The DICOM Standard

Universal Connectivity:
Now and Tomorrow

RSNA | Radiological Society of North America
Founded in 1915

Table of Contents

DICOM 1

DICOM Background 2

Comments from Dr. Ackerman 3

DICOM Applications 4-5

DICOM Implementation 6-7

Digigraphs *6*

Department of the Future *6*

Imaging Studies *7*

International Acceptance 7

How to Obtain a Copy of the DICOM Standard 7

How to Obtain a Copy of the Implementation Software 7

DICOM Exhibitors 8

Digital Imaging and Communications in Medicine

DICOM is the industry standard for transferring medical images and related information between computers. DICOM allows digital communication between diagnostic and therapeutic equipment from different manufacturers.

Cornerstone for Tomorrow's Radiology

As the pressure mounts for health care cost containment, DICOM will play a valuable role in radiology. Health care delivery systems in the United States continue to shift from retrospective fee-for-service payments to the broadly encompassing prospective payment structure of managed care. This shift presents radiology with new challenges: providing radiology services over great distances or within facilities, increasing the effective use of existing resources, and ensuring compatibility of new equipment and systems. DICOM will help radiologists meet these challenges.

At RSNA '94, participating DICOM demonstrators were identified by banners displayed above their exhibits.

The Need for an Information-Interchange Standard

During the past two decades, as computers became an integral part of radiology, image output was in a format unique to the vendor of the hardware and software. The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) realized that the purchase of a digital imaging network meant a commitment to that same vendor's products. Consequently, medical centers would not be able to take advantage of innovative improvements offered by competing companies nor were they in a position to negotiate price with the original supplier. That all began to change in 1992.

RSNA '92

The first public exhibition of the DICOM standard proved that universal compatibility between different types of computers was possible. Representatives of various vendors in radiology convened at the perimeter of the demonstration area in the middle of *info*RAD and sent images electronically with their own computer hardware to a central test node.

RSNA '93

The DICOM exhibit showed how the standard had been enhanced with greater functionality. Communication was now possible with other hospital systems and support networks rather than on a point-to-point basis. Also, the RSNA created RSNAnet, the newly installed local fiber-optic cable network connecting the exhibit areas of the North and East buildings of McCormick Place.

RSNA '94

RSNAnet became a totally distributed, as opposed to a centralized, network. As a result, exhibiting companies could show the advantages of DICOM by transmitting scientific information (text and images) between booths, as well as to anyone outside of McCormick Place that was connected to the Internet.

The development and enhancement of the DICOM standard since the early 1990s have given medical institutions the ability to communicate, internally and externally, regardless of type of equipment used. As a result, departments have become more productive, which translates into high-quality, cost-effective health care.

The Importance of Connectivity

As head of the RSNA Electronic Communications Committee, Laurens V. Ackerman, MD, PhD, from Rush-Presbyterian St. Luke's Hospital in Chicago, has been closely involved with the development of the DICOM standard. He talks about DICOM and its role in radiology.

On computer compatibility:

"I have always emphasized the concept of connectivity. Connectivity has led to networks—workstations hooked to the networks, to DICOM, and to the Internet. Through DICOM and the RSNAnet, the entire RSNA meeting is connected, internally and externally."

On the dual nature of DICOM:

"It not only sets up interchange standards so you can receive data on a variety of electronic devices, it establishes a formatting standard so that whatever data you generate and send can be accessed by others using different devices."

On a goal realized:

"Radiologists wanted to be able to buy a piece of equipment, connect it to a network, and have that equipment interact with other machines inside and outside of the department. DICOM made that happen."

Laurens V. Ackerman, MD, PhD, chairs the RSNA Electronic Communications Committee.

NEMA Seminar Offers Insights

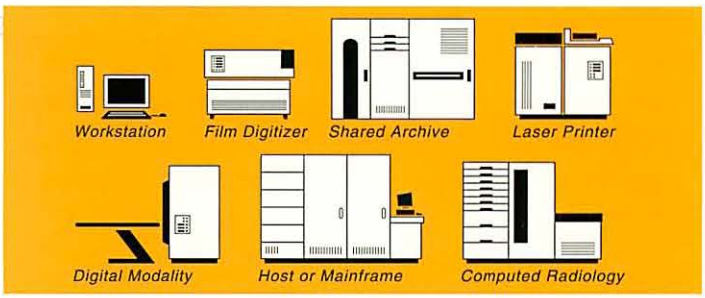
Details about the further development, implementation, and formal adoption of the DICOM standard will be the focus of the NEMA seminar, entitled "DICOM: The ACR-NEMA Standard Revisited," to be held Tuesday, November 28, 1995, 4:00–6:00 pm in Room N226 (M2), McCormick Place North. All RSNA '95 attendees are invited.

The Promise of Flexible Applications

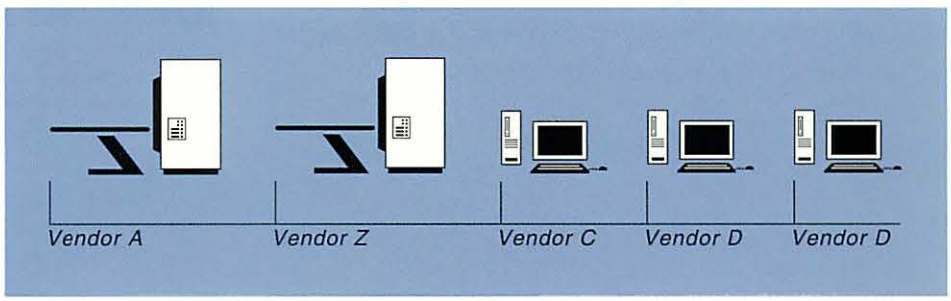
The icons, shown on these two pages, represent a wide range of equipment and systems. The intent is to help illustrate DICOM's flexibility to address your applications. You and your institution should view these drawings as basic explanations of the connectivity provided by DICOM and how it will affect the entire field of radiology.

The following configurations show a few of the popular multi-vendor, multi-user applications made possible by the DICOM standard.

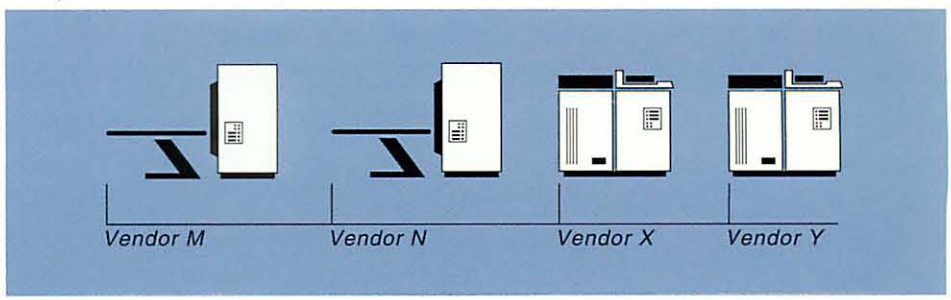
Equipment Key



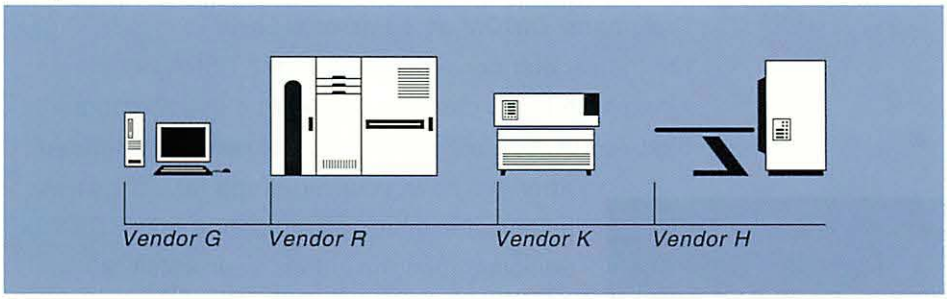
Hospital A: Multi-Vendor Modality and Workstation Integration



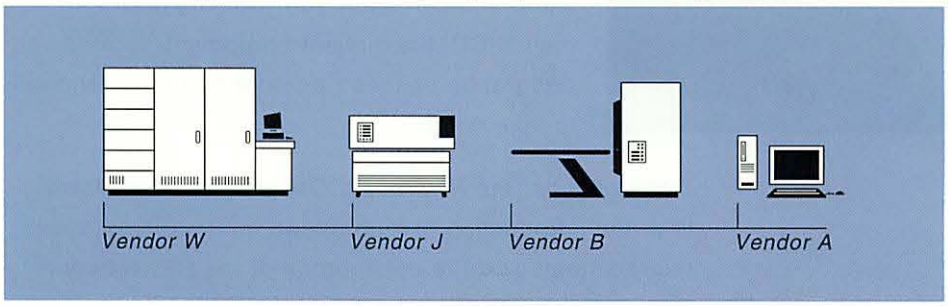
Hospital B: Printer Network



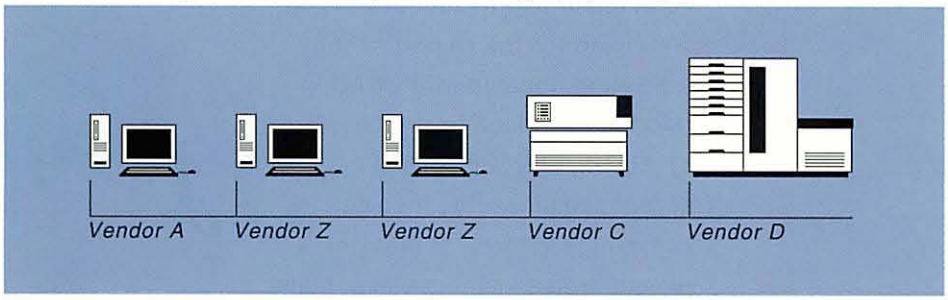
Hospital C: Shared Archive



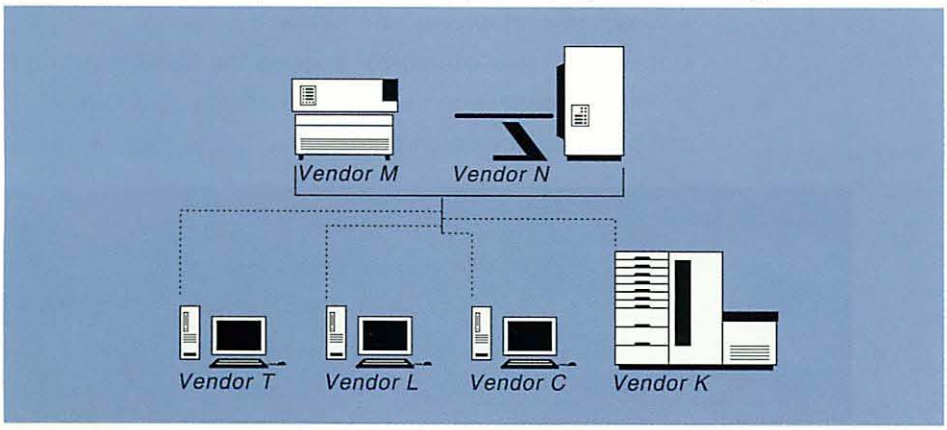
Hospital D: Integration with other (HIS/RIS) Information Systems



Clinic: Film Digitizer and Computed Radiography Image Distribution



Remote Connectivity: Mobil, Remote, or Deployable Radiology Units

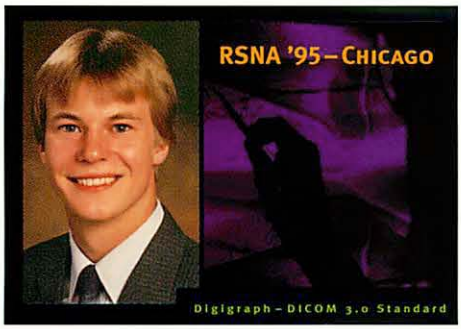


Major Tool for the Architects of the Future

The potential uses of the DICOM standard for radiology are being displayed today at RSNA '95.

Digigraphs: DICOM on a Personal Level

For the second consecutive year, the RSNA will set up kiosks with video cameras that will be used to obtain digitized photos, or "digigraphs," of meeting attendees.



After you have your digigraph taken, visit any technical exhibitor participating in the DICOM demonstration, give them your RSNA '95 badge number, and ask them to retrieve your digigraph. By using the RSNAnet, the exhibitors can show you your digigraph on their DICOM-compliant equipment. Printed digigraphs can also be obtained for attendees to take home.

Department of the Future: DICOM and the New Vision

With the introduction of high-speed information systems, teleradiology, and the acceptance of the DICOM standard, the traditional perceptions of a radiology department are changing. Future concepts, equipment, and techniques will be showcased in the Department of the Future, located in *info*RAD (McCormick Place North, Level 1). The display will consist of four scenarios: the medical community in times of disaster, a remote breast imaging clinic, home health care of a patient recovering from pneumonia, and a neuroradiology center. A video presentation will be followed by enactments of the four scenarios, offering the RSNA meeting attendee a chance to see highly technical, DICOM-compliant equipment in action.

radiology department of the *future*

The four scenarios representing the Department of the Future: times of disaster, remote breast imaging, home health care, and a neuroradiology center.

Imaging Studies:

DICOM and Its Impact on the Vendor-Buyer Relationship

An increasing number of technical exhibitors consider the RSNA meeting their best opportunity to show that their equipment is DICOM-compliant. This year, 40 exhibitors will be part of the DICOM standard demonstration. By interfacing with the RSNA-DICOM image server, these exhibitors can gain access to a common set of medical images, which they can show you on their equipment. Vendors will be able to display, store, query, retrieve, move, and print the data. The medical images, supplied by academic institutions and commercial vendors, include examples from CT, MR imaging, US, and CR. A list of the images is shown to the left.

International Acceptance

NEMA, a member of the American National Standards Institute (ANSI), participates in close cooperation with the ACR in the Healthcare Informatics Standards Planning Panel (HISPP). ANSI, in turn, is a member of the International Standards Organization (ISO). ANSI and The European Committee for Standardization Technical Committee on Medical Informatics (CEN TC 251) are cooperating to develop and implement the standard for digital imaging and communication. The Japan Industries of the Association of Radiation Apparatus (JIRA) are also supportive of international cooperation in standards development.

How to obtain a copy of the DICOM Standard

Copies of the DICOM standard will be on display at the DICOM Digigraph stations located at the entrances to the technical exhibit halls and in *info*RAD. Copies of the standard can also be obtained by sending a written request to: NEMA, c/o David Snavely, 2101 L Street, NW, Suite 300, Washington, DC 20037; telephone (202) 457-1965.

How to obtain a copy of the Implementation Software

The 1995 demonstration implementation software will be available after March 1996 through the RSNA Link at http://www.rsna.org/edu/dicom.html. For further information, contact the RSNA Department of Informatics, 2021 Spring Road, Suite 600, Oak Brook, IL 60521; telephone (708) 571-7810.

1995 Image Set

Mary Smith
Breast ultrasound,
Intraductal pappiloma

Kevin Wallach
Spinal cord ultrasound,
Normal exam

Lucy Krandell
Liver ultrasound,
Echinococcal cyst

Sam Weyman
Cardiac ultrasound,
Endocarditis

Hanako Tanaka
Upper GI,
Gastric carcinoma

Momoe Kobayashi
Tibia AP,
Non-ossifying fibroma

Toshiaki Ito
Chest PA,
Lung carcinoma

Takanori Nagashima
Chest PA,
Normal PA chest x-ray

Peter Offenmuller
ERCP,
Normal ERCP

Anna Neubauer
MRI: Pelvis,
Cervical carcinoma

Anna Schmidt
MRI Angiography: Renal,
Renal artery stenosis

Peter Baum
Myelogram,
Herniated disk

Anna Baumann
MRI: Brain with and without contrast,
Pituitary macroademona

Anna Cotta
CT Angiography: Renal,
Normal renal CTA

Anna Kraemer
CT: L-Spine,
Lumbar spine compression fracture

Margret Napper
Ultrasound: Right lower quadrant,
Appendicitis

Kenneth McAfee
Ultrasound: Liver,
Hepatic artery aneurysm

Laura Henderson
Ultrasound-OB,
Gastroschisis

Kathy Probst
CT angiogram: Brain,
Arteriovenous malformation

Laurie Pritchet
CT angiography: Renal,
Renal artery stenosis

Jerry Gale
Renal scan,
Normal real perfusion examination

James Long
Total body bone scan,
Normal bone scan

Nicole Bailey
MRI: Cervical spine,
Normal cervical spine

Jennifer Thomas
MRI: L-spine,
Lumbar spine disk bulge

Harold R. Smith
CT: Spiral angiography of the thorax,
Thoracic aorta dissection

John R. Walz
MRI: Knee,
ACL and meniscal tear

Charles Wilkins
CT: Abdomen,
Liver hemangioma

Steven Buxton
MRI: Brain,
Normal brain MRI

Fred Walden
MRI: L-spine,
Disk herniation

Bradley Tyson
History: Rule out internal derangement,
Intermeniscal degeneration

Louis Cross
MRI: Wrist,
Normal

Joshua Davidson
MRI angiography: Brain,
Normal

Mary Gamage
Portable chest x-ray,
Pneumothorax (series of 4 exams)

Jan VanDeBerg
MR ankle,
Sinus tarsi ganglion

Robert Nashed
MRI myelogram,
Normal MR myelography

Wayne Gerler
Cerebral MRA,
Normal cerebral MRA

Terry Lewis
Ultrasound: Thyroid,
Normal thyroid ultrasound

("Patient's" names are fictitious)

DICOM Exhibitors

At press time, the following exhibitors indicated their willingness to participate in the RSNA '95 DICOM demonstration. All RSNA '95 attendees are encouraged to visit these exhibitors. Remember to ask to see your digigraph.

Acuson
1220 Charleston Rd
Mountain View, CA 94043
Contact: Diane Klassen
415-969-9112 x5064
800-422-8766
415-968-1833 Fax

Adac Laboratories
540 Alder Dr
Milpitas, CA 95035
Contact: Rose Roman
408-321-9100
800-538-8531
408-321-9536 Fax

Agfa Medical, Bayer Corporation
100 Challenger Rd
Ridgefield Park, NJ 07660
Contact: Philip Mortillaro
201-641-9566
201-440-1512 Fax

Algotec Systems Ltd
4 Hamlacha St
PO Box 2408
Indst. Zone
Raanana 43000 Israel
Contact: Menashe Benjamin
972-9-982442
972-9-982411 Fax

ALI Technologies Inc
95-10551 Shellbridge Way
Richmond, British Columbia
V6X 2W9 Canada
Contact: Debbie Rand
604-821-6334
604-279-5468 Fax
info@ali.bc.ca

Applicare Medical Imaging B.V.
PO Box 416
2400 AK Alphen
The Netherlands
Contact: Ruud Kroon
31-1720-76955
31-1720-76965 Fax
100065.1756@compuserve.com

ATL Ultrasound
22100 Bothell Everett Hwy
Bothell, WA 98021
Contact: Elizabeth Rademacher
206-487-7721
206-487-7913 Fax

Cemax-Icon
47281 Mission Falls Court
Fremont, CA 94539
Contact: Tony Fillicelli
510-770-8612 x3312
800-886-5232
510-226-9167 Fax
tony@cemax.com

DeJarnette Research Systems Inc
401 Washington Ave, Suite 700
Towson, MD 21204
Contact: Dian Hicks
410-583-0680
410-583-0696 Fax
dhicks@dejarnette.com

Diasonics Ultrasound
2860 De La Cruz Blvd
Santa Clara, CA 95050
Contact: Jon Barnard
408-496-3814
408-496-3556 Fax

Dicomit Imaging Inc
75 E Beaver Creek Rd, Unit 9
Richmond Hill, Ontario L4B 1K6
Contact: Thomas Little
905-886-9496
905-886-2109
dicomit@gold.interlog.com

DR Systems Inc
6042 Cornerstone Cart West, Suite A
San Diego, CA 92121
Contact: Alice Mae Williams
619-625-3344 x112
800-794-5955
619-625-3335 Fax

DuPont Medical Products
Glasgow Business Community
PO Box 6101
Newark, DE 19714-6101
Contact: Janice Servais
302-774-2692
800-252-9099
302-451-0439 Fax

E for M Corporation
625 Alaska Ave
Torrance, CA 90503
Contact: Kate Challingsworth
310-320-8334
310-618-8315 Fax

E-Systems Med Electronics EMED
11550 1H 10 West
San Antonio, TX 78230
Contact: Michael Webb
210-641-8340
210-641-7428 Fax
info@emed.com

Eastman Kodak Company
343 State St
Rochester, NY 14650-1132
Contact: C. Ann Taber
716-724-5985
716-724-7252 Fax

Elscint
505 Main St
Hackensack, NJ 07601
Contact: Dawn Hrycak
201-342-2020
201-342-3782 Fax

General Electric Medical Systems
PO Box 414
NB-902
Milwaukee, WI 53201-0414
Contact: Sharon Works
414-827-3378
414-827-3363 Fax
works@med.ge.com

Hewlett-Packard Company
3000 Minuteman Rd
Andover, MA 01810
Contact: Michael Yow
508-659-3309
508-689-8295 Fax

Hitachi Medical Corporation
1963 Case Pkwy
Twinsburg, OH 44087
Contact: Kenny Sawada
914-524-9711
800-800-3106
216-425-1410 Fax

IDX Systems Corporation
888 Commonwealth Ave
Boston, MA 02215
Contact: Lisa-Jean Dale
617-424-6800
617-277-3426 Fax
dale@idx.com

ISG Technologies Inc
6509 Airport Rd
Mississauga, Ontario L4V1S7
Contact: Pat Scully
905-672-2101 x204
905-672-2307 Fax
pscully@isg.com

Konica Medical Corp
411 Newark Pompton Turnpike
Wayne, NJ 07470
Contact: Susan Kelly
201-633-1500 x301
800-934-1034
201-633-0562 Fax

Line Imaging Systems
430 Tenth St, Suite N-113
Atlanta, GA 30318
Contact: Gerald McCormick
404-872-5463
404-872-5428 Fax

Loral Medical Imaging Systems
2501 N Barrington Rd
Hoffman Estates, IL 60195
Contact: Nobie Tsukida
408-473-7670 CA
708-304-7400 IL
708-304-7704 Fax

Merge Technologies Inc
1126 S 70th St, Suite N 508 B
Milwaukee, WI 53214-3151
Contact: Paula Raskin
414-475-4300
414-475-3940 Fax
raskinp@merge.com

Olicon Imaging Systems Inc
1011 Calle Amanecer
San Clemente, CA 92673
Contact: Rose Stacy
714-361-4070
714-361-5736 Fax

Philips Medical Systems North America
710 Bridgeport Ave
Shelton, CT 06484
Contact: Jeffrey Adams
203-926-7647
203-929-6099 Fax

Picker International
595 Miner Rd
Cleveland, OH 44143
Contact: Jann Myers
216-473-3544
800-582-5504
216-473-2413 Fax
webmaster@picker.com

Polaroid Medical Imaging Systems
153 Needham St, Bldg No. 3
Newton, MA 02164
Contact: Andrea Teixeira
617-386-6175
800-435-4677
617-386-4140 Fax

Rogan Medical Systems
520 W27872 Kame Terrace
Waukesha, WI 53188
Contact: Mark Schwartz
414-524-8801
414-524-8182 Fax

Shimadzu Medical Systems
20101 S Vermont Ave
Torrance, CA 90502
Contact: Barbara Charbonneau
310-217-8855 x131
800-228-1429
310-217-0661 Fax
hirom@earthlink.net

Siemens Medical Systems Inc
186 Wood Ave South
Iselin, NJ 08830
Contact: Rachel Buonavolonta
908-321-4654
908-321-4761 Fax

SMS
51 Valley Stream Pkwy
Malvern, PA 19355
Contact: Melissa Garretson
610-219-3162
610-219-3124 Fax

3M Medical Imaging Systems
3M Center Bldg 223-2SW-03
St Paul, MN 55144-1000
Contact: Bobbi Piasecki
612-736-2154
800-228-3957
612-736-6886 Fax

Toshiba America Medical Systems
2441 Michelle Dr
Tustin, CA 92680
Contact: Jim Burch
800-421-1968
714-832-2570 Fax

Vital Images Inc
505 N 4th St
Fairfield, IA 52556
Contact: Blair Butterfield
515-472-7726
515-472-1661 Fax
blair@vitalimages.com

DICOM Standard Version 3.0

- Supports open-system architecture based on publicly available specifications
- Offers a format designed for capturing, transmitting, storing, displaying and printing medical images
- Specifies the widely used TCP/IP telecommunications protocol for sending and receiving medical images over both Wide Area Networks and Local Area Networks
- Designates both image formats and patient demographic header formats making it possible to organize images in many useful ways
- Enables users to implement integrated image and information management systems
- Provides a building block that can protect system investments and preserve a growth path
- Offers a protocol for linking radiologists with other physicians
- Positions medical imaging as a key discipline in telemedicine
- Enables radiologists and other physicians to utilize the information superhighway