Lizhong Liu. IP Management System. A Master's Paper for the M.S. in IS degree. April, 2005. 42 pages. Advisor: Dr. Gary Marchionini

This study involves systematic analysis of an existing IP Management System used by the UNC School of Medicine and UNC hospital to manage their network devices. The data structure and user interface in the current system were examined in this study. The data structure was evaluated on a set of criteria such as database normalization, data integrity, and indexing, and the user interface was studied through on-site interviews with its users, designers and systems administrators. Based on these analyses, a new system was designed and implemented. This process involved system design and implementation, data cleanup and migration, testing, and application deployment in the Web environment.

Headings:

System-Analysis-Design-Implementation

Data-Migration

Web-Application-Testing

IP MANAGEMENT SYSTEM

by
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Approved by

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Dr. Gary Marchioni

Part 1. Introduction and Background

A. Background

The UNC School of Medicine and UNC Hospital use their own Internet Protocol (IP) Management System to manage IP address assignments for devices connected to the school and hospital's network. The existing IP Management System was developed in-house and consists of a user interface application and a backend Ingress database. Approximately twenty users have access to this system, and their responsibilities range from entering new records and verifying information to generating reports for use by DHCP and DNS servers. Currently, the Ingress database stores about 9,000 devices along with their associated ownership, location, and technical contact information.

B. Problem Definition

The following problems were revealed after systematic analysis of the current system:

- Support for Ingress - the legacy database running the current IP Management System, has expired due to insufficient funding to sustain it;
- The current database contains (and does not adequately avoid) data redundancy;
- The current user interface is not Web based, but a command driven Perl application hosted on a Unix machine;
- The current user interface cannot check and report on either IP address or hostname conflicts, therefore different applications have to be used to fulfill single service requests;

- The user interface for the current IP Management System is not intuitive and has generated many complaints from Client Services staffs;
- A single systems administrator controls the export of database records and the import of bulk IP address updates;
- The method by which departmental support groups submit bulk IP updates is very error-prone and thus time-consuming for the systems administrator who must fix them.

C. Solutions

The current database management system was migrated to Oracle and an improved, Web-based IP Management System interface was designed and implemented after intensive information gathering and discussion with current users and departmental systems administrators. The new system uses a new data model to help ensure data integrity and scalability. In addition, the interface offers users several new features including available IP address search, IP address and hostname validation, bulk IP address changes, and report creation. The result of this study is a more user friendly and stable system that is ready to take on additional load as the number of hosts on the network increases.

Because this study uses resources that are already available to the School of Medicine, no additional funding has been requested.

Part 2. Description of the Current System

A. Structure of the current System and Its Weaknesses

The current use of the IP Management System is to assign IP addresses to new machines. This is how a new device is allowed onto the school's network. In addition to the IP address, IP Management System also keeps track of other information about each network device, including its user, location, and technical contact person.

The plan for investigating the current system is described in the following sections.

To gather data about the current IP Management System work model and any others associated with it, interview and on-site observation were chosen to be the main approach. One-on-one or two-on-one interviews with users who know the IP Management System were scheduled at their workplace. The principles of context inquiry were used to guide the interviews, which were conducted with people who perform widely different roles and work in very different ways with the IP Management System. This included the people who admin the IP Management System database and those who use the IP Management System application. Extensive note was taken during the interviews when possible. Interviews were focused on the preset topics, and time was tracked during the interview. One good practice to keep the interview on track was to prepare a pithy focus statement beforehand.

The overall goal was to have a complete picture of the current IP Management System database structure (how many tables are in it, what data is in each table, why they are there, and how the administrator uses/maintains the database, such as any additional tool used to maintain the database or generate reports from it); functionality of the current IP Management System application along with how it interacts with the data in the database; the physical location of the IP Management System database and its application; and how the program fits into the department's overall system structure. Most important, understanding user needs, desires, and their approach to their work regarding IP Management System was the key to recognize the overall work situation, identify specific strengths and weaknesses, and envision an integrated solution.

The current system used by the School of Medicine has the following properties:

Database. The DBMS is Ingress running on a Solaris server. Ingress is a relatively old database management system that is no longer developed or supported. The structure of the data is such that each of the 24 attributes is stored in a single record in a single table (as shown in Figure 4).

Interface. The user interface is exclusively an interactive text interface that is accessible only through a Secure Shell client. There is no Web application that is able to interact with the database.

Data Import. Batch updates of IP data are often required, and they can only be performed by the Unix systems administrators. Departmental support groups operating

within the School of Medicine are responsible for submitting these updates in the form of Excel spreadsheets. The administrator performs the updates by taking the preformatted Excel spreadsheet, exporting the data, parsing the data into a format that can be ingested by Ingress, and then finally importing the data into the DBMS.

Data Export. From IP address data stored in Ingress, the current system is able to generate DHCP configuration files and DNS records on demand. This functionality is absolutely mission critical, because no new devices can be added to the network without the proper generation of these items. One of the Unix systems administrators is the only person who produces the DHCP and DNS reports.

There are a number of weaknesses in the current system, as outlined below:

Non-optimal User Interface. The current terminal interface is fine for power users, but is too complex and cumbersome for those individuals with specific tasks to perform. It frequently generates errors that are hard to interpret for support staff; and, based on the rate of user complaints, one in every ten attempts to use the application fails. Apart from the hard-to-use interface, another problem is terminal emulation. The end user's SSH client itself will often result in differences in the behavior of the interface. For example, certain function keys often don't work when connecting from certain terminals.

Unfortunately, the current system does not support making the situation better. There is really not an advanced enough toolkit to support migrating to a Web interface or any other JDBC or ODBC client interface.

This situation has given birth to quite a few workaround systems so that people can do their jobs while minimizing their use of the current IP Management System and its Ingress database. For example, a Perl-based system that runs on a Web server assists support personnel by determining the next available IP address. Support staff must therefore open this Web page in one window and the IP Management System interface in another before they can assist a customer. Optimally, both of these functions should be available within IP Management System.

Another interface weakness is the inability of the current IP Management System to accept bulk IP address updates, which are commonly needed by departmental support groups who make many system changes. As a workaround, users can submit a bulk IP update spreadsheet to the Unix systems administrator.

Single System Expert. The developers of the current IP Management System have, over the years, left the School of Medicine. As a result, only one person remains who has control over critical IP Management System functionality: the Unix systems administrator. If this single expert is no longer able to perform his current database responsibilities, then batch updates could not occur and DNS records and DHCP configuration files will likely not be generated. Thus, this person has unwittingly become a single point of failure.

Further complicating the problem is the time required to train a new staff member in using the current system. Because the old Ingress DBMS does not conform to many

modern database constructs, and because several interface workarounds are in place, a new IP Management System administrator would have to invest a large amount of time learning the system.

No Database Support. An important consideration for the School of Medicine is support for its database software. The support contract for Ingress has run out, and no future support will be available. If the school continues to use the current database, and a major failure occurs, then vendor assistance will not be an option. This is a very precarious situation for a production, mission critical system.

Current Database Not Scalable. An examination of the current IP Management System data model reveals that the database schema does not scale. At the time this system was created, the concept of any individual having more than one computer was unheard of. However, with the advent of desktop, notebook, PDAs, and other network-aware devices requiring IP addresses, there has been an explosion in the number of addresses needed. It is now common for single users to have three or more devices registered to them. In the current data model, which has a single entity with 24 attributes, all personal data is recorded for each device registered. For owners of multiple devices, then, this ownership and contact information is needlessly repeated. Recently, this problem has become more pressing as users bring notebook computers onto the network with multiple interfaces (wired and wireless), which require a separate database record for each interface.

Further reinforcing the need for scalability, IP and hostname configurations within the school have become more complicated over time. Unlike in the past, it is now possible to have IP addresses with multiple hostnames, or single hostnames having multiple IPs on the network. These types of relationships simply can't be modeled using the present system.

As more devices are added to the network, including those with multiple interfaces, the database will grow very quickly. With the current system's poor data model, scalability is becoming an important concern.

Data Integrity Issues. As discussed previously, data redundancy already exists in the current IP Management System database, and this will continue to worsen if no action is taken. Redundancy creates its own type of data integrity problem, because it makes updating and searching for records much more difficult. For example, if a user's phone number changes, and this user owns five network devices, then the information change must be made in five records (one for each device). This type of data architecture is very unwieldy, hard to handle in an interface, and can cause many data integrity problems.

Redundancy, though, is not the only problem. All of the fields in the current database are stored as string values, so invalid data can easily be entered into the system. These errors can cascade into malformed DHCP and DNS files, which are exported from the database by the systems administrator. Such an event can render these two critical network services useless until the problem is tracked down and fixed.

While not as critical as the previous problem, data formatting issues also compromise data integrity. Because of the lack of validation, information entered through the current IP Management System interface often contains misspellings or unneeded characters such as spaces. Therefore, a search for machines by name or location can return far fewer results than should be the case. The end result is that IP Management System users cannot reliably access and update information because formatting varies throughout the records.

B. Current System Models

Several models of the current system were generated to help understand the work and data flow involved in updating and maintaining the IP Management System. Some of these models, which begin on the next page, illustrate the problems highlighted in section A above.

Sequence Model

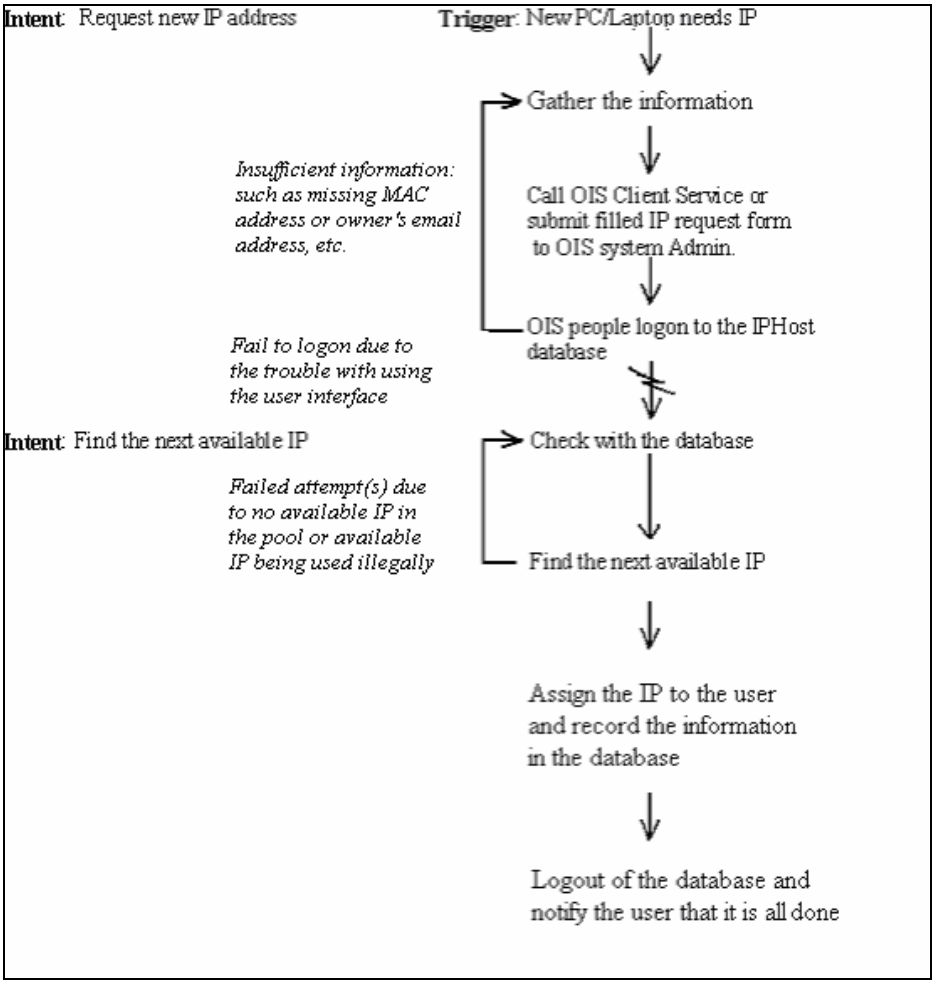


Figure 1: Sequence model. This sequence model traces the process of creating a new IP address entry in the IP Management System database from the perspective of a Client Services technician. The model highlights the accessibility and interface problems that support personnel may encounter.

Notes**:**

1. OIS stands for Office of Information Systems at UNC School of Medicine.
2. Client Service representatives have complained about the data entry troubles they have experienced when using the user interface of the database. The estimated failure rate is one of ten attempts, which could be due to user interface design error, such as no error checking codes in place.

Artifact Model

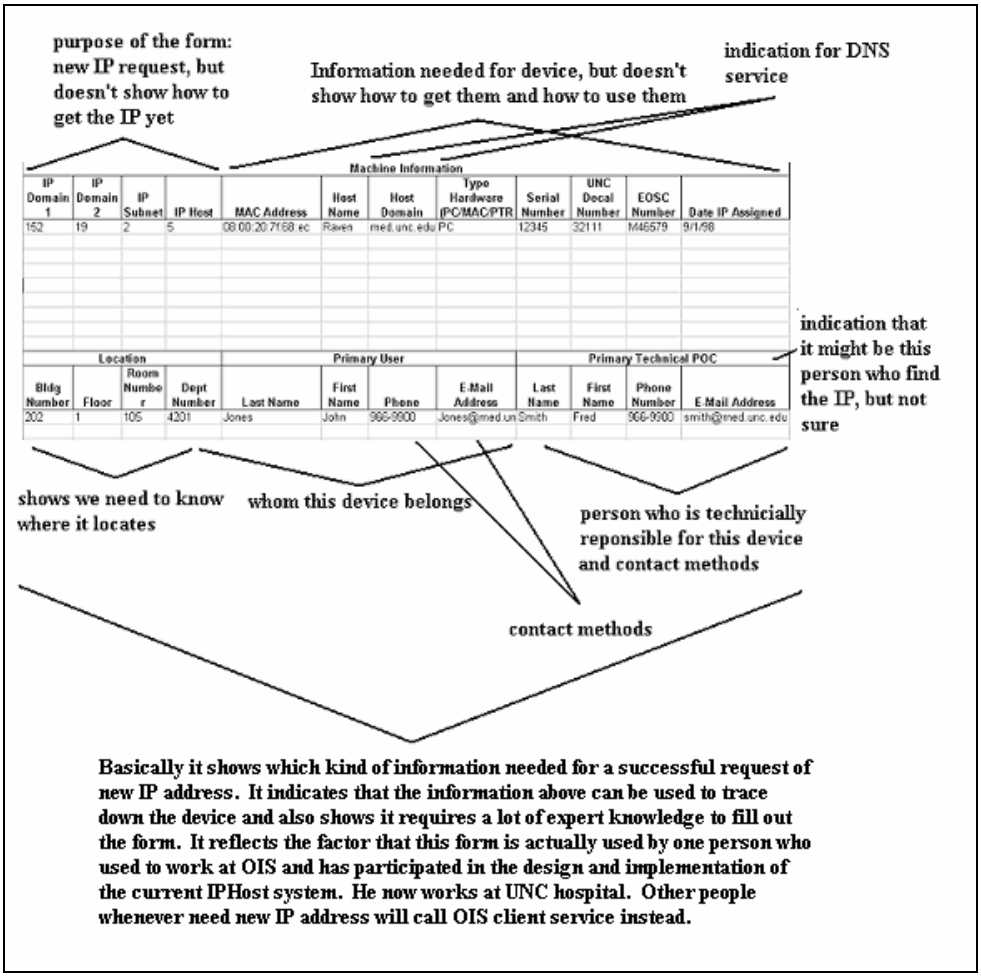
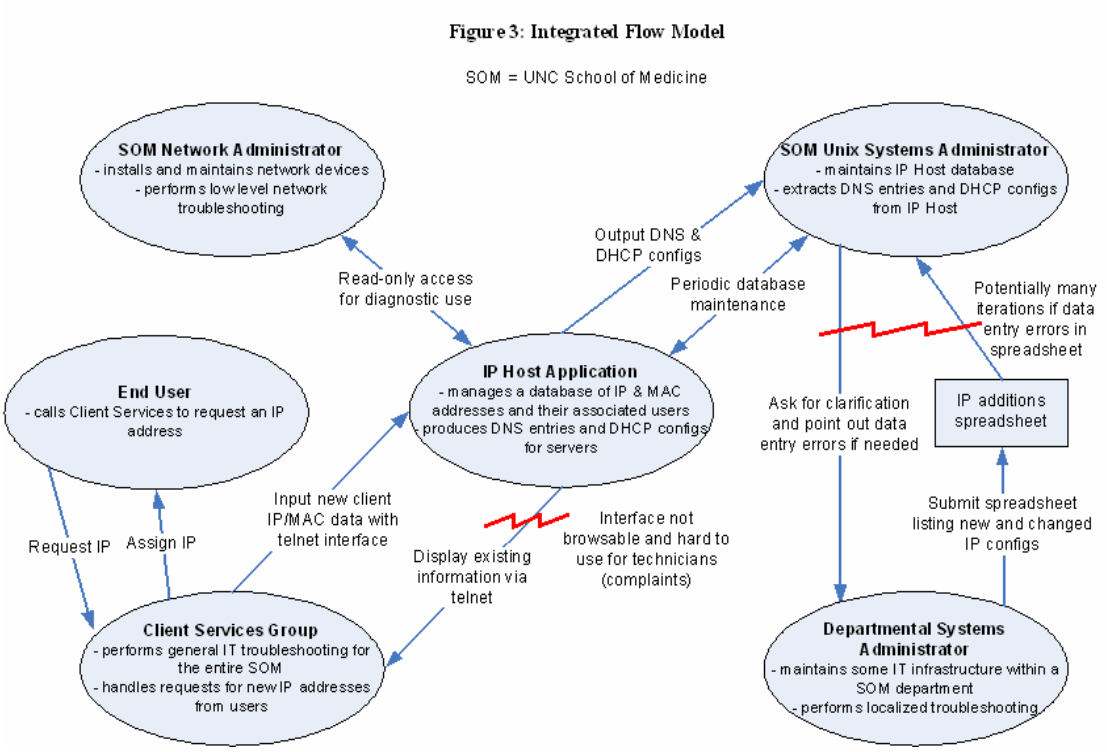


Figure 2: Artifact model for the IP request form. This form, which is submitted to the Unix systems administrator as a spreadsheet file, is used by some departments in the School of Medicine. The form provides a faster, more efficient way for departmental support groups to make bulk IP changes or additions (rather than accessing the IP Host client program and making changes manually). Frequently, this form contains data entry and formatting errors that the Unix administrator must resolve.

Flow Model

The flow model on this page illustrates problems with two components: the hard-to-use telnet interface and the error-prone IP additions spreadsheet. The interface frequently causes trouble for support technicians, who must use it to enter IP information manually. The IP additions spreadsheet, which is used by departmental support groups to submit bulk IP changes, commonly contains data entry and formatting errors that the Unix systems administrator must resolve. Also, the Unix systems administrator is the only person who has the knowledge to import these spreadsheets.

Figure 3: Integrated Flow Model



Entity-Relationship Diagram

The following illustration shows the data model used by the current Ingress database:

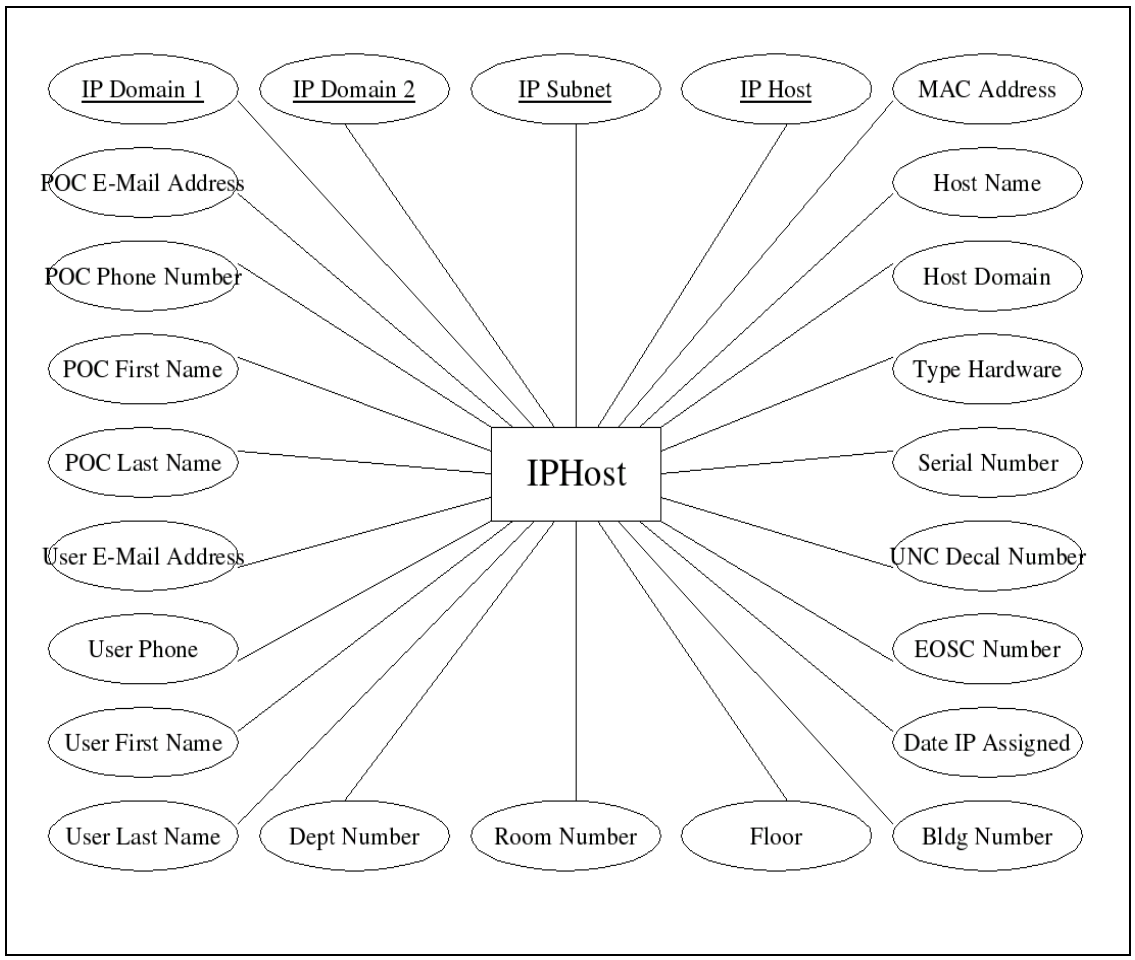


Figure 4: Entity-relationship diagram for the current system. All attributes in the current system are stored as text fields related to just one entity. For each record in the database, all 24 attributes are stored. Therefore, no cardinality is defined, and data redundancy is a major problem.

The models above highlight several of the problems in the current system, including:

- A troublesome interface that makes entering data difficult for the Client Services support staff;
- Reliance on a single system administrator to handle bulk IP additions and report creation;
- A lack of error checking in the current IP additions spreadsheet;

- A poor data model that creates redundancy and will not be scalable or ensure data integrity.

All of these problems were taken into consideration in designing the new system, which is outlined next in Part 3: New System Design and Implementation.

Part 3. New System Design and Implementation

A. Summary of Changes Needed

The final solution addresses all of the problems raised in the problem definition. It is a new system designed from scratch, which uses Web technologies and a back-end database management system. The new DBMS is Oracle, as it is already licensed and installed within the school. These technologies are presently available to the School of Medicine and require no additional cost on the part of the school for hardware or software. The total cost of resources for the new system is just the personnel time required for development.

The School of Medicine and all of its departments use a wide range of different systems, and in the years since the original IP Management System was created, the Web, and HTML specifically, has matured into the standard for accessing data from a distributed environment. Therefore, the School of Medicine should implement a Web-based system as the IP Management System interface. The Web server must be equipped with a programming environment that will support the communication between the HTML user interface and the SQL commands passed to and from the DBMS. For this function, Java Server Pages (JSP) is chosen because it leverages Oracle's built-in Web technologies. Development and deployment tools for JSP with Oracle database are part of the Oracle JDeveloper package, and the included Apache Web server will integrate tightly with both

JSP and the Oracle DBMS. Because all of these software tools are included with Oracle, no additional licensing is required for this study.

The new database implements the ER diagram shown below in section B to ensure that all the required data are available and normalized in the most efficient way. The system also implements strong user authentication through a user's ONYEN.

Because it is Web-based, this new system provides much easier access to all users that are authorized to view or edit data in the system. The design is scalable for future network growth while having a simple and intuitive interface. And the system is able to automatically produce an unlimited number of customized reports and configuration files needed now and in the future for IP and hostname management.

Data validation and formatting in the new system are done through JavaScript. Data integrity is also checked at the database level through defined constraints in the Oracle tables.

B. Resources and Schedule

The following requirements and schedule plan was laid out at the beginning of the study.

Based on feedback from the School of Medicine, the current IP Management System does not need immediate replacement – it is still functioning and will continue to be effective in the near future. The new system is therefore not a high priority.

Consequently, a very relaxed, approximate implementation schedule was proposed and changes/adjustments can be made to it during the study process whenever needed.

Personnel and Resources Required

The new IP Management System requires both a database migration as well as a completely new interface. Therefore, this study involves one developer who is competent in both of these areas and continual contact with other stakeholders in the School of Medicine, such as ongoing meetings with the Unix systems administrator, who can help with database migration and server issues, as well as support staff, who can give suggestions to improve application usability. In the final phases of development, the end users' roles will become very important, as they will need to spend some time testing and giving feedback on the new IP Management System interface.

For development and testing, an Oracle database server and a Web server are required. Fortunately, the School of Medicine already maintains development servers that are suitable for this task. In addition, the school has production servers that can take on the additional load of running Java Server Pages and handling the new Oracle database once the system is ready to go live. No additional investment in equipment should be required for this study.

Schedule

The implementation schedule was designed to balance the School of Medicine's current, most pressing needs with the need to design a new IP Management System database and

application. Since the new IP Management System is not mission-critical, no more than 10 hours per week was spent on its implementation. Of course, this number can be easily increased or decreased depending on the actual workload without jeopardizing the study's success. The following is the estimated time frame for developing the new system:

Information Gathering and System Design. Given the estimate of 10 hours per week devoted to IP Management System development, this process takes about two months, and it involves meetings with system administrators and technical support staffs, analysis on data structure, dataflow and workflow in the current system. Then based on these findings, a new system will be designed for implementation.

Data Migration. After the new data structure is created in Oracle, database migration will take place, and last for about 3 weeks. The goal of this process is to determine how to transfer data to a new database with a minimum of data loss and errors. This will require close work with the Unix systems administrator to clean up the data in the existing Ingress database before importing them into a new, multi-table Oracle database. Some testing should be done after the initial migration to determine if any data is missing or if errors are introduced. The entire migration process should be documented so that a final data migration can be performed when the new system is ready to be rolled out.

User Interface. After data migration testing is completed, work can begin on the user interface. With mock-ups as a template, Java Server Page will be used to design a

dynamic, database-linked Web interface. This portion of the implementation, which might take up to 30 days to complete, will require many meetings with end users to gauge their reactions and gather feedback.

Testing. Once a suitable interface is in place, the final testing phase can begin. During this process, the migration techniques determined earlier will be used to move data from the Ingress database to Oracle. Then, a test version of the interface will be rolled out to all support personnel for their evaluation and final comments. If all goes well (or only minimal changes are needed), this process should not require more than 30 days.

The testing consists of functional testing, system testing and usability testing. Functional testing mainly is carried out by developer through out, and after the development process. Based on the functions identified in the new IP Management System, test cases will be designed and created accordingly.

System testing includes verifying the new system with old request data. Then all support personnel and administrators will test the new system during their daily work with the real request data. The idea is to let the new system to work with the old system in parallel, and it should go for at least three weeks before deploying the new system and putting the old one out of service.

Training. Just before deployment, the School of Medicine technical staff will be divided into groups for training sessions. These sessions will involve all possible IP Management

System end users, including administrators, support personnel, and networking staff. In each session, an overview of the interface will be given and any questions or concerns will be addressed. Because all of the end users have technical experience, training should not take longer than one day.

Final Deployment. For the actual deployment phase, all documentation and feedback gathered up to this point will be used to perform the final data migration and roll out the user interface. These tasks should be carried out during non-work hours (possibly over a weekend) to minimize the effects on users. When the deployment is completed, the old Ingress-based system can be taken offline, and users should be notified that they will now be using the new system. By this time, the Oracle database and interface will be running on production servers maintained by the School of Medicine's Office of Information Services. The new Web-based interface will be the primary means of entering and viewing IP information, and the Oracle IP Management System database will be the authoritative source for all new DNS entries and DHCP configurations.

Future planning. After final deployment is completed, one task remains: planning for IP Management System's future. The most important consideration in this planning is disaster recovery. All of IP Management System's environmental needs (like certain Web or database server configurations) must be recorded so that, in the case of a disaster, a system supporting IP Management System can be quickly rebuilt and deployed. In addition, the School of Medicine's backup policy needs to be evaluated to make sure it is appropriate for this particular application.

C. New System Models and Implementation

Because the analysis of the current system revealed several areas that need improvement, new system models of a more efficient, more user-friendly version of the IP Management System database and application were generated. Each of these models was used as a framework to implement an improved IP Management System.

Entity-Relationship Diagram

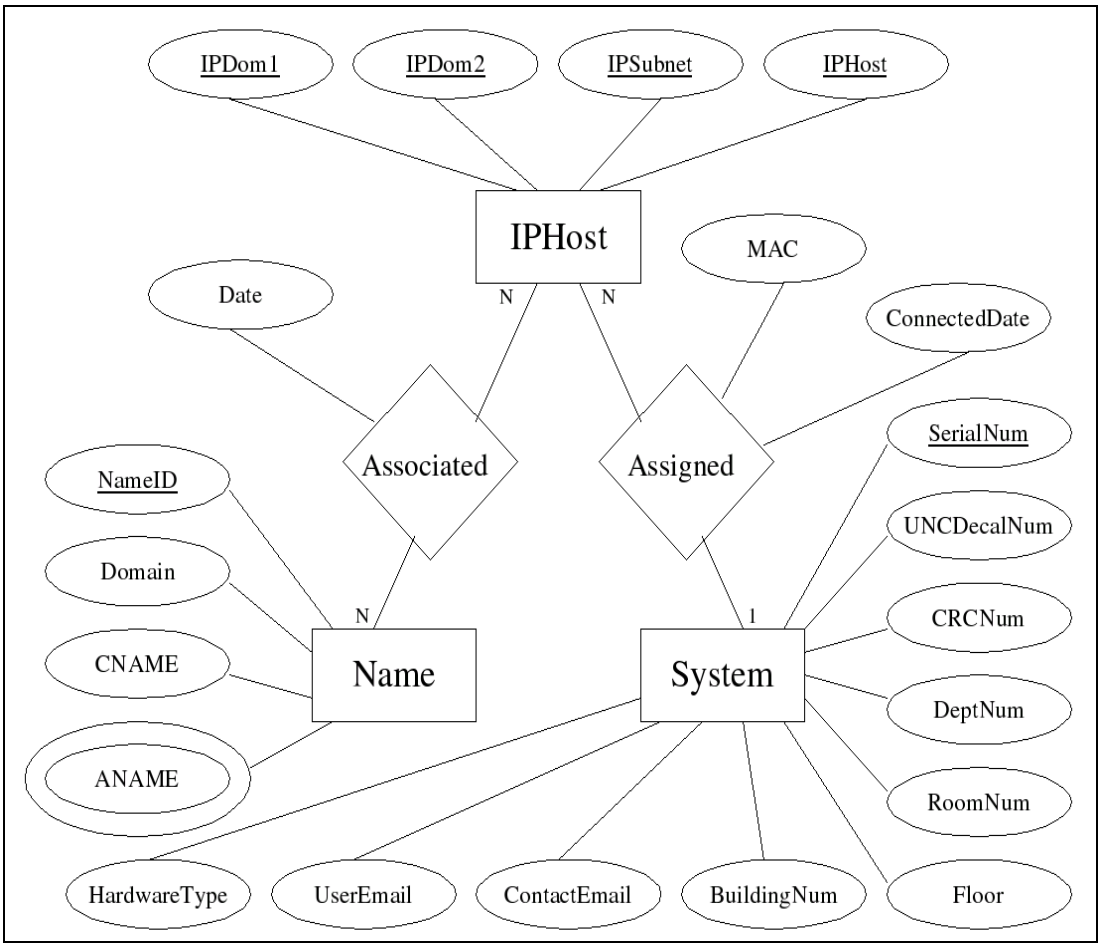


Figure 5: Proposed entity-relationship diagram for the new system. This system will reduce data redundancy and allow for a more flexible structure than the old setup, which used just a single table for storing all IP-related information. In the proposed database, three entities will hold information on 1) IP address (IPHost), 2) system-specific details (System), and 3) hostname information (Name). The System entity can be related to one or more IP addresses based on a MAC address and the date of connection. Therefore, a single system may have more than one IP address. Each IP address can then be related with one or more hostnames based on the assignment date. Conversely, one hostname may be assigned to more than one IP address. This setup if extremely flexible, as it allows for hardware replacement and IP and hostname reassignment without corrupting the database or causing undue burden on the administrator.

Data Dictionary

The following data dictionary describes the attributes outlined above in the new entity-relationship diagram:

Name	Description	Synonyms	Values	Format	Validation Rules
IPHost Entity					
IPDom1	First set of digits in IP Address (NNN.xxx.xxx.xxx)	Network1	152, 172	1-byte unsigned integer	152, 172
IPDom2	Second set of digits in IP Address (xxx.NNN.xxx.xxx)	Network2	2, 19, 23, 31	1-byte unsigned integer	2, 19, 23, 31
IPSubnet	Third set of digits in IP Address (xxx.xxx.NNN.xxx)	Subnet	0 – 255	1-byte unsigned integer	0 – 255
IPHost	Fourth set of digits in IP Address (xxx.xxx.xxx.NNN)	Host	1 - 254	1-byte unsigned integer	1 - 254
Assigned Relationship					
MAC	Twelve Hexadecimal numbers of Hardware Address	MAC Address	000000000000 – FFFFFFFFFFFF	12-digit hexadecimal number	000000000000 – FFFFFFFFFFFF
ConnectedDate	Date (in Epoch time) that an IP address is assigned to a system's MAC address	Date	0 – 2147483647	4-byte signed integer	0 – 2147483647
System Entity					
SerialNum	System vendor's serial number	Serial	Vendor Serial Number	128-byte string	ISO-8859-1 character set
UNCDecalNum	University Decal Number	UNCDecal	University Decal Number	6-character UNC decal number	######
CRCNum	Computer Repair Center Number (AKA Electronics Office Service Center Number)	EOSCNum	C00000 – C99999	6-byte string	C#####
DeptNum	Medical School Department Number		0 – 128	1-byte unsigned integer	0 – 128
RoomNum	Room Number system is located in		Room Identifier	64-byte string	ISO-8859-1 character set
Floor	Floor of building the the room is located on		0 – 32	1-byte unsigned integer	0 – 32
BuildingNum	University Facilities building assigned number		000 – 999Z	4-character facilities code	###?
ContactEmail	Technical Contact for system's email address	TechID	Email Address	128-byte string	RFC 822 email address
UserEmail	User of the system's email address	UserID	Email Address	128-byte string	RFC 822 email address
HardwareType	Generic type of system hardware		System Type	128-byte string	ISO-8859-1 character set
Name Entity					
ANAME	DNS Alias host name		Host Name	24-byte string	RFC 952 host name
CNAME	DNS Canonical host name		Host Name	24-byte string	RFC 952 host name
Domain	DNS Domain of the host name		Host Domain	24-byte string	RFC 921 domain name
NameID	Unique identifier of the Domain and host name combination		0 – 524287	3-byte unsigned integer	Auto-generated
Associated Relationship					
Date	Date (in Epoch time) that an IP address is assigned to a host name		0 – 2147483647	4-byte signed integer	0 – 2147483647

Figure 6: Data dictionary.

Data Migration

This process actually took about 45 days, which is more than twice the time that was anticipated in the original schedule. Most of the time was spent on the data cleanup.

The old data structure in the Ingress database has no constraints defined, which results in many incomplete and duplicate IP records in the table. These data must be corrected before they can be migrated into the new Oracle data tables, in which constraints had

been defined and enforced. This process had to be carried out with extreme care so as to fix these existing problems without introducing new ones. An incorrect IP record results in immediate inaccessibility of the associated network device to the network.

Multiple Perl scripts were developed to facilitate the data cleanup process:

- Run the script to get the data out of the Ingress database and save them into Spreadsheet in the format recognizable to Oracle Import utility;
- Run the script to take out any obvious unused/unneeded records, such as records with no IP field;
- Run the script to screen out any records with incomplete/missing fields, such as MAC address, missing department number, etc. Then support personnel would locate these devices and correct their records in the database;
- Run the script to actually "ping" IPs in the existing records. Any IP, which is unpingable for continuous two weeks during normal semester time, will be reclaimed back to the available IP pool;
- Run the script to get the data out of the Ingress database and import them into the Oracle database.

After the data cleanup process was completed, Oracle Import/Export utility was used to import the data into Oracle tables.

User Interface in the New System

The following interface screen-shots represent an improved IP Management System interface. The new interface is Web-based, which allows for easy access from any browser as well as a familiar, straightforward working environment for support staff.

Figure 7: Login screen for the new Web-based IP Management System. User authentication is done through the School's LDAP server, which essentially is the school's centralized user authentication server.

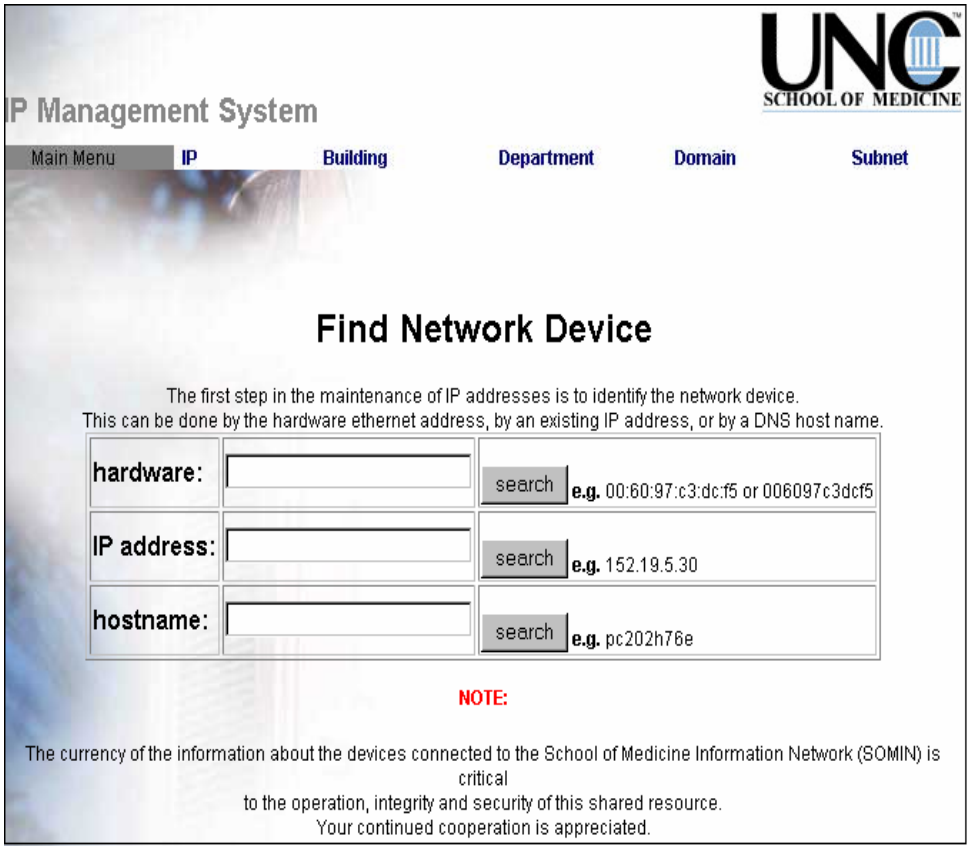


Figure 8: First page after successful login. This screen allows IP record search based MAC address, IP address or device hostname; if this device is not found in the database, the user will be taken to the page in which a new device can be added to the network.

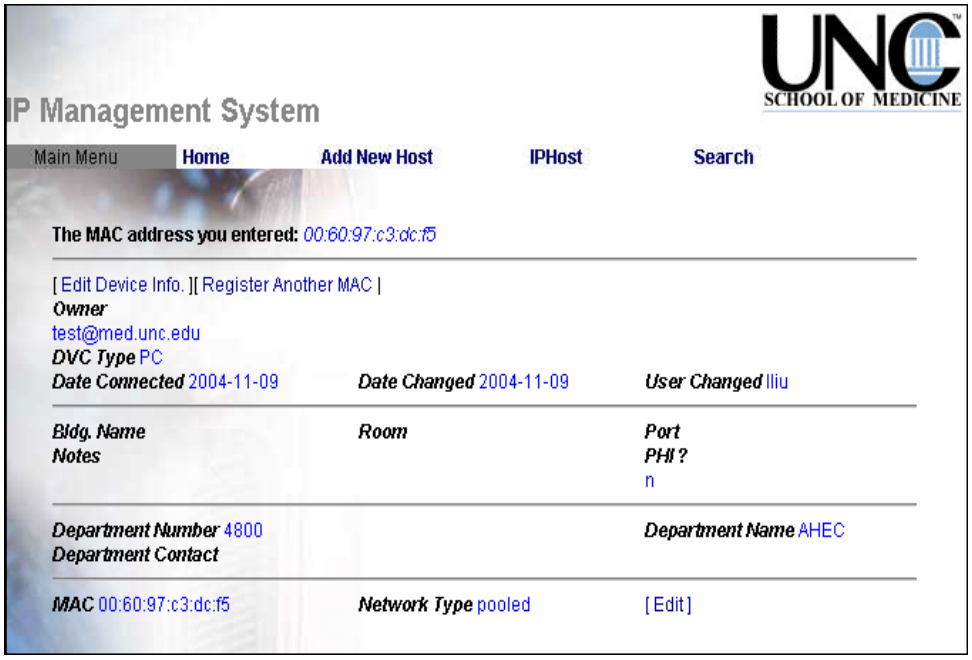


Figure 9: This screen shows the IP record after a successful search based on MAC address. Information about the device can be updated from this page.

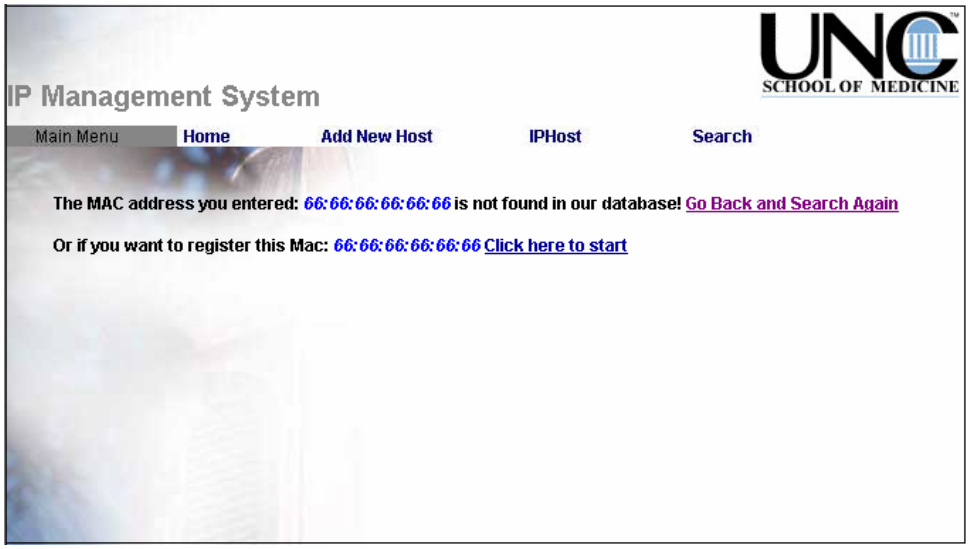


Figure 10: This screen shows no record found for the specified MAC address, but it allows the user to register it from this page if desired.

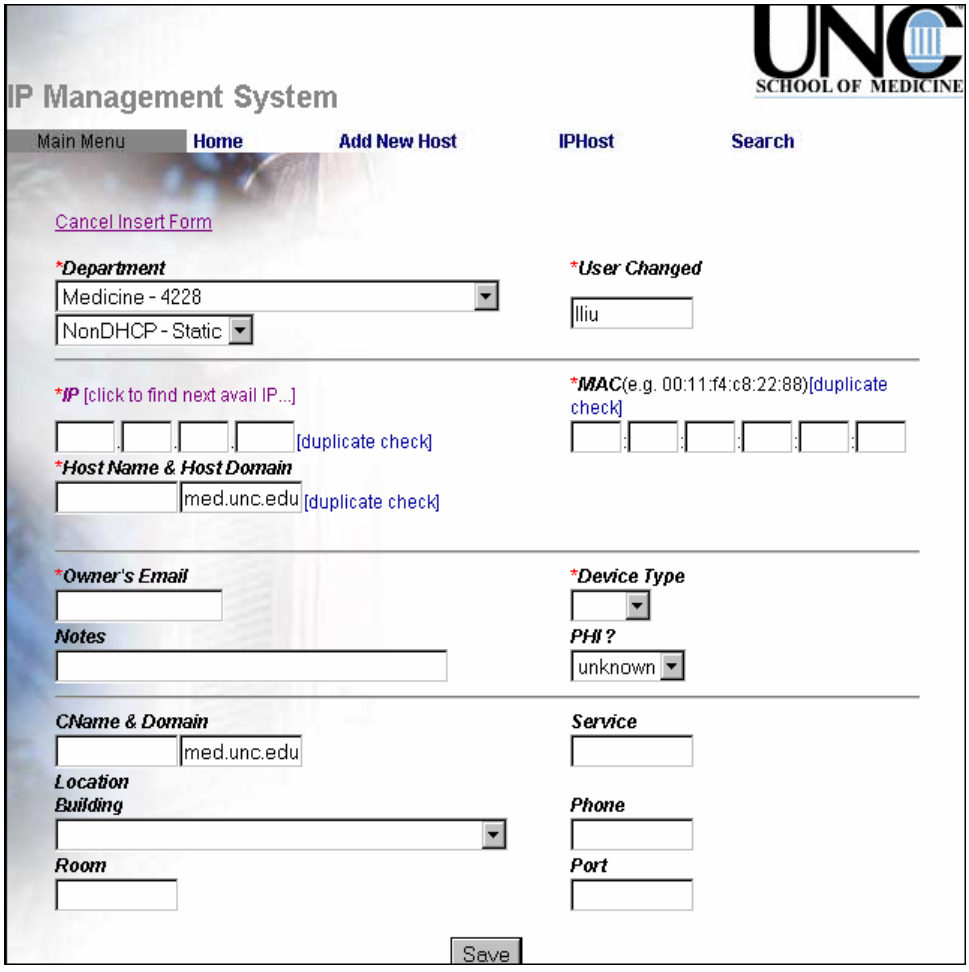


Figure 11: This screen allows IP record additions for non-DHCP type device and can check for IP and MAC address conflict as well.

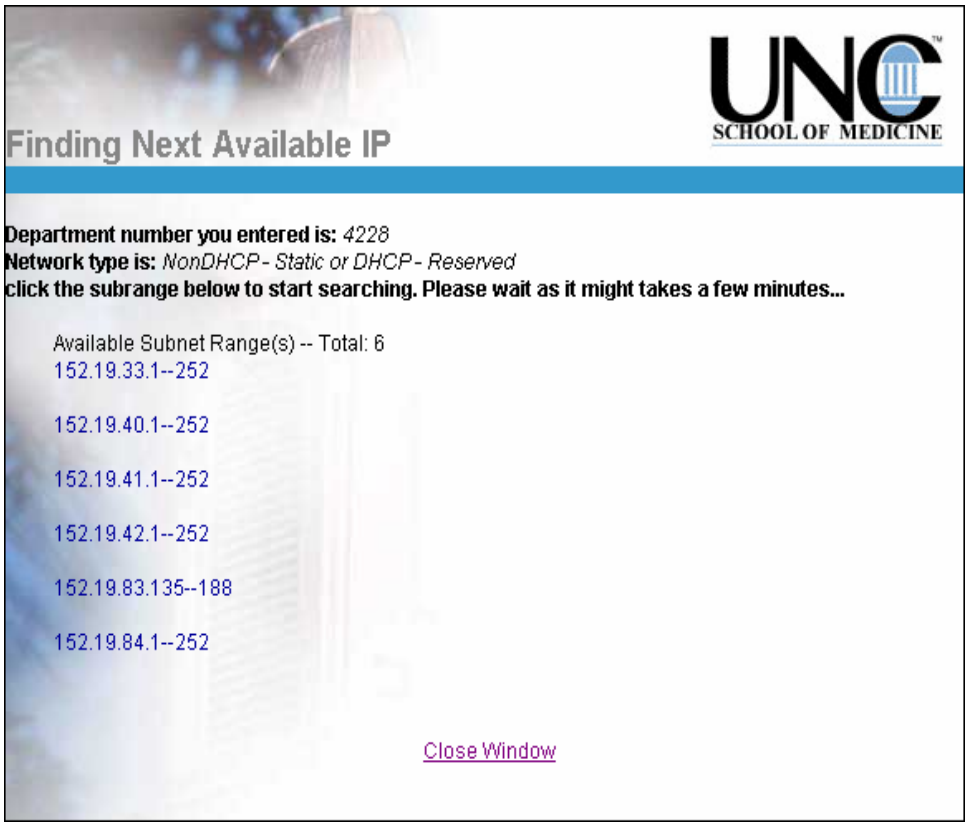


Figure 12: IP search screen. This screen allows the user to find the next available IP address in a particular IP subnet range.

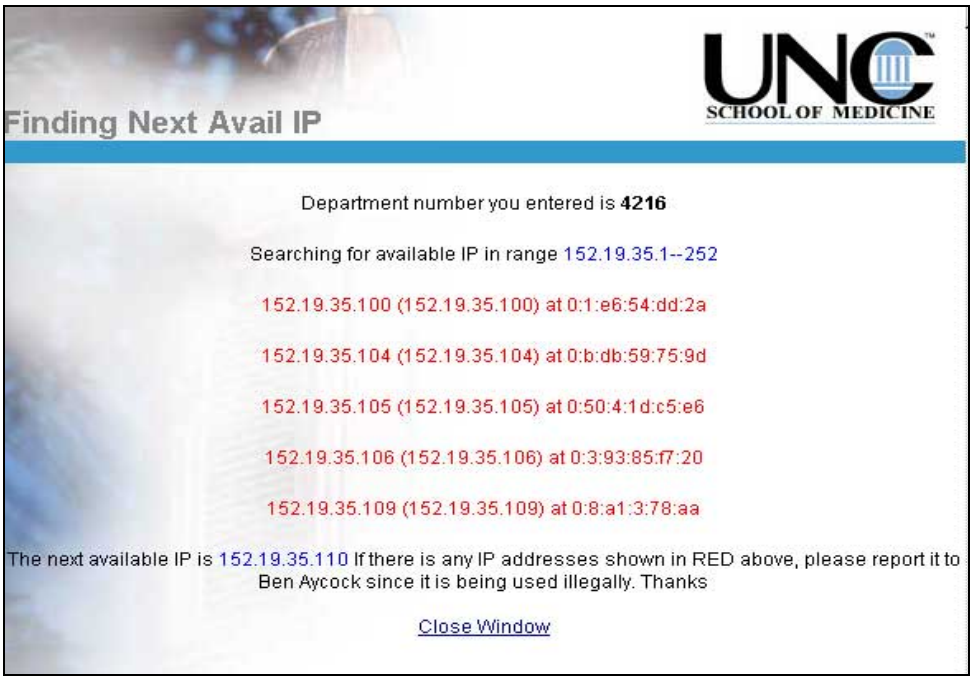


Figure 13: IP search result screen. This screen shows the next available IP address if found and flag any improperly used IP addresses (those that are being used on the network but aren't registered with the system).

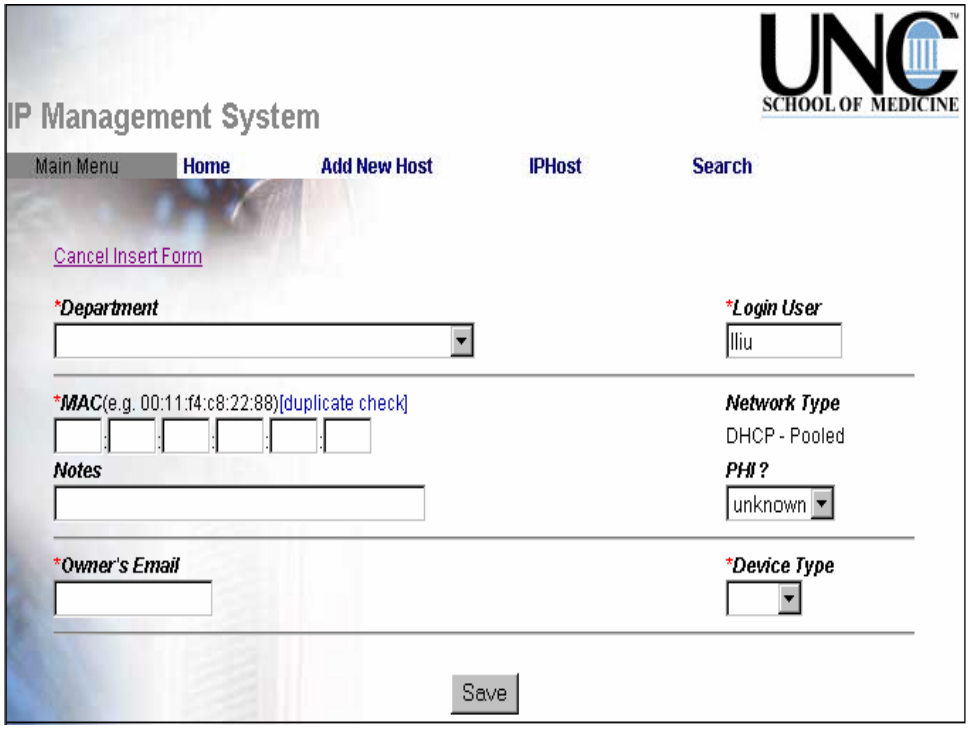
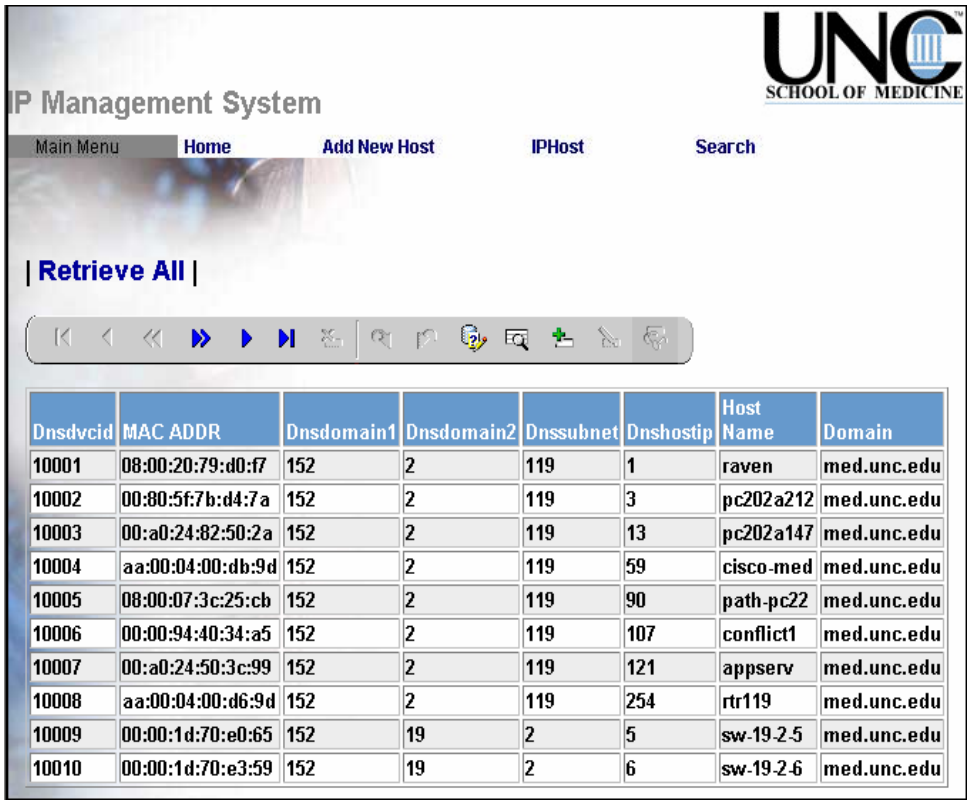


Figure 14: This screen allows IP record additions for DHCP type device, such as laptop, and can check for MAC address conflict.

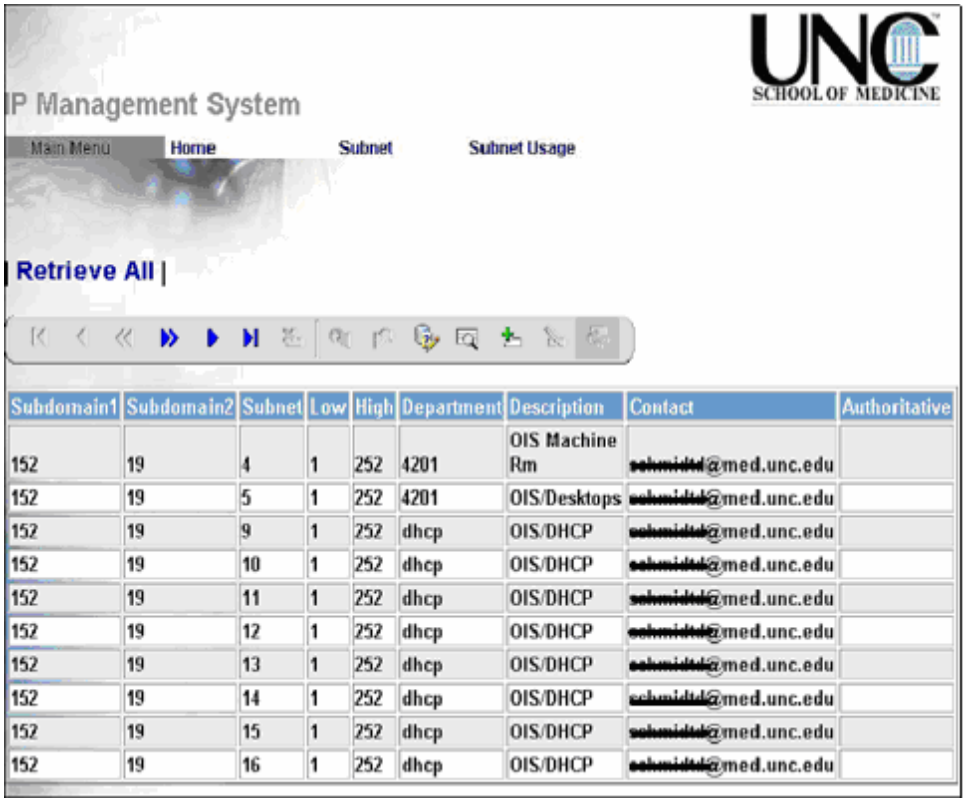


Dnsdvcid	MAC ADDR	Dnsdomain1	Dnsdomain2	Dnssubnet	Dnshostip	Host Name	Domain
10001	08:00:20:79:d0:f7	152	2	119	1	raven	med.unc.edu
10002	00:80:5f:7b:d4:7a	152	2	119	3	pc202a212	med.unc.edu
10003	00:a0:24:82:50:2a	152	2	119	13	pc202a147	med.unc.edu
10004	aa:00:04:00:db:9d	152	2	119	59	cisco-med	med.unc.edu
10005	08:00:07:3c:25:cb	152	2	119	90	path-pc22	med.unc.edu
10006	00:00:94:40:34:a5	152	2	119	107	conflict1	med.unc.edu
10007	00:a0:24:50:3c:99	152	2	119	121	appserv	med.unc.edu
10008	aa:00:04:00:d6:9d	152	2	119	254	rtr119	med.unc.edu
10009	00:00:1d:70:e0:65	152	19	2	5	sw-19-2-5	med.unc.edu
10010	00:00:1d:70:e3:59	152	19	2	6	sw-19-2-6	med.unc.edu

Figure 15: Lookup screen for IP records.

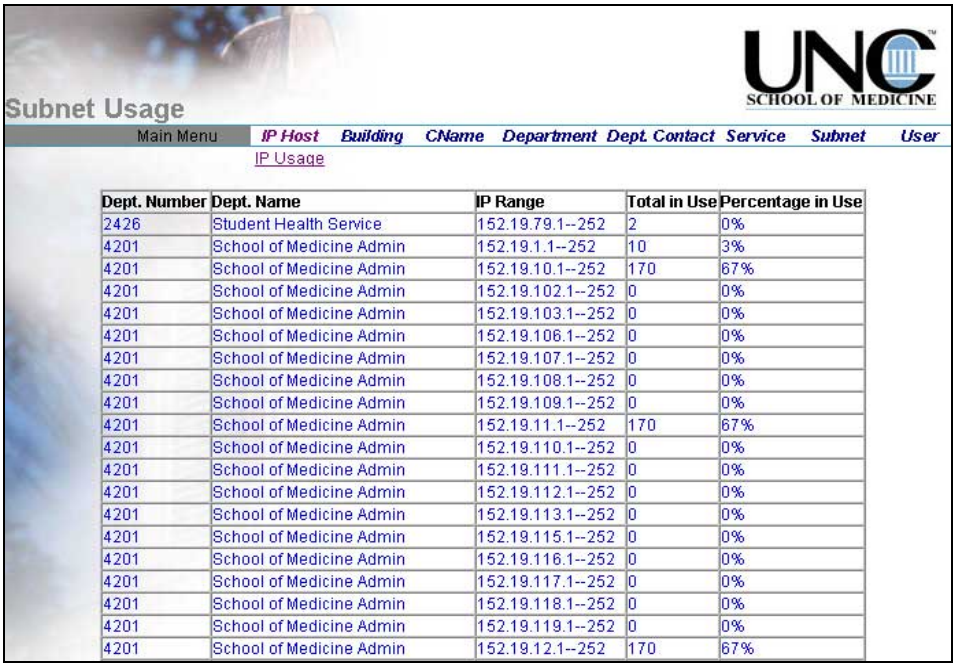
Figure 16: Lookup screen for buildings on campus.

Figure 17: This screen allows the user to edit the building record.



Subdomain1	Subdomain2	Subnet	Low	High	Department	Description	Contact	Authoritative
152	19	4	1	252	4201	OIS Machine Rm	[redacted]@med.unc.edu	
152	19	5	1	252	4201	OIS/Desktops	[redacted]@med.unc.edu	
152	19	9	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	10	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	11	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	12	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	13	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	14	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	15	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	
152	19	16	1	252	dhcp	OIS/DHCP	[redacted]@med.unc.edu	

Figure 18: Lookup screen for IP subnet ranges and associated departments.



Dept. Number	Dept. Name	IP Range	Total in Use	Percentage in Use
2426	Student Health Service	152.19.79.1--252	2	0%
4201	School of Medicine Admin	152.19.1.1--252	10	3%
4201	School of Medicine Admin	152.19.10.1--252	170	67%
4201	School of Medicine Admin	152.19.102.1--252	0	0%
4201	School of Medicine Admin	152.19.103.1--252	0	0%
4201	School of Medicine Admin	152.19.106.1--252	0	0%
4201	School of Medicine Admin	152.19.107.1--252	0	0%
4201	School of Medicine Admin	152.19.108.1--252	0	0%
4201	School of Medicine Admin	152.19.109.1--252	0	0%
4201	School of Medicine Admin	152.19.11.1--252	170	67%
4201	School of Medicine Admin	152.19.110.1--252	0	0%
4201	School of Medicine Admin	152.19.111.1--252	0	0%
4201	School of Medicine Admin	152.19.112.1--252	0	0%
4201	School of Medicine Admin	152.19.113.1--252	0	0%
4201	School of Medicine Admin	152.19.115.1--252	0	0%
4201	School of Medicine Admin	152.19.116.1--252	0	0%
4201	School of Medicine Admin	152.19.117.1--252	0	0%
4201	School of Medicine Admin	152.19.118.1--252	0	0%
4201	School of Medicine Admin	152.19.119.1--252	0	0%
4201	School of Medicine Admin	152.19.12.1--252	170	67%

Figure 19: Usage monitor for each of the School of Medicine's IP subnet range. This screens displays subnet IP usage and can help in administrative network monitoring.

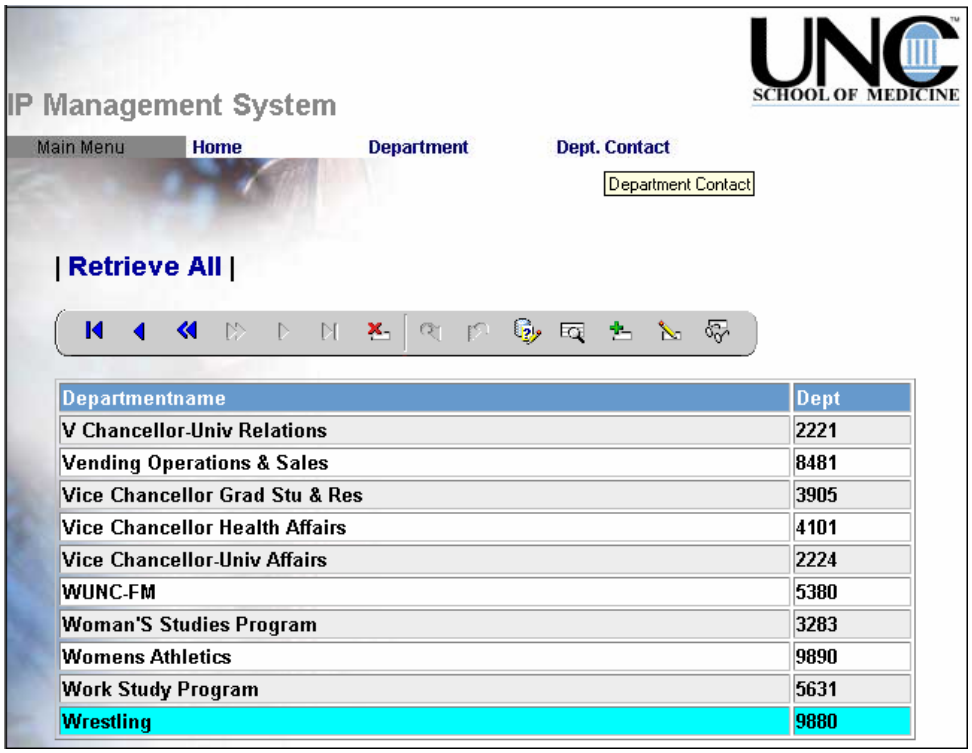


Figure 20: Lookup screen for departments on campus.

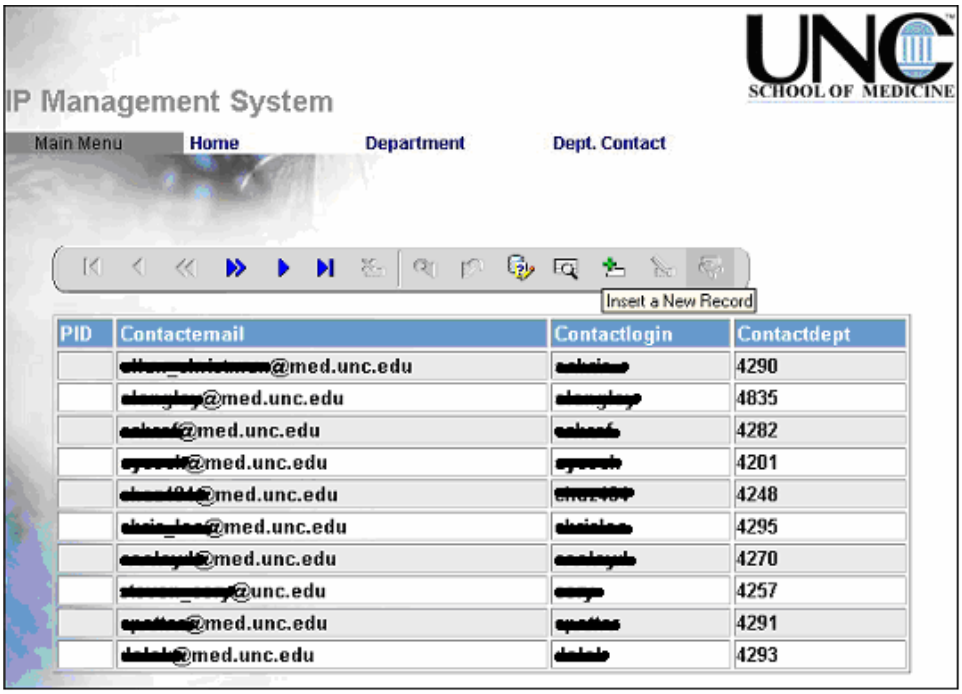


Figure 21: Lookup screen for technical contact person for each UNC-CH department. This lookup screen allows technicians to quickly find whom to contact in case of technical questions regarding a department's systems or devices.

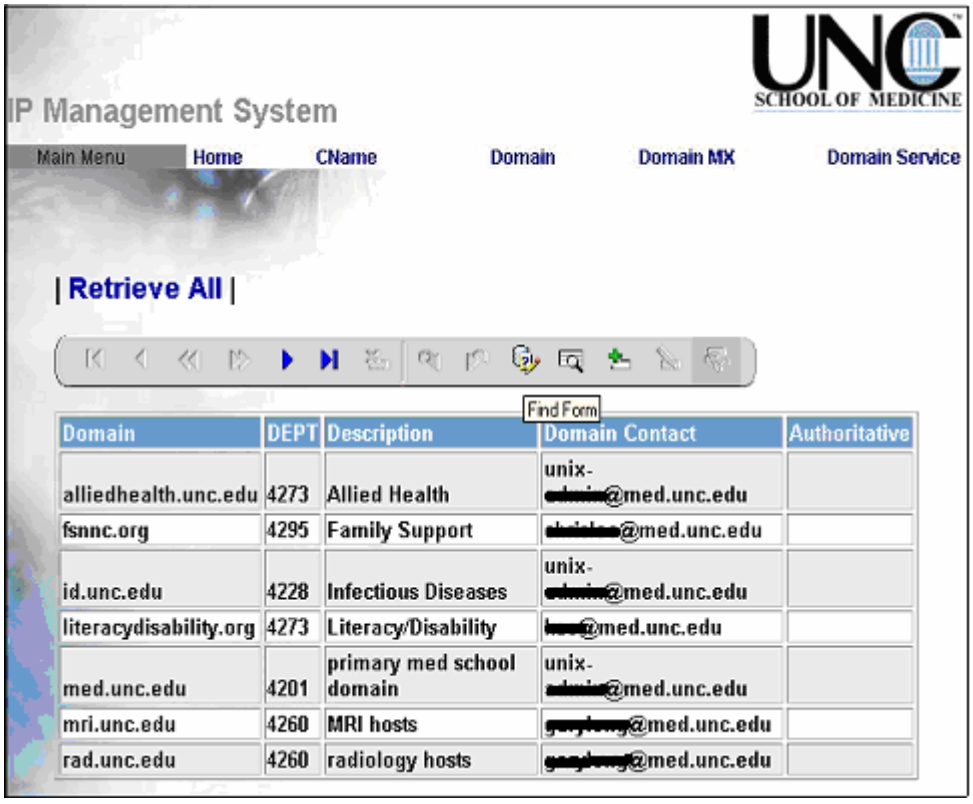


Figure 22: Lookup screen for UNC-CH hosts.

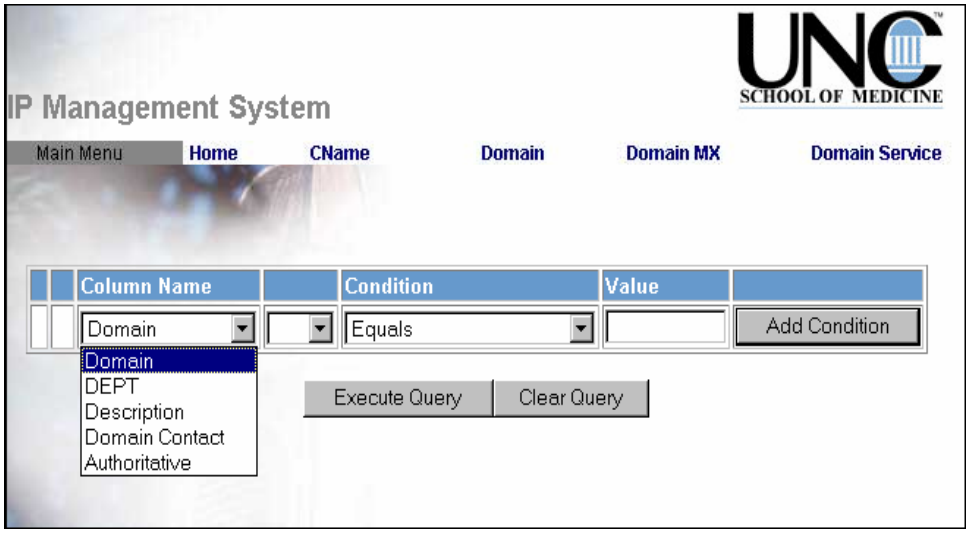
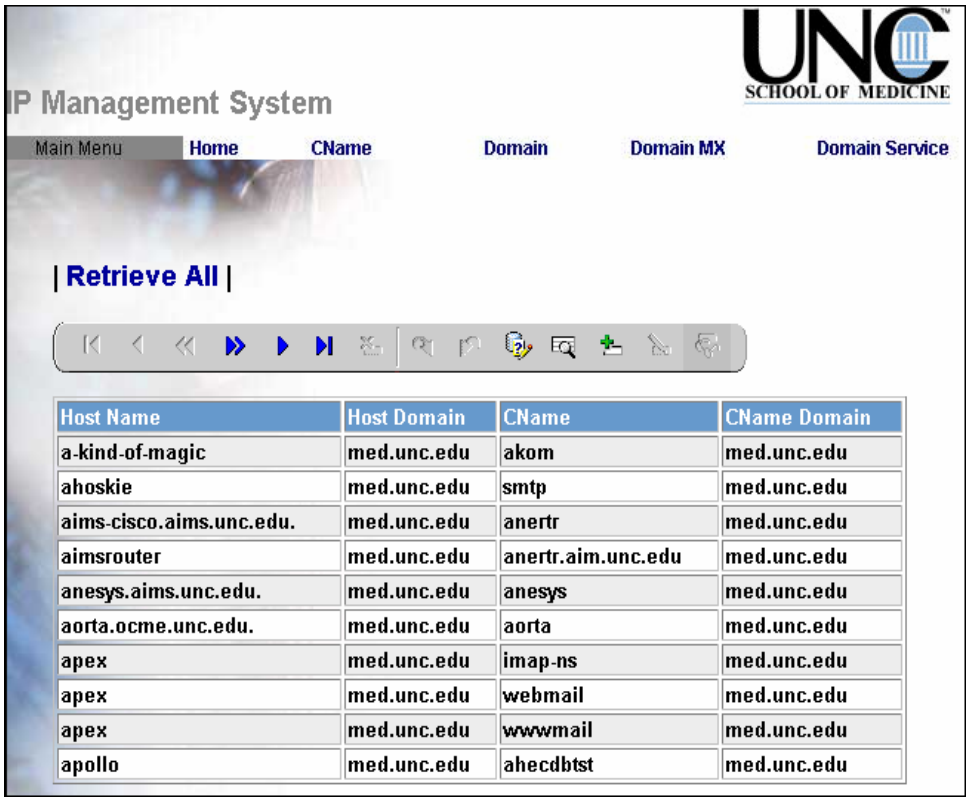


Figure 23: This screen allows the user to search network device based on hostname.



Host Name	Host Domain	CName	CName Domain
a-kind-of-magic	med.unc.edu	akom	med.unc.edu
ahoskie	med.unc.edu	smtp	med.unc.edu
aims-cisco.aims.unc.edu.	med.unc.edu	anertr	med.unc.edu
aimsrouter	med.unc.edu	anertr.aim.unc.edu	med.unc.edu
anesys.aims.unc.edu.	med.unc.edu	anesys	med.unc.edu
aorta.ocme.unc.edu.	med.unc.edu	aorta	med.unc.edu
apex	med.unc.edu	imap-ns	med.unc.edu
apex	med.unc.edu	webmail	med.unc.edu
apex	med.unc.edu	wwwmail	med.unc.edu
apollo	med.unc.edu	ahecdbtst	med.unc.edu

Figure 24: Lookup screen for UNC-CH hosts and their associated DNS canonical names and aliases, as listed in the database.

Part 4. Testing and Deployment

The system tests were performed according to the test cycles specified in the system test plan. For each test case the output was compared to the expected results. All differences were investigated thoroughly, if necessary, changes were made to the system and the relative part or parts of it were regenerated and tested again. This process was repeated until there were no discrepancies between actual system test output and expected output, or until any remaining discrepancies were understood and approved by the users. Additionally, usability testing was performed to make sure that the system meets the usability criteria required by the users.

It turned out that the plan to let technical support personnel use both old and new systems in parallel in the testing phase whenever a new IP request comes in was really effective and successful. The number of problem identified and corrected accordingly during this phase justified the extra work time, and it ensured a well-tested system, which is ready for deployment as scheduled.

Deploying systems in an enterprise environment can be a time-consuming and cumbersome task. Fortunately, Oracle provides tools to help in the deployment process in an enterprise environment quickly and effectively with minimal downtime.

Oracle JDeveloper provides a comprehensive Java and Web service development and deployment framework, which produces J2EE application optimized to run with the Oracle Application Server and Oracle Database. The new IP Management System was developed within the Oracle JDeveloper3.2.3 framework, and was deployed onto Oracle 8i database directly from the JDeveloper. The process to update the files on the Oracle database server from JDeveloper is easy and quick as well. It could be done remotely in a few seconds, even without any interruption to the normal database server operations.

The new system user interface was developed in JDeveloper3.2.3 on Window 2000, and was deployed to the Oracle HTTP server on Unix (Sun Solaris). Oracle HTTP server is part of the Oracle Database server package, and is optimized to run Java code against an Oracle Database. A deployment profile was generated in JDeveloper after the user interface was built, and it was used to facilitate the deployment process.

Part 5. Conclusion and Summary

In the following sections, the issues that arose during the study and some of the lessons learned from it will be discussed.

Potential Issues with the New System

It is fortunate that the users of the IP Management System all have technical knowledge. They generally enjoy new computer-based tools, and, unlike some other non-technical staff members, will not be threatened or afraid to learn a new system. The interviews confirmed that the support staff was especially anxious to move to an improved system; they are tired of struggling with the old text interface and dealing with workarounds. However, reactions to a system change were not equally enthusiastic throughout the organization. The Unix systems administrator, who is currently the most influential stakeholder in the IP Management System, does not see a pressing need for a new system. In his view, the current interface is perfectly usable, and the database has been stable and should be adequate. He bases his opinion on two points: the current system works, and it has been functioning reliably for many years.

This conflict of opinion between the client support personnel and the systems administrator can best be described as a culture clash. The support staff – the “services” people – must quickly handle requests from non-technical users, so they want a friendly

user interface and are not interested in the inner workings of the system (i.e., the database structure). The “systems” people, on the other hand, are very concerned with backend details, and they value the power that a textual interface offers.

Though this type of culture clash could lead to complete project failure in other situations, it turned out not a major problem for the School of Medicine. The Unix systems administrator understands why a new system would be beneficial, and, according to the interview with him, he will support development. However, as the developer, it is important to certainly be aware of how the needs and opinions of the “systems” staff differ from those of the client support staff. Awareness of this culture clash can help make switchover to a new system smoother, as the developer can anticipate end user reactions and be ready to address their concerns.

Lessons Learned

During this study, its scope was changed drastically from the beginning to the end. When it was started, the School of Medicine just needed some database migration work and interface streamlining. The initial information gathering indicated that there were indeed problems with the database structure. And further research and interviews revealed that the current data model was worse than expected, and necessitated a completely new approach. Moreover, the only way to fix the interface was to do a total overhaul, because the existing technology base would not support the development of a more advanced, Web-accessible interface. During interviews, new user needs were identified, such as the ability to create reports on the fly.

Therefore, this study moved from a relatively simple exercise in interface streamlining and database migration to a much larger systems development plan. So it is very important to anticipate that system scope can be much larger than the initial problem definition might suggest. This is an important point to take into consideration when approaching systems analysis and development, because it can considerably change the cost, time, and skills required to solve a problem.

Part 6. Bibliography

Alan Daughetee, Zain Kazim, Simplifying System Deployment, http:// http://www.dell.com/downloads/global/power/ps4q04-20040147-Daughetee.pdf.

Craig Larman, Applying UML and Patterns – An Introduction to Object-Oriented Analysis and Design, Prentice Hall, (1997).

David Flanagan, JavaScript – The Definition Guide, O'Reilly & Associates, Inc., (1998).

Duane Fields, Mark Kolb, Web Development with Java Server Pages – A Pratical Guide For Designing and Building Dynamic Web Services, Manning, (2000).

Julien Dubois, Master and Commander – Mastering J2EE Application Development Series, Oracle Technology Network, http://www.oracle.com/technology/pub/articles/masterj2ee/j2ee_wk2.html.

Kevin Loney, George Koch, Oracle9i – The Complete Reference, Oracle Press, (2002).

Paul Albitz, Cricket Liu, DNS and BIND, O'Reilly & Associates, Inc., (1992).

Paul Dorsey, Peter Koletzke, Oracle JDeveloper 3 Handbook, Oracle Press, (2001).

Larry Constantine, Lucy Lockwood, Software for Use – A Practical Guide to the Models and Methods of Usage-Centered Design, Addison-Wesley, (1999).

Louis Rosenfeld, Peter Morville, Information Architecture for the World Wide Web, O'Reilly & Associates, Inc., (2002).

Martin Fowler, Kendall Scott, UML Distilled – A Brief Guide To The Standard Object Modeling Language, Addison-Wesley, (2000).

Seth White, Maydene Fisher, Rick Cattell, Graham Hamilton, Mark Hapner, JDBC API Tutorial and Reference – Universal Data Access For The Java 2 Platform, Addison-Wesley, (1999).

Raghu Ramakrishnan, Database Management Systems, WCB/McGraw-Hill, (1998).

Randal Schwartz, Tom Christiansen, Learning Perl, O'Reilly & Associates, Inc., (1997).

Richard Monson-Haefel, Enterprise Java Beans, O'Reilly & Associates, Inc., (2000).

Timothy Howes, Mark Smith, LDAP – Programming Directory-Enabled Application with Lightweight Directory Access Protocol, Macmillan Technical Publishing, (1997).