Radiation Oncology Networking and Information Systems

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Introduction

Due to the increasing complexity of radiation therapy, government regulations, and legal liability, computerized radiation oncology information systems are becoming a necessity. Selection of an information system involves understanding of both computer software and hardware issues. Topics such as network infrastructure, software interfaces, and hardware interfaces, which are not part of the normal physics training must be understood by the medical physicist. As the person with the most technical training in the radiation oncology department they will be called upon to do one or more of the following; specify a system, setup and installation, troubleshoot the system when things go wrong. This course will identify both hardware and software issues to consider when either first implementing a computerized information system or changing to an electronic treatment record.

Educational objectives:

1. Understand basic network infrastructure for both local area networks (LAN) and wide area networks (WAN).
2. Understand interfaces to both hospital information systems and various radiation oncology devices.
3. Understand differences in network requirements for both single department and multi-department institutions.
4. Understand what is required when migrating from a paper treatment record to an electronic treatment record.
5. Be able to generate specifications for a radiation oncology information system.
6. Understand the personnel requirements for implementing and maintaining a radiation oncology information system.

Networks

A computer network connects the various sources of Radiation Oncology information together. What once was considered a luxury item is now a required component of any department. The network may exist within a single building or connect geographically dispersed centers. A local area network (LAN) typically connects computers within a single building or limited area while a wide area network (WAN) connects computers in geographically dispersed areas.

The most common type of network is an Ethernet based system. The IEEE 802.3 standard was developed from this medium. A bus topology is used with traffic regulated by an access protocol called CSMA/CD (carrier sense multiple access with collision detection). In a bus system all computers connect directly to the same cable segment (Figure 1).

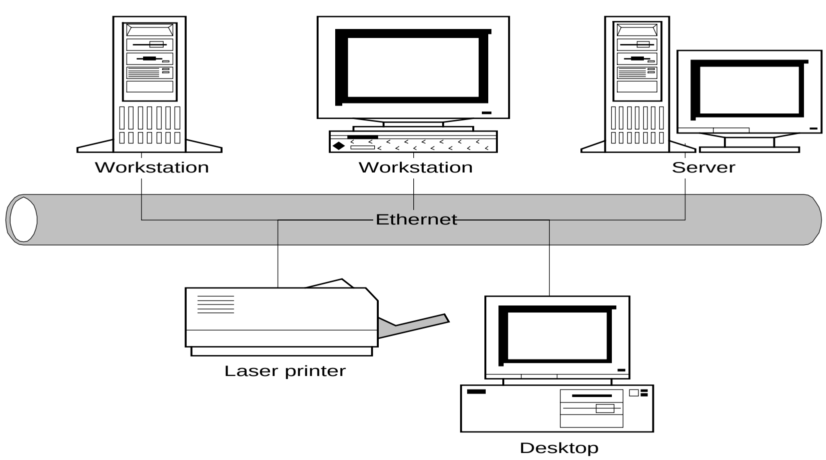


Figure 1. Local Ethernet Network

Multiple LAN's can be connected together by routers, bridges or switches. A router uses routing protocols to forward information to the appropriate destination. Software on the router is used to examine the data packets and to communicate with other routers to determine the best path for the data packet to reach its destination. Different types of networks can be connected by routers, for example connecting an Ethernet to a Token Ring network.

Switches use temporary connections for routing information which can provide better performance than using a router. The routing of packets is accomplished by the switch hardware which is faster than router software. Also the switch allows the network to be broken up into smaller segments allowing communication within each segment to be unaffected by network traffic from other segments.

A bridge can connect multiple networks or subnets together to form one logical network. A data packet is either forwarded or not forwarded to a subnet based on the node address. Figure 2. shows an example of a network connecting multiple areas.

Connections to a WAN can be through various connection types; T1 (1.536 Mbps), T3 (43 Mbps), SDSL (1.544 Mbps), HDSL (1.544 Mbps), Cable Modem, or Satellite.

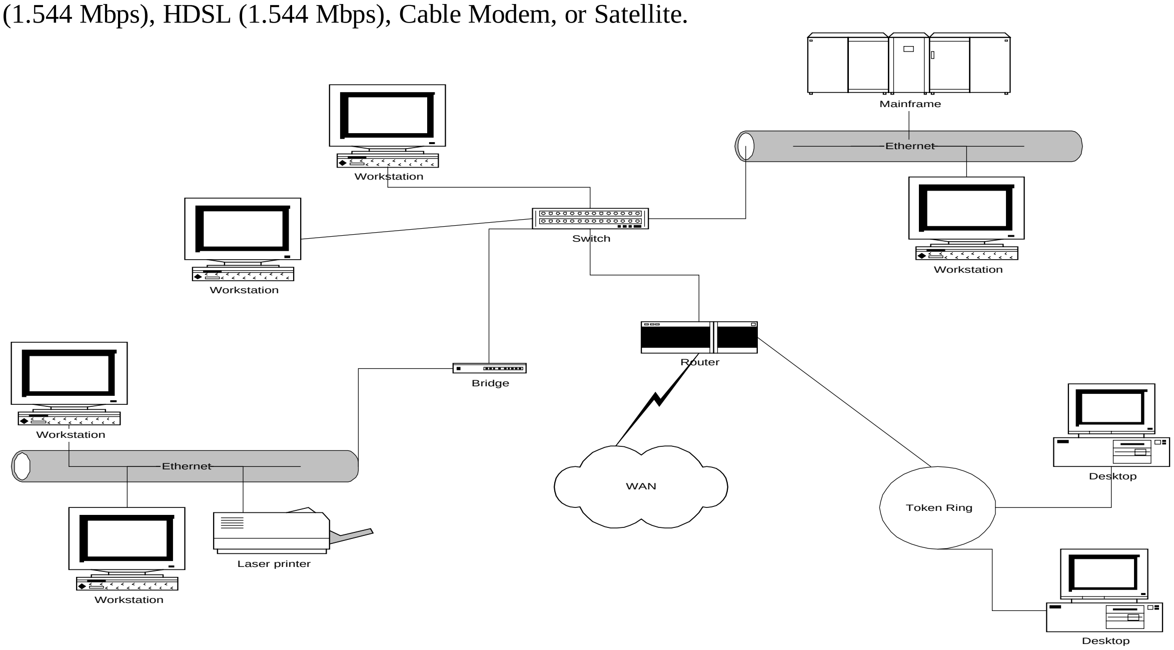
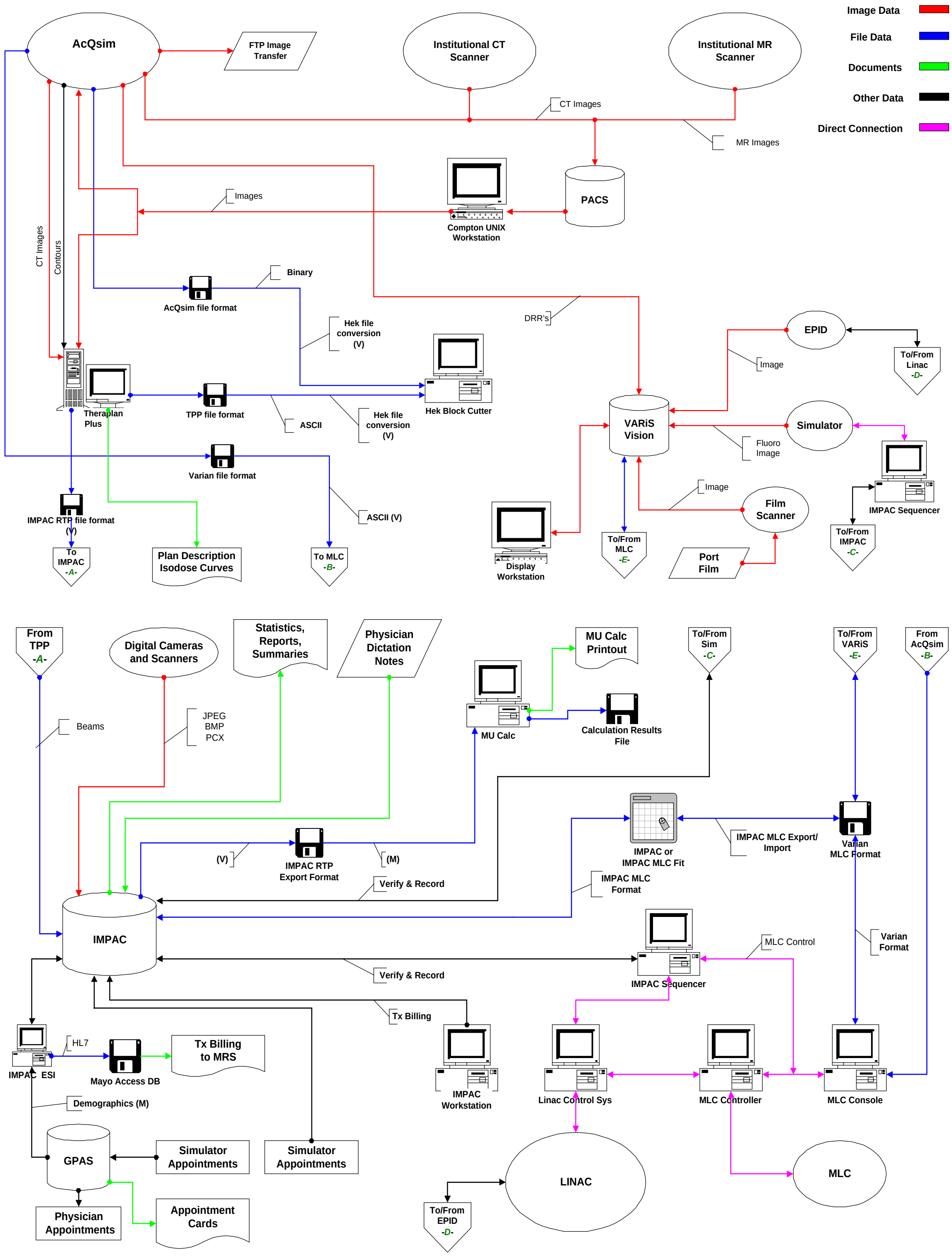


Figure 2. Multiple Networks

Interconnections

One of the first steps when analyzing the computer information flow within the department is to map out all the sources and destinations of computer data. Figures 3a and 3b. shows the electronic data flow within our department, circa 1999. With the advent of DICOM RT(1) this data flow map has changed, but the general principal is the same. The type of information being sent is needed, for example, image data vs. file data. Connection type, whether by network, removable media, or manual data entry. Finally the format of the data being sent, some examples being ASCII, proprietary vendor format, HL7, DICOM or DICOM RT. With the publishment of the DICOM RT standard in 1999 the use of proprietary information protocols should diminish as software is updated. When selecting any new equipment which involves the generation of electronic data one of the primary specifications should be DICOM RT compatibility.



Figures 3a and 3b.

Specifications

The Treatment Management Information System (TMIS) is what ties all the various sources of information together. Ideally all information would go directly to the TMIS with minimal or no user intervention. Conversion programs would not be needed to convert data from one vendors system into data that can be stored in the TMIS. Redundant data entry would be eliminated, along with multiple copies of the same data in different places. Currently a system such as this does not exist which is why it is important to develop specifications for a TMIS that encompass what is currently possible along with what is desired in the future.

The first step in specification development is to complete a process map of how information flows in the department. Each area whether it be nursing, scheduling, secretarial, physics, or treatment needs to document the processes that are used on a daily basis. Who enters what data when, how many times does the same data get entered, are different groups doing the same function; those are some of the questions that can be easily answered by looking at the process maps.

Once the current status of department data flow is understood, specifications can be developed that both encompass what is currently done and what would improve data flow in the future. Below are some sample specifications from different areas that encompass both current expectations and future desires. Prior to being sent to vendors the specifications from the different groups would be combined, grouped into specific functions and prioritized (ex. mandatory, highly desirable).

Physics / Dosimetry

ACCESS TO DEPARTMENT AND INSTITUITIONAL SCHEDULES

1. Auto- notification to appropriate physicist when special procedures are scheduled or changed.
2. Access to all Rad Onc physician, simulator, treatment machine, shop and patient schedules
3. Ability to attach info or appointments to patients treatment, simulation and block room schedules in TMIS…….

INFORMATION TRANSFER

1. All patient treatment information available in digital format must follow the latest
2. DICOM-RT standards to allow for seam-less transfer of data
3. Sectional image based treatment port design should not produce multiple data sets
4. Transfer of data should be done without “patched network software” or programs
5. Information should be able to be imported into the TMIS from normal page scanners or digital cameras……..

TREATMENT PLANNING STATIONS - DICOM RT COMPATIBLE

1. IS system(s) should not inhibit running multiple treatment planning applications available from a single workstation as permitted by application vendor and hardware configurations
2. Seam-less import/export of patient information from shop/treatment machines/CT-simulators for contouring/ segmentation/DRR’S/image fusion. Direct import of ALL geometric beam design (CT-simulator) information into relevant TX isodose planning systems.
3. Ability to fuse CT scans/MRI scans/PET scans done anywhere on Mayo campus.
4. All sources of electronic port images (DRR, EPID, and Digitized sim or port films) can be compared and approved at any EED workstation campus wide.
5. Divisional IS systems should not inhibit the implementation of a totally electronic environment for patient data and treatment records. They should also be consistent with institutional guidelines as well as meet or exceed institutional guidelines for patient data access and security.
6. There should be available an adequate archive system to store all electronic format treatment data (e.g., isodose distribution, treatment beam data, treatment delivery data, treatment delivered data, MU calculations as well as portal image simulations/films). Archived data must be easily retrievable throughout the Division and be seamlessly reimported into any application from whence it was generated…….

Treatment

Access to Schedules:

1. Access to patient's schedule to include divisional and institutional appointments.
2. The divisional system should auto check institutional system for conflicts.
3. Access to physician and nurse schedules for availability………

TMIS scheduling features need to include:

1. Ability to view individual machine daily schedule for recent past, present and future. (No archiving needed)
2. Non-incremental timeslots that are easily used and viewed
3. Customizable display options (hours, ½ day, and whole day)
4. Automatic notification of patient arrival
5. Auto-call back system
6. Patient treatment status (completed)
7. TMIS needs to have flexibility to easily switch patients time (click and drag) and also between machines without adding data.
8. Ability to attach notes to patients appointment slip……..

Treatment Delivery:

1. Auto transfer tx plan into scheduling and R & V system in TMIS with minimal manual entry. Fields should auto assign to a session number into treatment delivery system.
2. Treatment chart / schedule should:
3. match regarding programming and number of sessions
4. be easily modifiable
5. allow alert notes to be attached to a session
6. R & V component should:
7. be flexible with the ability to program treatment order
8. allow auto set-up for selectable field parameters (f.s., gantry, coll, etc.)
9. allow patient set-up notes to be separate, configurable, and available in drop down menu
10. have specific field notes that are entered once and option to update automatically to all fields if changes are made.
11. allow MLC/ Cerro daily verification for daily treatment to assure correct patient, correct field, and in place for treatment…….

Physician

Scheduling

1. Single scheduling system for patients and physicians and treatment machines (no dual entry of appointment times into multiple systems)
2. Access to treatment schedules for patient and machines
3. Electronic scheduling available from anywhere in the institution (E-purple)
4. Access to patient appointment schedule: consults, labs, x-rays, treatment, etc………

Simulation

1. Automated electronic system for retrieval of hard copy images needed for simulation, linked to electronic scheduling system
2. Digital availability of all needed images (internal and external) in the simulator
3. Ability to place or supervise placement of isocenter from remote locations (for example over the web)
4. Rapid reconstruction of images
5. Single copy of all simulation datasets
6. Searchable and retrievable archive system
7. Ability to fuse diagnostic images of all types with digital simulation dataset
8. No mysterious unexplainable losses of digital information by the system (automated backup)….

Treatment Planning

1. Dose engine integrated with simulation system (no duplication of effort)

2. Automated segmentation
3. Automated DVH reconstruction
4. IMRT capability……..

Treatment

1. Electronic portal verification
2. Ability to review electronic portal verification data from any location in the institution
3. Automated link between treatment system and lab ordering system
4. Automated lab query at check-in for each treatment visit with programmable variable alert levels by physician
5. TMIS viewable from any location in the institution
6. Automated billing based on single stroke physician entry at time of management
7. User friendly searchable complete tumor registry with single entry of key data
8. Simple communication system between treating therapist and physician…….

Electronic Treatment Record

The use of an electronic treatment record has numerous advantages over the conventional paper record. The treatment record is available for viewing at any time, it can be viewed by several people simultaneously, it does not have to be physically transported from one location to another, and the data in the record can be extracted for data analysis. However, the conversion process from paper to electronic is not necessarily easy or painless. Each institutions paper record has evolved over many years and no mass marketed information system could possibly cover all possible permutations. Thus, processes must be adjusted to fit what is available in the electronic treatment record.

Reduction in personnel will probably not result from going to a paperless system for several reasons. Depending on department size it will most likely take at least one FTE to manage the training and implementation of the electronic record. If dedicated computer personnel are not available, someone (Physicist?) will have to assume the role of networking, computer hardware, computer software guru. Also, since there will be a wealth of digital data easily available the uses for that data will also expand.

Conclusion

The complexity of radiation treatments is increasing every year. Computers are a vital part of every step in the treatment process from the time the patient walks in the door until the treatment course is completed. It will take an expanding information systems backbone to handle all the information and interactions between the different treatment modalities. The medical physicist will have to assume roles that are probably not in the strict definition of what a medical physicist does. Whether one is dealing with one treatment machine or a dozen, the information requirements and challenges are the same.

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