

VoIP at Paulding County Schools: A Formula for Success

While organizations many times their size struggle to get VoIP right the students, faculty and administrators of the Paulding County School District have been enjoying the benefits of a scalable, cost-effective and feature-rich VoIP system for over three years. Their success with VoIP can provide important insights for others.

Background There are two other counties in Georgia and only ten others in the United States whose population is growing at a faster rate than



Paulding County's. For this reason the Paulding County School District is in the middle of an aggressive five year plan that will add four new elementary schools, one new middle school and one new high school plus a performing arts center to the existing mix

of twenty five elementary, middle and high schools and one alternative school serving over twenty thousand students today and growing by over 1,200 students each year. With over 2,500 employees the Paulding County School System is the largest single employer in Paulding County and their annual budget exceeds \$123 million.

It is the job of Paulding County School District's CIO Chris Ragsdale and his IT Department to assure that all technology needs are met. This includes data and voice connectivity to the classrooms and

for faculty and administrators and assuring system availability and security. A key issue in the "post-Columbine" and "post-9/11" eras is a focus on student safety and campus security that surpasses all other issues in overall importance.

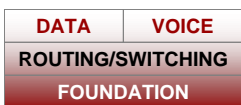
Paulding County has achieved success in voice over IP for three main reasons: short distances, big bandwidth and a keen, disciplined, attention to detail including wise application of technology, careful integration of voice and data and impeccable vendor selection.

Drivers it is no surprise that financial drivers are on this list yet they are not the primary drivers. The four primary elements that drove Paulding County Schools to initiate their Data and Voice Technology Replacement project in 2000 were:

- > provide consistent, reliable high quality voice and data services
- > reduce the impact of shrinking funding
- > reduce or eliminate the cost of Centrex
- > proactively deal with staffing issues

Some other common drivers in school districts, absent in Paulding County's list, are video surveillance, distance learning and multimedia labs. Though not on the list of original objectives these are now within Paulding County's reach.

Architecture Most telecom professionals visualize their systems in terms of "layers" with foundational layers



providing the basis for the layers above them, all the way up to the

layers where users interact with the system. This is often described in terms of the layers of a cake or floors of a building. As with the foundation for a building, and the floors of the building built on that foundation, the upper layers of a network can be no better than the foundation provided by the layers below them. In fact, over two thirds of network problems are attributed to problems with the foundation.

To Paulding County the layered approach meant that they had to start from the "ground up" and assure that each lower layer met all requirements before selecting the technologies for the layer above.

The specific layers we will discuss briefly are "the foundation", which is the nerve system of wires and fibers over which both voice and data flow and the switching and routing layer, which directs the voice and data traffic over the proper wire or fiber path. Both of these layers are shared by voice and data and must be properly designed and implemented in order for the combined system to work.

Foundation Layer Paulding County's converged voice, data, and video-ready architecture consists of one pair of fiber connecting each of 25 outlying schools to the administration center at 1 billion bits per second (1 Gbps). In the schools Paulding County chose to use fiber from the centralized location where the outside fiber enters the building to very near the point where personal computers and telephones are connected using fiber at 100 million bits per second (Mbps). All telephone equipment and mission critical data servers are housed centrally in the

administration center where they can most cost effectively be maintained and physically secured.

The fiber decision for Paulding County was made easier due to a substantial discount their local cable provider for outside fiber to the schools.

Each fiber pair creates a bi-directional optical pathway capable of transporting one billion bits per second (1 Gigabit/second (Gbps)) in each direction today and can be upgraded in the future, without replacing the actual fiber to many times that capacity. While Paulding County pays one-time construction costs for any school not within easy reach of Comcast's fiber the cost is a fraction of what a private company would pay for a similar system.

Costs were kept down and capability and reliability kept up by scalable Waters' switches from Waters Network Systems (www.watersnet.com).

The chosen endpoint switches allow a pair of fibers to be brought in from a single centrally located and locked wiring closet, to a classroom, computer lab, office, library or anywhere else that computers and/or phones need to be connected. From the Waters' switches up to eight twisted pair cables can go to face plates or directly to devices that need to be connected using the cost-effective twisted pair connections that come with all network-able devices.



Waters ProSwitch® Secure Ethernet Switch

The fiber optic and twisted pair wiring configured in a single wiring closet arrangement with fiber distribution, called zone cabling, combined with the Waters ProSwitch® Secure series of Ethernet switches comprise the "foundation" layer

Procurement & Implementation

One reason why the Paulding County VoIP implementation is so good is that it is free of the compromises and miscommunications that often accompany decisions made by committee or using rigid purchasing procedures designed more for desks and chairs than for technology. The Paulding County vendors and components were chosen by one person, Chris Ragsdale, based upon his personal knowledge, the best advice and research available at the time and installed with a singularity of purpose and resolve usually reserved for one's own "pet" projects, in this case Chris Ragsdale's. Vendors were chosen based on an informal RFP and a limited committee to review the results and then Paulding County moved quickly to the implementation phase of the project.

Procurement Paulding County's choice of US LEC, their fiber contractor and Waters Network Systems were all based on a combination of references, reasonable pricing and an ability to work together collaboratively and cooperatively to help Chris Ragsdale implement his vision. Not only were these providers the lowest bidders they were all deemed to be the best value, which is a very rare case

upon which sit the routing and switching layer and the VoIP system on top of that. The ProSwitch® switches also providing localized switching to offload the routing and switching layer and make the system, overall, more efficient.

In terms of growth for the future, it is estimated that only six percent of the capacity of the fiber optic infrastructure is currently being utilized during periods of peak traffic.

Routing and Switching Layer

It is noteworthy that all components comprising both the Routing/Switching layer and VoIP service layer are from the same provider, Alcatel (www.alcatel.com).

The routing and switching layer in Paulding County's system is comprised of 16 slot Alcatel OmniSwitch 7800 switches in the larger schools and 9 slot Alcatel switches in the smaller schools. The remote switches provide localized switching between systems within the same building and connect each school to

but one that Paulding County School District took great advantage of and the final results prove both points: the value of saving money and getting the highest possible quality. This formula equals value for all participants and is the type of win-win situation that is the most desirable in any technology procurement.

The choice of Alcatel, however, was not clear from the beginning. What was crystal clear to Chris Ragsdale was that, because this was to be an IP-only network, it must, by default be a Cisco-Powered network. The more deeply Chris dug into Cisco's solution the more impressed he became with Cisco and their people - many of whom literally created the Internet. But, as his confidence in their data abilities increased his comfort level with their voice expertise, and their ability to reliably meld the two together, began to decline considerably.

This is the point at which Alcatel caught Chris's eye. In 2000 Alcatel acquired highly regarded data systems provider Xylan and won a prestigious industry award for their OmniPCX VoIP platform giving them legitimacy in Chris's view. Chris's informal Request For Proposal (RFP) went out only to Cisco and Alcatel. Impressed with Alcatel's response, their credibility in both voice and data, their hundred year plus history, global

the administration center and all other schools via a large Alcatel OmniSwitch 7800 located at the administration center.

Data and VoIP Services Layer

This layer is comprised of just Alcatel equipment supporting Paulding County's 50+ data servers, security firewalls, 45 Mbps DS3 Internet connection and other data systems.

The VoIP Services layer uses an Alcatel OmniPCX system, which is a Unix-based VoIP server, connected directly to the administration center OmniSwitch 7800 via a local fiber with the Ethernet and IP protocols and connected to the public telephone network by 7 US LEC (www.uslec.com) provided T1s in a Primary Rate ISDN (PRI) arrangement providing a maximum of 161 simultaneous calls between Paulding County Schools and the public switched network in addition to the hundreds possible within the schools. A single FAX/9-1-1 line is also installed at each school.

credentials, responsive and professional sales and support team and financial stability Paulding County Schools chose Alcatel over Cisco and began their implementation.

Implementation Chris Ragsdale refers to the summer between the 2000 and 2001 school years, during which he implemented the Technology Replacement Project as "the summer that lasted until Thanksgiving". It is so-called because even though the project began on June 30th and much of the implementation occurred during the summer break, while school was not in session, the project took until late November to be completed.

The implementation of the Technology Replacement Project was executed predominantly by Chris Ragsdale and two technicians supplemented by vendor and service provider personnel and involved:

- > Complete change from IBM Token Ring to industry standard Ethernet
- > Replacement of over 2,000 PCs
- > Implementation and/or migration of over 50 servers
- > Replacement of copper cabling with fiber in 16 schools, bringing all of the Paulding Schools to an all fiber infrastructure
- > Implementation of VoIP
- > Migration of ESSX/Centrex to VoIP
- > Roll-over BellSouth PRI lines to US LEC
- > Management of phone number changes

Migration & Training

Migration and training were very simple and straightforward. Phone systems were flash-cut with no parallel operation, an approach that is much less disruptive over the summer than over a weekend. A third-party service provider, recommended by Alcatel, provided on-site training at each school for faculty and staff.

The Alcatel VoIP phones contain sophisticated VoIP features that can be programmed and turned on and off as

needed but, in general an Alcatel VoIP phone looks and acts like a regular telephone and anyone who can make a call from a regular phone can call from an Alcatel phone with no problem.



Alcatel IP Phone

Much of the training was focused on using Voice Mail, a feature which was new to many of the Paulding County faculty and staff.

Training was also simplified by the fact that special features, dialing directories and other personal settings are tied to the individual's profile, and not the phone device. This means that once a faculty member or administrator have personalized how the system operates for them the settings travel with them from phone to phone not only within the same school, but anywhere in the school district.

Operational Issues

Though Paulding County School District now has a complete, working system the implementation was not completely smooth. During implementation a number of operational issues were encountered, including:

- > *Difficulty in 9-1-1 Implementation*
- > *Outsourcing vs Do-It-Yourself*
- > *Conflicts between Voice and Data Traffic*
- > *Lead times on Non-VoIP Service*
- > *Echo problems*
- > *Advanced features not working*

These areas are described in detail in the complete case study as described at the end of this document.

Return on Investment

There are three ways to approach the Return on Investment for this project. We will show all three. The first model is Voice Rides Free, the second is Port Allocation and the third is Capacity Allocation.

Sources of Savings Even though the system provides additional "soft" benefits the ROI and TCO calculations are treated as if this is a straight functional replacement of a phone system. No savings will be calculated for the move of PRIs to USLEC: This could be achieved without a migration to VoIP.

Voice Rides "Free" In the first model we assume that the system needed to be installed for data and, because it was so substantially overbuilt, the VoIP traffic represents a small impact. Therefore the ROI can be calculated as the cost for VoIP systems and phones of \$450,000 divided by the \$33,000 per month savings to yield a **ROI of 13.6 months**.

Port Allocation The alternative to "voice rides free" is for both voice and data to share the costs of the system. In the first allocation model, "port allocation", costs are allocated based on the total number of ports. If we were allocating the costs of a road system this would be the equivalent of splitting the total cost by the number of driveways, regardless of the type of vehicle that would use the road.

With a total allocated cost of \$716,850 and a savings of \$33,000 per month the **ROI, calculated this way, would be 21.7 months**. The Port Allocation Model calculation is shown in the table below.

Capacity Allocation Capacity-based allocation takes into account the demands placed on the network by voice and data and sharing the cost of both network use and network idle capacity. If

Outside Fiber Construction	\$60,000
Inside Fiber Construction	636,000
Inside Fiber Equipment	450,000
Routing Switching Infrastructure	<u>+306,000</u>
Sub-total (infrastructure cost):	\$1,452,000
Divided by (2,000 data + 450 voice ports)	<u>2,450</u>
Subtotal (cost/port):	\$593
× 450 voice users (Allocated Infrastructure Cost for Voice Users)	266,850
VoIP Systems and Phones	<u>+ 450,000</u>
Total Cost for VoIP System	\$716,850

Using these figures an organization considering a new system can calculate the rough costs of their own converged voice and data solution. Keep in mind that financial modeling shows these costs to be roughly consistent with the costs of a traditional PBX so these figures are not valid for comparing VoIP vs PBX. If a change of telephony system is mandated then the numbers show a move to VoIP is viable while a more reasonable decision point might be "are there compelling reasons for a move to a new telephony system now or can we wait?"

the network were a road system this is the equivalent of allocating costs based upon the size of the vehicles that use the road. Based upon an average demand of 384 thousand bits per second (kbps) per data user and average demand of 70 kbps per voice user we could allocate 18% (70/384ths) of the infrastructure costs (18% of \$1,452,000 or \$261,360) to voice, add the \$450,000 cost of VoIP Equipment and divide the total of \$711,360 by the \$33,000 of savings per month to yield an **ROI using this method of calculation of 21.55 months**.

Total Cost of Ownership

Total Cost of Ownership is always a tricky calculation but a very useful one, especially when used to compare two or more systems for which the TCO has been calculated using the same algorithm. In the case of the Paulding County School District VoIP project the system life of five years will be used for calculation of all recurring costs. Because there are no dedicated staff no personnel overhead will be calculated but the outside maintenance fees will be considered.

A useful figure for comparison purposes is the total cost/user and this will be calculated based upon 450 users. Fixed costs will be based upon the Port Allocation Method shown above for the ROI calculation.

Based upon these rough order of magnitude calculations, for budgetary purposes, the cost to provide VoIP-based phone service for a single Paulding County School District telephony user is \$2,953 for five years, or \$49 per month, a figure substantially below the \$74 per month cost of the Centrex service being replaced.

There are two forces at play here. The first one is the usual impact of replacing a ten plus year old technology with a new technology: the double impact of a lower price and more capability. The second

be more realistic for an organization of similar size, which would mean that even traditional Centrex may be more cost effective and the cost difference may have to be justified based upon strategic

Fixed/One Time Costs:	
Allocated Infrastructure Cost for Voice Users	266,850
VoIP Systems and Phones	+ 450,000
Total One-Time Cost for VoIP System	\$716,850
Recurring Monthly Costs:	
Outsourced Monthly Costs	3,400
Outside Fiber	500
LEC T1 Lines	+6,300
Sub-total Monthly Costs	\$10,200
System Life	x 60 months
Total Recurring Monthly Costs	\$612,000
Total One-Time Cost for VoIP System	+ \$716,850
Five Year Total Cost of Ownership (TCO) Estimate	1,328,850
Divided by Total Number of Users	450
Five Year Total Cost of Ownership (TCO) per user	2,953
Monthly TCO per user	\$ 49

force is the financial impact of Paulding County's very favorable monthly fiber cost. With normal fiber pricing a budgetary figure of \$80 to \$100 per month per user to provide VoIP-based phone service would

application benefits or on a "voice rides for free" strategy, which also makes sense for many organizations. This example clearly highlights the importance of keeping infrastructure costs under control.

Expectations &

Lessons Learned

While Chris Ragsdale claims, as "a data guy", he had no "expectations" of his venture into VoIP, other than dial tone and the ability to make phone calls, the process was not without its "surprises".

Expectations One aspect of the migration to VoIP that startled the implementation team was the "gnashing of teeth" over replacement of the old phone with the new phone. Even though both phones have red hold buttons and both allow calls to be transferred in the phone

zone, far more than in the data world Chris observed the manifestations of user reluctance to change and their fear of not having service.

Lessons Learned Among the lessons learned by Paulding County are that better user expectation management will help solve the reluctance and harsh criticism issues described above and better project management practices, including bringing in an outside project manager for the duration of the project, will pay big dividends. Areas where better project management would have helped:

- > *Managing interaction of 5 vendors*
- > *Providing more deadlines and assuring compliance*
- > *Assessing impact of excessive BellSouth lead times and missed schedules*
- > *"Big picture" project management chart*
- > *Creating a common "war room" for coordination*

While the results are sterling Chris Ragsdale points out that the journey could have been a lot smoother, especially with a disciplined project management regimen which was not adopted until very near the end of the project.

Looking Ahead

The Paulding County School System has done more than just replace an aging phone system and provide dial tone: they have laid a cost-effective foundation for a future full of opportunities. By uniting their telephone system with school information Paulding County is poised to further enhance all areas of school life, from the learning experience to day-to-day school operations. Just imagine what is possible.



About the Author This case study was written by James P. Cavanagh, a global telecom, network and security consultant who has been involved with packet voice technologies since the mid-1980s. Much of Jim's time for the last decade has been in helping prove out both the technologies and business cases for VoIP for a variety of organizations ranging from manufacturers and service providers to small and medium enterprises, government agencies and multinational global 200 companies.

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