches in most network applications, allowing for central office consolidation and switch collapse. More importantly, flexibility in network deployment options allows operators to create emergency serving areas to ensure that communities of all sizes will have access to emergency services in the event of lost connectivity to the host switch is lost.

Major Benefits and Features of Solution

- True ESA enables intra-community dialing and access to local emergency 911 services in the event of a line-cut or host switch failure.
- Dual processor, fully redundant control cards and high availability software ensure ESA service is available when needed.
- Interoperates with all GR-303-based switch and access equipment.
- Can link multiple DLCs/BLCs/MSAPs from different vendors into a single ESA community.
- Compact design and environmentally hardened so that it can easily be deployed in a field cabinet.
- Ideal solution for replacement or decommissioning of proprietary Class 5 remote switch units.
- IP ready: easy upgrade to IP (SIP or H.248) uplink to softswitch.

Acronyms:

API	Application Programming Interface
ATM	Asynchronous Transfer Mode
BSS	Billing Support System
CALEA	Communications Assistance for Law Enforcement Act
CO	Central Office
CSA	Carrier Serving Area
DLC	Digital Loop Carrier
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EMS	Element Management System
ESA	Emergency Stand Alone
FTTX	Fiber to the "x"
LNP	Local Number Portability
MSAP	Multi Service Access Platform
NECA	National Exchange Carrier Association
NENA	National Emergency Number Association
NGN	Next Generation Network
OSP	Outside Plant
OSS	Operating Support System
POTS	Plain Old Telephone Service
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RLS	Remote Line Unit
RSO	Remote Switch Office
RSU	Remote Switch Unit
SIP	Session Initiation Protocol
SS7	Signaling System 7
TDM	Time Division Multiplexing
VoIP	Voice over IP

About the Author

Teresa Mastrangelo, Principal Analyst and Director of Research, brings over 19 years of telecommunications experience to The Windsor Oaks Group. She is responsible for research activity for the broadbandtrends.com service and is regarded as one of the leading analysts covering both broadband and VoIP infrastructure and services.

In her role, Teresa works as a consultant to equipment manufacturers, service providers, financial analysts and venture capital firms, identifying emerging trends, new market opportunities and advising on product positioning, market development, and business plans. Her custom work includes Competitive Assessments and Market Entry Strategies for NGN/VOIP and FTTH as well as Product Portfolio Assessments, Market Validation Studies and White Papers.

She is an invited speaker at major industry events around the world, including the Broadband World Forum in Europe and Asia, FTTH Councils, VON, and SUPERCOMM, and is frequently quoted in trade and business publications such as *VoIP Magazine, Telephony, San Jose Mercury, Telecommunications, New York Times, Wall Street Journal, Network World, Lightwave*, and *CableWorld*. In addition, she has written columns for a number of these same publications.

Prior to founding The Windsor Oaks Group, Teresa worked for RHK as the Program Director for RHK's Broadband Network Strategies program, where she had responsibility for the development of global market research and analysis of broadband infrastructure and services; as well as circuit to packet migration and VoIP. Prior to RHK, Teresa held senior level product marketing and product management with Cisco Systems, Advanced Fibre Communications (now part of Tellabs) and NEC America, where she was instrumental in attainting product approval at a number of key accounts.

Teresa was awarded her BS in Electrical Engineering from Virginia Polytechnic Institute in 1987 with post graduate work at Penn State University and Roanoke College.

THE WINDSOR OAKS GROUP

About The Windsor Oaks Group

The Windsor Oaks Group LLC is an independent market research firm specializing in the coverage of network transformation activity related to broadband infrastructure and services, including IP-TV, VoIP and NGN. Our continuous information service referred to as broadbandtrends.com, offers both quantitative and qualitative analysis to equipment vendors, network operators and the investment community with a specific focus on competitive and market intelligence.

The Windsor Oaks Group LLC has worked on numerous consulting projects with Tier 1 equipment vendors which include product portfolio assessments, market entry strategies and strategic partnership opportunities.

