Enterprise Imaging by definition

The basic idea of Enterprise Imaging is to take all data (which includes images, waveforms, reports and other patient data) and amalgamate it into one place, instead of the current system of data residing in numerous, disconnected departmental data silos.

An Enterprise Imaging Platform (EIP) provides the reliable infrastructure, and integration points, on which the Enterprise Imaging strategies and initiatives can be based. At the center of an enterprise imaging platform is an Enterprise Image Repository, which provides standards-based image archive infrastructure and services for storing and retrieving DICOM and non-DICOM clinical imaging content.
Explosion of data...

Imaging data has exploded 4X in the last decade
The Carestream Solution
“Carestream PACS”

404. That’s an error.
Significant Changes

Changes in 12.1

- **64-bit** for larger datasets and server-side rendering
- DICOM **Structure** broken down
- Removed **file-size** limitation
- **IHE** Enhancements
  - Support of FHIR, JSON

- Vue Explorer (CCP GUI)
  - Integrated **Vue Motion**
  - **Capture** Portal
  - Enhanced **APIs** to image enable the EPR
The platform can perform 4 major workflow steps:-

**Capture** – various modules that can easily **acquire different data formats**
**Manage** – various modules that can drive productivity through **efficient data management**
**Archive** – various modules that can **consolidate various data silo’s** to reduce costs
**Collaborate** – various modules that can enable **timely sharing and exchange** amongst different stakeholders
Building Blocks

Application Services

Common Application Infrastructure
(Configuration Mgmt., User Mgmt., Audit, Chat, etc.)

Software Infrastructure
(Operating System, Database, Web Server)

Compute Service
(Physical or Virtual)

Storage Service
(Block, NAS, Object, etc.)
Building Blocks

Application Services

- Clinical Archive (VNA)
- Workflow Orchestrator
- Diagnostic Viewer
- Imaging Analytics
- Interactive Multimedia Reporting
- Enterprise Viewer
- Image Sharing & Patient Portal
- Business Analytics

Standard Protocols Stack

- DICOM, WADO, DICOMWeb (WADO-RS, QIDO, STOW*)
- XDS-I, XDS (Non-DICOM)
- HL7, FHIR

Private Web Services / Protocols
(overcomes lack of standards, improves performance)

Common Application Infrastructure
(Configuration Mgmt., User Mgmt., Audit, Chat, etc.)

A SMARTER WAY FORWARD
Building Blocks

Application Services

- Clinical Archive (VNA)
- Workflow Orchestrator
- Diagnostic Viewer
- Imaging Analytics
- Interactive Multimedia Reporting
- Enterprise Viewer
- Image Sharing & Patient Portal
- Business Analytics

Standard Protocols Stack

- DICOM, WADO, DICOMWeb (WADO-RS, QIDO, STOW*)
- XDS-I, XDS (Non-DICOM)
- HL7, FHIR

Private Web Services / Protocols
(overcomes lack of standards, improves performance)

Common Application Infrastructure
(Configuration Mgmt., User Mgmt., Audit, Chat, etc.)
Challenges and Solutions
What are the challenges?

- **Workflow**

  As images have increased in importance, hospitals have **struggled to effectively store, display, and distribute** these images throughout the enterprise. This has remained a struggle because of **inefficient workflow** and **incomplete solutions**.

- **Technical**

  The **types of acquisition devices** used for various general-purpose photography and **specialized applications** including dermatology, endoscopy, and anatomic pathology are reviewed.

  The **formats and standards** used, and the associated metadata requirements and communication protocols for transfer and workflow are considered.

  Particular emphasis is placed on the importance of **metadata capture** in both order and encounter-based workflow. The benefits of using DICOM to provide a standard means of recording and accessing both metadata and image and video data are considered, as is the role of **IHE and FHIR**.
Challenges...

Workflow

- Each specialty acquires and uses images differently

- In Radiology, the image acquisition process begins with an order placed by a referring physician. Once the order is placed, it is transferred to RIS. The RIS uses the information contained within the order to create a worklist on the imaging modality. Technologists select the patient from the worklist, ensuring that all demographic and order information is correct. After the images are obtained, they are sent to PACS for storage and viewing. Even though this workflow is elegant, it is not able to be generalized within the hospital.

For example, a dermatologist may see a patient in clinic and take a photograph in order to document a skin lesion. Because the dermatologist is the one taking the photograph, he or she does not need an order to perform this imaging procedure...
### Dermatology Orders

<table>
<thead>
<tr>
<th>Exam</th>
<th>Patient Name</th>
<th>Patient ID</th>
<th>Date of Birth</th>
<th>Gender</th>
<th>Accession</th>
<th>Procedure</th>
<th>Referring Physician</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bailey, Abigail</td>
<td>3464086478</td>
<td>6/1/1964</td>
<td>F</td>
<td>A7C7C13</td>
<td>17000 Premalignant 1st lesion</td>
<td>Morrison, Daniel</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Bell, Ava</td>
<td>1767026720</td>
<td>3/14/1981</td>
<td>F</td>
<td>A7C7CD6</td>
<td>11401 Excision, benign lesion including margin...</td>
<td>Morrison, Daniel</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Brown, Alexander</td>
<td>273391457</td>
<td>8/7/1974</td>
<td>M</td>
<td>A7C7A32</td>
<td>11100 Biopsy skin 1 lesion</td>
<td>Williams, Alexander</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Evans, Daniel</td>
<td>1766232087</td>
<td>10/15/1996</td>
<td>M</td>
<td>A7C7E1B</td>
<td>95567 Levulan PDT</td>
<td>Sanchez, Michael</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Fisher, Elizabeth</td>
<td>1543921001</td>
<td>8/20/1939</td>
<td>F</td>
<td>A7C7E9B</td>
<td>11822 Excision, malignant lesion including mar...</td>
<td>Williams, Alexander</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Flores, Ethan</td>
<td>1116056434</td>
<td>6/4/2004</td>
<td>M</td>
<td>A7C7F73</td>
<td>15100 Split graft, right arm, first 30 sq cm</td>
<td>Sanchez, Michael</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Ford, Emily</td>
<td>2746122336</td>
<td>5/11/1968</td>
<td>F</td>
<td>A7C8046</td>
<td>12032 Layer closure of wounds of scalp, trunk...</td>
<td>Morrison, Daniel</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Foster, Emma</td>
<td>4091890987</td>
<td>12/30/1999</td>
<td>F</td>
<td>A7C810B</td>
<td>10040 Acne surgery - comedones</td>
<td>Sanchez, Michael</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Johnson, Isabella</td>
<td>1125638758</td>
<td>2/6/2002</td>
<td>F</td>
<td>A7C61C2</td>
<td>J7308 Levulan Kerastick</td>
<td>Sanchez, Michael</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Kelly, Jayden</td>
<td>673056169</td>
<td>9/17/1960</td>
<td>M</td>
<td>A7C9795</td>
<td>15781 Dermabrasion; segmental, face</td>
<td>Williams, Alexander</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>King, Jacob</td>
<td>2401962816</td>
<td>3/17/1990</td>
<td>M</td>
<td>A7C988F</td>
<td>17000 Premalignant 1st lesion</td>
<td>Morrison, Daniel</td>
<td>12</td>
</tr>
</tbody>
</table>

**A SMARTER WAY FORWARD**
Patient Identification

Correct patient identification is imperative.

The correct images must be placed within the correct patient’s medical record every time. As such, all images must include patient identification.

In DICOM, this identification is automatically applied with an order is selected from the modality worklist supplying the necessary metadata, as described above.

In non-DICOM imaging, an automated solution must be identified to correctly identify patients. Potential solutions include workflow reminders, adding patient identifying information to every image or create a new modality worklist.
Capture Portal...

A SMARTER WAY FORWARD
Challenges...

 Metadata

Reports are not the only information to give image context, metadata also serves this purpose. In DICOM-based imaging, metadata is applied at the patient, study, series, and image Level. Whilst we will focus on study-level information as it provides the basic information needed to classify an imaging study, it is likely that series and image level metadata will need to be modified for enterprise imaging. This information is crucial for driving display protocols, comparison studies, and searching.

- Body Part
- Procedure Description
- Department
- Imaging Source
Images are worth a thousand words, but only if you understand the context of the image. A person can describe a photograph of a landscape in detail because he or she understands what the photograph is showing, even if he or she has never seen the location. The same is not true for medical imaging. While a medical provider can describe portions of an image, specialists are needed to provide the exquisite detail in describing the image. Therefore, it is crucial to be able to link the text describing an image or an encounter with each image.

Bi-directional association: Links in reports to images
Images and Reports

A SMARTER WAY FORWARD
Image Enabling the EPR

**Patient Reports**

1/1 Jennings, John (Md)

Report date: **12/17/2015**

(Report matches study selected on Patient History pane)

**PROCEDURE:** CT abdomen

**CLINICAL INDICATION:** Follow-up of metastasizing melanoma

**TECHNIQUE:** CT examination with I.V contrast

**FINDING:**

Status post removal of malignant melanoma in the right groin. Ascites, peritoneal carcinomatosis, multiple liver metastases. A target lesion was noted in the liver.

**Patient History (4)**

Baker, Blake 2013160035297 12/17/2015 7:09 PM

Acc: 2013150629559  Pos: 145.30 mm

Study Desc: CT 2D REFORM STAT ... SW: 0.60 mm

Series Desc: BODYAXW 0.6 I31f 2

1 - 1

Lossy (1:13)
Mobile Devices

It is clear that providers are currently using their devices to capture images, videos, and sounds from their patients. In many instances, this practice raises concerns related to patient privacy. Mobile devices, such as Smartphones, are designed to allow users to take and share photographs. Many people have hundreds of photographs stored on their phone and personal cloud solutions.
Mobile Device Support

A SMARTER WAY FORWARD
Technical challenges...

Integration with the Departmental Imaging Systems

- Departments that use image acquisition devices that **natively work with DICOM images and protocols**.

- Departments that use **Endoscopes, Microscopes, and Digital Cameras**.

- **Medical photos** or **videos** that were previously captured, or have just been captured, and saved **as consumer camera format files**, which need to be imported into the Enterprise Imaging Platform.

- **Image exchange and sharing**: exporting and importing **outside** studies (foreign exam management).
Technical challenges...

Standards, File Formats, Protocols, and Profiles

Non-DICOM and DICOM image files may include still images, dynamic image sequences, waveforms, video, audio, and multimedia documents. Non-DICOM, or native, images may be acquired and maintained as standard digital image and multimedia formats such as JPEG, TIFF, WAV, and MPEG4. Some vendors choosing to provide acquisition in proprietary formats may still deliver post-processed images in standard file formats.

Metadata
- Within the image files, as DICOM does
- Separately in a system that associates it with the image files.

Image Compression and Compressed File Formats

Communication Protocols
- REST-based
- XML/SOAP-based
- Other methods
Technical challenges...

Source Devices

Acquisition devices vary among specialties, although many devices may be shared between specialties, as may occur with a hybrid device used for radiology-performed ultrasound and cardiology-performed echocardiograms. The same device type may be used to acquire images across varied specialties.

- For example, video capture devices are used to acquire video and still images through Endoscopes, Cameras, Microscopes and Bronchoscopes.

- Diagnostic imaging, Procedural imaging, Evidentiary Imaging, Image-Based Clinical Reports, Visible Light Imaging Devices (Consumer devices, Medical Photography devices, Dermatology devices, Endoscopy devices etc)
Clinical Repository: Archive every file.

**Features**

- **DICOM modalities**
- **Non-DICOM modalities**

**Hospital IT**

- DICOM
- HL7
- ADT

**Benefits**

- Store data in **multiple formats**, **multiple standards**
- **Mobile acquisition** compatible
- Highly effective in **multi-site** and regional installs
- HW platform independent
- Consolidate image repositories and image enable the EMR

**A SMARTER WAY FORWARD**
Things to Consider in Enterprise Imaging

- **Component Interoperability**
  - A Platform designed for this, not pieced together

- **Multiple Viewer Options**
  - allows clinicians to easily choose between “reference-quality” image viewing and full-fidelity “diagnostic-quality” image viewing with the click of a mouse

- Federated **Image Viewing**

- **Mobile Image Acquisition**
  - Real-time worklists, Acquire

- **Image Exchange and Sharing**

- **Longitudinal Patient History**
  - present a patient’s complete longitudinal imaging history regardless of image type

- **Data Integrity**
USE CASE: DIGITAL PATHOLOGY
Example: Integrating Digital Pathology

- Integrating Digital Pathology
- Receiving Grossing Processing Embedding Microtomy Primary Staining (H&E) Advanced Staining Sorting
- Archiving
- Analysis by Technician
- Review & Report by Pathologist
- Client Tools
- Lab Workflow
- Capture Tools
- A SMARTER WAY FORWARD
A SMARTER WAY FORWARD

Integrating Digital Pathology – CS Client
Integrating Digital Pathology – ROI on Gross image etc.
Integrating Digital Pathology – Patient Mini Archive
Integrating Digital Pathology – Vue Explorer
Integrating Digital Pathology – Side By Side images
Integrating Digital Pathology – Capture Portal (Gross Image)
Takeaways

- Without images, EHRs don’t tell the whole patient story.

- Images should follow a patient throughout the progression of a health event for continuity of care.

- The entire multi-specialty care team needs to see a patient’s longitudinal image history.

- Comparing images side-by-side in a clinically relevant context is a significant diagnostic and treatment tool.

- Radiology workflows are not one-size-fits-all and should not be re-purposed for non-radiology clinicians.

- New mobile and web applications allow clinicians to work naturally.

- Thanks to the interoperability of its single, converged platform, enterprise imaging is a modular solution that focuses the care team on the patient, not on the technology...
Carestream