

Replacing Centric Voice Services with Hosted VoIP Services: An Application of Real Options Approach

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ABSTRACT

The objective of this paper is to apply real options techniques to justify the replacements of a Centrex PBX telephony solution for a new Voice over IP (VoIP) based solution. In this proposal we are looking at replacing the hardware components of managing a PSTN service with one which is hosted and managed from remote facility.

We apply the real options approach to compare the Centrex based solution currently deployed by the traditional voice carriers like the RBOCs and IXC's using the hardware from Nortel, Avaya, and Siemens with one currently being developed and deployed by the VoIP providers like Vonage, 8 by 8, Deltathree, Net2Phone. We investigate the potential savings in hardware cost, provisioning, billing, maintenance and service with new features sets created as a result of converging voice on a data platform using the Internet Protocol (IP). Another important factor we consider is our evaluation is the drastic reduction in costs for providing VoIP.

The analysis shows that a hosted managed solution is the most effective solution for a company engaged in acquiring a new telecommunications solution. Furthermore we predict early adapters would be small business units particularly with less than 100 employees.

I Introduction

The deep-rooted old Public Switched Telephone Network (PSTN) has evolved from traditional circuit switched systems to digital circuit-switched systems. Telephone service carried by the PSTN is often called Plain Old Telephone Service (POTS). PSTN networks which was initially used for end-to-end voice communication in the past is now used as data network. With the evolution of Internet, the telecommunications industry has witnessed the convergence of voice and data applications thanks to the success of Internet Protocol (IP) and IP based networks.

The Internet Protocol (IP) is now used to transport voice packets within the IP datagrams through variety of link layer systems. Internet Protocol (IP) has been successful in making the network transparent to the upper layers involved in voice transmission through an IP based network. Considering the recent success and advancement in IP, it is yet to mature for voice communications. Real time applications such as voice and video require guaranteed connection with consistent delay characteristics. Currently there are two protocols, Transmission Control Protocol (TCP) and User Datagram Protocol (UDP), available at the transport layer when transmitting information through an IP network. Voice is a real-time application, and mechanism must be in place to ensure that information is received in correct sequence, reliably, and with predictable delay characteristics.

The high-tech US based market research firm, In-Stat/MDR¹ forecasts strong growth, about 100% year-over-year, for IP Centrex/Hosted PBX (Private Branch Exchange) through 2008. PBX is a private telephone network within an enterprise. Users share a set of common telephone lines for making outside telephone calls or connecting to external PBX's. Most medium-sized and larger companies use a PBX because it is much less expensive than connecting an external telephone line to every telephone in the organization. Nortel, Avaya, and Toshiba own most of this market. Much of this growth will come from Tier 1 providers entering the market. A network-hosted voice application, IP Hosted PBX Voice, provides, at a minimum, business users with local dial tone, long distance, and voice features similar to that of an IP PBX. At the present time, this service is provided by Competitive Local Exchange Carrier (CLECs), the new entrants to the market place will be the Regional Bell Operating Companies (RBOCs), e.g., Verizon, SBC, and Qwest along with the cable companies, e.g., Comcast, Cox and Cablevision.

Another US market research firm, IDC projects that revenues for the overall market will grow from \$281 million in 2003 to \$6.7 billion 2007². Much of this revenue will consist of ac-

¹<http://www.instat.com/>

²<http://www.idc.com/>

count conversion from the traditional Centrex base, which will decline to \$2.8 billion in 2007.

The objective of our paper is to compare the Centrix based solution currently deployed by the traditional voice carriers, e.g., the RBOC's and IXC's using the hardware from Nortel Networks, Avaya and Siemens with the one slowly being developed and deployed by the new Voice over IP providers, e.g., Vonage, 8 by 8, Deltathree, Net2Phone, and Skype in Europe.

We examine the potential savings in hardware costs, provisioning, billing, maintenance and service with the new feature sets created as a result of converging voice on a data platform using the Internet Protocol (IP). The importance of transferring voice from an analog network to a digital network provides the new service providers with a breadth of new services that were either too costly to the average customer to use or non existent. Another important factor we will be considering in our evaluation is the drastic reduction in costs for providing voice over IP. The cost reductions have been introduced due to the new high performance networks that scale efficiently and reduce a fraction of costs from the legacy class 4 and class 5 switches.

We use Real Options Theory as a means of evaluating capital investments. Furthermore our goal is to investigate whether the business manager, in our case the chief technology officer, has the right to exercise an option and pursue the project based on financial analysis or decline not to. If he declines not to exercise the option then he forfeits the right to pursue the business project.

The value put on by the CTO is very strategic to the success of the company. As the Voice over IP market place starts to expand and new entrants make their way, the value proposition of being the first in the market and take a slice of the market space decreases.

The use of real options is relatively new to evaluating telecommunications projects to evaluate the opportunities that are embedded in the projects. It is important to realize real options considering the fact that project acceptance depends upon net present value (NPV). Options analysis is heavily dependent on the assumptions made prior to the calculation of the option price, for which there are standard assumptions based on industry standard values and practices [1, 2, 3, 4, 29].

The structure of the paper is as follows: In Section 2, we review the background of VoIP in the telecommunications industry. In section 3, we discuss the value proposition for Hosted solution. In Section 4, we study the use of the Real Options theory to evaluating the case of Hosted Services. Finally we summarize our findings in Section 5.

II Technology Setting

I Hosted Voice over Internet Protocol (VoIP) Services

Before we discuss Hosted VoIP services and its advantages it would be worth while to spend some time on understanding “What is Hosted Voice?” Hosted voice services offer voice telephony services over IP network as its core network [16]. With hosted voice services customers reap the benefits such as: Self Service Management, Enterprise Networking: Multi site IP-based voice, virtual private networking (VPN), Messaging services- Unified voice and fax messaging, Enhances Services- Auto-attendant, interactive voice services (IVR), conferencing, call centers, mobility, follow-me, one number, and Desktop Collaboration- web conferencing, instant messaging, and presence, document sharing, and desktop video (see Figure 1).

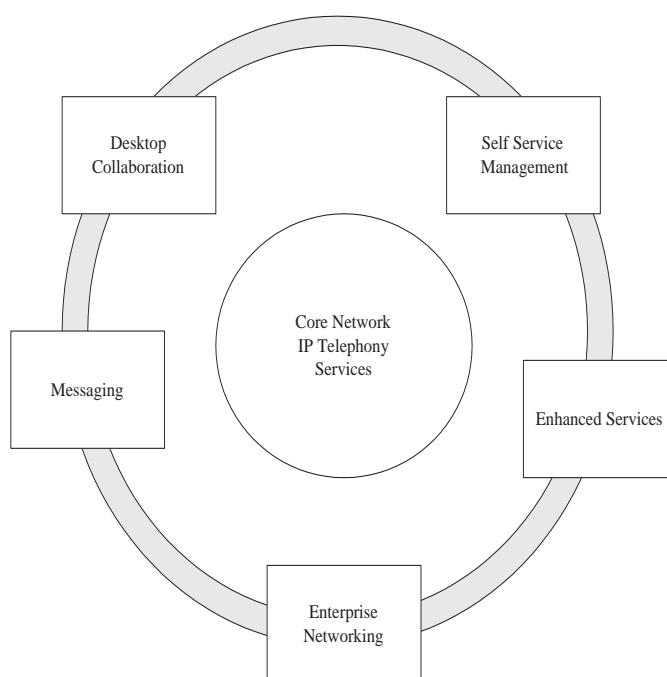


Figure 1: **What is Hosted Voice?**
Source: Level 3 Communications LLC

Hosted IP services are based on Voice over Internet Protocol (VoIP) rather than traditional circuit-switched networks e.g., PSTN. The Internet or IP core network acts as switching center where we have computing devices or IP telephones instead of traditional telephones. The most significant difference between PSTN and VoIP, is the backbone trunking

resources are not assigned in a dedicated, and predictable manner to support a voice call. Instead, trunk bandwidth for VoIP telephone conversation is assigned as needed, via packet switching. The Hosted Voice service tries to reduce operating cost as well as provide a communications service that optimizes end-user productivity.

With Hosted VoIP services, enterprises and carriers have the opportunity to create a large geographic campus network, which would unite all the locations, small offices, telecommuters, into a one managed service which is experienced as a single environment. For an end user this translates into: 4 or 5 digit dialing across locations with full geographic transparency, home office and mobile workers can access all calling features and can call from a main office number regardless of their location, conferencing and voice mail features, and unite are available across all locations. Unified corporate directory for all sites, and soft attendant receptionist switchboard can migrate transparently from office to office depending on the time of business day (see Figure 2) [16].

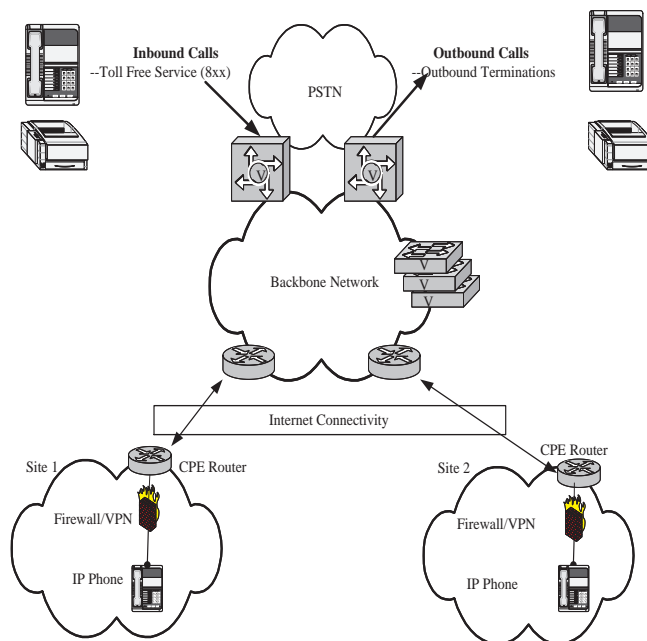


Figure 2: **Centralized Operations and Control**
Source: Level 3 Communications LLC

II Comparing Benefits of Hosted Services to PBX and Centrex Services

Studies have been conducted by many hardware and service providers on the effectiveness of the hosted market space. Level3 communications along with service providers such as Vocaldata and Broadsoft have done extensive internal research on the merits of hosted services for enterprise markets (see Table 1)[16, 27, 7].

Table 1: **Hosted Services Vs. PBX and Centrex Services**

| VS. PBX | VS. Centrex |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Avoid capital outlay and need for in-house expertise | “Look Big”; full feature set/phones, multiple line appearances |
| Reduce administration of moves, adds & changes | Avoid moves, adds, changes charges from LEC (\$100/empl./yr) |
| Reduce costs by consolidating voice & data; single wiring infrastructure | Reduce cost by consolidating voice & data |
| Reduce maintenance costs (23% - Yankee Group) | Reduce costs of interoffice call by 97% and average by 23% (Yankee Group) |
| Platform for enhanced service -unified messaging, voice mail conferencing | Platform for enhanced services -unified messaging, voice mail, conferencing |

Enterprise customers considering the Hosted Voice over IP solutions will consider it in comparison to other key systems. Alternatives to a hosted solutions are:

1. *Centrex*: Remote services provided by the local exchange carrier. Suitable for local campus environment e.g., healthcare, universities and small business units.
2. *Key Systems*: Very simple systems appropriate only for small offices. Typical end users are small business units.
3. *TDM PBX*: Traditional in-house telephony solution with in-house switching equipment. Best suited for small business units and large fortune companies.
4. *IP PBX*: In- house IP switching equipment to provide a PBX environment using IP services. Typically deployed in large enterprises.

In the traditional PBX/Key systems environment there are separate providers for data services and a separate voice network with VPN or dedicated line between offices in integrate phone systems with PBX. Traditional PBX systems require large initial investment and total

cost of ownership (TCO), e.g., for an average TDM-PBX, 50seats/3 locations solution, requires a total expenditure of \$119K, whereas for the Hosted VoIP solution total expenditure amounts to \$53K [16]. Traditional PBX environments are complex and costly to manage; redundant trunking is required between offices to enable interoffice dialing plans. Systems have complicated user interfaces and cabling, require actual physical proximity to phone and patch closet that requires expensive localized maintenance, administration, and weeks of end user training. Telecom systems professionals average \$80/hour [16]. The resulting inconsistency of service results in additional staff requirements and productivity losses.

III Value Proposition

The core value proposition for Hosted PBX Business revolves around speed to market, and providing a turn-key solution [16]:

1. *Speed to Market:* Hosted PBX solution can be provided in 60-90 days from time of placing an order.
2. *Turn-Key Solution:* The Hosted PBX Business solution provides a complete Hosted VoIP suite of interoperable services including voicemail, conferencing, user and administrative portals, LNP, 911, and Class 5 services.
3. *Reduced Capital Outlay:* Costs for Hosted PBX Business are only incurred on a variable basis as seats are sold. The initial investment for a Hosted PBX Business Partner is therefore minimal and costs only occur as business grows.
4. *Ease of Use:* With the Office Administrator interface, any administrative employee can perform all basic management functions needed to maintain the system. This can lead to significant operational expense savings. The Web User Interface also provides easy access to the enhanced features of the product without complex telephone key-pad sequences.

I Reduce New Capital Cost

New capital investments for communications can eliminate the need for incremental PBX, IP-PBX, or Key Systems, and voicemail system equipment. Operating budgets can be devised based on actual head count rather than by amortizing equipment over a fluctuating number of employees, enabling finance organizations to better manage their true costs.

The high-tech market research firm, In-Stat/MDR³ forecasts strong growth, about 100% year-over-year, for IP Centrex/Hosted PBX through 2008. In-Stat/MDR has also found that:

1. At the end of 2003, service providers had approximately 40,200 IP Centrex/Hosted PBX seats in service in the United States. Covad (GoBeam) had the largest market share with 32% of the market.
2. The RBOCs' entrance into this market will greatly accelerate overall growth. Both SBC and Qwest launched their service offering in 2004. In-Stat/MDR expects to see the other two U.S. RBOCs Verizon and Bell South to enter the market as well.
3. The current average monthly service for IP Centrex/Hosted PBX is \$65, with \$20 going toward Internet access and \$45 for the voice applications. The estimated average service installation fee is \$175 per seat. In-Stat/MDR believes that these prices will remain relatively consistent during the forecasted period as a result of the overall competitive nature of the IP Centrex/Hosted PBX market.

II Reduced or Eliminated Operating Expenses (OpEx)

Many of the core operating expenses necessary to support a traditional IP PBX, TDM PBX or Centrex environment are eliminated with hosted services such as [16]:

1. *Telephony support staff costs reduced:* Office Administrator (OA) portal allows all service administration functions such as Moves, Adds, and Change (MACs) to be performed for any location, from any location, over the Internet. Basic functions such as MACs, establishing hunt groups and Bridged Line Appearances (BLAs), and managing voice mail and conferencing can be supported by an administrative specialist rather than requiring a telephony professional.
2. *Reduce, or even eliminate, new capital cost:* Eliminate the need for incremental PBX, IP-PBX, or key systems, and voicemail system equipment. As an enterprise grows or contracts, Hosted services sizes immediately to the appropriate scale since operating budgets can be devised based on actual head count.
3. *Reduce voice mail and conferencing costs and complexity:* Eliminate costs of supporting and maintaining multiple disparate voicemail and conferencing systems. (3)Tone Business service replaces multiple systems with one network-based application that has a uniform operating procedure across all enterprise locations. Employees can self-manage conferencing and voice mail features through the PCM (Web-based Personal Communications Manager).

³<http://www.instat.com/>

4. Eliminate costs for Centrex system access and support.
5. Eliminate incremental costs for moves, adds, changes and disconnections.
6. Eliminate reimbursements for communications costs to remote and mobile workers.

IV Case Study: Financial Investment Firm

I Technology Assumptions and Parameter Calculations

In the current section we use Real Options approach in the valuation of our hypothetical enterprise customer. Our hypothetical company is headquartered in downtown New York City along with small office in three other cities: Chicago, Atlanta and Los Angeles. The greater concentration of their fifty strong staff consisted of account executives, project managers, designers, and copy specialists who were full time employees or contract workers.

The projections for the new VoIP Hosted services are that we will be purchasing new telephones sets for the offices. We anticipate that 20% of the sets will have advanced features, most used by administration and senior management, 50% will have a medium set of features and 30% will have basic set of features used in lobbies, copier rooms and general areas.

We assume the backbone carrier is a Voice over IP provider with a robust network infrastructure that has the ability to provide circuits on a virtual private network solution using Quality of Service (QoS) and Priority Queuing of voice traffic within the network infrastructure.

We assume the cost of a voice Primary Rate Interface (PRI) line with 24 channels is \$1,150 per month with an non-recurring one time install charge of \$575. For individual Digital Signal One (DS1) charges we will assume that a fixed price national wide of \$545 per month and a one time install charge of \$350 [16].

Our assumptions in regards to local and long distance use and charges are based on market research. Companies such as Vocaldata and Sylanro have done internal research to provide similar numbers: The number of calls per day per VoIP station is 13, 5 local, 2 intrastate and 7 interstate. The average length of these calls is 3 minutes. We will use a 20 day month resulting minutes per seat per year: 3600 local minutes, 1440 Intrastate and 5040 Interstate minutes. The average call breakdown is 50% Interstate, 15% Intrastate and 35% local calls.

As mentioned earlier capital budgeting is our analysis factor. The required capital expenditure will be to take on hosted managed services VoIP solution with upfront costs for the telephone system and installation or to lease one of the three alternative solutions: Centrex Lease System which includes leasing the phones and system. The Centrex solution is usually leased from a Regional Bell Company, for instance Verizon in New York/ New Jersey area. Second, the IP PBX solution we choose to evaluate is from CISCO systems. CISCO does not sell directly to the enterprise market space. Firms such as Altura and Vertical Networks are Value Added Resellers (VAR) and channel distributors for CISCO. Avaya Networks, although not considered for this evaluation also offers comparable models also sold through the VAR channel. Third, the traditional TDM PBX market was once dominated by Nortel, Lucent and Ericsson from Norway. We have selected to compare the Nortel solution since it was the industry leader in the TDM-PBX market space. Again, similar to the IP-PBX, TDM-PBX has to be leased through a Nortel VAR member. Presidio Communications is one such company in New Jersey. Refer to Appendix 1 for detailed descriptions on software/hardware vendors.

The total capital required to migrate from a non-hosted environment to a hosted environment is broken down into three cost categories: Service costs, associated with the lease of the hardware and software. Phone costs, linked with the purchase or lease of the desktop phones and finally the staffing costs, related with the maintenance, MAC (moves, add, change), upgrade costs and finally the labor costs associated with the maintenance.

In order to provide a framework for the analysis, we choose to use two VoIP models that are available to enterprise corporations in order to evaluate the costs of migrating to VoIP. We used the Nucleus Research VoIP model as one comparison factor and we also used a model developed internally by Level 3 communications to help our Partner channel evaluate the best VoIP solution for their enterprise customers.

We made certain assumptions in our evaluation to perform this analysis. The solution is not a migration, solution but rather an overhaul of the existing solution. We had not considered for any co-existence and any salvage value of the existing system. The solution provided assumes that the data infrastructure is already in place, for instance, there is a private line, Frame Relay, or some type of IP-VPN solution exists. The paper assumes that voice will ride over the same data network but with additional bandwidth. In all cases, we have included in our operational monthly charges, a transport cost associated with additional bandwidth riding over the same data network.

Using the assumptions discussed above; we look at the capital costs associated with each alternative. We calculate the NPV of the project for a 5 year time period. We then use the Derivatives theory to value the option. The value of the option is estimated using the

Black-Scholes option pricing model. The option to purchase provides management the best solution to lease as the best alternative to cost savings in the telecommunications market space.

As far as the option parameters are concerned the following are our realistic assumptions: the value of the underlying asset (S_0) or the current price, is the savings, present value of savings when a Hosted solution is deployed other than the alternative solution (IP PBX, TDM PBX, and Centrex). The investment cost (K) is its strike price, which includes service, phone and staffing costs of the alternative solution. The life of the project is five years relates to the maturity of the option (T). The uncertainty of the underlying i.e., volatility (σ), we look at historical stock price movements of hardware vendor providers (Lucent, Cisco, and Nortel) for the past five years i.e., the life of the project. The range for the above three mentioned companies varied from 47% to 53%. For our analysis we took a value of 50%. The risk-free rate (r_f) is 8% a standard estimate used by many VoIP hosted service providers [16].

I.1 Cost Break Down and Estimates

Table 2 shows the capital costs incurred by each alternative solution for VoIP. These costs show both Capital expenditure (CapEx) and Operational expenditures (OpEx) during the 5 year period. First year costs include installation costs associated with setting up and configuring the solution. These include setup of hardware, software, the telephones on the desks, along with configuring the call manager and voice mail software. We also assume that there is a 10% growth from year to year, we start off with 50 stations and at the end of 5 years we will end with 83 stations.

Table 2: Investment Cost Break Down for Each Alternative

| Year | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | PV (K) |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|
| Hosted | \$45,370.34 | \$42,391.38 | \$44,748.11 | \$46,899.52 | \$49,563.60 | \$172,707.98 |
| Centrex | \$48,385.77 | \$47,421.04 | \$52,474.72 | \$57,558.55 | \$63,338.49 | \$201,244.52 |
| IP-PBX | \$121,272.50 | \$110,401.80 | \$112,175.11 | \$113,480.94 | \$115,440.80 | \$434,956.37 |
| TDM-PBX | \$139,547.26 | \$130,813.23 | \$132,737.34 | \$134,401.13 | \$136,562.92 | \$511,291.39 |

Operational Expenditure

We assume the costs of transport to be fixed charge through the 5 year project. The value of the transport cost will be different in each proposal since the amount of bandwidth required per voice line differs in order to maintain quality of service and hardware constraints. There are no transportation costs in the Centrex model since the Regional Bell Company includes the cost of transport in the total lease price.

The present value of the investment cost (K) for alternative solutions considered are: Hosted Services \$172,707.98, for Centrex Services \$201,244.52, for IP PBX solution \$434,956.37 finally for the traditional TDM PBX solution \$511,291.39 using a discount rate of 10%⁴ for the calculations.

I.2 Savings Projections

Table 3 shows the cost saving of selecting an alternative solution when compared to a Hosted solution. Year 1 costs are higher due to the initial investment in operational costs to install, program desktop phones and associated switches and train the user base. For the TDM and IP-PBX solutions, the costs tend to flatten out with gradual reduction in year 2 since the lease costs of equipment, software and phones will remain fixed for the length of the lease. These expenditure projections allow us to calculate the present value of the future cash flows (S_0) (see figure 3).

Table 3: **Capital Savings Projections Per Solution**

| Year | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | PV (S_0) |
|---------|-------------|-------------|-------------|-------------|-------------|--------------|
| Hosted | \$0 | \$0 | \$0 | \$0 | \$0 | \$0 |
| Centrex | \$3,015.42 | \$5,029.66 | \$7,726.60 | \$10,659.03 | \$13,774.89 | \$28,536.54 |
| IP-PBX | \$75,902.16 | \$68,010.43 | \$67,427.00 | \$66,581.42 | \$65,877.20 | \$262,248.40 |
| TDM-PBX | \$94,176.92 | \$88,421.85 | \$87,989.23 | \$87,501.61 | \$86,999.32 | \$338,583.41 |

II Valuation

The selection of Hosted VoIP services and replacement of current key systems can be considered as a compound option (*option on option*) [23]. For example, enterprise can replace their costly existing solution with Hosted solution (*Option to Switch*) as long as the benefits outweigh costs. Furthermore, enterprise customer can lease the services from the service provider (*option to lease*) i.e., enterprise can eliminate the cost of in-house maintenance by contracting with a third party by paying a fixed fee and only incurring additional cost while activating new features. Venturing into Hosted VoIP services is challenged with uncertainties, technical uncertainty, and market space, interdependency among the equipment players, growth potential and competition from its substitutes. In our case, the opportunity to save in terms of initial investment cost, man power, billing and provisioning is viewed as a portfolio of options. The enterprise customer can take the opportunity to deploy the Hosted VoIP services, expand using the Hosted VoIP services or switch between the alternatives

⁴Level 3 Communications uses 10% interest rate for cash flow comparisons for providing VoIP solutions

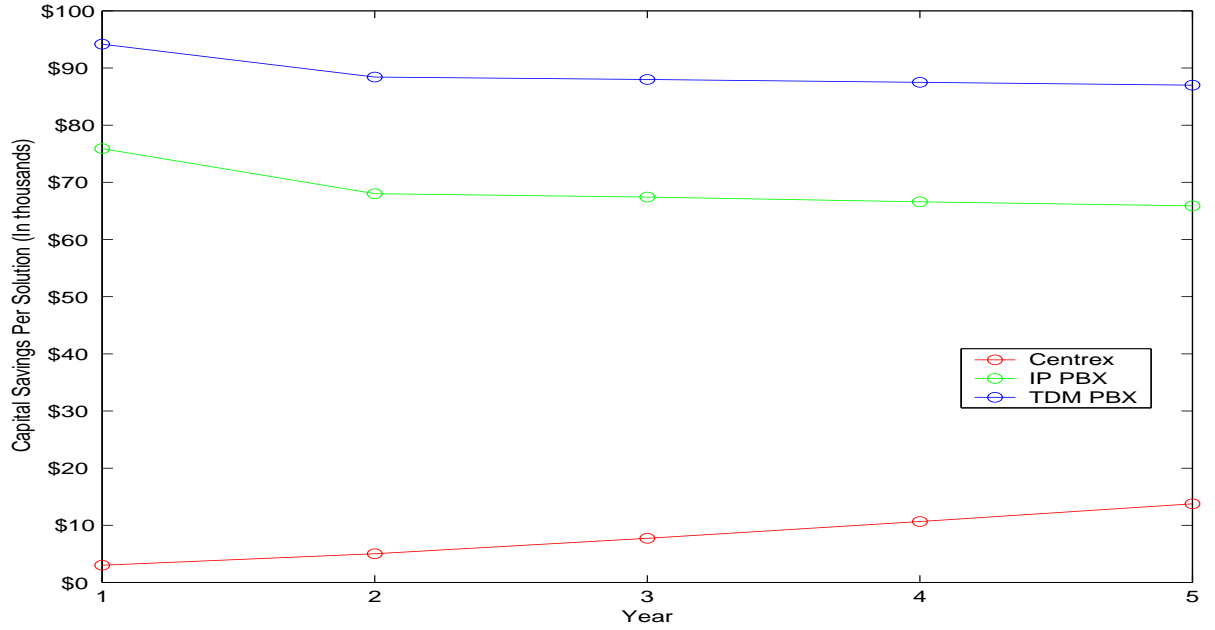


Figure 3: Capital Savings Projections Per Solution

based on cost saving projections. As far as the service provider is concerned it can expand into new market segment offer new features, be first in the market and lead the competition.

In our case, the enterprise wants to select the best solution based on a comparative analysis of Hosted solution with other systems currently available in the market. Revisiting the option parameters, the data in table 2 corresponds to required investment cost (K) in case of each alternative solution. The present value of cost savings from table 3, corresponds to the underlying asset (S_0) for each variable. The life of the project (T) is five years. The annualized standard deviation, i.e., the volatility (σ) equals 50%. The risk-free interest rate (r_f) of 8% corresponding to life of the project. We use the Black-Scholes option pricing formulae to value the options [9]:

$$c = S_0 N(d_1) - K e^{r_f T} N(d_2) \quad (1)$$

$$d_1 = \frac{\ln(S_0/K) + (r_f + \sigma^2/2)T}{\sigma\sqrt{T}} \quad (2)$$

$$d_2 = d_1 - \sigma\sqrt{T} \quad (3)$$

Using (1)we calculate the option value with respect to Hosted VoIP solution. From

Table 4: **Real Option Value**

| Solutions | Centrex | IP PBX | TDM PBX |
|-------------------|----------|-------------|-------------|
| Real Option Value | \$142.28 | \$14,455.21 | \$20,885.93 |

table 4, as we compare the Hosted VoIP solution with alternatives present in the telecommunications market space we observe that the real option value is high when you replace the in-house switching services (IP-PBX and TDM-PBX) with hosted managed solutions. This is also reflected in the cost saving projections (see table 3) savings are higher when customer opts for Hosted solution in comparison to IP-PBX and TDM-PBX solution. Incase of Centrex solution, the value of the option is small; this is because of the scale of deployment, in our case the hypothetical company is a 5-50 user business unit. The option value will make a difference in case of a large scale deployment e.g., Universities, Government agencies.

II.1 Effect of Life of Project (T) on Option Value

We wanted to observe the effects of changing the time parameter when calculating the value of the option price using the Black-Scholes formulae. All other parameters are kept

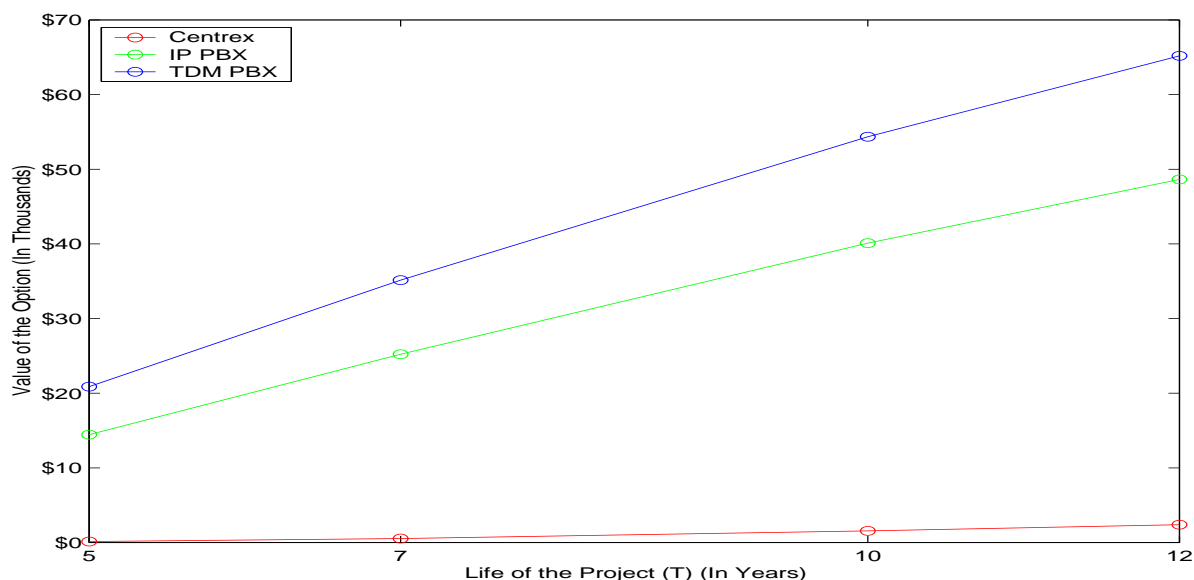


Figure 4: **Effect of Life of Project (T) to Option Value**

unchanged then we randomly selected 4 different values of life of project (T). Figure 4 shows the results on the value of the option when T is modified from 5, 7, 10 and to 12 years. As time increases the value of our option increases as expected. Where there is large value in the option initially changes in T significantly increases the value of the option. This is more prevalent in solutions where there are high NPV values. One reason for the sharp increase is that we are increasing the value of the lease of the capital at the same price point, rather than a reduced price point due to longer lease time.

V Summary and Conclusion

From the evidence provided in this paper Voice over IP (VoIP) is the new frontier in the transition of migrating voice from a Time Division Multiplexing method based on analog signaling to one which is digital and uses a data networking protocol, the IP. Our research shows the adoption rate to VoIP is unfortunately behind the forecasts predicted by research firms in the last five years.

IP is not a new protocol; it is been around for over 30 years and is widely used and accepted as a de-facto standard protocol for data transmission. However, the convergence of voice on the same network as data is a bottleneck for today's players transitioning to a converged voice and data network. Data networking switches and routers are not as robust and scalable as voice switches of the past decade. In one hand, we have capital expenditures made in thousands of dollars for routers and switches compared to the millions of dollars that are spent on voice switches. We have been intuitively programmed to send and receive voice calls without interruption. Performance metrics exceeding 99.999%, the norm standard uptime for voice switches is slowly coming to the data switches; however the price of those switches is also much higher than the data switches generically found in network centers now. By comparison to the voice switches, the data switches are still at least ten times more affordable than the old voice switches.

The core technical change that is bringing voice readily available, is the breakout of the priority network infrastructure that was deployed in the old architecture. The new paradigm is a scaleable decentralized architecture. We have many different companies building specific segments of the complete architecture. Sonus Systems builds the Softswitch boxes, Volcal-Tech builds the routing engines, and however there is still Nortel and Lucent and Siemens that are building the complete all in one box to replace their TDM systems.

The early adopters of VoIP are the small companies with less than 1000 employees, particularly those with less than 100 employees. From our analysis above, we can see that a hosted managed solution is the most cost effective solution for a company engaged in acquiring a new telecommunications solution.

Our assumptions on our comparison are based on a smaller company base of 50. The effect of larger number (over 500 seats) will have a reducing factor on the value of the option, thus it is cost prohibitive for those companies to migrate to a full scale VoIP solution. Companies with over a 1000 employees and those who have already invested heavily in a traditional TDM-PBX will find it cost prohibited to move over so quickly to VoIP.

References

- [1] Alleman, James and Kim, Hak-Ju, "Voice over the Internet: An Application of Real Options", International Telecommunications Conference, Buenos Aires, Argentina, 2-5 July, 2000.
- [2] Alleman, James and Noam, Eli. Real Options: The New Investment Theory and its Implications for Telecommunications Economics. Kluwer Academic Publishers, 1999.
- [3] Alleman, James, "A new view of Telecommunications Economics", Telecommunications Policy, 26, 87-92, 2002.
- [4] Alleman James., Rappoport, Paul., "Modeling Regulatory Distortions with Real Options", The Engineering Economist, 47(4), 390-417, 2002.
- [5] Altura Solutions, Ayava IP-PBX solutions provider, <http://www.alturacs.com/>
- [6] Ayava, <http://www.avaya.com/>
- [7] Broadsoft hosted services provider, <http://www.broadsoft.com/>
- [8] Cisco Systems, <http://www.cisco.com/>
- [9] Damodaran, Aswath, Investment Valuation: Tools and Techniques for Determining the value of Any Asset, Second Edition, Wiley Finance Publishers, 2002.
- [10] Federal Communications Commission (FCC), <http://www.fcc.gov>
- [11] Harmantzis, F. and Tanguturi, Venkata P., "Delay in the Expansion from 2.5G to 3G Wireless Networks: A Real Options Approach", International Telecommunications Society 15th Biennial Conference, Berlin, Germany, 2004.
- [12] Harmantzis F. and Tanguturi Venkata P., "Real Options Analysis for GPRS Network with Wi-Fi Integration", 31st Annual Conference of the Northeast Business & Economics Association, New York, NY, 2004.
- [13] Institute of Electrical and Electronics Engineers (IEEE), <http://www.ieee.org/>
- [14] Kim, Hak-Ju, & Weiss, M., "Strategic Options for Managing Technology Evolution in Wireless Industry", International Telecommunications Society 15th Biennial Conference, Berlin, Germany, 2004.
- [15] Kulatilaka, Nalin., "A Real and Better Option for Valuing Highly Speculative Investments Focus: The 3G Spectrum Auction", Working Paper, 2001.
- [16] Level 3 Voice Services, <http://www.level3.com/>

- [17] Nortel Networks, <http://www.nortel.com/>
- [18] Paxson, Dean and Pinto Helena, “Third Generation Mobile Games - An application of real competition options”, 8th Annual Real Options Conference, Montreal, Canada, 2004.
- [19] Presidio Corporation TDM services Provider, <http://www.presidio.com/>
- [20] Sonus softswitch services, <http://www.sonus.com/>
- [21] Sylantro Systems softswitch services, <http://www.sylantro.com/>
- [22] Tekcetera hosted services provider, <http://www.tekcetera.com/voip.htm>
- [23] Triegeorgis, Lenos., Real Options: Managerial Flexibility and Strategy in Resource Allocation. The MIT Press. 1996.
- [24] Veraz Networks softswitch services, <http://www.veraznetworks.com/>
- [25] Verizon Networks, <http://www.verizon.com/>
- [26] Vertical Networks, total solutions provider, <http://www.vertical.com/>
- [27] Vocaldata hosted services provider, <http://www.vocaldata.com/>
- [28] Vonage voice services, <http://www.vonage.com/>
- [29] Weiss, M., KIm, Hak-Ju, “Voice over IP in the Local Exchange: A Case Study”, 29th TPRC Conference, 2001.

Appendix 1:

The tables show the Vendors selected for comparison and the software/hardware costs associated with each of the solution compared. The data is derived from pricing found on the internet available through resellers and value added dealers:

Hosted Services Costs:

| | | | |
|----------------------------------------|-------------|-----------------------------------|------------|
| Seat Cost (\$20 User per month) | \$1,000.00 | | |
| Voice Mail Charge (\$5 User per month) | \$250.00 | | |
| Phones – 15@\$200, 24@\$250, 10@\$325 | \$12,500.00 | Phone Install Charge (\$75/phone) | \$3,750.50 |

Centrex Costs:

| | | | |
|---------------------------------------|-----------|------------------------------|----------|
| Centrex line per month | \$35.00 | Voice Mail Installation: | \$200.00 |
| Installation per station | \$60.00 | Voice Monthly charge/system | \$275.00 |
| Phones – 15@\$105, 24@\$145, 10@\$215 | \$7350.00 | Voice Monthly charge/mailbox | \$9.50 |

IP-PBX Costs:

| | | | |
|----------------------------------------|------------|---------------------------------------------------------|-------------|
| Cisco ICS 7750 System | \$7817.00 | Phones – 7901 -15@\$225, 7940-25@\$325, 7960 -10@\$569) | \$17,150.00 |
| Cisco Call Manager Software Server 4.0 | \$3,400.00 | Phone Installation | \$4,060.00 |
| Cisco Server User License | \$4,513.00 | Phone Maintenance/year | \$1,875.00 |
| Cisco Unity Voice Mail software 4.0 | \$5699.00 | | |

TDM-PBX Costs:

| | | | |
|-------------------------------------------------|-------------|--------------------------------------|------------|
| Nortel Meridian 1 PBX (TDM or traditional PBX) | \$12,600.00 | Phones (15@\$99, 25@\$199, 10@\$309) | \$9,550 |
| Option 11C main cabinet, software release 25.08 | \$3,400.00 | Phone Installation | \$5,081.00 |
| Other equipment, /Meridian Mail voice rel 13 | \$10,600.00 | Phone Maintenance/year | 7 |
| | 0 | DS1 (setup - \$350) | \$2,046.6 |
| | | | 5 |
| | | | \$545.00 |

Appendix 2, 3 4, and 5:

Appendix 2, 3, 4 and 5 show the cash flow reports of Hosted Services, Centrex, IP-PBX, and TDM-PBX solution for a five year period. The cash flow reports show the breakdown of total expenditure in terms of capital expenditure (CapEx), nonrecurring expenditures, and recurring operational expenditure (OpEx) for all the four solutions considered in the analysis.

Appendix 2: Hosted Services Data

Hosted Services

| | <i>Year 1</i> | <i>Year 2</i> | <i>Year 3</i> | <i>Year 4</i> | <i>Year 5</i> |
|-----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| <u>1. Capital expenditures</u> | | | | | |
| System (purchase) | \$0 | \$0 | \$0 | \$0 | \$0 |
| Stations (purchase) | \$13,750 | \$1,500 | \$1,750 | \$1,750 | \$2,000 |
| System & stations (lease) | \$2,791 | \$2,791 | \$2,791 | \$2,791 | \$2,791 |
| <i>Total, capital expenditures¹</i> | <i>\$2,791</i> | <i>\$4,291</i> | <i>\$4,541</i> | <i>\$4,541</i> | <i>\$4,791</i> |
| <u>2. Other nonrecurring expenditures</u> | | | | | |
| System installation / service activation | \$1,925 | \$210 | \$245 | \$245 | \$280 |
| Per-station installation | \$3,080 | \$336 | \$392 | \$392 | \$448 |
| Transport installation | \$1,050 | \$0 | \$0 | \$0 | \$0 |
| <i>Total, other nonrecurring expenditures</i> | <i>\$6,055</i> | <i>\$546</i> | <i>\$637</i> | <i>\$637</i> | <i>\$728</i> |
| <u>3. Recurring operational expenditures</u> | | | | | |
| Transport | \$19,620 | \$19,620 | \$19,620 | \$19,620 | \$19,620 |
| Per-station charges for services | \$14,924 | \$15,738 | \$17,502 | \$19,401 | \$21,436 |
| Maintenance | \$0 | \$0 | \$0 | \$0 | \$0 |
| MACs | \$0 | \$0 | \$0 | \$0 | \$0 |
| Supporting IT/telecom staff | \$0 | \$0 | \$0 | \$0 | \$0 |
| Remote employee telecom reimbursements | \$0 | \$0 | \$0 | \$0 | \$0 |
| Local/toll voice calls | \$1,980 | \$2,196 | \$2,448 | \$2,700 | \$2,988 |
| <i>Total, recurring operational expenditures</i> | <i>\$36,524</i> | <i>\$37,554</i> | <i>\$39,570</i> | <i>\$41,721</i> | <i>\$44,044</i> |
| <u>4. Total expenditures</u> | | | | | |
| Per station | \$825 | \$695 | \$658 | \$625 | \$597 |

¹ The total, capital expenditures for year 1 shows the cost for leasing the systems and stations.

Appendix 3: Centrex Solution Data

Centrex

| | <i>Year 1</i> | <i>Year 2</i> | <i>Year 3</i> | <i>Year 4</i> | <i>Year 5</i> |
|---------------------------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| <u>1. Capital expenditures</u> | | | | | |
| System (purchase) | \$0 | \$0 | \$0 | \$0 | \$0 |
| Stations (purchase) | \$8,085 | \$882 | \$1,029 | \$1,029 | \$1,176 |
| System & stations (lease) | \$1,641 | \$179 | \$209 | \$209 | \$239 |
| <i>Total, capital expenditures²</i> | <i>\$1,641</i> | <i>\$1,061</i> | <i>\$1,238</i> | <i>\$1,238</i> | <i>\$1,415</i> |
| <u>2. Other nonrecurring expenditures</u> | | | | | |
| System installation | \$200 | \$0 | \$0 | \$0 | \$0 |
| Per-station installation | \$3,300 | \$360 | \$420 | \$420 | \$480 |
| Transport installation | \$0 | \$0 | \$0 | \$0 | \$0 |
| <i>Total, other nonrecurring expenditures</i> | <i>\$3,500</i> | <i>\$360</i> | <i>\$420</i> | <i>\$420</i> | <i>\$480</i> |
| <u>3. Recurring operational expenditures</u> | | | | | |
| Transport | \$0 | \$0 | \$0 | \$0 | \$0 |
| Per-station charges | \$23,100 | \$24,360 | \$27,090 | \$30,030 | \$33,180 |
| Voice mail | \$9,570 | \$9,912 | \$10,653 | \$11,451 | \$12,306 |
| Maintenance | \$0 | \$0 | \$0 | \$0 | \$0 |
| MACs | \$2,406 | \$2,669 | \$2,975 | \$3,281 | \$3,631 |
| Supporting IT/telecom staff | \$0 | \$0 | \$0 | \$0 | \$0 |
| Remote employee telecom reimbursements | \$0 | \$0 | \$0 | \$0 | \$0 |
| Local/toll voice calls | \$5,610 | \$6,222 | \$6,936 | \$7,650 | \$8,466 |
| Voice conference calling | \$2,558 | \$2,837 | \$3,163 | \$3,488 | \$3,860 |
| <i>Total, recurring operational expenditures</i> | <i>\$43,244</i> | <i>\$46,000</i> | <i>\$50,817</i> | <i>\$55,901</i> | <i>\$61,444</i> |
| <u>4. Total expenditures</u> | <i>\$48,386</i> | <i>\$47,421</i> | <i>\$52,475</i> | <i>\$57,559</i> | <i>\$63,338</i> |
| Per station | \$880 | \$777 | \$772 | \$767 | \$763 |

² The total, capital expenditures for year 1 shows the cost for leasing the systems and stations.

Appendix 4: IP PBX Solution Data

IP-PBX

| | <i>Year 1</i> | <i>Year 2</i> | <i>Year 3</i> | <i>Year 4</i> | <i>Year 5</i> |
|-----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| <u>1. Capital expenditures</u> | | | | | |
| System (purchase) | \$17,147 | \$0 | \$0 | \$0 | \$0 |
| Stations (purchase) | \$18,865 | \$2,058 | \$2,401 | \$2,401 | \$2,744 |
| System & stations (lease) | \$7,311 | \$7,311 | \$7,311 | \$7,311 | \$7,311 |
| <i>Total, capital expenditures³</i> | <i>\$7,311</i> | <i>\$9,369</i> | <i>\$9,712</i> | <i>\$9,712</i> | <i>\$10,055</i> |
| <u>2. Other nonrecurring expenditures</u> | | | | | |
| System installation | \$13,070 | \$747 | \$871 | \$871 | \$996 |
| Per-station installation | \$0 | \$0 | \$0 | \$0 | \$0 |
| Transport installation | \$1,725 | \$0 | \$0 | \$0 | \$0 |
| <i>Total, other nonrecurring expenditures</i> | <i>\$14,795</i> | <i>\$747</i> | <i>\$871</i> | <i>\$871</i> | <i>\$996</i> |
| <u>3. Recurring operational expenditures</u> | | | | | |
| Transport | \$41,400 | \$41,400 | \$41,400 | \$41,400 | \$41,400 |
| Per-station charges | \$0 | \$0 | \$0 | \$0 | \$0 |
| Maintenance | \$5,265 | \$5,565 | \$5,916 | \$6,267 | \$6,669 |
| MACs | \$3,369 | \$3,736 | \$4,165 | \$4,594 | \$5,084 |
| Supporting IT/telecom staff | \$45,000 | \$45,000 | \$45,000 | \$45,000 | \$45,000 |
| Remote employee telecom reimbursements | \$0 | \$0 | \$0 | \$0 | \$0 |
| Local/toll voice calls | \$3,366 | \$3,733 | \$4,162 | \$4,590 | \$5,080 |
| Voice conference calling | \$767 | \$851 | \$949 | \$1,047 | \$1,158 |
| <i>Total, recurring operational expenditures</i> | <i>\$99,167</i> | <i>\$100,286</i> | <i>\$101,592</i> | <i>\$102,898</i> | <i>\$104,390</i> |
| <u>4. Total expenditures</u> | | | | | |
| | \$121,273 | \$110,402 | \$112,175 | \$113,481 | \$115,441 |
| Per station | \$2,205 | \$1,810 | \$1,650 | \$1,513 | \$1,391 |

³ The total, capital expenditures for year 1 shows the cost for leasing the systems and stations.

Appendix 5: TDM PBX Solution Data

TDM-PBX

| | <i>Year 1</i> | <i>Year 2</i> | <i>Year 3</i> | <i>Year 4</i> | <i>Year 5</i> |
|-----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| <u>1. Capital expenditures</u> | | | | | |
| System (purchase) | \$18,900 | \$0 | \$0 | \$0 | \$0 |
| Stations (purchase) | \$10,505 | \$1,146 | \$1,337 | \$1,337 | \$1,528 |
| System & stations (lease) | \$5,970 | \$5,970 | \$5,970 | \$5,970 | \$5,970 |
| <i>Total, capital expenditures⁴</i> | <i>\$5,970</i> | <i>\$7,116</i> | <i>\$7,307</i> | <i>\$7,307</i> | <i>\$7,498</i> |
| <u>2. Other nonrecurring expenditures</u> | | | | | |
| System installation | \$10,672 | \$416 | \$485 | \$485 | \$555 |
| Per-station installation | \$0 | \$0 | \$0 | \$0 | \$0 |
| Transport installation | \$1,050 | \$0 | \$0 | \$0 | \$0 |
| <i>Total, other nonrecurring expenditures</i> | <i>\$11,722</i> | <i>\$416</i> | <i>\$485</i> | <i>\$485</i> | <i>\$555</i> |
| <u>3. Recurring operational expenditures</u> | | | | | |
| Transport | \$61,020 | \$61,020 | \$61,020 | \$61,020 | \$61,020 |
| Per-station charges | \$0 | \$0 | \$0 | \$0 | \$0 |
| Maintenance | \$4,299 | \$4,466 | \$4,662 | \$4,857 | \$5,081 |
| MACs | \$3,369 | \$3,736 | \$4,165 | \$4,594 | \$5,084 |
| Supporting IT/telecom staff | \$45,000 | \$45,000 | \$45,000 | \$45,000 | \$45,000 |
| Remote employee telecom reimbursements | \$0 | \$0 | \$0 | \$0 | \$0 |
| Local/toll voice calls | \$5,610 | \$6,222 | \$6,936 | \$7,650 | \$8,466 |
| Voice conference calling | \$2,558 | \$2,837 | \$3,163 | \$3,488 | \$3,860 |
| <i>Total, recurring operational expenditures</i> | <i>\$121,856</i> | <i>\$123,282</i> | <i>\$124,946</i> | <i>\$126,609</i> | <i>\$128,511</i> |
| <u>4. Total expenditures</u> | | | | | |
| | \$139,547 | \$130,813 | \$132,737 | \$134,401 | \$136,563 |
| Per station | \$2,537 | \$2,144 | \$1,952 | \$1,792 | \$1,645 |

⁴ The total, capital expenditures for year 1 shows the cost for leasing the systems and stations.