

## Radiology Workload Sharing

### Thin Client or P2P Thick Client reporting what is best for you?

For radiology clinics seeking increased efficiency and additional cost competitiveness it is becoming essential to move images to Radiologists for interpretation. The problem being faced is how to get images from modalities to the reporting radiologist in the fastest possible time.

Radiology clinics often ask, what is the best way to load share Radiology Workload. Considerations of speed, network bandwidth, thin client central server, or P2P thick client, scalability, integration storage, redundancy, and cost.

#### What is the difference between “thin client” and “P2P”?

**Thin Client** is often referred to as “web” and uses a central server. The image data is stored on the server, as well as the viewing application. A standard workstation with no DICOM software can log into the server using Internet Explorer as the shell.

The first time the workstation logs in, a program applet (small program bundle) is loaded onto the workstation.

This program allows viewing of images over the web directly off the server. Generally no image data is stored in a database on the workstation; therefore if the server connection is lost image data cannot be seen.

**P2P** is short for “peer to peer”, also known as “thick client”. Thick client is where the actual software that runs the system resides on the workstation. This means the workstation can operate independently of a server.

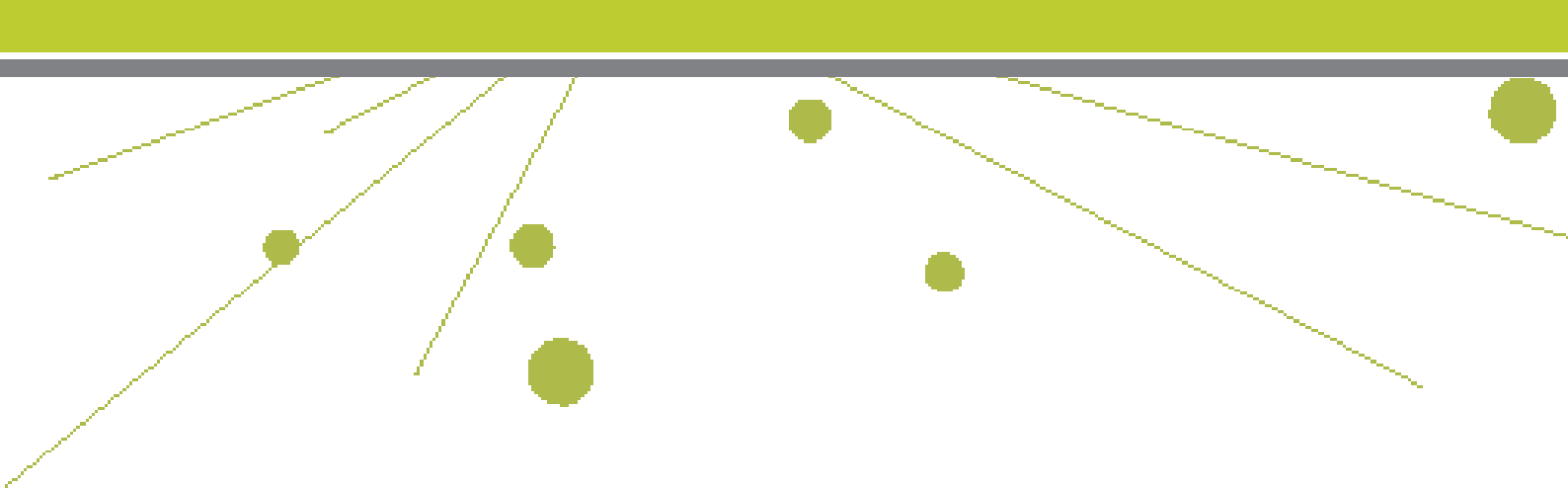
The workstation can also operate connected to a server to view images off that server like the “thin client” above.

The benefits are that P2P systems are

- Workstation can operate as an independent local storage and reporting system thus giving network independent redundancy.
- Workstation has the ability to send images to a remote workstation or server, giving added teleradiology functionality to load share, and
- Workstation can view/retrieve images/database of a remote server (PACS) or workstation, therefore operating in a PACS environment.
- No need at all for expensive server hardware on site as well as workstation.

#### The challenges of getting images from remote sites to the reporting area with speed

Radiology generates large volumes of image data that need to be collated, stored and sent for interpretation.



The challenge primarily revolves around speed of image access; that is how fast I can get a patient study from a modality to a computer for reporting.

There are two ways the image data can be accessed

1. By sending the image data direct to a workstation or “image cache” at the reporting workstation.
2. By retrieving or “pulling” the image data from a workstation or “image cache” to the reporting workstation.

### The factors that affect transmission

Two factors only affect image transmission speed

1. Size of data set (study)
2. Network Bandwidth

Most image sets these days range from 5MB upwards of 100MB (or greater) for large CT studies.

Most available affordable bandwidth over a Wide Area Network (Practice to Practice) is currently in the order of 512kb/s synchronous.

The combination of large data size and relatively low bandwidth means we have to efficiently use available resources.

### The factors that increase image availability and speed

Multiple factors can speed up image delivery, both real and perceived.

1. Image compression
2. Bandwidth of network (both LAN and WAN)
3. Whether images are available locally or remotely
4. Whether images are “on demand” or can be “actively routed”

### Image Compression

Most software providers today integrate compression algorithms into their DICOM software. The effect of compression is to make the data set as small as possible without compromising diagnostic

image quality. Both Web and Peer to Peer (routed) applications have the ability to compress image data. Generally compression can be described as lossless and lossy.

- Lossless compression is generally up to 2:1 compression (halving data set size, therefore halving transmission time), and does not have inherent data loss when reconstructed.
- Lossy compression can be much greater, with compression up to 40:1 not unheard of. Lossy compression involves “loss of data”. This may not be apparent to the human eye at low compression ratios, but as more compression is applied, clinical data will be lost.

Other compression factors often used are “streaming” or “on demand” compression. This type of compression is common in web based PACS systems. This is where the image is sent with high compression, and as the user needs more information the data is streamed to “fill in the pixels” and thus paint a better quality image. The result is still the same though, it is not faster but a perception as data is streamed on demand from the server to the client. The initial image is painted on the screen, and may be of lower quality at first, until the entire data set arrives. This gives the perception of the image arriving early.

### How do we “work load balance” our reporting

Most radiology practices today suffer from too much ground to cover due to geography and too few specialists to report. The solution is to move the radiologist physically or move the image data (work load balancing)

There are 2 clear models to workload balance image data for reporting. The models that are marketed fit into two camps

1. Web Based PACS systems
2. Thick Client Teleradiology Systems (peer to peer)
  - a. Addition of PACS with Web application



With a Web Based PACS system, a PACS server is installed in a central site and images are routed directly to the main server over the network.

The reporting workstation is generally what is called "thin client". This is where the reading software is loaded onto the workstation by the Webserver. There is no DICOM data base or DICOM smarts at the workstation, it is simply a thin terminal. If the web PACS goes down, the reporting stops. In private practices purchasing with a limited budget, this is extremely important to know, as a poorly deployed Web PACS without redundancy can bring down an entire practice group.

### Web Based PACS workflow.

The modalities are very simple in their image transmission rules. For example they cannot compress images therefore from a remote site over a low bandwidth connection, image transmission will be slow. Further, large data set generating modalities (eg 32 slice CT) transmitting across typical ADSL bandwidths of 512kb without compression, will consume all available bandwidth and take between 10 mins and 4 hours to upload to the Web server (depending on the number of images – see appendix).

Once images are on the Web Server the radiologist has a web worklist to choose patient studies for reporting. They select the studies and "pull" images to their local workstation. This may mean that the radiologist is pulling images from a remote server in a distant location, for a CT study that was sent up from the room next door. Over a WAN this is very inefficient.

To rectify this, a Web PACS over a WAN environment should have image caching servers at each site with a master database at the main site server. This would allow the images at each site to be locally cached, therefore making better use of bandwidth and increasing speed significantly. The image cache is another server, and of course adds more cost, and you will still need a workstation.

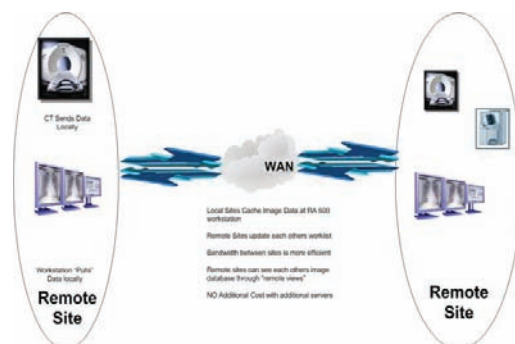
### How can we fix slow transmission inherent in Web PACS over WAN?

The big issues here are bandwidth and bandwidth conservation.

Most images are reported at the site they are generated at, and additional work load balancing, that is a remote radiologist helping work load from another site is a secondary consideration.

That being the case sending uncompressed images direct from the remote site to the central server and then "pulling" images back from the Web PACS is very inefficient. The way around this is to maintain the central site with the database (not images) and keep a cached server at all sites WITH workstations. This will eliminate traffic over the WAN and speed up the system seamlessly. The image cache can then update the main image vault at the central site over night for long term storage.

The down side of this is cost. On top of the central server and workstation at the central site, you will need another server and workstation at the remote site.



## A simpler more cost effective alternative: Peer to peer (P2P)

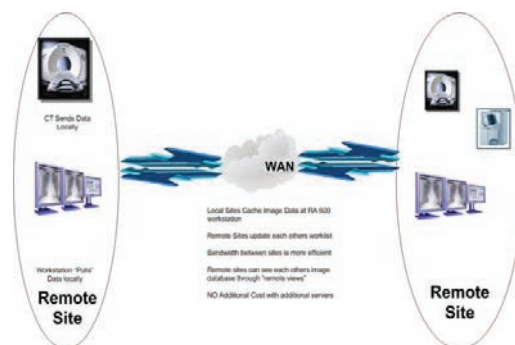
Web PACS may seem a simple solution at first look. Put a big server in, send all image data to it both remote and local, and report on demand. The promise is fast, distributed reporting. The reality is quite different!

There is another way – P2P; A diagnostic workstation that can act as a reporting console and a network gateway to other sites for workload balancing.

Essentially every workstation is a DICOM SCP / SCU. That is, it is a standalone DICOM entity, which can receive, store, view, send, compress images, burn media (CD/DVD) as well as have advanced diagnostic tools (MIP/ MPR etc)

P2P is somewhat more effective and scalable in today's climate of large image files, and relatively slow bandwidths.

The difference between Web PACS and P2P is shown to the right.



P2P is the transmission of data between workstations without the need for a core server and the added cost. Each workstation has its own DICOM database and can be set up to manually or automatically route between workstations – in the file share tradition. Workstations can also see other Workstations (and PACS) on the network and query their data base as before pulling images – just like the promise of Web PACS, but without the server cost.

## P2P workflow

What makes P2P so great and cost efficient is its simplicity and speed. The modality pushes to the DICOM workstation/s and all images are stored locally for reporting. Images are pulled from the local hard drive of the workstation for fast access. Images can also be routed to another site manually or automatically. Images can be automatically routed by time, modality type, referring doctor or any number of DICOM tags. Images can also be sent to PACS through the workstation.

## P2P is fast

Workstations receive images directly from the modality locally, and images are accessed directly from the local hard drive for local reporting.

Workstation can have inherent compression on board to send either lossless or lossy compression to other sites including a central PACS.

## Data and hardware redundancy

P2P has inherent hardware and data redundancy – giving greater failure resilience.

## P2P can grow with you at you pace

Most solutions can start with a simple workstation for reporting and remote image viewing and move right up to an enterprise wide PACS/WEB and RIS system.

## P2P is reliable and proven technology

The technology has been around for decades, and operates in a push/pull scenario. The software is thick client which means the DICOM software resides



Feature	Web PACS	P2P
Needs Central Server	Yes	No
Bandwidth Dependant	Yes – if no remote cache server	No
Up Load Speed – modality to server or workstation	Bandwidth dependant, no or little compression in background	Over local network – seconds Over WAN – compression
Down Load Speed – server or workstation to workstation	Bandwidth dependant, no or little compression. Images are pulled to workstation, may result in lag between start and receipt of images.	If routed in background – user does not see images being downloaded.  If “pulled” from remote – Bandwidth dependant, user selectable compression. Images are pulled to workstation, may result in lag between start and receipt of images.
Redundancy	None at workstation as the workstation is a thin client without DICOM database. If server or WAN is down reporting cannot take place.	Each DICOM workstation has a DICOM database. All images are stored at the workstations.
Additional Hardware	Needed for local image caching to overcome bandwidth issues as well as workstation.	No additional caching needed as DICOM workstation is a local cache inherently.

right on the workstation. This means redundancy, if the WAN or central server goes down in Web PACS reporting stops.

### Summary

Distribution of image data can be a challenge for most busy radiology clinics looking to better manage resources and deliver better service.

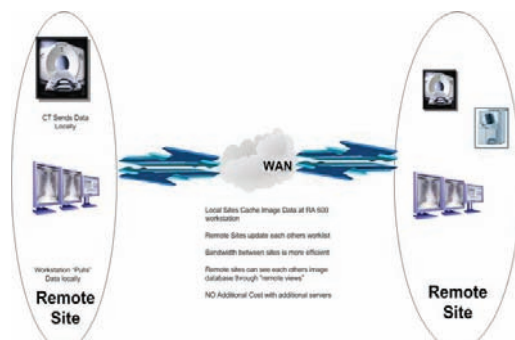
The challenge is whether a simple reporting workstation (P2P) is adequate to share images

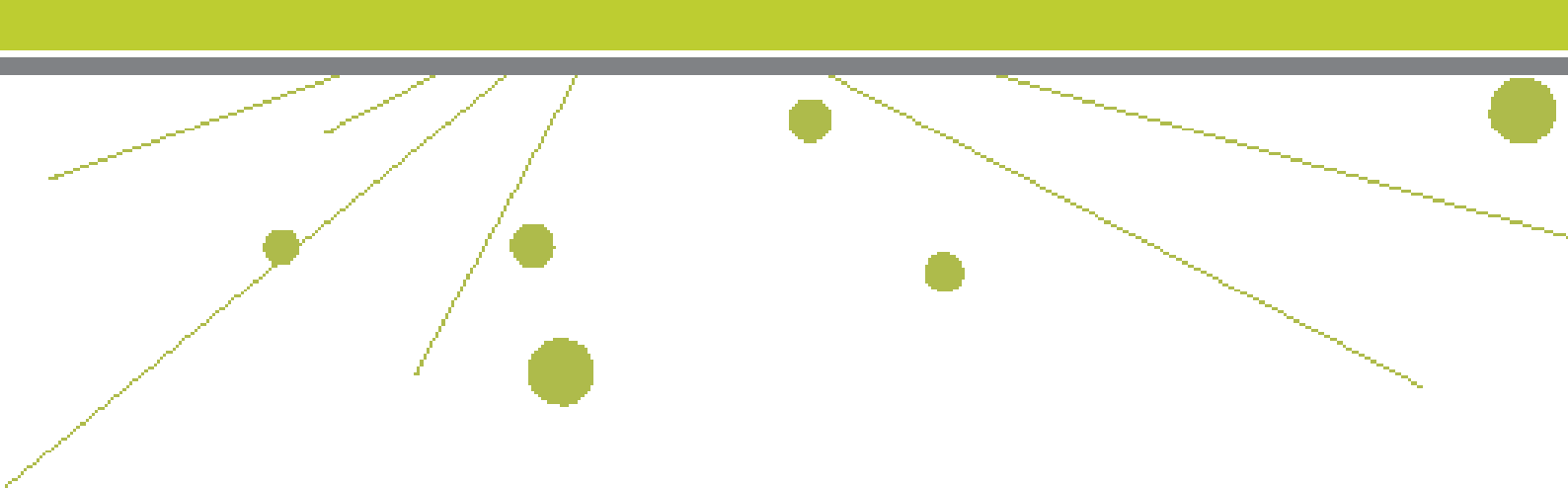
over the enterprise, or if a central web PACS is going to give enough performance over available internet bandwidth.

It is our opinion that for private clinics looking to workflow with average bandwidth and limited budget, a P2P workstation system gives the optimal result.

This system can also be grown into a strong wide area solution, allowing users to securely and rapidly view, send and retrieve data between sites.

It also protects against down time of the network between sites, and allows the clinic to grow into a multi site PACS solution with either central or distributed servers, thus protecting initial investment.





Web PACS may look a good option at first, but take into account image file size, transmission speeds, bandwidth costs, additional distributed server costs, and network outages, and the total cost of ownership investment may not quite be as it seems.

### Contact Us

Healthinc Pty Ltd  
Email: [info@healthinc.com.au](mailto:info@healthinc.com.au)  
Website: [www.healthinc.com.au](http://www.healthinc.com.au)  
Tel: 61 2 9999 2998  
Fax: 61 2 9999 3995

### More Information

For the latest information about our product and services, please see the following resources:

<http://www.healthinc.com.au/Products.htm>

Healthinc logos, and trademarks or registered trademarks of Healthinc Pty Ltd or its subsidiaries.

Copyright ©2004 Healthinc Pty Ltd All Rights Reserved.

Other names and brands may be claimed as the property of others. Information regarding third party products is provided solely for educational purposes. Healthinc Pty Ltd is not responsible for the performance or support of third party products and does not make any representations or warranties whatsoever regarding quality, reliability, functionality, or compatibility of these devices or products.



### Appendix I. Uncompressed Image Set Transfer over ADSL

Modality	Typical image size (KB)	Number of images	Upload bandwidth (kilobits per sec)	Time to transmit (mins)	
CT	512	60	256	18.4	
		100	256	30.7	
		1000	256	306.7	
		1500	256	460.0	
	512	60	512	9.2	
		100	512	15.3	
		1000	512	153.3	
		1500	512	230.0	
	512	60	1500	3.1	
		100	1500	5.2	
		1000	1500	52.3	
		1500	1500	78.5	
MR	512	80	256	24.5	
		120	256	36.8	
		150	256	46.0	
	512	80	512	12.3	
		120	512	18.4	
		150	512	23.0	
	512	80	1500	4.2	
		120	1500	6.3	
		150	1500	7.9	
	US – Mono	256	16	256	2.5
			20	256	3.1
			25	256	3.8
256		16	512	1.2	
		20	512	1.5	
		25	512	1.9	
256		16	1500	0.4	
		20	1500	0.5	
		25	1500	0.7	



Modality	Typical image size (KB)	Number of images	Upload bandwidth (kilobits per sec)	Time to transmit (mins)	
US – Colour	512	6	256	1.8	
		6	512	0.9	
		6	1500	0.3	
Plain film – CR	8000	2	256	9.6	
		4	256	19.2	
		6	256	28.8	
	8000	2	512	4.8	
		4	512	9.6	
		6	512	14.4	
	8000	2	1500	1.6	
		4	1500	3.3	
		6	1500	4.9	
	Plain film – Scanned	4000	2	256	4.8
			4	256	9.6
			6	256	14.4
4000		2	512	2.4	
		4	512	4.8	
		6	512	7.2	
4000		2	1500	0.8	
		4	1500	1.6	
		6	1500	2.5	

Notes.

Calculations assume no other data is being sent over the wide area network connection.

Typical ADSL connections are different speed upload and download (with download usually much faster)

Bandwidth loss due to inherent TCPIP overhead – 15%