



FDA Cleared | CE Marked | Clinically Proven | Enterprise Wide

Enterprise-wide capability, processing scans from all CT manufacturers and acquisition protocols.

High throughput, scalable computation using off-the-shelf hardware with virtual machine deployments.

Supports contrast and non-contrast scans.

Supports standard, low-dose, non-contrast and contrast CT scans.

Automatically detects nodules at or above 5mm and supports visualization of nodules smaller than 5mm.

Detects all nodule types: solid, part-solid, and ground glass.

Provides differential measurements.

1 Lo, S. B., Freedman, M. T., Gillis, L. B., White, C. S., & Mun, S. K. (2018). JOURNAL CLUB: Computer-Aided Detection of Lung Nodules on CT With a Computerized Pulmonary Vessel Suppressed Function. *American Journal of Roentgenology*, 210(3), 480-488. doi: 10.2214/ajr.17.18718.

**29** Fewer Missed Nodules<sup>1</sup>

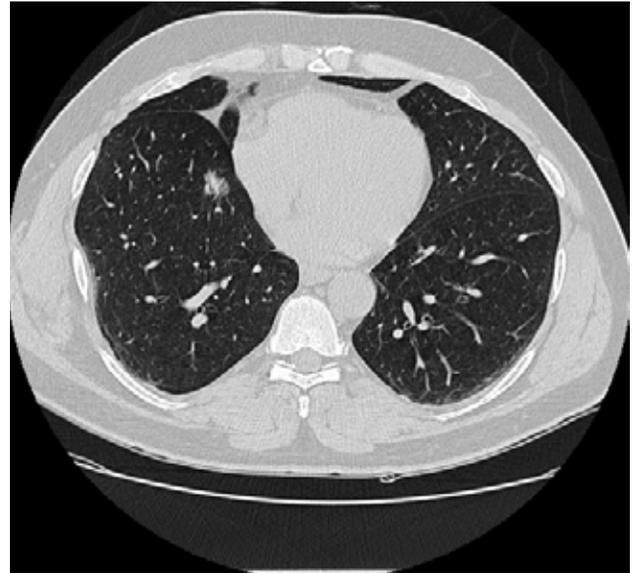
**26%** Faster Reads<sup>1</sup>



**Riverain**<sup>TM</sup>  
TECHNOLOGIES



ClearRead CT is the first FDA-cleared device to support concurrent reading, allowing for faster reading with proven superior automatic nodule detection performance for all nodule types, including solid, subsolid and ground glass nodules.



## Vessel Suppress

ClearRead CT Vessel Suppress produces a secondary series, suppressing vessels and other normal structures within the lungs to improve nodule conspicuity as shown in the image to the right. The Vessel Suppress series gives users access to a truly unique and patented technology that aids in improving reading accuracy and efficiency. The processed series can even be easily linked with the original CT series for synchronized scrolling.

Vessel Suppress not only enables improved nodule detection by eliminating obscuring normal structures, it also allows improved nodule characterizations for all nodule types. Improved characterization derives in part from the ability for precise segmentation of nodule boundaries. Aside from volumetrics, the Vessel Suppress series enables a unique view of nodules.



## Detect

ClearRead CT Detect leverages the vessel-suppression series to locate and characterize suspected nodules, enabling transparent, precise automatic measurements. The image to the right shows the detection and characterization of a ground-glass nodule.

Detect provides measurements related to each detected region of interest including: location, type, volume, maximum, minimum, and average axial plane diameters, depth, and average density in Hounsfield units.



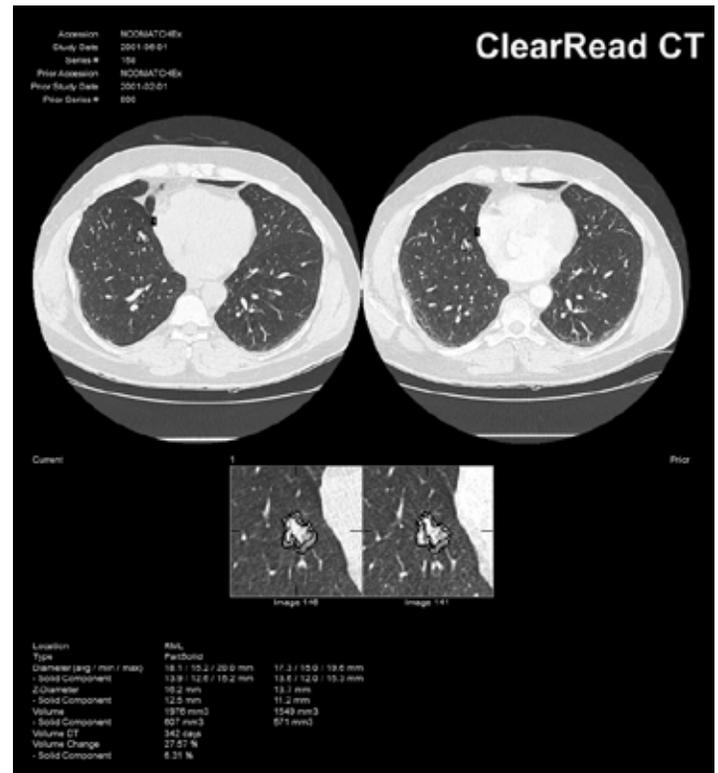
## Compare

ClearRead CT Compare extends Detect by automatically matching nodules found in a current exam to the same nodule in a prior exam, enabling efficient visual and volumetric comparisons. The image to the right includes the current exam on the left and the prior exam on the right. The image chips at the bottom provide a close-up view of the individual finding, along with extracted measurements.



**“Vessel-suppressed CTs had 21% greater nodule detection rates, much higher inter-reader agreement rates, and significantly shorter average read times.”**

Professor Thomas Frauenfelder, MD  
Professor of Radiology University Hospital of Zurich, participating study clinician



## At the Forefront of Lung Cancer Detection: Duke University Medical Center



As one of the country's first facilities to institute a Lung Cancer Screening program, Duke University Medical Center is a thought leader and reference site for

institutions initiating similar programs. As an American College of Radiology (ACR) designated center for Lung Cancer Screening, The Duke Lung Cancer Screening program is recognized for providing safe, effective care for at-risk lung cancer patients, while maintaining the highest possible standards.

The shift toward implementing lung cancer screening programs began in 2011 with the release of the National Lung Cancer Screening Trial (NLST) results. The study concluded that annual screening with low-dose computed tomography (CT) could detect lung cancer in its earliest stages, reducing lung cancer deaths by 20 percent.

According to Jared Christensen, MD, Division Chief of Cardiothoracic Imaging and Director of The Duke's Lung Cancer Screening program, one of their biggest challenges in thoracic imaging is searching for lung nodules.

For every chest CT exam, radiologists are obligated to search for lung nodules. Due to the lack of early-stage lung cancer symptoms, detecting incidental pulmonary nodules is critically important for early lung cancer detection. To help their radiologists detect more efficiently, Duke University Medical Center has deployed Riverain ClearRead CT software throughout their entire health network across all chest CTs, whether taken for screening.

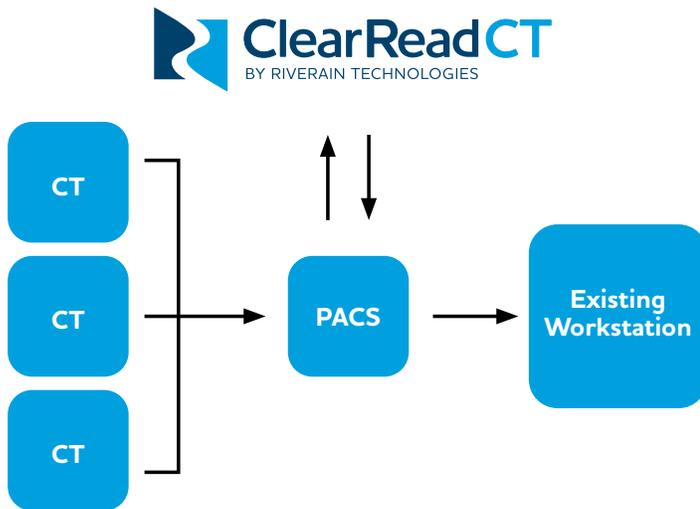
“Riverain ClearRead CT was deployed as a part of our routine Chest CT exams, including patients in our Lung Cancer Screening program,” said Dr. Christensen. “The ClearRead CT technology has helped us detect lung nodules that may have otherwise been missed. The workflow is faster and more accurate than other technologies.”

Duke University Medical Center has deployed Riverain ClearRead CT software throughout its entire healthcare network, providing a standard of care to its total patient population. The ClearRead technology seamlessly processes CT scans from all 15 CT scanners, regardless of manufacturer or acquisition protocols.

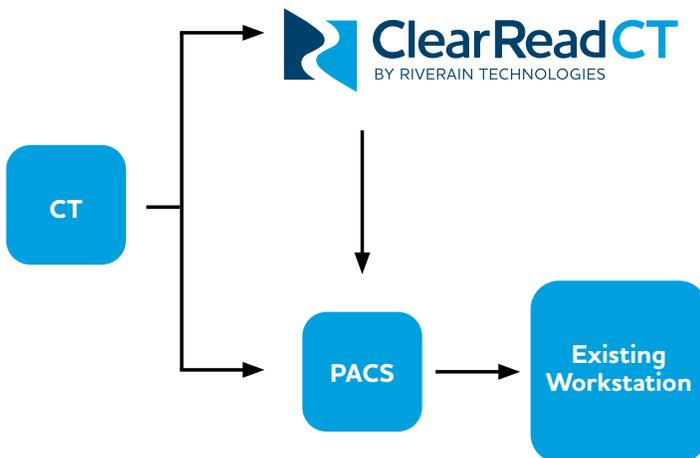
## Installation and Workflow

Acquisition normalization technology, along with programmable routing and exam filtering tools, allows rapid installation and site-specific configurations. ClearRead applications produce adjunctive content that seamlessly interfaces with the existing facility PACS. The result is a cost-effective, efficient viewing experience for the radiologist.

## Enterprise PACS Push Workflow



## Modality Dual Push Workflow



## Host Machine Specifications

### Minimum server specifications:

- Intel Xeon E3-1230 v5
- 16 GB RAM
- 100 GB disk (dedicated storage)
- Disk I/O at 300 IOPS with 4k block size
- 1 Gbit/sec Ethernet controller

### Minimum virtual specifications:

- 4 vCPU with 14 GHz CPU reservation
- 16 GB RAM reservation
- 100 GB disk
- Disk I/O at 300 IOPS with 4k block size
- 1 Gbit/sec Ethernet controller

### Operating System:

- Windows 7 Professional/Enterprise/Ultimate 64-bit
- Windows 8.1 Professional/Enterprise 64-bit
- Windows 10 Professional/Enterprise 64-bit
- Windows 2008 R2 Server 64-bit
- Windows 2012 R2 Server 64-bit
- Windows 2016 Server 64-bit
- Windows 2019 Server 64-bit

### Web Browser:

Microsoft Internet Explorer 10 or better, with cookies and Javascript enabled.

### Supported Virtualization Environments:

VMWare® 5 or later

### Software Protection Key:

The HASP-HL key requires:

- One USB Type A port available
- Power consumption 50mA operating / <0.5mA standby

### Third Party Software:

Riverain strongly recommends against installing ClearRead CT on a multi-use instance of a VM or having multiple roles for a physical server by adding additional third-party software.

**17** Improved Nodule Detection<sup>1</sup>

**19%** Faster Reads<sup>1</sup>

Enterprise-wide capability powered by acquisition normalization technology that allows “plug in” ability across all manufacturers and diverse imaging protocols.

High throughput, scalable computation on off-the-shelf hardware and virtual machine deployments.

No additional radiation dose or changes to existing imaging protocols are required.

Reduces the burden of visual search and assessment.

Automatically inserts the images into the patient’s file for instant access.

## Bone Suppress

ClearRead Xray Bone Suppress increases the visibility of soft tissue in standard chest Xrays by suppressing the bone on the digital image without the need for two exposures. The bone-suppressed image helps radiologists to detect 1 out of 6 previously missed nodules.<sup>2</sup>



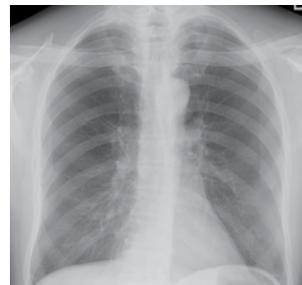
Original



ClearRead Xray | Bone Suppress

## Detect

ClearRead Xray Detect identifies regions of interest that warrant further examination. The software can detect 1 in 2 previously missed nodules<sup>3</sup> allowing identification of lung cancer up to 18 months sooner.<sup>4</sup>



Original



ClearRead Xray | Detect

## Confirm

ClearRead Xray Confirm optimizes and standardizes portable chest Xrays and improves the conspicuity of lines and tubes without compromising diagnostic image quality. The application minimizes or eliminates the need for image adjustments, reducing reading time by 19-35%.<sup>5,6</sup>



Original



ClearRead Xray | Enhanced



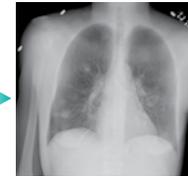
ClearRead Xray | Confirm

## Compare

ClearRead Xray Compare aids in the detection of soft tissue interval changes across current and prior chest Xrays by registering the bone-suppressed images and creating a difference image. The software allows detection of 1 in 10 previously missed emerging nodules.<sup>6</sup>



Current Xray



ClearRead Xray | Bone Suppress (Current)

Register and Subtract (Prior-Current)



ClearRead Xray | Compare



Prior Xray



ClearRead Xray | Bone Suppress (Warped Prior)

# Unique Technology for Computer Assisted Reading

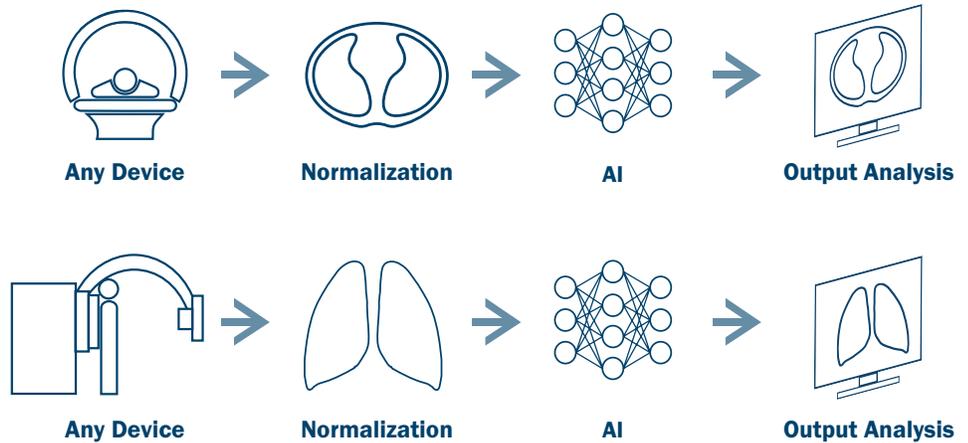
## Acquisition Independence

ClearRead handles a broad range of acquisition protocols, a difficult problem for automatic analysis algorithms. Riverain Technologies developed adaptive algorithms, so each scan is normalized for factors such as:

- Noise
- Reconstruction kernels
- Slice sampling effects

Conventional approaches collect data from different sensors to adjust component algorithms. This leaves them vulnerable to changes in hardware, protocols, and reconstruction methods.

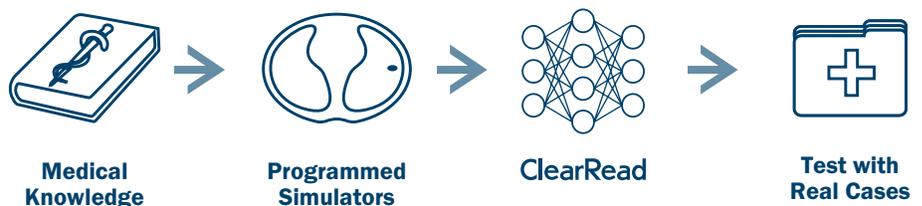
Our adaptive process allows our software to be vendor neutral. ClearRead provides enterprise imaging without compromise, while also enabling fast and simple installation.



## The Riverain Technologies Difference

The standard approach to building large, complex models requires large measured training sets. These high-quality medical data sets are both time consuming and expensive, to collect. Many cases look similar, and do not include rare cases.

Riverain developed the capability to create synthetic nodules automatically and place them into relevant anatomical contexts – such as next to the pleura wall or attached to a vessel. ClearRead was built on thousands of simulated, diverse nodules. By doing this, our software has been trained on more complete cases (including more rare cases), and tested on full training sets.



**Standard Approach**  
90% of cases are used to build the model



**Our Approach**  
Using simulated data allows cases to be used for testing



### ClearRead Xray References

- 1 Lo, S. B., Freedman, M. T., Gillis, L. B., White, C. S., & Mun, S. K. (2018). JOURNAL CLUB: Computer-Aided Detection of Lung Nodules on CT With a Computerized Pulmonary Vessel Suppressed Function. *American Journal of Roentgenology*, 210(3), 480–488. doi: 10.2214/ajr.17.18718.
- 2 Freedman, M. T., Lo, S.-C. B., Seibel, J. C., & Bromley, C. M. (2011). Lung Nodules: Improved Detection with Software That Suppresses the Rib and Clavicle on Chest Radiographs. *Radiology*, 260(1), 265–273. doi: 10.1148/radiol.11100153
- 3 Chen, J. and White, C. (2008). Use of CAD to Evaluate Lung Cancer on Chest Radiography. *Journal of Thoracic Imaging*, 23:93-96.
- 4 Gilkeson, Robert C. and Frolkis, Calen. Performance of a Next Generation Computer-Aided Detection Algorithm for the detection of overlooked lung cancers on Chest Radiographs. RSNA, 2013.
- 5 Riverain Technologies ClearRead +Confirm FDA 510(k) Reader Study Results, 2012.
- 6 White, Charles. Verbal quotation of site findings. University of Maryland Medical Center, MD. 27 August 2012.