Powering the Future
of Healthcare ▶

**CitiusTech**

# Medical Imaging

**Enabling healthcare provider's imaging services to digitally transform legacy infrastructure, automate workflows and improve quality of diagnosis**

# Who we are

**As a strategic imaging partner across healthcare ecosystem (Providers, MedTech and Life Sciences), we play a deep and meaningful role in accelerating digital innovation, driving sustainable value and helping improve outcomes across the healthcare market.**



Everest Group PEAK MATRIX® STAR PERFORMER 2022 HEALTHCARE PAYER DIGITAL SERVICES

The Top 100 Healthcare Technology Companies 2022

healthcare innovation — PEOPLE. PROCESS. TECHNOLOGY TRANSFORMATION.

Gartner

FROST & SULLIVAN 2021 BEST PRACTICES AWARD — GLOBAL DIGITAL TRANSFORMATION SERVICE PROVIDER FOR LIFE SCIENCES CUSTOMER VALUE LEADERSHIP AWARD

**As a pure-play healthcare technology company, we are uniquely positioned to drive digital transformation, automate workflows and improve quality of diagnosis for healthcare providers and global medical imaging leaders.**

**400+**

Medical imaging experts

**Multiple specialized offerings**

like Interoperability, Clinical Imaging Services - Digital Pathology, Oncology, Mammography etc.

**50+**

Active projects across the Imaging practice

# Medical imaging offerings

**CitiusTech has extensive experience in healthcare ecosystem (Providers, MedTech and Life Science). Our experiences extend across entire healthcare ecosystem including legacy and emerging technologies .**

## *Imaging Solutions*

| Imaging Analytics / AI | Clinical Services | Interoperability | Visualization & Archival | Strategic/Informatics Consulting | Service & Support |
|---|---|---|---|---|---|

## *Tech Services*

| Product Engineering | Cybersecurity | Data Management | QA & Automation | Sustenance & Serviceability | Data Science & AI |
|---|---|---|---|---|---|

**Customer Value**

| Improved Radiologist Productivity | Intelligent Radiology Workflows | Improve care Outcomes | Augmented clinical decision support | Faster time to market |
|---|---|---|---|---|

# Preferred digital engineering partner for healthcare ISV's

## Visualization

- Product development for Thin and Thick Client (Client Server architecture)
- Integration of AV tools, real-time 3D Processing over web
- UX Modernization

## Product Deployment

- Remote serviceability
- Continuous integration and continuous delivery
- Customized deployment
- Docker and container approach of development and deployment

## Archiving

- Access to data from third-party sources
- Data curation services
- 3rd party data validation
- De-identification services
- Synthetic data generation
- SaMD / 510K regulatory support

## Enterprise Imaging Workflows

- Seamless access to patient data using Cloud based Imaging solutions (case exchange)
- Longitudinal view of patient data, De Identification
- Third Party Integration

# Addressing next-gen technology for medical imaging services

## Image Acquisition

- Console application development for Modalities CT, MR, USG
- Endoscopy, Portable modalities
- Protocol Management
- Workflow optimization

## AI & Machine Learning

- Automate customer service with Chatbot
- Operational and financial efficiency
- AI based imaging solutions e.g. worklist prioritization, image pattern recognition, etc.

## Next-gen Services

- FHIR-based Mobile apps.
- Teleradiology
- Image sharing networks & Edge gateways
- IOT, Cloud & Big Data
- Cybersecurity & vulnerability assessment

## Interoperability

- Imaging solutions based on Healthcare Standards IHE, DICOM, DICOMweb, FHIR, HL7
- Imaging workflow with EHR Integration using FHIR resource
- IHE based imaging workflows

# Case Study: Prefetching Imaging Studies from Cloud Using VNA

A leading provider of cloud computing and storage services wanted to demonstrate Cloud capabilities for radiology by developing a smart prefetch system, which would fetch archived images of the visiting patient from VNA using HL7 orders. The system would also import imaging data from the VNA, reconcile, and transfer to local PACS.

CitiusTech was selected to develop the information management solution given its expertise and proven experience in medical imaging standards and health Cloud.
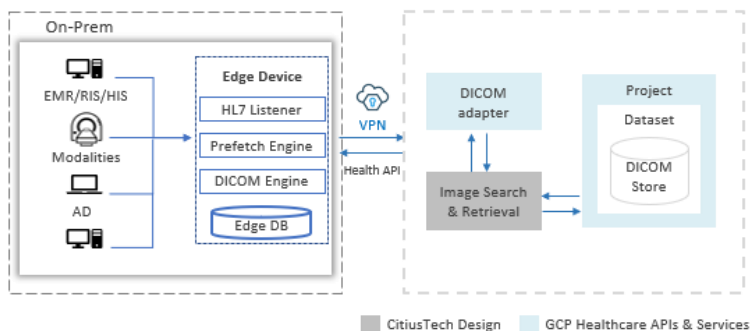


## CitiusTech Services

- CitiusTech developed an information management solution on the Google Cloud platform to aggregate and auto-download PACS data, accelerating the fetch process for each patient visit.

- Fetched today's patient list from HL7 ORU or RIS MWL queries & parse patient ID. Ran custom prefetch algorithm to identify relevant images to retrieve. Retrieved images from VNA using APIs

- Pushed retrieved imaging data in DICOM format to local PACS for fast access

- Deidentified and enabled batch upload of new imaging data from PACS to cloud VNA

- The Google Healthcare API-enabled VNA gateway identified and prefetched imaging data.

## Highlights

- Centralized, scalable, and interoperable repository for medical images

- Single source of truth on Cloud for all PACS and hospital data

- Remote access to patient images 24/7 through multiple devices

# Case Study: Cloud Enablement Solution for Imaging & PACS

Client is a leading Imaging/PACS product and solution provider with presence across global healthcare providers. Client's requirement was to integrate their existing PACS system and imaging viewer solution in the public cloud

The solution developed should enable the existing product to be sold to a new market segment of independent radiology practice and small hospitals
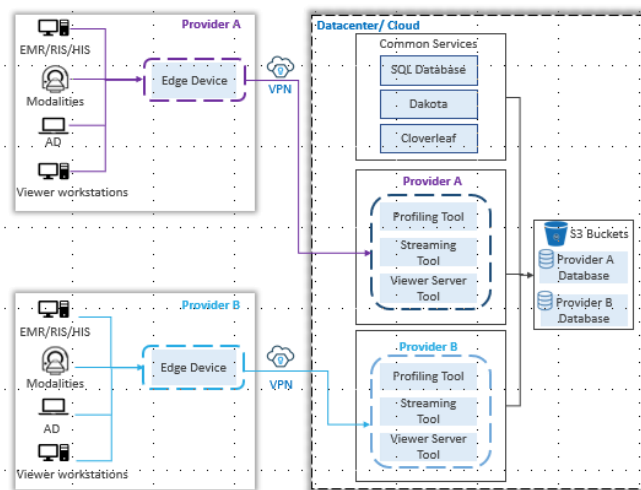


## CitiusTech Services

- Provided Infrastructure product engineering services to support the application deployment in hyper scaler environments

- Adhered to security standards for cloud enablement

- Created multiple data backup zones for disaster management and faster data access using AZ's

- Monitoring of the cloud infrastructure enabled auto-scalability of the solution as a part of the implementation

- Leveraged Data Management Services for building tightly coupled pipeline data migration from on-prem to cloud

- Data Migration from SQL Server to RDS with DMS implemented to utilize platform services to reduce cost and archive migration without down time

## Highlights

- Streamlined deployment/install/ upgrades approach for providers minimizing the site-based customizations

- Stable & simplified deployment helped client in saving service cost and infrastructure management

- Enabled support of multiple-viewers based applications in cloud

# Case Study: Research Platform for Imaging Data

Client is a global biotechnology corporation which wanted to build a cloud-hosted global collaboration portal across multiple stakeholders including data scientists, providers, governments, and scientific and research communities

Client engaged CitiusTech to build the imaging specific portion of their portal to ensure that the implementation was compatible with their comprehensive data management strategy
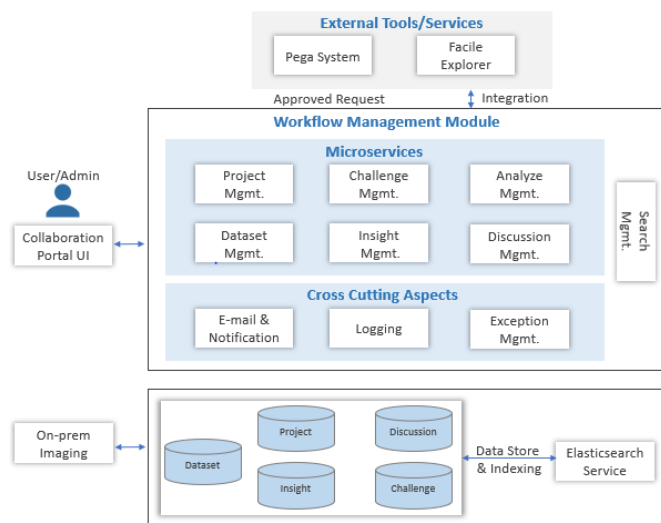


## CitiusTech Services

- Executed a short-term consulting engagement to clearly define the requirements for imaging data integration by working with a broad set of stakeholders across the client's user base

- Worked closely with key technical stakeholders from the client side to ensure that the overall imaging solution was seamlessly integrated into the existing collaboration portal

- Built a robust image ingestion infrastructure to move imaging data into the AWS S3 buckets

- Developed a search module to provide access to key imaging data attributes requirement for research purposes spanning across public and private DICOM metadata as well as pixel level insights

- Built a comprehensive auditability module to trace the transfer and record access of imaging data in a DICOM compliant format

## Highlights

- Developed an imaging ingestion pipeline to move data from multiple sources including research orgs, Providers, etc. into the AWS environment

- Developed an integrated search which allowed users to extend existing search capabilities into imaging related parameters

# Case Study: Secondary Analysis for Real World Imaging Data

Client is a leading Pharmaceutical company powered by technology leadership in R&D, world-class drug commercialization, global access and data science.

Client wanted CitiusTech to conceptualize and implement an image management solution to support ingestion, storage, data search and image annotation into their RWE data management platform
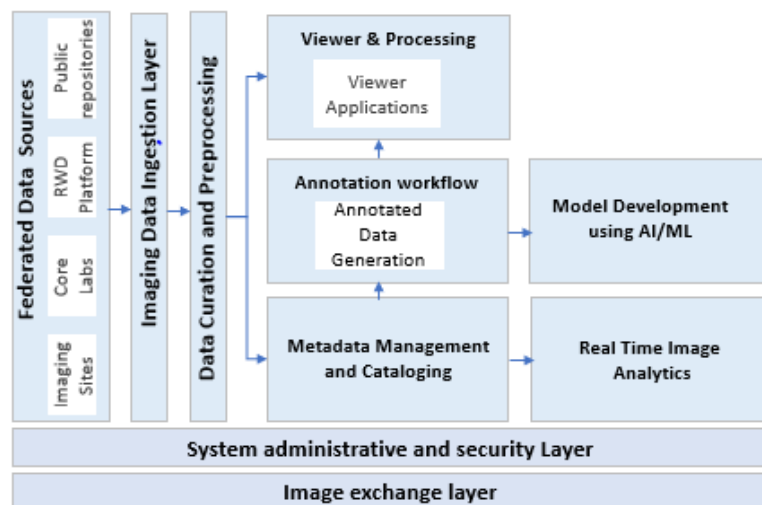


## CitiusTech Services

- Helped set up ingestion pipeline for DICOM and non-DICOM native data formats
- Standardized metadata using sponsor defined taxonomy and structured codes
- Performed extraction of metadata from DICOM and non-DICOM images and mapped it to FHIR resources to create a systematic approach to metadata cataloging and management
- Automation in Quality control and de-identification of image and metadata
- Designed UX/UI to facilitate data browsing and viewing through robust search on the platform
- Orchestrated Radiologist workflow for image access through 3rd party viewer
- Exchanged annotated data internally and externally to build cohort for machine learning

## Highlights

- Reduced time & effort in acquiring medical imaging data from multiple external real world data sources
- Developed integrated search app providing access to relevant imaging across enterprise platform
- Developed a curated imaging dataset which was leveraged for training machine learning algorithms

# Case Study: Oncology Treatment Planning as a Service

Client is a leading provider of oncology treatment devices and software and holds an OIS set up at various radiation oncology clinics.

To lower infrastructure / staffing costs at local clinics, a Centralized Treatment Planning System and an automated workflow was needed, thereby offering Treatment Planning as a Service.

CitiusTech was selected to design the architecture and build a Centralized Treatment Planning solution.
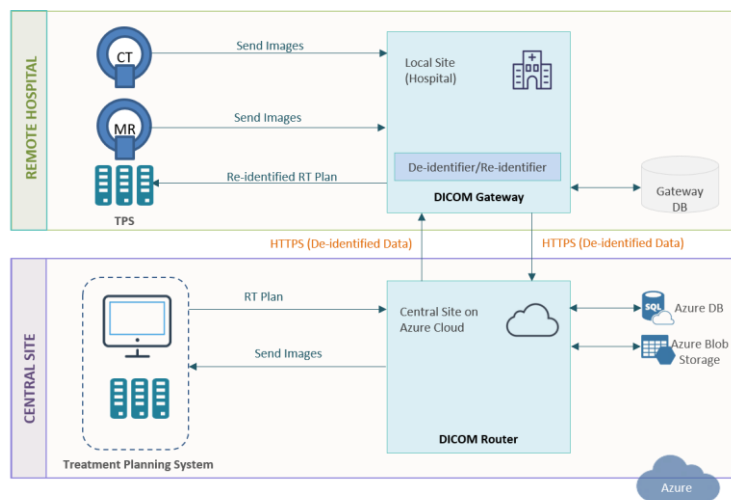


## CitiusTech Services

- Designed the architecture and UX design of Centralized Treatment Planning System

- Developed an intuitive UI solution for Oncologist to create a treatment plan directive

- Built de-identifier / re-identifier module to mask / unmask DICOM PHI data to ensure no PHI data is exchanged between remote hospital sites and centralized system

- Designed Azure cloud infrastructure for centralized system deployment

- Orchestrated CI/CD pipeline for deploying services on Azure app and cloud service

- Integrated the client's billing systems and AI applications

## Highlights

- Leveraged CitiusTech's expertise in UX design, Azure cloud, DICOM, and oncology domain for accelerated development

- Detailed product requirement documentation, product UX design and enhanced user experience

- Delivered highly available solution covering the security aspects of data in transit as well as at rest

# Case Study: ZFP Viewer for Leading Imaging Vendor

Client is a leading healthcare medical device and imaging solutions vendor and wanted to build a web based, multi-modality viewer that can be accessed from desktop and mobile devices

CitiusTech was chosen as the preferred partner for this innovative engagement given its expertise in medical imaging and proven record of successful engagements with the client

CitiusTech worked on various features in terms of development. Enhancements, testing, maintenance support over the course of the engagement
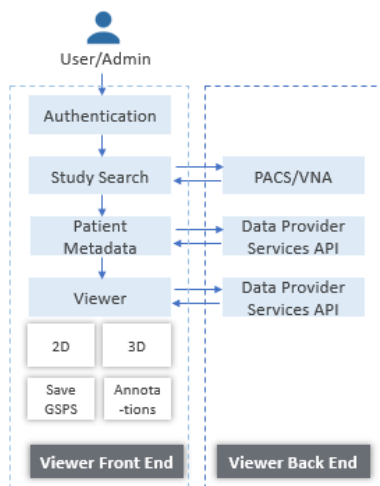


## CitiusTech Services

- Built a responsive UI with standard 2D viewer features including hanging protocol support & presentation state
- Enabled support for 3D rendering (MIP/MPR), customized views & rendering of non-DICOM doc.
- Provided support for exporting DICOM images and Sharing of DICOM data to external archives
- Developed a reporting functionality which supports voice to text reporting
- Application also supports customizations for patient or study based view
- Enabled support for VNA integration
- Support for a patient timeline to display studies chronologically

## Highlights

- Enabled Image rendering of the study is done in <3 seconds as KPI
- Viewer helped save up-to 19% of radiologist's time by rendering faster images
- Enhanced the workflow through 32% reduction in duplicated tests with anytime access to data
- Image rendering using cloud solution made clinicians to access the images faster and simpler

# Case Study: Cyber Security of Medical Device (CT Scanner)

Client is a leading medical device company. Client required assistance in meeting US Department of Defense (DoD) and recommended FDA compliance on cybersecurity for its CT scan device.

Customer faced challenges with Authorized Device Dealers (ADD) installing unapproved software as freebies and top-ups and tampering customer software to win hospital/clinic purchase contracts.

CitiusTech was selected to provide required assistance in cybersecurity engineering of CT Scanner
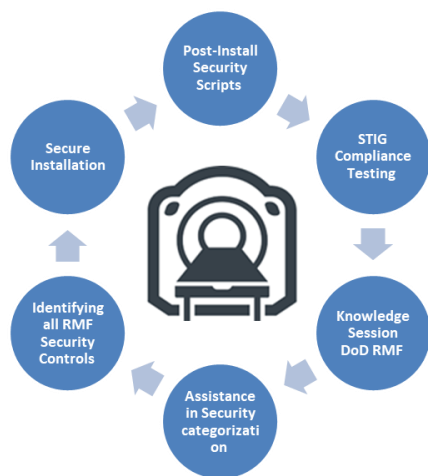


## CitiusTech Services

- Developed Shell Scripts to strengthen OS security, as per DoD STIGs. Upon installation completion scripts will be executed as post-installation security scripts
- STIG Compliance testing was conducted regularly to keep track of improvements in Security Posture
- Proposed near Ideal solution for Secure Installation using Trusted computing and Public Key Infrastructure
- Developed best-fit Secure Installation process using GnuPG to ensure only customer signed patches are installed under Org constraints
- Knowledge sharing session on DoD RMF was conducted
- Assisted in categorizing CT Scanner from security perspective. Followed by identifying list of all Security Controls applicable as part of  RMF

## Highlights

- Department of Defense's(DoD) OS level STIG compliance was met partially.
- STIG Compliance testing helped in planning next security development iterations
- Malicious Attacker, Distributor, Field Engineer,  or Hospital staff will not be able to install unauthorized malicious software on the CT Scanner

# Case Study: Securing Central Station

Customer is a leader in medical device industry and medical device systems.

Customer engaged CitiusTech to perform vulnerability assessment for OS and all SOUP items of Central Station (SOUP items are third party software's installed in medical devices), carryout STIG compliance testing, orient the Monitoring Solution's Engineering team with DoD RMF process.

Central Station receives data from multiple bedside monitors in the ICU. Nurses can remotely monitor patient data/status from one central station, thus increasing efficiency.
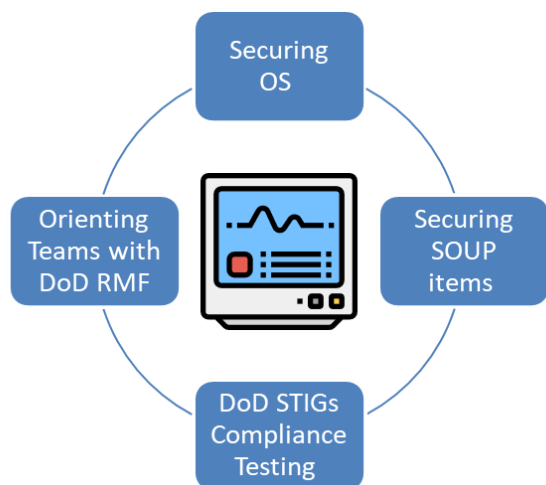


## CitiusTech Services

- CitiusTech carried out OS Vulnerability assessment and found 35+ OS level vulnerabilities. Identified, analyzed & deployed all required OS patches

- CitiusTech carried out manual vulnerability assessment for all SOUP items. Found 145+ vulnerabilities. Identified and addressed all vulnerable SOUP items

- CitiusTech conducted knowledge sharing session on DoD RMF and trained 35-40 Engineers with DoD RMF processes

- CitiusTech conducted STIG Compliance testing and found 150+ non-compliant implementations which needed to be addressed prior to releasing the product

## Highlights

- All identified Items were successfully upgraded addressing critical system level security vulnerabilities

- Provided a detailed assessment on how the existing vulnerabilities could be exploited by malicious actors to compromise the patient care process. Sensitized the engineering leadership to conduct similar assessments across the entire product portfolio

# About CitiusTech

With 7,500+ healthcare technology professionals worldwide, CitiusTech helps leading healthcare and life sciences organizations reinvent themselves by accelerating digital innovation, leveraging next-gen technologies, and driving data convergence across the healthcare ecosystem.

We provide strategic consulting, digital engineering, data, analytics & AI, specialized platforms and end-to-end solutions to over 130 organizations across the payer, provider, medtech and life sciences industries. Our key focus areas include healthcare interoperability data management, quality performance analytics, value-based care, omni channel member experience, connected health, virtual care delivery, real-world data solutions, clinical development, personalized medicine and population health management.

Our cutting-edge technology expertise, deep healthcare domain expertise and a strong focus on digital transformation enables healthcare and life sciences organizations to deliver better outcomes, accelerate growth, drive efficiencies, and ultimately make a meaningful impact to patients.

**100%**
healthcare focus

**130+**
healthcare clients

**50M+**
lives touched

**4.5/5**
client satisfaction score

**$420 M**
2023E revenue

# Key Contacts

**Dhaval Shah**
Exec. Vice President
Healthcare Technology
CitiusTech

20+ years of experience in healthcare technology, spanning various domains including healthcare interoperability and enterprise application architecture. At CitiusTech, Dhaval heads strategic partnership management for large healthcare organizations.

Prior to CitiusTech, Dhaval worked with leading healthcare organizations and contributed in different roles such as Research Engineer, Lead Engineer and Chief Architect.

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**John Memarian**
Vice President
Imaging Technology & Informatics
CitiusTech

25+ years of industry experience including - 7+ years of clinical & technical experiences with extensive hands-on experiences in both invasive and non-invasive adult and pediatric imaging & surgical procedures. At CitiusTech, John leads the Imaging Consulting practice team.

Previously worked across multiple roles in Imaging domain in various capacity such as consulting and business development experiences in bioscience, IT Solutions, cloud technologies, enterprise imaging, digital pathology and clinical genomics

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