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Image Sharing
Use Cases and Standards

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Image Sharing Use Cases

- Encompassed by View/Download/Transmit (VDT):
  - View – select, navigate, display, interact, measure, analyze
  - Download – to local machine or media – use, archive, share
  - Transmit – to 3rd party – provider, archive, analysis service

- For each:
  - Who – imager, clinician (ordering, referral), "team", patient
  - What – complete set, subset, key images, report, other 'ologies
  - When – manual or automatic (triggered)
  - Where – EHR, PHR, PACS, VNA, HIE Archive, …
  - Why – reporting, diagnosis (clinical decision), review, audit, …
  - How – push/pull, payload, protocol, quality/speed, identifiers

AMA Safety Panel - CDs

- *"All medical imaging data distributed should be a **complete set** of images of **diagnostic quality** in compliance with those found in the **IHE** PDI (Portable Data for Imaging) Integration Profile"*

- complete, diagnostic, standard
- clinician and imaging industry consensus

*http://www.ama-assn.org/assets/meeting/2013a/a13-bot-24.pdf*

More CD lessons – IHE PDI

- Requires DICOM files on CD (or DVD)
  - further constraints on DICOM standard
  - goal: simplify reading, displaying, importing
- Optional on-board viewer
  - was deprecated (security issues with executable code)
  - now potentially standardized (Basic Image Review – BIR)
- Optional "Web Content"
  - i.e., HTML + JPEG versions of all/subset images
  - "faithfully represent the patient's clinical condition"
  - nice idea, not widely requested or implemented
- Optional report
  - file format not constrained – readable v. importable

IHE – Basic Image Review Standard Interface Behavior

- Direction of mouse movement (window, scroll, …)
- Mouse actions (left button click)
- Keyboard shortcuts
- Icons – "*not intended to be used exactly with the bitmap illustrated … as long as they are recognizable as being the same symbol*"
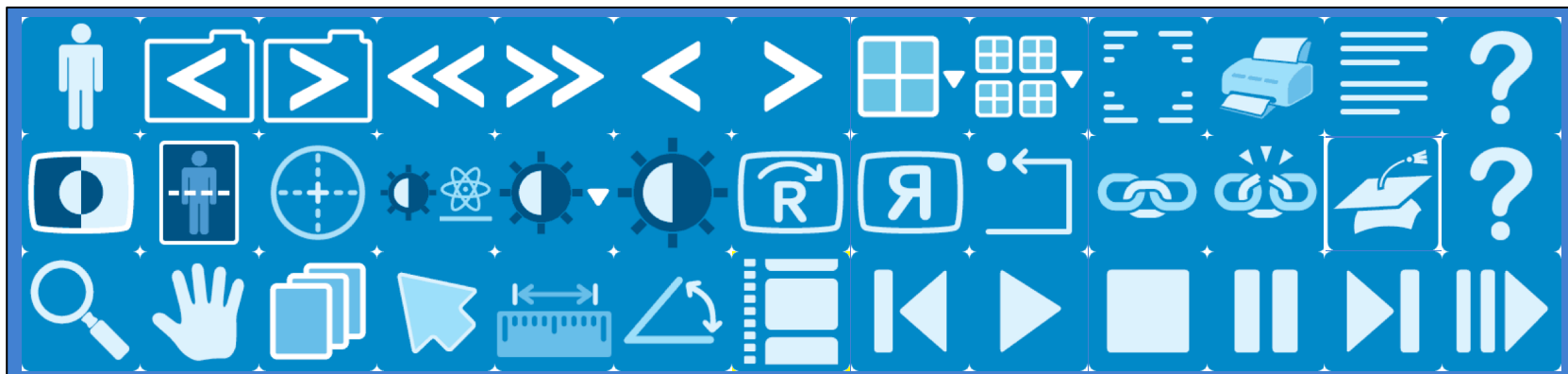
More CD lessons – IHE IRWF

- Vast numbers of CDs are "imported"
  - into PACS or VNA – for time limited or long term use
  - for any registered patient bringing media
  - for clinical viewing, priors for comparison, etc.
  - goal: same user experience as if locally acquired
- Format issues solved by DICOM & PDI
- Import Reconciliation Workflow (IRWF)
  - scheduled or unscheduled (expected, ad hoc)
  - reconcile identifiers (MRN, accession), codes
  - any DICOM content, images, "evidence documents"
  - does not address import of non-DICOM reports

Network Sharing – Payload

- A complete set of DICOM images
  - satisfies the required quality standard
  - allows for all import/read/analysis use cases
- Modality -> Archive/Server: DICOM
- Inter-provider transfer: DICOM
  - point-to-point (push, i.e., VDT "transmit")
  - via 3rd party (patient) (e.g., VDT "download")
- View: any suitable format for the task
  - DICOM for demanding tasks (??diagnostic)
  - JPEG/PNG/GIF for simpler tasks (??review)

Network Sharing – Protocol

- Who cares, as long as it works?
  - standards not always needed when tightly coupled
- Different protocols may be required for
  - View
  - Download
  - Transmit
- Selection depends on actors involved
  - EHR performs VDT versus delegating to PACS/VNA
- Selection depends on relationship & distance
  - Inside facility v. to partner v. to stranger

Protocol – Transmit (Push)

- DICOM original TCP/IP C-STORE
  - all Modality -> XXX transfers; wrapped photos, paper, video
  - fine inside firewall or secure network
  - fine for push beyond enterprise too (if other end listening)
- DICOM STOW-RS (new)
  - HTTP POST of DICOM images
- IHE XDR-I (no XDS-I manifest) ?XDM ?DIRECT
- Sender and receiver need to agree on standard(s)
- Initiated by whom? Performed by whom?
- Addressing – where to send it
  - discovery/lookup of appropriate addresses for protocol

Protocol – Download (Pull)

- DICOM original TCP/IP C-GET or C-MOVE
  - fine inside firewall or secure network
  - C-GET fine for pull from beyond enterprise too
- DICOM WADO-URI, WADO-WS or WADO-RS
  - HTTP GET of DICOM or image rendered as JPEG
  - separately obtain meta data from pixel data
  - single or multiple images
- IHE XDS-I
  - registry, repository (manifest), imaging document source
- Proprietary – tightly coupled client/server
  - web browser JavaScript "save as file" like function
- "Download As …" – DICOM, JPEG, whatever

Protocol – View (Pull) – I

- Depends entirely on viewer technology & paradigm
- Who provides the viewer "code"?
- Zero footprint
  - No helper apps, plugins, applets, Flash or SilverLight
  - Not even any JavaScript ????
- Absolute zero – HTML pre-5, frames, tables, images
- Almost zero – JavaScript +/- HTML5 Canvas
- Pretending to be zero – Flash (etc.) dependency
- Not zero at all – just fine for many deployments
- Thick client spawned by browser (or EHR "app")
- "Web-based" PACS & "remote" viewers since 1990s

Protocol – View (Pull) – II

- Tightly-coupled client-server (browser-server)
  - web-based, including but not limited to, variants of zero
  - server has images (or is proxy for getting them)
  - no standard "protocol" needed
  - e.g., JavaScript can HTTP GET anything
  - "server-side rendering" (even 3D or advanced visualization)
  - no standard "payload" needed
  - e.g., JavaScript can process anything, including DICOM
  - JPEG/PNG/GIF may be used, esp. if no interactivity needed
- If viewer server decoupled from image source
  - choose a standard HTTP-based protocol (e.g., WADO-URI)
  - "universal" "clinical" viewers – image source independent?

Protocol – View (Pull) – III

- Separation of requestor from performer
  - EHR/PHR/etc. user requests viewing of study
  - PACS/VNA/etc. actually performs it
- EHR vendors do NOT want to store images
- Very common proprietary pattern
  - e.g., encrypted URLs – identify, authorize, time-limited
  - n:m permutations of requestor/performer to customize
- Storing fully qualified links (URLs) – go stale
- Common identifiers, dates, etc. more reliable
- IHE Invoke Image Display (IID) profile (new)
  - standard display request – now only n+m permutations

IHE Invoke Image Display

- A minimalist means of image-enabling non-image-aware systems

- Uses simplest available HTTP-based request

- Supports patient and study level invocation

- Usable with or without a priori knowledge of individual study identifiers

- Requires servers to provide at request of the user

  - interactive viewing

  - review or diagnostic quality

  - key images only

- Independent of how/where server gets/stores the images

- Any mutually agreed HTTP security mechanism

Mobile Device Considerations

- Relatively limited memory/CPU/network bandwidth
- Assuming that mobile devices are used only for low quality use cases is not valid – e.g., are now some FDA-cleared mobile "apps"
- RESTful versus SOAP for protocol
- JSON versus XML for meta data
- Not all browsers HTML5/Canvas yet
- New crop of MHD standards mirroring XDS
- Payload: DICOM v. JPEG v. proprietary
- Protocol: DICOM v. WADO v. proprietary
- Viewing environment and display quality (FDA)
- One day all viewing will be on mobile devices?
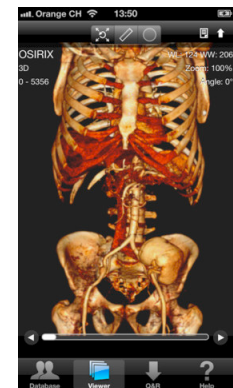
Architecture

- ## Push "architecture"
  - easy, tempting
  - duplication (stored many places)
  - change management (wrong patient, side marker, etc.)

- ## Pull "architecture"
  - federated/distributed queries v. centralized registries
  - centralized image storage v. expose locally at edges
  - links go stale, enterprises go out of business, etc.

- ## "Brokered" "hybrid" "clearing house"
  - intermediary holds images transiently (possible encrypted)
  - sender pushes, then recipient notified and pulls
  - analogous to DropBox file sharing service, Filelink email

Other Considerations - I

- Business model and sustainability issues
  - insurmountable for some architectures?
- Learn from global experience
  - Canada (DI-r) … regional repositories
  - UK (IEP) … point-to-point push -> brokered -> centralized
- Report in scope or not?
  - format (rendered, structured, both, text, PDF, DICOM, CDA)
  - just another document
  - shared identifiers … fetch separately
  - convenience of packaging with images
  - duplication if redundant pathways
  - what about amendments (report often, images not so much)

Other Considerations - II

- "Security" – authentication, authorization, SSO, trust
  - not image-specific … leverage EHR … SSO and delegation
- Identifiers – scaling beyond single site or enterprise
  - reconcile/match/map MRN, accession numbers, etc.
  - scalability across enterprises – similar to any other record
  - qualify all encoded identifiers by issuer
  - IHE – XCA & XCA-I; MIMA; PIX, PDQ, PAM (MPI access)
- Lossy image compression – before, after or during
  - Diagnostically Acceptable Irreversible Compression (DAIC)
- Practical issues related to fringes of standards
  - standard codes, new features, education, cooperation

Conclusion

- Probably don't need entirely "new" standards
  - for payload or for protocol
- Do need
  - improved use of existing standards
  - improvements to existing standards
  - convergence on useful subset of standards (?)
  - agility to adapt to rapidly changing technology (mobile)
  - more seamless transition from local to remote experience
- Proprietary solutions OK for functional requirements
  - when no "interoperability" boundary exists to justify standard
- Keep it simple and leverage the installed base