Efficient Data Flow in RadCalc: Unraveling the Dynamics of 3D Dose Calculation

This technical document provides insights into the communication protocols within RadCalc components during 3D dose computation. It distinguishes between local and external communications, detailing the processes in secured and distributed environments. The document covers RadCalc, RadCalcAIR, Queue, and Dose Calculation Engine Applications, emphasizing the importance of accurate communication for seamless operation.

This reference is suited for Information Services/Administrator personnel though general users may find the information helpful for use in analyzing IT infrastructure and security, as well as providing a general overview for how RadCalc communicates between RadCalcAIR, the Queue and the Dose Calculation Engine installations. Technical Reference-11 (RadCalcAIR Configuration) and Technical Reference-18 (3D Dose Calculation Engine Configurations) will provide more detailed information regarding installation and configuration. Additionally Technical Reference-20 (Advanced 3D Calculation Engine User Guide) and Technical Reference-21 (Running Queue as a service) contains in-depth information for complex setups involving multiple calculation environments.

This document describes the communications between various RadCalc components during 3D dose computation. The communications that would take place, where all components are in a secured environment such as all contained within a single datacenter or private communications lines, are talked about in the Local section of this document. The additional communications and setup which would be utilized in a distributed environment, where the physical 3D calculation engines would not be contained within the secured environment, are talked about in the External section of this document. The anonymization and encryption of the data being transferred to the calculation engines, local or remote, is talked about in the Anonymization and Encryption section of this document.

If you have any questions not covered in this reference, or need assistance please call or email Lifeline Software Technical Support at 866.592.1343 Option #2 or International +1.903.207.4298 Option #2 or radcalc.support@lap-laser.com

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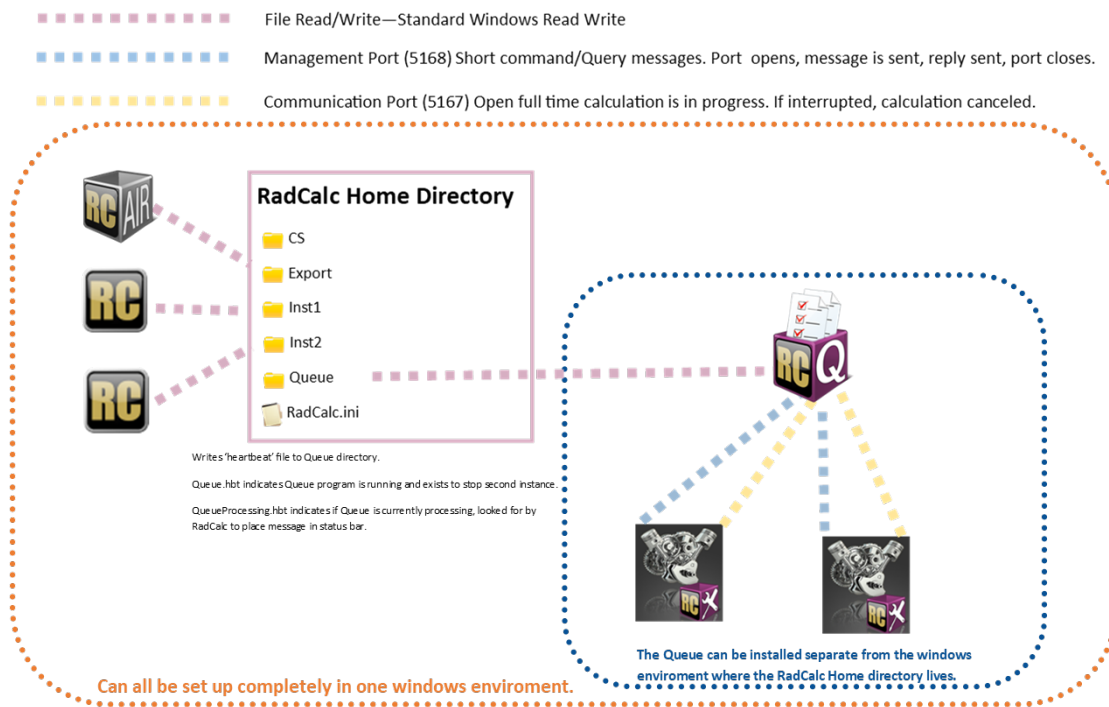# 1 RadCalc Local Communications Between Applications

Figure 1 Communications from a 3D calculation view

1.1 RadCalc

RadCalc may be run on as many computers as is necessary. RadCalc is an interactive program and requires a device context. RadCalc reads and writes information through standard Windows files to the RadCalc Home Directory.

The only communication the RadCalc program has with the local 3D calculation engines is through the Test button on the Calculation Engines dialog box (curved light blue line in Figure 1). The Test button functionality is not mandatory for 3D dose computation and typically is only used when dose calculation computers are initially being set up. If Remote Queue Forwarding is set up the RadCalc application will perform a similar communication with the External Queue for testing that the communications are set up properly. The test functionality to the External Queue from the RadCalc application is not mandatory for Remote Queue Forwarding to function and is typically only used during initial configuration. See below for more information.

1.2 RadCalcAIR (Automatic Impot and Reporting)

One instance of RadCalcAir will provide automated import and reporting services for all institutions listed in the RadCalc.ini file. The RadCalcAIR application resides in the RadCalc Home Directory and can be launched from any connected workstation. However, ideally it would be best run from the workstation of the install of the RadCalc home directory. The institution, user and email configuration files are checked for changes at the beginning of the polling interval, thus changes made from the RadCalc executable that would affect RadCalcAIR operation will be reflected immediately by RadCalcAIR.

RadCalcAIR requires a display context and thus should be started from a scheduled task set to run upon login of a user which will automatically be logged onto the computer when the computer is started or via a shortcut in the Windows StartUp folder. RadCalcAIR may be set to run as a normal window or minimized. No regular user interaction with the RadCalcAIR application is necessary.

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RadCalcAIR only reads and writes information through standard Windows files to the RadCalc Home Directory, it does not directly communicate with either the Queue application or the 3D calculation engines.

1.3   Queue (For Load Sharing and Calculation Prioritization)

One instance of the queue provides communications for all dose calculation engines configured for all institutions configured in the RadCalc home directory. The Queue will simultaneously communicate with all configured calculation engines and ensure all are kept busy as long as there are calculations in the computation queue. The Queue application resides in the RadCalc Home Directory and can be launched from any connected workstation. However, ideally it would best be run from the dose engine workstation for single dose engine setups. More on the ideal Queue launching location is discussed in TR-18 and TR-20. The Queue monitors various components of RadCalc and automatically updates itself when parameters have changed. When started, the Queue application immediately starts processing calculations in the queue. No user interaction with the Queue is necessary.

Queue should be started from a scheduled task set to run upon login of a user which will automatically be logged onto the computer when the computer is started or via a shortcut in the Windows StartUp folder. Queue may be set to run as a normal window or minimized. Additionally, the Queue can be run as a service, see TR-21 for more information. No regular user interaction with the Queue application is necessary. Queue is designed to run without user interaction and the interface is present for support purposes. The main RadCalc program provides an interface for users to interact with calculations present in the queue.

1.4   Dose Calculation Engine Applications (MC Engine and CS Engine)

The RadCalc 3D Dose Calculation Engine Management Service (RadCalc_CEMS) application runs as a service. This software can be installed on as many dose engine systems meeting the minimum specifications as is required by the installation. RadCalc_CEMS can be set to start automatically when the computer starts or set to be started manually through other means. RadCalc_CEMS must be running for Queue to communicate with the calculation engine application.

The Queue communicates with the calculation engines through two TCP ports which may be configured by the user. Queue reads the port configuration set in the Calculation Engines dialog which is accessed from either the Queue or the RadCalc main executable. The configuration of RadCalc_CEMS and the information entered into the Calculation Engines dialog must correspond or Queue will not be able to communicate with the calculation engines. All data being transferred between the Queue and Dose Calculation Engine is anonymized and encrypted, see below for more on this.

Each 3D Dose Calculation Engine Application is assigned a unique identifier when added to the software. The calculation engine unique identifier applies to one instance of computational hardware. A user supplied display name can also be configured.

Queue needs to be able to reliably communicate with the calculation engine. It is recommended that the calculation engine computer is assigned a static IP address. The software will resolve through DNS when supplied a machine name instead of a fixed numerical address.

2   RadCalc External Communication Between Applications

A RadCalc institution may be configured to forward 3D dose calculations to a second Queue instance for computation, this is referred to as Remote Queue Forwarding. All data being transferred to the second Queue is anonymized by the first queue before transfer and the communication is encrypted. See below for more on this.

2.1   Remote Queue Forwarding

Remote Queue Forwarding is functionality allowing a local RadCalc installation that does not have any physical computation engine computers to use external RadCalc systems with Dose Calculation Engine Applications configured.

Configuration of Remote Queue Forwarding is a two-part process:

1.   First, the external (Second) Queue application must be configured to accept forwarded queue requests from each of the Local RadCalc institutions. More on this in the next section

2. Second, the Local RadCalc institution must be configured to forward calculations to the external Queue application. The external Queue configuration should occur prior to the Local RadCalc configuration.

2.1.1   Accepting Forwarded Requests

This configuration occurs on the external RadCalc Dose Calculation Engine's Queue Application. When configured, the "Remote Institutions To Service" dialog (see Figure 2) allows adding and removing institutions to receive calculations from the "Remote Queue Listening Address" (An IP address, or DNS resolvable name) on the "Remote Queue Listening Port".

The forwarding institutions need to be defined by Institution Name and a unique Queue Check Value is generated to be supplied to local Queue of the forwarding institution.

A "Retention Period" is defined retaining completed calculations before discarding if not retrieved by the original institution that submitted the calculation. The forwarding institution can be assigned a relative starting priority for all calculations from that institution.

Figure 2 Accepting Forwarded 3D Calculation Requests

The forwarded requests will be reflected in the 'Calculations in Q:' number displayed in the status bar of the main RadCalc application. No identifying information reaches the external RadCalc Dose Calculation Engine or External Queue.

The forwarding institution replaces the Patient Name, Patient MRN# and Calculation Name with fixed text. The Institution name is the only identifying piece of information. Additional information below.

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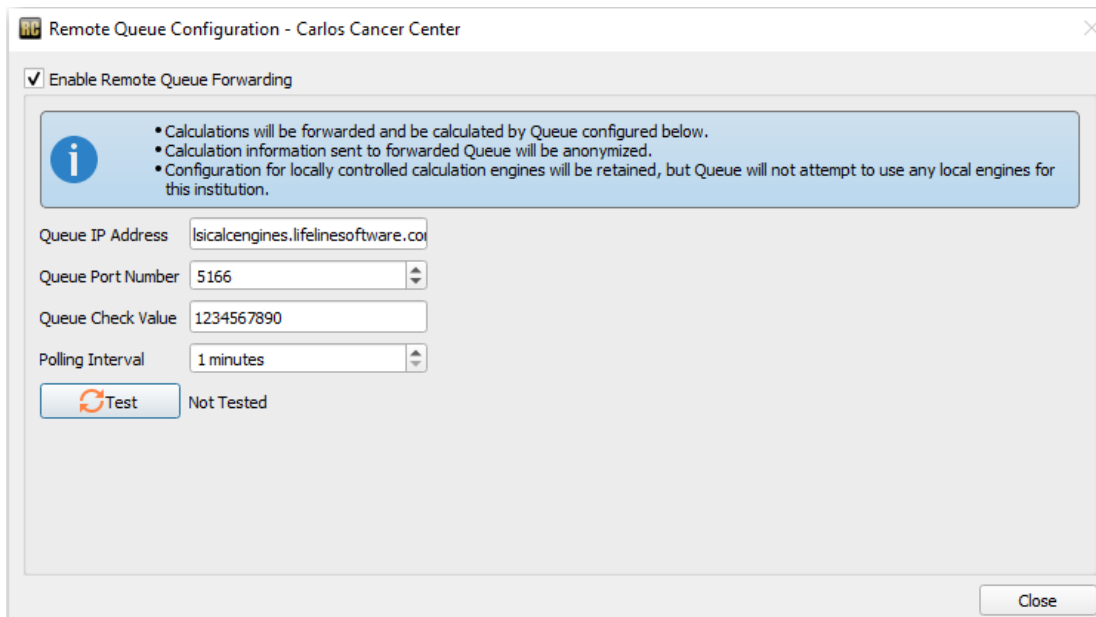## 2.1.2   Configuring Local RadCalc Institution

Figure 1 Configuring Local Institution for Remote Queue Forwarding

Each institution configured in the External Queue must then be configured to forward their Queue Requests. Figure 3 shows the dialog. The Queue Check Value is the value created from the External Queue and is essentially a password allowing the institution to connect.

3   Anonymization and Encryption

There are two levels of anonymization which occurs with RadCalc 3D Dose Calculations, anonymization between Queues and anonymization between the Queue and the Dose Calculation Engines.

3.1   Anonymization of Data Sent Between Queues

When Remote Queue Forwarding is used and a local Queue sends the calculation to remote Queue, the local Queue removes all patient information and replaces the information with the following static strings:

1.   Patient name replaced with "Name Removed"

2.   Medical Record Number replaced with "MRN Removed"

3.   Calculation Name replaced with "Calc on Remote Queue"

The effect of this is anyone accessing the forwarded Queue request will not be able to access any patient identifying information regardless of access through the Queue application, or direct access to the underlying data. The only identifying information left in the calculation data is the name of the institution the calculation came from, and a GUID number generated for this calculation.

3.2   Anonymization of Convolution Superposition Calculation (CSEngine)

For Convolution Superposition Calculations, DICOM Plan and CT datasets are exported to the RadCalc Dose Calculation Engine either from an interactive RadCalc session or RadCalcAIR. During export all DICOM files are anonymized by replacing all identifying tags with fixed text. When the completed calculation is retrieved by the local Queue Application it is re-assigned to the patient that initiated the request. The exported DICOM anonymized files are destroyed by the RadCalc Dose Calculation Engine as they are not needed.

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3.3 Anonymization of Monte Carlo Calculation (MCEngine)

For Monte Carlo Calculations, all the data exported is in BeamNRC format. No patient identifying information is present. These files are destroyed by the RadCalc Dose Calculation Engine after the completed calculation is retrieved by the Queue Application.

3.4 Data Encryption for Dose Calculation Engine and Queue Communications

All network communications between Queue applications or Queue applications and Dose Calculation Engines are encrypted. The encryption is accomplished via an implementation of Internet Research Task Force RFC 8439. The implementation of this protocol packetizes the data into 50,000 byte packets, the packets are transmitted via a proprietary lockstep communications protocol which requires each packet to be authenticated. Failed packets will be retried up to 10 times.

Connections between Queue applications are also secured by the requirement of the Queue Check Value needing to be passed by the connecting Queue.

For more information and clinical implementation examples on these processes, please consult the Advanced User Guide, Technical Reference-11 (RadCalcAIR Configuration), Technical Reference-18 (3D Dose Calculation Engine Configurations), Technical Reference-20 (Advanced 3D Calculation Engine User Guide) and Technical Reference-21 (Running Queue as a service).

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