Establishing Radiologic Image Transmission Via a Transmission Control Protocol/Internet Protocol Network Between Two Teaching Hospitals in Houston

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The technical and management considerations necessary for the establishment of a network link between computed tomography (CT) and magnetic resonance imaging (MRI) networks of two geographically separated teaching hospitals are presented. The University of Texas Medical School at Houston Department of Radiology provides radiology residency training at its primary teaching hospital and at a second county-run hospital located approximately 12 miles away. A direct network link between the two hospitals was desired to permit timely consultative services to residents and professional colleagues. The network link was established by integrating the county hospital free-standing imaging network into the network infrastructure of the Medical School and the main teaching hospital. Technical issues involved in the integration were reassignment of internet protocol (IP) addresses, determination of data transmission protocol compatibilities, proof of connectivity and image transmission, transmission speeds and network loading, and management of the new network. These issues were resolved in a planned stepwise fashion and despite the fact that the system has a rate-limiting T1 segment between the county hospital and the teaching hospital the transmission speed was deemed suitable. The project has proven successful and can provide a guide for planning similar projects elsewhere. It has in fact made possible several new services for the teaching and research activities of the department's faculty and residents, which were not envisaged before the implementation of this connection.

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THE DEPARTMENT of Radiology faculty of the University of Texas Medical School at Houston provides radiology services and radiology residency training to more than 40 residents per year at Hermann Hospital, its primary teaching hospital, and at the Lyndon B. Johnson Hospital (LBJ Hospital), a part of the Harris County Hospital District (HCHD), which is located approximately 12 miles away. The Medical School is a division of the University of Texas Health Science Center at Houston (UTHSC).

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A direct transmission control protocol/internet protocol (TCP/IP) network link between the two teaching hospital's computed tomography (CT) and magnetic resonance (MR) imaging networks was desired to permit timely consultative services for residents and professional colleagues. The network link would be established by integrating the LBJ Hospital free-standing imaging network into the existing network infrastructure at LBJ Hospital, which already had a TCP/IP network connection to UTHSC, the Medical School, and Hermann Hospital. An additional consideration was that the LBJ Hospital imaging network was already connected to the imaging network at Ben Taub Hospital, HCHD's other public hospital.

MATERIALS AND METHODS

The network equipment and services available were well defined; however, the successful establishment of the network connection required attention to both technical and management issues.

Equipment

10 Base T (twisted pair) Ethernet service, General Electric Advantage Windows workstations (General Electric Medical Systems, Milwaukee WI), Cisco Systems 2800 series hubs (Cisco Systems, San Jose, CA), and T1 service were in place and functional at both county hospitals. GE workstations were also used at Hermann Hospital. Image transmission between the two county hospitals was already available on a routine basis for consultative purposes and in cases involving patient transfer between the two facilities.

Technical Issues

Many GE workstations use router information protocol (RIP) to establish network connections between workstations. As a matter of policy, the RIP is not used on the UTHSC network and would not be available following the integration of the LBJ Hospital imaging network into the UTHSC network. It was essential to determine as early as possible if RIP was indeed required.

The IP addresses of all of the CT, MR, film printers, and network equipment on both the LBJ Hospital and Ben Taub Hospital imaging networks would have to be changed to conform to the class B IP address space used by (UTHSC). This was necessary because the IP addresses assigned to the isolated imaging networks at both county hospitals were fabricated and were not compatible with those in use by the UTHSC or Hermann Hospital.

An examination of the main router at LBJ Hospital and the

hub serving the LBJ imaging network showed that a simple Ethernet link between the two would permit network traffic to move from the imaging network to the main UTHSC network. The appropriate workstation-to-workstation communication protocols would be determined empirically.

Management Issues

The proposed network linkup would cross three political boundaries: Harris County Hospital District, UTHSC, and Hermann Hospital and required the assistance of GE Medical Systems technologists. The cooperation of the technical and management staffs of the various institutions would be essential for successful implementation. The names and affiliations of those involved in the project are listed in the Acknowledgment.

RESULTS

Technical Issues

To determine if the RIP protocol was required for workstation-to-workstation transmission, we temporarily connected an Advantage Windows workstation to the main network at LBJ Hospital and attempted to push studies to it from a similar workstation located at Hermann Hospital. This experiment was successful with CT and MR studies and because the RIP protocol is not in use over the network path between Hermann Hospital and LBJ Hospital we had demonstrated that RIP was not required.

Before connecting the isolated imaging network to the main network, the IP addresses of all equipment on both the LBJ Hospital and Ben Taub Hospital networks were changed. One subnet was assigned to the hubs for each hospital's network, a separate subnet was assigned to the imaging network at each hospital, and a fourth subnet was used for the CT array processors at Ben Taub Hospital. This work was carried out by GE Medical System's service personnel and to minimize disruption of service the work was done during off-hours. As expected, changing the IP addresses of the equipment did not affect their network functionality or disturb image transmission between the county hospitals.

The actual linkup of the county hospital imaging network and the main network was achieved via an Ethernet connection between the hub serving the LBJ Hospital imaging network and the router at LBJ Hospital. The router already provided network connectivity to the Medical School and Hermann

Hospital via the UTHSC network. Immediately following this connection, the routers belonging to the UTHSC network were updated to route traffic to and from the imaging networks.

Proof of connectivity between workstations at Hermann Hospital and LBJ Hospital was demonstrated by pushing and pulling studies between the two hospitals. The GE SdCNet protocol was used.

Management Issues

Most of the management issues involved identifying the key technical and managerial personnel at each institution and making them aware of the project and its goals. Without exception, all involved agreed on the clinical and educational benefits to be derived from the connection.

DISCUSSION

The project has proved successful in permitting the exchange of CT and MR images between hospitals and it also provides an opportunity to capture individual images or entire image series for use in the preparation of teaching materials. Image capture for teaching using the Digital Jacket (DesAcc, Inc, Chicago, IL) software¹ was recently described at the 1998 Radiological Society of North America Annual Meeting by this author.

Because the UTHSC provides the IP address space and maintains the routers required for the image net connection, we assign IP addresses and control network access to all equipment installed on the image networks at both JBJ Hospital and Ben Taub Hospital. The author of this report currently manages these activities.

Security for the imaging networks is provided at the router level. Outbound routing information is not provided and the routes to the imaging network are not published by UTHSC routers. Connections are permitted only from specified devices with known IP addresses. Network protocols such as telnet and file transfer protocol (FTP) are also filtered out at the router, except between allowed external devices.

The key to the success of this project was dealing with the technical and management issues one step at a time. It is important to identify the key technical and managerial personnel involved in the project and the key technical problems to be solved. Above all, a large degree of patience is required. This project, which had been in various phases of

discussion for 2 years, required 6 months to complete.

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REFERENCE

1. Huynh SL, Tamm EP, Ernst RD, et al: Creating a window into DICOM: How to access DICOM material for teaching (non-DICOM) applications. Proceedings of the Radiological Society of North America, Annual Meeting, Chicago, IL, November 1998