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THE UTILITY'S ROLE IN THE
FUTURE OF PC SERVICES
AND THE NII

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FINAL REPORT

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(Formerly Known as CSW Communications)

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Executive Summary

The following paper is a report by C3 Communications (formerly CSW Communications) summarizing the experience and lessons learned during an 18 month Department of Energy Grant to evaluate how electric utilities can further the growth of the NII by developing a hybrid Internet - energy management service. In addition, the project was also expanded to include evaluation of residential gateway issues, in particular the energy management aspects of this developing area.

The report is broken up into three sections, the first section focuses on the issues surrounding the start-up of a traditional ISP and provides a road map for utilities interested in this area. The second section provides an overview of the Internet energy management projects which were undertaken and the key lessons learned from each. Lastly, the third section outlines the gateway progress made during the grant and provides some of the recommendations which the work produced.

For a utility interested in any of these areas, this grant report provides a wealth of information. The report produced here is a culmination of efforts from C3's grant team, the Department of Energy and technical team members from Los Alamos National Labs. C3 wishes to thank all of the above for their contribution to this effort.

Introduction

The grant was performed over 18 months. The majority of the work was performed in Laredo, Texas at C3 Labs (C3 communications advanced energy management technology laboratory). Included in the grant were C3 Communications, the Department of Energy and Los Alamos National Labs. The role of each is outline below:

Roles

CSW Communications

- Project management
- Access to customers and broadband network
- Installation of Internet Point-of-Presence (POP) and required customer premise equipment
- Operation of Internet service provider POP
- Development of Internet energy management applications
- Market research and analysis of response and value of services provided
- Analysis report of results and recommendation to DOE

Los Alamos National Labs

- Technical assistance in setting up Internet service provider POP
- Assistance in solving security and authentication requirements of Internet transactions
- Review/analysis of home LAN technical architecture
- Assist with Internet training for schools and libraries, etc.

Department of Energy

- Funding for Internet service provider POP, required access tolls, customer premise equipment, and other related costs
- Project guidance

The underlying theory of this project was that by re-engineering existing platforms and extending existing services to take maximum advantage of the Internet as a medium, an energy management driven NII could significantly add to the competitiveness and viability of smaller metropolitan areas. In addition, by giving public schools/libraries access to information technologies and the Internet, the educational levels of students in these areas could be kept abreast with students in more affluent and larger metropolitan areas.

A related goal of the project was to test the impact that both advanced energy management and high-speed broadband access have on the desirability and success of traditional "dial-up" Internet access when provided by an electric utility.

Phases

The Grant and covered three distinct and separate research areas.

Phase One entailed setting up and operating a fully functional ISP POP in Laredo, Texas. In addition, the grant also set up a MAP or Metropolitan Access point and provided Internet access to several schools and businesses in the Laredo metro area. The ISP was fully functional and provided services for as many as 300 individuals and several businesses. It was staffed with technicians and customer service representatives to provide day to day support and operations. In addition, the concept of ISP "Hoteling" was trialed in the last 6 months of the grant and a secondary ISP was setup on the same equipment to test the viability of two ISP's sharing the same terminal infrastructure. Phase one of the report will attempt to guide the reader through all of the intricacies and lessons learned associated with designing and running an Internet service provider.

Phase Two involved research in the area of Internet-based energy management. We set up and trialed a wide variety of hardware and software products that performed various energy management functions. These products ranged from a hardware-based energy management devices like Intellinet and WebIO to software solutions like Savoy Cyberhouse. This area of research is one where we succeeded in learning a tremendous amount of information concerning Internet Energy Management.

Phase Three was an effort to examine and understand the implications of the residential gateway concept and to try and design on paper the functions of a gateway and how it might service the consumer and the energy provider. Several brainstorming sessions were held with scientists from Los Alamos National Laboratory, San Diego Gas and Electric and C3 Communications personnel. A paper was the result of these sessions and a presentation was made by C3 at the Park's Conference on Residential Gateways in May, 1997. The information from the sessions was also turned over to a standards committee on Residential Gateways (EIA TR41.5) for inclusion into their standardization efforts.

Phase One

Overview

Phase one of the research was the design, setup and operation a fully functional Internet Point of Presence (POP). This section will describe this effort in the following subsections:

- POP Architecture
- Operations Overview
- Operations Manual
- Customer Support
- Network Management/Fault Management
- Customer Site Issues
- Billing

POP Architecture

The initial efforts were in the area of design. The core router chosen was a Cisco 4700 with 4 T-1 ports and two Ethernet ports. This router proved to be very flexible and allowed us to assign IP network numbers to each port as needed. Since part of the objective was to hook up C3's HFC network and cable modems to the Internet, this allowed us to assign a separate network number to the cable modem network and maintain it separately from the dial-up numbers. The modem terminal device was an Ascend 4004 with a complete set of digital/analog modems. This gave the dialup a capacity of 92 incoming calls on four separate PRI trunks. The PRI's were separated into two hunt groups. The first group was for dynamic access and encompassed 3 spans and the 4th PRI was used for ISDN business accounts that were permanently nailed-up. In addition to the Cisco router and Ascend terminal server, we used ADC/Kentrox CSU/DSU's to connect the T-1's. ADC's CSU shelf was used which gave us the gross capacity of 12 T-1 circuits. The shelf also allowed us to keep an extra CSU/DSU on hot backup in case of failure.

Web servers were two Pentium Pro 200 MHz industrial rack mount computers. Each had 128 MB of RAM and a 2-gig boot drive. Initially one was configured as a mail server and DNS server and one was setup as a Web server. The web server had an 8-gig RAID 5 array and was also used as storage for all files and documents. The machines were backed up by a 4mm DAT and backups were performed daily. This configuration used Microsoft Windows NT4.0 as the OS and these machines provided all services as well. The goal of using the Microsoft product as a turnkey POP was to test the viability and ease of use of this operating system. We surmised in the beginning that it would be significantly easier to find talent to maintain these machines as compared to an all UNIX POP.

The mail package we chose was Post.Office from Software.com. We were impressed by the ease of use of this product and the configuration was from a browser. This mail package performed flawlessly through the entire project and while we felt the price was a little steep (you pay by the number of users) the performance and reliability were superb.

Operations Overview

Random failures led us to the conclusion that if we were going to maintain a 24/7 Internet service we were going to need to set up some sort of network monitoring/failure alerting mechanism. This search led us to a product from IpSwitch called "What's UP!". "What's UP!" was a network monitoring package that ran on NT or Win95 and monitored all aspects of Internet operation. It monitored Mail, DNS, Ftp, Http and a variety of other critical services such as routers and terminal servers. Upon a failure the machines would pickup the phone and page the technician on call as well as other people on the list. This package was incredibly efficient and somewhat inexpensive for the job it performed. While it did not have network management functions, it did an excellent job of monitoring the core services and alerting technicians when the system was experiencing a problem. This made our service much more reliable and allowed us to track and pattern any failures.

In addition, to improve reliability we decided to move core ISP functions over to a SUN Sparc 5. We set up primary DNS and Mail on the Sun under Solaris 2.4 and our reliability factor went up considerably. As a fact we NEVER experienced an unplanned DNS outage through the rest of the project. The Web server performed fine under NT and IIS, and while we did experience a few anomalies in the HTTP server it was nothing like the previous failures.

During the first six months we ran the control service RADIUS on the NT platform for permissioning users to dial-in to the network. RADIUS is a standard that most of the ISP's of today use to maintain user lists and passwords. RADIUS ran fine on NT but when we switched our core ISP services to Solaris, we also moved RADIUS to the UNIX platform as well.

Our opinion was that while NT was the best platform for our purposes of web serving and the training of operators, UNIX is the best platform for core services like DNS and RADIUS. Later we set up a Sun Sparc2 as a backup machine and by running the Sun Solstice client on the NT boxes, we were able to backup the Solaris boxes as well as the NT boxes.

Besides providing dial-in access and cable access, the POP was the MAP (metropolitan access point) for the local college. Laredo Community College did not have Internet access when we started the project and we provided them with a Cisco 2500 series router and T-1 access to the Internet. In addition, we provided them with several Ascend Pipeline 50 model routers and allowed them to connect remote campus locations through our Ascend 4004. This, in effect, served as a WAN for the

University and allowed the connection of remote buildings to the main Internet connection. We also helped them set up an Email server and trained their personnel on the care and maintenance of the system. In addition, we consulted with them on a wireless T-1 link and one of our technicians helped with the install and tuning. The T-1 we provided served 80 workstations in two separate computer labs. This service allowed the Laredo MAP to serve as an aggregation point for the entire city and after the conclusion of the research, one of the ISP's involved in the Hoteling project has taken over the operation of the MAP and provides service to the College.

Operations Manual

We knew if we were going to establish a first-class ISP, it would be imperative to establish standards that, if enforced, would ensure smooth operation and superior customer service. We established these standards in writing and created an operations manual. This manual will be available on C3's Web site (WWW.c3com.com) as an appendix to this report. The manual helped us enforce these predefined standards and told the system operators what to do in any given situation hence, ensure smooth operation.

When we wrote the manual we already had the POP up and running. Most all of the equipment was configured and working properly. All that was needed on a daily basis was to maintain the servers and equipment as our customer base grew. We had already tested different software and platforms for core services and had decided that Unix was the best platform for core (DNS & Mail) services and NT was best for WWW services. Our next step was to analyze the main functions a system operator was to perform in order to maintain the POP. We narrowed the functions of a system operator to two main categories. The first category was domain hosting. An ISP often hosts a domain for a business or an individual. This involves several phases of configuration such as registering the domain, binding an IP to a network card, entering DNS information, and setting up virtual web servers. The second category was connection maintenance and installation. Our customers can connect to our services at various connection speeds and with different equipment. The setup and configuration of these services varies depending on the equipment.

Since both of these services can involve configuring e-mail accounts, we thought it best to point our system operators to the web site for the software package that we were using since it contained concise information on handling e-mail accounts and hosting e-mail domains.

A brief listing of the major subheadings in the Implementation Manual follows.

Domain Hosting

- Domain Name Availability
- IP Addressing
- DNS
- Creating Client WWW and FTP Directories
- Creating Virtual Web Roots.

Connection

- Dial-up
- ISDN
- T1

We also added several other reference sections to the Operations Manual. We added what we called an IP Bible and an IP Map. The IP Bible defined the varying subnetting schemes in CIDR format. This information was used when configuring ISDN modems/routers, T1 routers, or an account that called for a static IP. The IP Map was a listing of all of our Class C IP's and the machine/router each IP was assigned to. Any additions or omissions were documented on the IP Map. This template was also given to our ISDN or T1 customers. This template enabled them to keep track of their IP usage. Additionally, web sites were bookmarked or added to the manual explaining a process or function, such as CIDR format definitions.

In the long run this manual was one of the better investments in time we made. We were able to give this manual to our system operators, and they were able to maintain the POP with virtually no problems. Setting up web sites and entering customer information was done in a very efficient and timely manner as operators had an excellent reference for setting up and maintaining the aforementioned. Additionally, the operators were able to add in some sections to the manual. When a more efficient process was discovered it was documented and incorporated into the manual for reference. Most of our day to day functions were documented in this manual and updated in this way. What proved especially helpful were the various tables and appendixes that the manual contained. These served as quick reference guides and enabled pointed reaction to requested customer services.

If anyone is considering getting into the Internet as a business, the operations manual in the appendix will be a very good and current reference as to what needs to be done day-to-day. In addition, an HTML version is available on our website. This may be browsed or searched for the answers or the entire manual can be downloaded in Microsoft Word97 format or HTML.

An operations manual is one of the best investments in time and money you can make. It not only will save you time training new employees, it will also speed up customer service requests and make for a more efficient organization.

Customer Support

Overview

Customer support is THE key to a successful and respected ISP. Some customers select an ISP based on customer support alone. In order to provide good customer support, a plan has to be implemented that gives the customer the level of support expected and yet does not unduly over-utilize technician's time. This section documents some of the options available to an ISP and what we chose as a solution.

Options

Help Desk Line /CSR/Help Desk

Help Desk lines are an excellent means of maintaining high quality customer support. Customers can be given a phone number that can be used for service inquiries or service problems. This line should be staffed by capable service representatives which can handle most customer inquiries or problems. If they are unable to answer or help, and then they would transfer the customer to a capable representative or systems operator. Usually, most small to medium size ISP's have a help desk staffed with customer service representatives whose sole job is to handle customers. The hours of the help desk vary and the norm among most ISP's is to have the help desk operate from early morning to night and have a messaging service that can be used to contact the customer the next day.

Call Center

Another means for high quality customer support can be achieved by having a call center, this is similar to a help desk only larger. Call centers are usually staffed 24 hours/ 7days a week. Accessibility to these services is typically much higher and some ISP's outsource this service to a qualified call center. Others have their own call center with qualified customer service representatives. There are several software packages available, which can help a call center or help desk track customer inquiries and problems. Such packages indicate the status of a service call, who handled the call, and when or how it was resolved. In a large ISP where you have a high volume of customer support calls, this is the only way to effectively monitor and track support issues and not let customer problems "fall through the cracks".

Grant Approach

Our solution was to setup a small help desk. We gave each of our customers a phone number to call whenever they had questions or experienced problems. This line had a voice mail system attached that would page a CSR when a customer left a message. Generally, a customer service representative would be there from 8:00AM -6:00PM. The paging feature worked 24 hours / 7days a week. One of the advantages of this set up was that all customer calls were handled on the same day a customer called. In addition, each CSR had a permanent Internet connection at home and could access the operations manual via the website and generally solve most customer issues within a few minutes of the center receiving the call.

We found the bottom line to running a successful ISP business was customer service. Taking care of your customers will keep them satisfied and they will in turn help by telling others about the quality of service they receive.

This was one of the areas that also needs careful scrutiny as far as budgeting is concerned. It is VERY DIFFICULT to find pleasant, knowledgeable employees that enjoy helping others. A help desk can be one of the more expensive budgetary items in running an ISP but without a GOOD one you WILL lose customers.

Network/Fault Management

The following section addresses the network management issues associated with running an ISP - what was done and what was learned.

Upstream Provider

- Our upstream provider was the Digital Design Company (DDC) of San Antonio, Texas. DDC is a tier 2 Internet provider with POPs in most of the large cities in Texas and has an Autonomous System (AS) that has multiple T-1 connections to Sprint and MCI and runs BGP4 for best route selection. This makes for a very fault tolerant system that gave us very high "uptime". Sometimes we did experience service problems and most of the time it was due to a telco problem or a "backhoe created airgap". The transport provider would restore this within a few minutes and most service interruptions were never very long. In addition, DDC supported us on routers, ISDN modems, and the MAX 4004 for our modem pool. DDC was helpful and extremely knowledgeable in these issues and was available 24/7 via cell phone and pager.

Equipment

- Most of the equipment was state of the art so we experience no major failures during the 18-month period. Once the core services stabilized around the Unix/Solaris platform our service failure rate went to zero. The Sun Sparc series is one of the most reliable platforms to work off of and we were very pleased with the performance and reliability. While we had backup hardware on the shelf, we never used it. All in all, the equipment chosen was very reliable and performed as expected.

Telco Contact

- We made a list of contacts that we could use whenever we faced problems with ISDN or T1 lines. There were local contacts and phone numbers to a help desk in San Antonio. There were even numbers to call if we experienced problems at night or on the weekend. Additionally, we had a sales contact which we often referred our customers to or that we would call for pre-sale help.

Contract Agreements

- We established servicing contracts with hardware/software vendors. With these we could call a help desk or information center and get help on the issues at hand.

Backup/Recovery Plan

- Back-up is crucial, we devised a plan that would backup all of our crucial system files. We were able to back-up multiple boxes and multiple platforms. We used Windows NT Backup, the utility that comes with Windows NT to backup all of our servers onto an 8mm-dat drive. We then acquired Solstice Backup from Sun. We used it to backup our Sun servers and continued to use NT backup for our Windows-based servers/workstations. When any of our systems would crash, we would restore the whole system or the suspected files. We did restore our core Unix server once.

Having an operations plan with resources to call on when trouble is experienced is the critical link for minimizing service interruptions and ensuring customer satisfaction. The more you plan and prepare, the better you will be able to respond when problems occur. We found that for extremely critical elements, (routers, CSU's and hard drives) it was better to keep hot spares in the rack or on the shelf. For other items we maintained minimum level support contracts that guaranteed service and parts within a specified number of hours. If your business is to keep a network available for customers 24x7x365 then every effort must be done to ensure that you have parts and spares on hand for the inevitable failure.

Customer Site Issues

Introduction

Customers with high connection speeds required special attention. Usually, these customers had high-end equipment that allowed them faster access to the Internet. We faced many issues when extending high connection speed services to our clients. Such issues included who should buy this equipment, where to put the equipment and who should maintain the equipment. We, as an ISP, had to have answers or suggestions for these issues.

Customer Premise Equipment

Customers who had equipment on site were typically ISDN and T1 customers. We provided Ascend ISDN routers and Cisco routers for our customers. We configured, setup, and maintained any equipment that we provided.

Telephone Line

Once a customer decides that they need high speed access to the Internet and that they want to use you as a service provider, the next step is ordering the telephone service

line. It is usually the customer that should order the line especially if it is a T1 line. The reasoning is that the line is ultimately the customer's. We would offer advice and offer to order the line for the customer, though.

If the service is T1, the telephone company will want access to the main demarcation point which provides the customer with telephone service. At times the demarcation point may be a distance away from where the servers and machines are. Hence an extended demarcation point needs to be installed. This can be added dollars to the initial installation fee. Thus, location of the demarcation for T1 connections is an issue. For ISDN lines (BRI - Basic Rate Interface), demarcation is not an issue, but rather the issue is where would the customer want the phone line to be placed. This is typically in a machine or computer room where access is limited to administrators and operators.

Routers

The customer can buy the router or the service provider can. Leasing is an option that both ISPs and customers can consider. Ultimately, it would be wise to let the ISP recommend a router. This enables fast set up and ensures proper maintenance, as the ISP has familiarity with the equipment.

Installation

Once the lines and equipment were delivered, our technicians would go onsite and help during the installation process. For T1 lines this often involved the telephone company. For ISDN lines, having the telephone company's number in hand is a good idea. Equipment placement quickly becomes an issue. We found it helpful to go onsite before installation time to discuss with customers where they are planning to put the equipment. We often would give them our input and advice. We always would recommend that the equipment be placed where only limited personnel could enter. In schools, we found it best to keep it away from areas where students could have easy access to.

Maintenance

When it came to maintenance, we opted to maintain the equipment. As mentioned earlier, we recommended that the equipment be placed in a restricted area. This being the case, we found that when we had to go onsite we had problems accessing these restricted areas. This would increase downtime. We mostly tried to maintain the equipment remotely, but there were times when onsite maintenance could not be avoided.

Billing

Introduction

Internet billing systems are an integral part of an Internet service provider for more reasons than providing a billing platform. Internet billing systems can also help one run the operation more efficiently and gather important data to help one better understand the market. The billing systems on the market today range from low cost systems that provide basic billing functions to very expensive systems that integrate with an ISPs' core software infrastructure to provide a more efficient way to conduct business. These products are able to configure hardware, add and manage accounts in both the billing and service systems from one interface, track usage, and group subscribers by demographic profiles aside from the billing functions. In this capacity the billing system becomes the common tie for every aspect of the business. As part of our evaluation for ISP operations we tested 3 billing systems based in these criteria:

Billing Feature Set

- Usage Based Billing
- Flat Rate Billing
- Credit card transactions
- Account Maintenance
- Integration

Performance

- Data Access Speeds
- Reliability
- Accuracy
- Scalability

Price

These features are ranked on a scale from 1 to 10 based on how well we felt they the performed in each category.

Product One

Product 1	44
Billing Feature Set	26
Usage Based Billing	5
Flat Rate Billing	8
Credit card transactions	9
Account Maintenance	3
Integration	1
Performance	18
Data Access Speeds	3
Reliability	4
Accuracy	5
Scalability	6

Price \$5,000 for 1000 accounts

This product could be used with either an MS Access or MSSQL database back end. We chose to configure it with MSSQL. Installation and setup of this product was fairly straightforward. All of the SQL scripts required to build the database were included with the distribution and the instructions were very thorough. The installation was distributed on a pair of Pentium Pro 200 Mhz (128 MB ram) machines. One was used as the SQL server and the other had the application installed itself. The connection to the database was done over an ODBC connection.

As we began using the software it became increasingly apparent that as we added new accounts data access was becoming rapidly slower. Adding accounts was fairly fast but in order to query the database and pull records we were having to wait up to 30 seconds for the results to appear. This was with no more than 100 records in the database. This was very difficult to deal with for a CSR while a customer was on the line as well as taking that much longer to get to the next customer.

In addition, this system was not able to integrate into our core services as an ISP. This meant that synchronization between RADIUS authentication, mail accounts and billing accounts were all done manually. This approach left room for human error and if an account was not synchronized correctly the bills for that account were not generated correctly and in most cases crashed the billing operation.

At billing time, billing of the flat rate customers was easily generated. All that was required was a command from the user interface and the users would be billed according to their flat rate pricing plan. Generation of usage-based bills was somewhat more laborious. Since the software did not integrate with RADIUS, a batch process was required to import RADIUS usage log files into the database and then generate bills. The batch process typically took hours, utilized a large amount of system resources and frequently crashed even if the billing and RADIUS accounts were synchronized correctly.

As time went on we discovered a licensing issue with this product. At one point we found that even though we had only 75 active accounts in the system we only had licenses for 800 more on a 1000 user licensed copy of the software. We discovered that the software license was based on the total number of records in the database, whether they were active or inactive. To actually gain the licenses back from inactive users you would have to remove them from the database completely. This results in a loss of historical data as well as more labor involved with the process. The only way around this was to pay for more licenses, which meant that every time you sign a customer on you incur an equal incremental cost whether that person stays with you 5 years or 5 minutes.

Product 2

Product 2	49
Billing Feature Set	34
Usage Based Billing	5
Flat Rate Billing	8
Credit card transactions	9
Account Maintenance	5
Integration	7
Performance	15
Data Access Speeds	3
Reliability	4
Accuracy	7
Scalability	6

Price \$1,495 for 500 accounts

Although this product was still in beta when we tested it, we found that in a few ways showed more promise than the first. The installation of the software was again distributed across the same Pentium Pro 200 Mhz (128 MB ram) machines and again one was configured as the SQL server while the other had the application installed connecting over ODBC.

Because of the similar architecture we found many of the same data access problems as the first, although this product did integrate with NT-RADIUS and "Post.Office" mail server software. This meant a one-stop shop for the creation of customer accounts as well as an easier usage-based billing process.

This brings us to the issue of platform stability. Although this billing system showed promise in its functionality, Windows NT did not prove itself to be a suitable platform for our core service architecture. We experienced problems with NT-RADIUS as well as Post.Office running on Windows NT. We had multiple unexplained situations where each of them crashed, requiring a total reinstall of the software and restoration of backups to recover. This was also the case with NT-DNS. As we moved our core services over to Solaris, we found that these services were much more stable.

Product 3

Product 3	83
Billing Feature Set	46
Usage Based Billing	9
Flat Rate Billing	10
Credit card transactions	9
Account Maintenance	8
Integration	10
Performance	37
Data Access Speeds	8
Reliability	10
Accuracy	9
Scalability	10

Price \$25,000 for 100 accounts

This product by far was our product of choice. Based on Sun Solaris and Sybase (with an Oracle port in the works), this product was extremely powerful. The installation of this system was performed by the vendor and was about a two-day process. Although the hardware requirements for the software (Sun Ultra 150 with at least 64 MB of ram) were much greater than we installed it on (Sun Sparc 5 with 64 MB of ram), this product out performed the first two. The billing operation for 100 accounts in the same ratio of flat rate vs. usage-based as the first two took place in a matter of a few minutes. Account data access queries on our system did take some time, but when we tried the same operations on one of their Ultra 150 machines, the results were almost immediate. The User Interface for this system is a web browser, making it accessible to any machine with network access to the billing system. Because of this, user security is also an issue that they dealt with through Sybase permissions that are configurable through a browser by the administrative account.

This product was able to integrate with Solaris-based RADIUS and "Post.Office". The RADIUS server required for this was a modification of the public domain RADIUS and authenticated users from the Sybase database but the "Post.Office" mail server was no different from the off of the shelf version and was communicated to via secure shell.

The structure of this system was designed to allow the owner of the system to become an ISPs' ISP, or in other words become an "ISP Hotel". By creating a top level account you basically created an ISP under which you can specify any unique hardware configurations. For example, The "Hotel" may sell an ISP billing, the use of a mail

server and the use of a RADUIS authentication server but the ISP would like to maintain and manage their own terminal servers. This would be done by creating a top level account that is associated with the "Hotel's" RADIUS and mail servers but looks at any traffic coming from their terminal servers as being billable by that ISP. The system tracks their usage as well as provides the functionality of billing by the "Hotel". Since the interface is based on an HTTP connection the "Hotel" can also allow that ISP to manage their own accounts.

Aside from billing and account maintenance this system was able to group accounts by demographic profiles allowing for marketing data to be retrieved from the system. The product also included the ability to create and install media that would allow an ISP to bulk mail CDs or diskettes and let people sign themselves on as your customer.

These two features used together are very powerful. For example, we created an install set that was targeted to go out to people ages 45 to 55, that lived in the more prosperous side of town. When the software was installed on a computer and executed it connected to us via our access number with restrictions that did not allow them to access anything but our sign on pages. Based on information passed to the system from the client side sign on software, the system presented customized sign on pages with special packages. Once the customer entered their information, decided what user name, password and service packages he or she wanted it was submitted to the database, with that user associated with the profile stored on the install media created for that person. At this point we had a new customer and associated the account with a demographic profile and we didn't have to enter any data. From the customers' perspective, once this process was completed they can dial right back into the system and got access to the Internet with the new connection icon that appeared on their screen. This system also had the ability to automatically freeze accounts based on non-payment.

Comparison

We found that the first two products we tested did not have the data integrity of the third. In some cases we were able to delete records that were linked to other transactions causing the system to malfunction.

All of the products were able to bill usage although the labor required to do it was different on each system. Product 1 required long batch processing of the RADIUS logs that in some cases took hours. Product 2 did not require batch processing but was considerably slower and less reliability. Product 3 was much easier and required only the time to execute two command lines and print invoices.

All systems used the same methods for credit card transactions.

Integration was varied throughout the products. Product 1 integrated with our service systems only by means of its ability to process RADIUS logs. Product 2 did a considerable amount of integration. It was able to create both billing and service accounts from one interface. Product 3 went further with its ability to communicate with the hardware for special configurations, such as assigning any given number of PRI ports in a terminal server to a client for ISP hotel functions.

We found that you get what you pay for with the three billing systems we tested. The first two products were comparable in price and performance. Either of these two products would be a good solution for a small ISP, whereas for regional and national ISPs, a product like the third one we tested is a necessity. A distributive and scaleable architecture along with critical data analysis of market information as well as easy one stop account creation abilities is critical for a large operation to run efficiently.

Because these products are an ISPs cash register and from the access provisioning and tracking system one generates bills and payments, this might be the ISPs most important set of software. If price is a critical issue then a smaller ISP has no choice but to look at the first two packages. The third package was by far the superior of the set but in our opinion too expensive. While this package was the most scalable and the prices did get a lot more reasonable when large amounts of accounts were purchased, the volume to achieve significant discounts put this billing package right at upper limits of what most ISP's pay for their total POP. So if you know you are going to become a national or regional ISP with hundreds of thousands of clients, the only solution is number 3. However if you are a small town organization and you think you might have a few thousand clients, the first two are a much better choice.

Billing Summary

Billing features critical to every ISP

- Ability to bill by usage or flat rate
- Integration with credit card systems
- Ability to easily create and bill for new services
- Vendor support

Billing features critical to large ISPs

- Fast data access & processing
- Ability to manage billing and service accounts through one interface
- Ability to report when usage reaches set usage tolerances
- Real time data analysis as opposed to batch processing
- Distributive architecture
- Scalability

Phase Two

Introduction

Phase two of the research project evaluated the different approaches to energy management as it related to the home PC and the Internet. We evaluated DOS-based systems, Windows95-based systems and we tried JAVA applications from within browsers to access meter data and interface with load control modules.

In all, we ran three different projects during our evaluation and research efforts. The following is a narrative describing what we accomplished and what we learned evaluating the PC for Internet-based Energy Management.

Overall we found the PC was more than able to accomplish the tasks given it. The biggest limiting factor seems to be the Operating System not the CPU or hardware. The OS was the critical link in determining robustness as well as how the PC multi-tasked. We found that the more advanced the OS, the more capable the PC was at accomplishing energy management tasks.

Project 1 - Honeywell

Project Overview/Goals

Our first attempt at Internet energy management was with the Honeywell system (an energy management solution developed by Honeywell that allowed for AMR, customer load profile data collection, and Customer Controlled Load Management). It consisted of an Energy Management Module (EMM), up to two Load Shed Modules (LSM), American Innovations Powerlon meter, a modem (cable or telephony), a Honeywell Gateway, an FTP server, and an Access database. The Gateway's (client) application was written in C and the head-end (host) application used MS-Access. C3 & Honeywell developed this application to read meters remotely via modem. The infrastructure was then used for internode communicate via PLC and client/server communication through a dial-up modem. This solution required a dedicated Gateway PC in every house on which no other applications were able to run.

Originally, we had intended to evaluate nodes for reliability, functionality and robustness by implementing the system on a small test bed. We soon saw the potential that this system could have if we could background the process which communicated with the nodes on the Gateway PC, thus enabling the customer to use the PC for home use and to control their energy management devices. This system already used TCP/IP for host/client communications. Naturally, extending the system for Internet applications became a goal.

Development Issues (What We Did - What We Learned)

We deployed this solution in four homes. We were the first to use an HFC network and cable modems to communicate with Honeywell's Gateway. Our main test was to see how robust the Honeywell nodes were. Additionally, we wanted to see if there was some way in which we could use the "Gateway" as a personal PC, whereby a user could use the Internet as well as manage their energy using the same PC.

Once into the deployment we found it was not possible to run the applications for the "Gateway" under MS Windows 95. The application required all the system's resources to operate efficiently. Running these applications in the background proved fatal to the application, thus halting communication to the nodes. The Honeywell solution for Internet Energy Management and home PC usage was not technically possible under Win95. This would have required us to re-write over 75 percent of the applications in win32 to use Windows 95.

Conclusion

We were able to use TCP/IP to communicate between the operations center and the "Gateway" and the "Gateway" was able to talk to the nodes using LonWorks. This solution proved unfeasible due to cost per home and the high developmental costs, which we would incur if we were to further develop the system. However we did learn that a PC does make an adequate gateway device and if further development warranted, it could possibly be used as a dual purpose machine... allowing the utility company to manage energy and read consumption and allowing the homeowner to access the Internet.

Project Two - WebIO

Project Overview/Goals

Over time, C3 has gained tremendous experience with control networks, especially power line carrier networks that employ LonWorks technology by Echelon. We have tested and implemented several devices that communicate over PLC using LonWorks and devices that gateway from LonWorks to TCP/IP. All of these technologies, which we implemented, were maintained via TCP/IP within an Intranet. All billing and research data was handled via this Intranet. Our next step was to be able to give our customers access to their energy bill and in-house devices over TCP/IP. Naturally, the best way for our energy customers to reach this data is over the Internet. Seeking an Internet energy management solution, we turned to a company called Coactive Aesthetics. They had developed a device known as WebIO LE, which enables one to manage their control network and associated LonTalk devices via a Web page.

We wanted to see if Coactive could develop an energy management solution using their product. They specialize in LonWorks products that enable communication to different types of networks. Their technology is somewhat generic in that they do not develop their technology for a specific customer. They consented, though, to creating

a small demo that would enable us to read a meter and control a load-management device over the Internet via a web page. They had created a product called WebIO, which acted as a gateway between Ethernet and power line carrier, and coded some Java classes and applets embedded in a web page that queried or control different

functional and to look for new directions for development and improvement in this area.

This schematic below is a high level view of the network and the WebIO components. This project encompassed every portion of an advanced network scenario. Cable modems, fiber optics, TCP/IP, Internet Web Browsers, Power Line Carrier and Java applets. The integration of all these different transport mediums was an extreme challenge and required many hours of trouble shooting and development.

WEBIO

Description of Components

PC with connection to the Internet, Java enabled browser, and Coactive's Java classes

We used a 486 PC that had a Java enabled web browser. We were to set the class path and place the Java classes, which they had created, in a specific directory. Additionally, we were to edit the web page that had the Java Applets embedded and specify certain parameters for the given applet such as the IP of the WebIO.

WebIO LE – Coactive's gateway

A gateway developed by Coactive Aesthetics, which acted as the gate between Ethernet and Power line Carrier. This device has a 3120 10MHz neuron chip. It employed LonTalk, a protocol from Echelon's LonWorks family, to communicate to the power line network. This device was configured through an RS-232 port. The configuration of the WebIO entailed binding an IP to it and specifying whether 10Base-T or 10Base2 was to be the choice medium used for Internet connectivity. Additionally, the WebIO LE had three lights. The power LED was a solid green color indicating that it was on. The status LED blinked red when it was not connected to a web page and became solid when it was bound or communicating with a web page with the appropriate Java Applets. The service LED became a blinking yellow light when it was being either serviced via the RS-232 port or during the power line carrier binding process. As with most all power line devices, it too had a service pin, which, when pressed, would send its neuron information. It was equivalent to sending a ping in an IP network. In addition to the Ethernet ports, the WebIO also had an FTT-10 port, which could interface with a router. The protocol used here was LonTalk.

Landis & Gyr Electric Meter with AIM's PowerLon retrofit

A standard meter with an AIM module was used in this demo. The retrofits plugged into the power line network via a ground. It had it's own set of variables and a 3150 10MHz neuron chip. Additionally, this retrofit had many load profile capabilities. A 10MHZ crystal had to be used since that was the transceiver timing rate at which the WebIO and router talked.

Honeywell LSM

A Honeywell load shed module (LSM) that can be wired to shed 240V or 120V was used in the demo. When wired 120V, you can attach a power outlet that can power any 120V or 110V appliance. It had a 3120 5MHz neuron chip. It also needed a 10MHz crystal upgrade before it could communicate within the power line network. It originally had a 9.68MHz crystal.

PC PLC Binding Station (IceLanG) with PLC coupler.

All LonWorks nodes had to be bound to the devices that they were communicating with. Often each node had its own set of standard network variable types (SNVTs). SNVTs enabled internode communication. We used a package called IceLan-G, which enabled us to view a node's parameters and network variables.

The version of IceLan-G that we used ran on a Windows 3.1 platform. Additionally, we had to run special device drivers for a LonWorks PLCTA adapter card. It was through this software utility and a LonWorks PLCTA board and coupler that enabled us to communicate with the power line network and bind the aforementioned nodes. The PLCTA board had a jumper setting which gave one the option of setting the transceiver timing rate at 9.68MHz or 10MHz. There is a small coupler that connects the PC to the PL network. A small coaxial cable was used to connect the coupler to the PLCTA adapter. A power cord from the coupler was the direct link to the PL network.

Development Issues (What we Did - What we Learned)

Coactive had developed specific Java classes that would query different LonTalk devices over a web page. We were able to create SNVTs on the WebIO that could communicate with the meter, and had developed some SNVTs, which they had not tested, for the LSM. As we were unable to go to California and have them give us a mini training session, they sent the equipment to Laredo, TX. There we unpacked the hardware and set up the devices on a power line network. The equipment came with a disk. The disk contained the Java classes, the html web page with the appropriate Java classes embedded, and html-based instructions, which documented what to do, how it works, and what everything meant. When initially setting up the devices, configuring the WebIO, and changing the appropriate parameters on the web page, the system did not appear to function. The status light on the WebIO did not turn a solid, steady red light. It was blinking red. We then had to buy IceLan-G and put together a binding station that would let us bind the nodes together. This process took us over a month to do. We learned that knowing the correct neuron chip types was essential when binding. If one binds a device that does not have the correct neuron chip specifications, all SNVT information is lost and the node is rendered useless. The developer must return the SNVT information or replace the neuron chip to revive the device. The sensitivity of the neuron chip varies. The 3150 chip is more robust when it comes to human error than the 3120, we found. We had to send back the WebIO once and we *ruined* one LSM in this learning process. Finally, after a month, we were able to bind the nodes and get them to communicate to each other. The WebIO's status light turned a solid red once communication was established on the IP side between the web page and the WebIO. We were able to see the meter read on the web page over the Internet and control the load node. We had connected a lamp to the extended 120 outlet of the LSM. The SNVTs worked well. The light was turning on and off. We soon learned, though, that when power was disconnected from the devices, they could no longer talk to each other. It was as if all binding information was lost. Coactive told us that the binding software that we were using did not commit the binding information to the neuron chip. They told us to invoke certain procedures from IceLan-G so as to commit the binding information. Still, we found that it did not work - we had to rebind the devices after power has been removed.

After evaluating Coactive's Internet energy management solution, we then met with them and discussed the possibilities and potentials of WebIO. Many issues were

brought out. For example, what would the premise equipment look like? The WebIO and router were not necessarily deployable at the time. How much does it cost to maintain such a device? Most of the projects that we had deployed had huge maintenance costs. Must a user always have to install the Java classes on their PC and set the CLASSPATH to where the classes are? To add to that, what if a user is at another PC and wants to turn on their water heater or turn up their thermostat, does the user have to install the Java classes? How much time would it take to develop a fully functional device? At the time, summer was fast approaching and we felt that if we were to deploy such a product, summer would be the best time to for deployment to see if the solution was robust. We wanted them to develop a full-blown Internet Energy Management System. Cost was a big issue as well. There would no doubt be a huge development cost, but how much would each WebIO-LE PLC system cost per home? All of the above were the issues we uncovered as to whether this approach to Internet energy management can be deployable

Project Three - Savoy Cyber House

Introduction

As we approach the "Golden Age of Computing", many promises are on the horizon - voice recognition, automatic agents that learn your routines and prepare your (house/car/office) to personalized settings and media presentation mode desired, and many other intelligent uses of computing power are just about to be realized on an everyday common basis.

One of the areas with a very promising future is home automation. The home automation market is small but a growing one. While it has primarily in the past focused on high-end residential housing, it is now moving more into mainstream residential markets. The high-end approach has largely been the result of high prices for equipment and time consuming installation. However, as the PC age starts to enter every phase of how we live, many of these expensive home automation tools are migrating to the PC platform at a much lower cost. While still out of reach of the lower end consumer, the price will continue to fall as more consumers are educated to the advantages of home automation and volume pricing lowers costs.

The area of home automation we focused on for this research was energy management. By utilizing the intelligence of software coupled with reliable and low cost PC's, the energy consumption in a house can be monitored and modified in real time to help the homeowner use energy more efficiently and therefore save money. In addition, added benefits like security monitoring and lighting control can be added to significantly enhance the overall value of automation technology. These were the applications we were focused on when we chose to test Savoy Cyberhouse to manage energy and security in our test home in Laredo, Texas.

CyberHouse was a home automation and facility management application for Windows 95 that integrates information processing with your home environment.

Based on a Client/Server architecture, Cyberhouse offered not only advanced home automation but also remote management through TCP/IP and NetBEUI protocols. The software was user configurable and used state-based rule sets to achieve a very high level of interactivity and control.

The software had two distinct and interrelated components. The house manager was the server portion and the client was called the House Viewer. Together they formed a robust and fairly complete set of controls for almost any appliance or device. In addition, multiple house viewers accessed the House Manager through a passworded login setup. This gave the software a large amount of flexibility, especially when deployed over a WAN like the Internet.

Savoy Automation's CyberHouse product integrates off-the-shelf, security, lighting, home entertainment, and energy management products with PC applications such as the Internet, email, faxing, paging, digital video, audio, text-to-speech, and telephony. The server side of the product is called the House Manager and uses TCP/IP to communicate with the client PC or another PC. The client side can communicate with the house manager and is the window where users set up rule sets and status updates are viewed here as well.

The diagram on the next page is a pictorial representation of a Cyberhouse Network. This provides a high level view of one of the systems we set up and tested.

Development Issues/What we did/What we learned

The relevance of CyberHouse to our research was largely the remote and local energy management capabilities of the product and future plans of AMR with this product. Its ability to communicate to security panels, such as the Napco Gemini Security Panel, allows for a very robust security system as well.

Communicating via RS-232 to an Enerstat HVAC control node, we were able to control and schedule the HVAC functions in the house from any PC that was able to

gateway into the home network and had the proper software and licenses installed. This allowed us to schedule the HVAC such that energy consumption was reduced during peak hours by default, yet the programming could be overridden through a standard thermostat interface at any time.

Connecting to a Napco Security Panel via RS-232, we were able to integrate high end security features into the house. We set up a digital video camera at the front door that would begin to capture video as soon as the door was opened. A voice recording would alert anyone coming through the door that they were being recorded and that if the alarm were not disarmed that video would be transmitted to a security provider. This was triggered by the open state of the Napco door switch. If the security system was not disarmed in time, that video was emailed to a mailbox designated as the security provider.

Since the rule sets are based on the state of a component, we were able to base the actions of one component on the state of another. For example, as the front door opened, a lamp in the doorway was turned on if it was past 6:00pm. This was triggered with motion sensors as well as door and window sensors and communications to home components established over standard X-10 PLC. HVAC nodes were also programmed to respond based on the state of the security system as well. If the alarm was 'armed away' the thermostat dropped to 80°F and if it was disarmed or 'armed home' the thermostat will kick up to 75°F. This type of home automation is very instrumental in energy management.

Conclusion

Although the feature set of this product was impressive, we found that the system resource demands on a typical PC (Pentium 100 w/32 MB ram) were very high. Not only was the House Manager demanding but the software architecture was designed to integrate with many third party software components. This architecture was an excellent design for flexibility and functionality but at the same time required more system resources to run the third party software. This issue is resolved through its server to server architecture. This allows one server (House Manager) to connect to another giving any client (Viewer) connected to either server the functionality of both. Under this configuration we were able to manageably reduce system resources by distributing the load across computers.

We found Savoy Cyber House to be inherently very adaptable to home energy management although it was designed as a full blown home automation product. Because of this it offers an array of home automation and security features along with home energy management.

Phase Three

Introduction

The trend towards a common centralized service entry point for residential communications is a juggernaut that is gaining in momentum and technological support. Many companies, from computer giant IBM to startups like UTEL are developing residential gateways. But a residential gateway has as many connotations as there are industries serving the residential market. The TELCO industries view the gateway as their demarcation box on the outside of the house. The SECURITY industry says they already have a gateway installed as a security system and the CABLE industry says the residential gateway is really built into their set top boxes. The POWER industry says we don't have a gateway YET... but just wait... we are going to put a box on the side of every house that will provide an entry point for all services... it just has to provide an automated metering function first and all other services can then tag along.

Defining a residential gateway is a lot like hitting a moving target... once you finally decide where to aim it's moved somewhere else. One of the goals of this phase of the research project was to define a common energy management features list for residential gateways that addressed the needs of ALL service providers and yet positioned the home to take advantage of future services and products in development. In addition, by submitting this "strawman" features list to gateway standards bodies, this future scenario of a common service entry point that is modular and upgradeable might become a standard that companies could develop products and services for.

The fact that a common development standard is good for an industry is quite evident in the computer industry. The IBM AT ISA architecture and the Intel PCI standard are good examples of standards that evolved and became the defacto architecture. Others like 802.3 Ethernet enabled whole industries to develop around network services. The fact that one can buy a 3Com Ethernet card and it can talk to an IBM hub or a Cisco switch is based on everyone supporting a common interface and communication parameters. Likewise, one have no concerns or doubts that I could go down to my local computer store and buy a PCI graphics card and have 99% certainty that when I plug it in, it will work.

This interoperability is the foundation that allows the modern computer industry to function in the highly charged and innovative environment it enjoys today. While it does take cooperation and industry buy-in to standards, it also allows many, many companies to participate and bring product to market that has a very good track record of interoperability. This is not the case in the cable industry today. Nor is it the case in the cable modem industry today. Likewise in the utility automation industry, you have as many flavors and distinctly different products.

What Was Done-What Was Learned

In this phase of the research project we worked closely with the Los Alamos National Laboratory group and other technical standards bodies to try and define what a standard for an energy management residential gateway might look like. This involved several meetings and brainstorming sessions to define architecture, purpose and functionality of a residential gateway. The following is a list of the features and functions and specifications the group came up with;

Functions and Applications

These are the set of Core and Future applications that should be supported by a Gateway Device.

Core functions

- Automatic Meter Reading (Tiered Pricing Capable)
- Power Outage Detection
- User Device Control

Expansion Slots for

- Home Security System
- Data Services
- Home Automation
- Entertainment
- Telephony
- Future Services

Specifications

These are key specifications for the Gateway System

Core Specifications

- Plug and Play Features
- PCI 2.0
- AC Bridge for PLC
- Hot Swap PCI
- SNMP MIB Layer
- Flash RAM
- Software Upgradeable
- Robust Management Tools
- Secure Transactions and Control
- NEMA Casings and Equivalent Connectors
- Passive Backplane - Standard Size and Configuration

"Processor" control

Functions include

Plug and Play

Diagnostics

POST

Watchdog Timer

Command - I/O Port

Expandable for

- JAVA Applets
- JAVA Processor

Approach

This is the outline we followed in the research work for Residential Gateways in Phase Three. This work is ongoing and C3 has been invited to present at a number of conferences in 1998 concerning residential gateways and where the industry is headed. C3 also intends to continue research in this area to help drive the market to an implementable standard.

1. Present the Concepts
Brainstorming sessions on content and functionality
1. CORE Functionality
BOX
CARDS
1. Examples
Simple
Type 1
Type 2
Complex
1. Standards Bodies
Present to TR 41.5 Standards Committee
Present findings at Parks's Conference on Residential Gateways in May 1997
IISP ANSI Organization on International Infrastructure Standards Panels
2. Work with manufacturers in testing prototypes of Residential Gateways
IBM prototype/Cyberhouse
Intellihome/RF Gateway
In-house Prototy

Conclusion

C3 Communications pursued many ideas towards the concept that the PC-oriented Gateway could be a major factor in the emergence of the NII. Based on our total summation of research in this area, we feel that the RG is a product that will play a very significant factor in the furthering of the NII. As manufacturers have standards to develop towards, many types of gateways will emerge over the next few years. This will increase consumer demand for information and the need to hook into the NII. The growth predictions of the Internet today are coming true. What may be the most significant event of the latter 20th century is the emergence of the Global NII. With the promise of broadband satellite delivering multi-megabit capabilities to people all around the world, the global village concept of Marshall McLuhan is finally becoming a reality. Today in 1998 it is entirely possible to log onto a vast network of globally linked computers and participate in a lively chat or conduct commerce or research information from millions of sources.

As this national village becomes more and more a global village, the ability to link every person and every residence together will be the driving force behind the NII and the GII. In 1998 the PC is the main conduit for accessing the NII, but as PC functionality moves into devices and appliances, the major market force in the next century will be the need for devices to login to the network.

The single unifying force today in the NII and the GII is interoperability of computing systems via TCP/IP. In the world today there are 4 major utilities providing services to consumers and business; Telephone, Electricity, Water and Gas. In the next millenium a new type of utility will be emerging, The Information Utility. This utility will be the convergence of all the previous services rolled into one convergent service provider that is a one-stop-shop for everything from energy to information.

The information utility will be the industry that NEEDS the infrastructure provided by a Residential/Business Gateway. This gateway will serve as the business/consumer gateway to the world of advanced services and be the connection point to the rest of the global community.

However, the utility company who builds this next generation of information services will need a reliable and standardized product that is flexible and upgradeable. If industry can cooperate to develop the standards for interoperation, the utility can purchase with confidence, a product that will server their interests as well as provide users services and convenience only dreamed about today in the latter 20th century.

The next century will be the golden age of communication and global community. The ability for The Fifth Utility to emerge will be based on standards and the Residential Gateway concept is too important to allow market forces to define standards. Industry needs to start production TODAY and the only way anyone will be comfortable enough to invest the billions necessary to bring this concept to fruition is the adoption of open standards