EasyViz Medical Insight

Server-Side Computing and Distribution of Access to Medical Images – Overview of Technology and Methods

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Introduction and Summary

Over the past several years the medical imaging market has experienced a growing need for providing access to image data outside of radiology departments. The deployment of EMR systems and the consolidation of healthcare institutions have increased the demand for mobility within healthcare enterprises. Clinicians want instant and secure access to images and reports from anywhere inside or outside the hospital facility without compromising image quality or reducing available clinical functionality.

These market changes require healthcare IT vendors to think differently in order to support the nomadic workflows of clinicians. One such response has been the emergence of systems based upon server-side computing architectures to provide increased mobility to clinicians, wider deployment of access to images, greater clinical functions, and decreased need for service/support throughout the enterprise.

This white-paper describes the technology and trends regarding the use of server-side computing, streaming and thin clients for the distribution of access to medical image data throughout and among healthcare enterprises.

Solutions or systems employing such technology are designed to perform all or most computationally-intensive tasks on dedicated server machines, and thin or ultra-thin client applications are used to provide the application interface to users on common desktop, laptop or mobile/wireless computers. Some form of streaming is typically used for the connection between servers and clients.

The key forces pushing the development and use of server-side computing systems are the following.

- The use of medical imaging procedures is growing both for diagnostic and therapeutic purposes, and the use of images outside of radiology departments is becoming more common for information purposes as well as decision-making.

- Computers and applications that can effectively display and process image data are typically too large and expensive for deployment to every location at which access to images is desired.

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- Similarly, complex and heavy end-user applications may require significant amounts of service and support when deployed to a large number of client stations (clients which may even be under separate jurisdictions).

- Transmitting images throughout an enterprise, especially larger multi-dimensional data sets, places significant loads and stresses on network infrastructures.

- As healthcare organizations become less self-contained than in the past, there is a clear need for ways of easily sharing patient data and images among disparate care-givers, and providing seamless tools for tele-consultation and tele-medicine.

Server-side computing and ultra-thin clients are emerging as the technology of choice for image-enabling EMR systems and for providing efficient access to images and analysis tools throughout a healthcare enterprise or organization. In the following sections, the current state-of-the art is presented, as well as an overview of future directions regarding server-side computing.

Taxonomy of Server-Side Computing

There are a number of different technologies used within systems that are based on server-side computing, and these technologies can be characterized along several key dimensions, as listed in the following table.

Technology Element	Characteristic Dimensions		
Server Footprint	Large – Few Users Per Server Node	Medium	Small – Highly Dense Server
Server Scalability	None – Each User Tied to Specific Stand-Alone Server Node	Moderate	High – Server is Load-Balanced Across Nodes and Nodes Can be Added as Needed
Streaming Methods	None – Transmission of Raw Pixel Data	Moderate – Some General Compression of Pixel Data	Adaptive – Specialized Compression or High-Fidelity Images as Needed Under Varying Circumstances
Required Bandwidth	Large– Dedicated High-Speed Connections Required (+100 Mbps)	Moderate – High-Speed Connections Required (10 Mbps - 100 Mbps)	Small – Acceptable Performance Over DSL Connections (2+ Mbps)

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Technology Element	Characteristic Dimensions		
Security Feature Set	Minimal – Security Aspects Provided Externally (VPN, Authorization)	Moderate	Extensive – Built-In Encryption of Connections, SSO.
Clinical Feature Set	Minimal – Only Basic Viewing and Analysis Tools	Complete – Most Common Tools are Available Including 3D Functions	Specialized – Tools Focused on Particular High-End Applications (Such as CAD)
Client Footprint	Large – Client Application is Large, Complex and Requires Significant Support	Medium – Client is Easy to Deploy But Still Requires a Properly Configured Machine	Small – Client Application Can Operate on Any Device with Minimal Support Required
System Integration	Minimal – Stand-Alone System, Data are Pushed to Server	Moderate – Certain Integration Options, Data Cache Required	Complete – System is Standards-Based and Can be Fully Integrated with Various Data Sources

All server-side computing systems have a set of characteristics which specify the particular focus area of the system. For example, initial systems were designed to provide highly specialized and powerful analysis tools to expert clinicians—servers were not necessarily scalable and bandwidth requirements were substantial. A trade-off or balance is always required among these characteristics—a small client foot-print may require a minimal feature set, and an efficient use of bandwidth may necessitate a large foot-print on the server-side.

The *EasyViz* system from Medical Insight is a server-side computing system with ultra-thin clients and adaptive streaming, and the system is designed to provide efficient and effective distribution of access to images and analysis tools throughout healthcare enterprises. To achieve this goal, a balance was needed between the various technology elements comprising the system. Specifically, the following are the characteristics that make *EasyViz* unique in the area of distribution of access to medical images and analysis tools.

Technology Element	*EasyViz* Characteristic
Server Footprint	Small and highly dense server; use of hardware-assisted CODECs; smallest server footprint for a server-side computing architecture
Server Scalability	Highly scalable cluster server – COTS nodes added/removed as needed; load balancing across nodes; cluster managed as a single entity; 20+ concurrent users per node

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Technology Element	*EasyViz* Characteristic
Streaming Methods	Adaptive streaming technology with various CODECs specialized for medical image data; full-fidelity and lossless image display on clients; highly adaptive to changing user requirements and available bandwidths
Required Bandwidth	Adaptive streaming technology allows use of low bandwidth connections (1 Mbps – 2 Mbps); mobile/wireless devices can be used with effective performance
Security Feature Set	Connections between clients and servers are SSL/TSL encrypted; authentication via AD/LDAP methods—allowing Single Sign On (SSO)
Clinical Feature Set	Full-featured PACS viewer; full DICOM support; advanced viewing features—3D, image display shutters, image subtraction (DSA), support for Presentation States (GSPS, CSPS, PCSPS), DICOM Hanging Protocols, annotations/measurements, PET/CT fusion, etc
Client Footprint	Zero-footprint client—does not require Administrative privileges to install, 1.5 MB download file, installs in seconds, no OS services required (Java, ActiveX, .Net, Ajax); configurable client ports; client can be deployed under the most stringent IT lock-down conditions;
System Integration	Fully standards-based—support for integration via DICOM, HL7, XML, IHE; direct integration with disparate PACS archives and generation of aggregate worklists; cacheless configuration; access to reports; client can easily be integrated with an EMR system (in case of a Citrix-based EMR, integration is via Content Redirection); One-Time Password (OTP) facility

Future Developments Regarding Server-Side Computing

Although *EasyViz* is the most advanced and effective server-side computing system in the medical imaging industry today, development efforts are underway to further improve the product. The more obvious enhancements to the system are improved bandwidth usage, a smaller server footprint, and additional clinical features (3D measurements, support of additional data types, etc). However, the true leap to a new level of performance for *EasyViz* will come about from *an optimization of overall resource utilization*.

A server-side computing system such as *EasyViz* might be “improved” by making the client even thinner (using only HTML or Javascript, not a native Windows application), but such a change would have minimal impact on the ease of client deployment (which is already nearly optimal), and might require significant reduction in the available feature set. The greatest potential for improved performance for *EasyViz* is to harness the overall resources available to the system.

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Streaming and ultra-thin clients enable enterprise-wide deployment and give access to full and powerful feature sets regardless of the power of the client device. However, client devices are capable in many cases of contributing additional CPU cycles to improve overall system performance—CPU cycles which could be used to decrease the computational load on the server. That is, if the aggregate sum of available computing power on client devices could be used to offset computations on the server, then overall system performance could be dramatically improved.

The idea behind *optimization of overall resource utilization* is just that—to continue with ultra-thin clients and adaptive streaming, but rather than primarily streaming compressed pixel data, various commands are also streamed such that the client can perform certain computations locally (if the client is capable of such tasks). A good example of such a technique is the recent addition of a predictive CODEC to the adaptive streaming module in *EasyViz*. This CODEC is used during window/level manipulations and basically transmits an equation to the client that indicates how pixel intensities are modified in response to user actions. In the future, similar commands or equations can also be streamed to execute other fine-grained image-related manipulations on the client-side. Additionally, various screen areas or image regions can be cached on the client rather than being sent from the server more than once.

This concept of *optimizing overall resource utilization* is an ongoing development effort at Medical Insight and is aimed at harnessing the significant unused computing power of client devices in a server-side computing system. Success in this area will bring the *EasyViz* system to a new level of performance and capability.

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