The
Medicine
Behind the
Image

DICOM
Media Management

David A. Clunie
Princeton Radiology Pharmaceutical Research

RadPharm

Outline

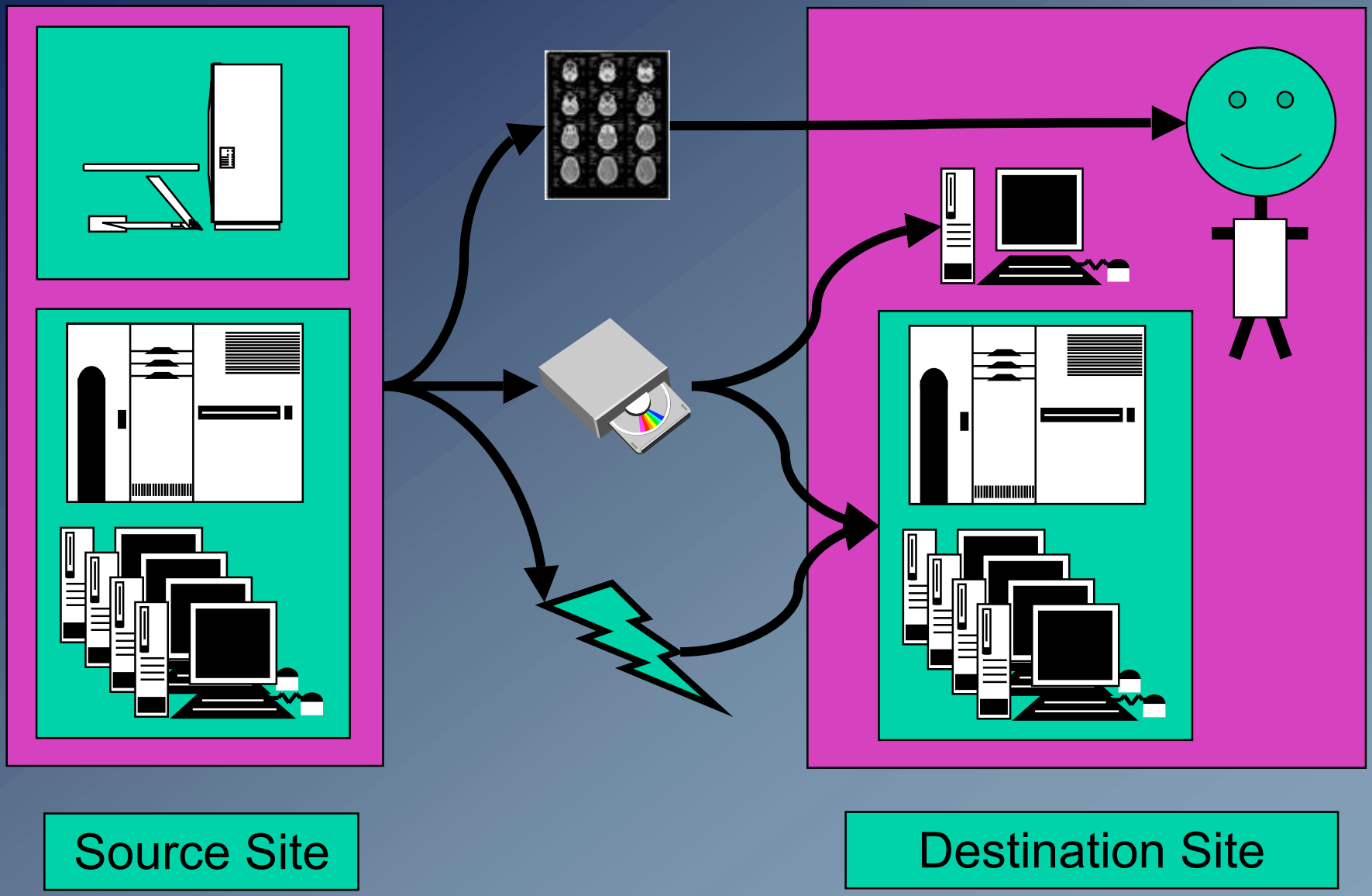
- Transport of images between sites
- Obstacles to the use of CD to replace film
- Media importation workflow issues
- Media creation workflow issues
- Higher capacity media - DVD
- Other media types - RAM-based media

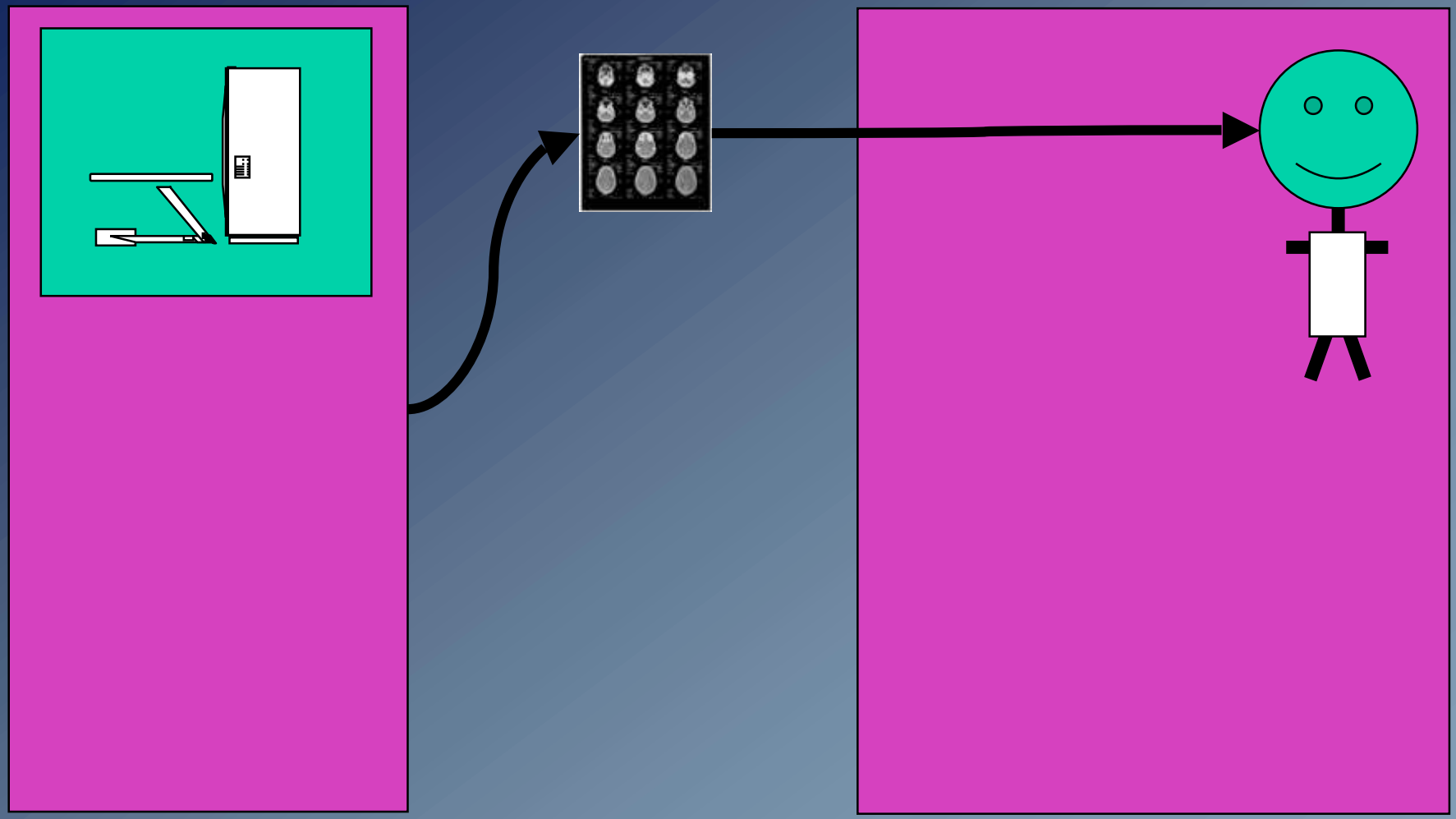
Primary Use Case

- Images of patient made at source site
  - Hospital
  - Imaging center
  - Doctor's office
- Need to be used by staff at Site B
  - Referring doctor who ordered exam
  - Doctor to whom patient has been referred
  - Specialist hospital (tertiary referral center)
  - Interventional facility

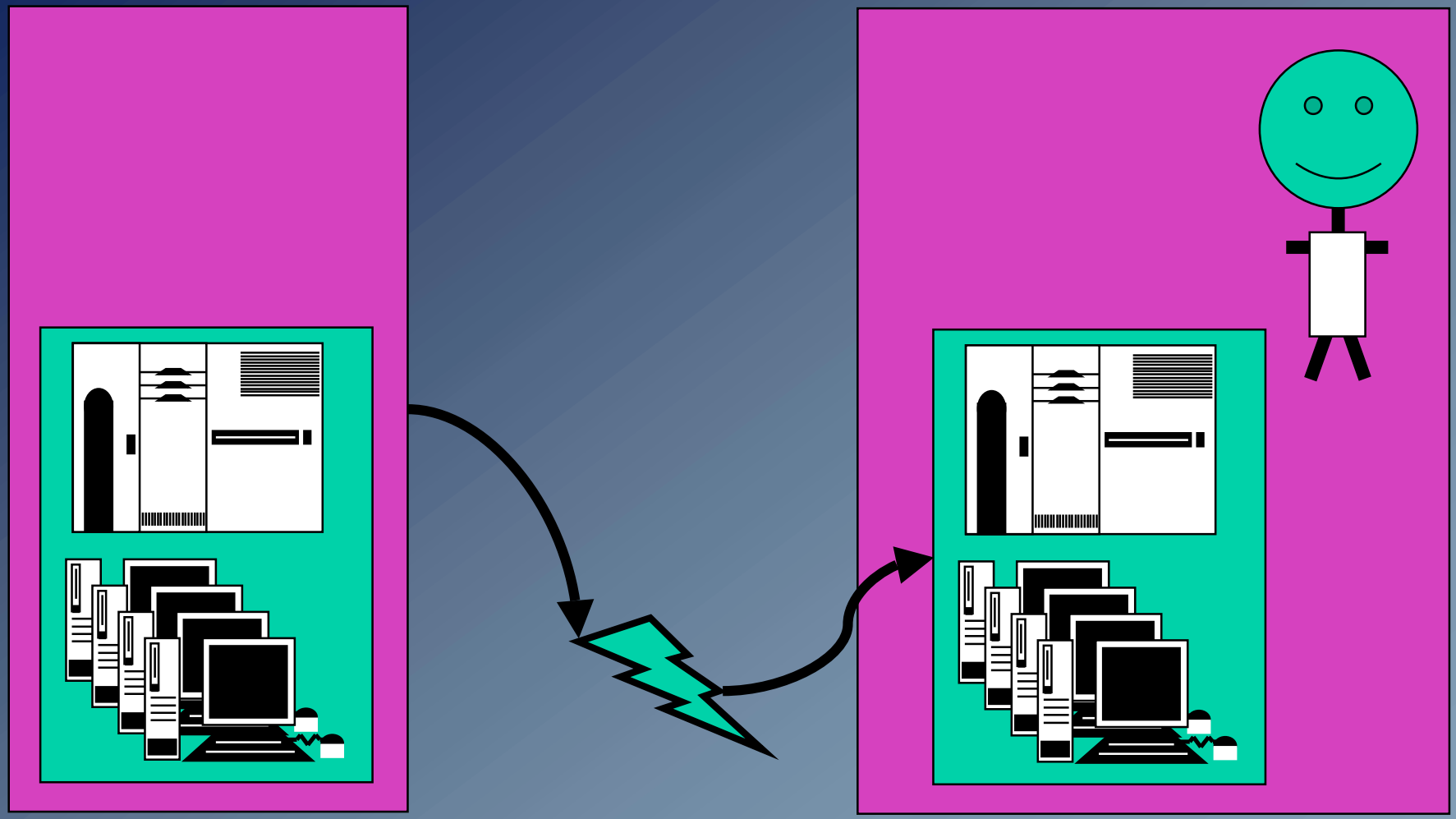
Three possibilities

- Film
  - Traditional, cost-effective, familiar
  - Undesirable if film-less source or destination
- Network between sites
  - Sufficient (affordable) bandwidth
  - Available communication infrastructure
  - Security infrastructure
- Interchange media
  - Carried by patient
  - Sent in advance of patient by courier

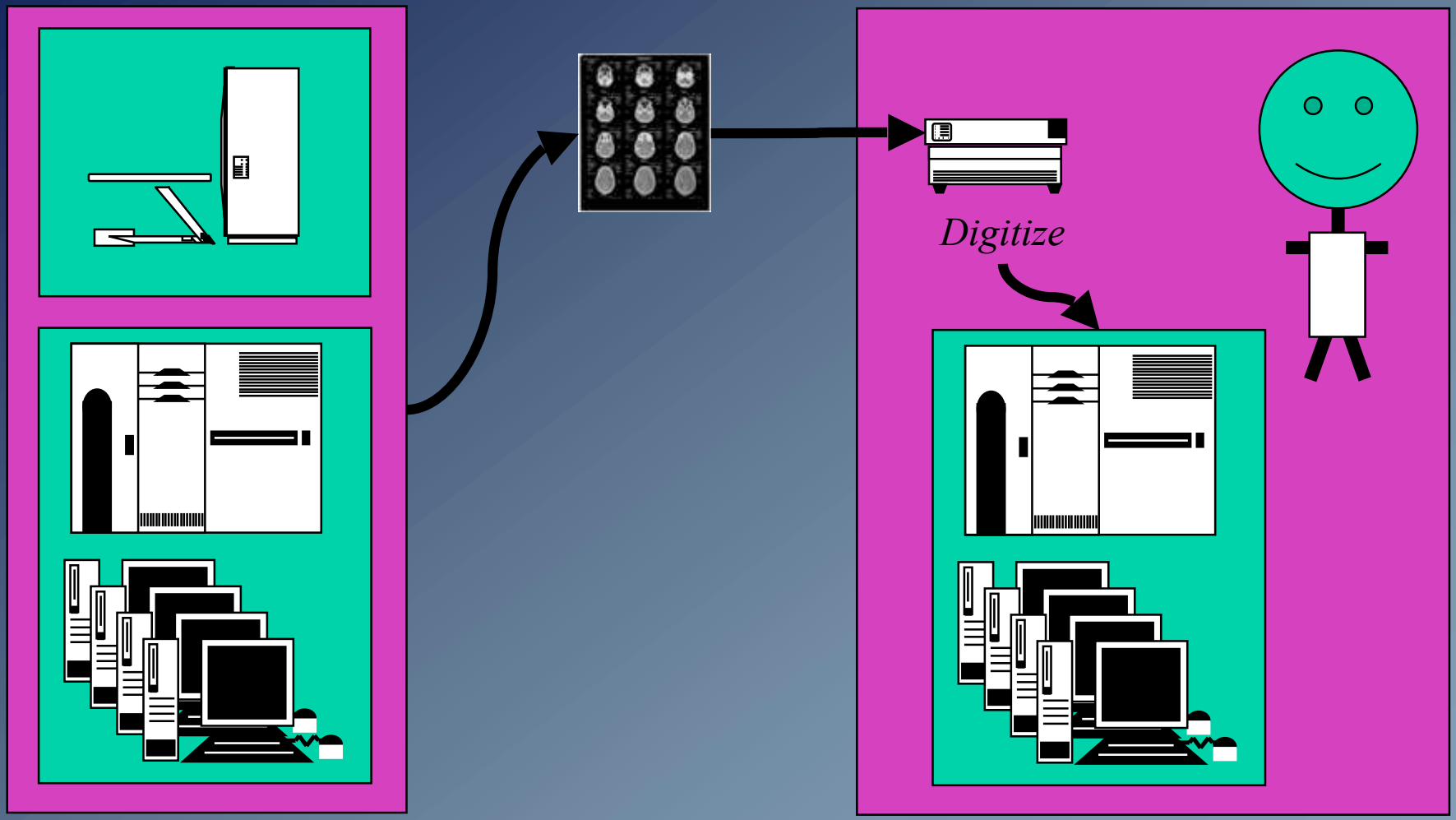

Source Site
Destination Site



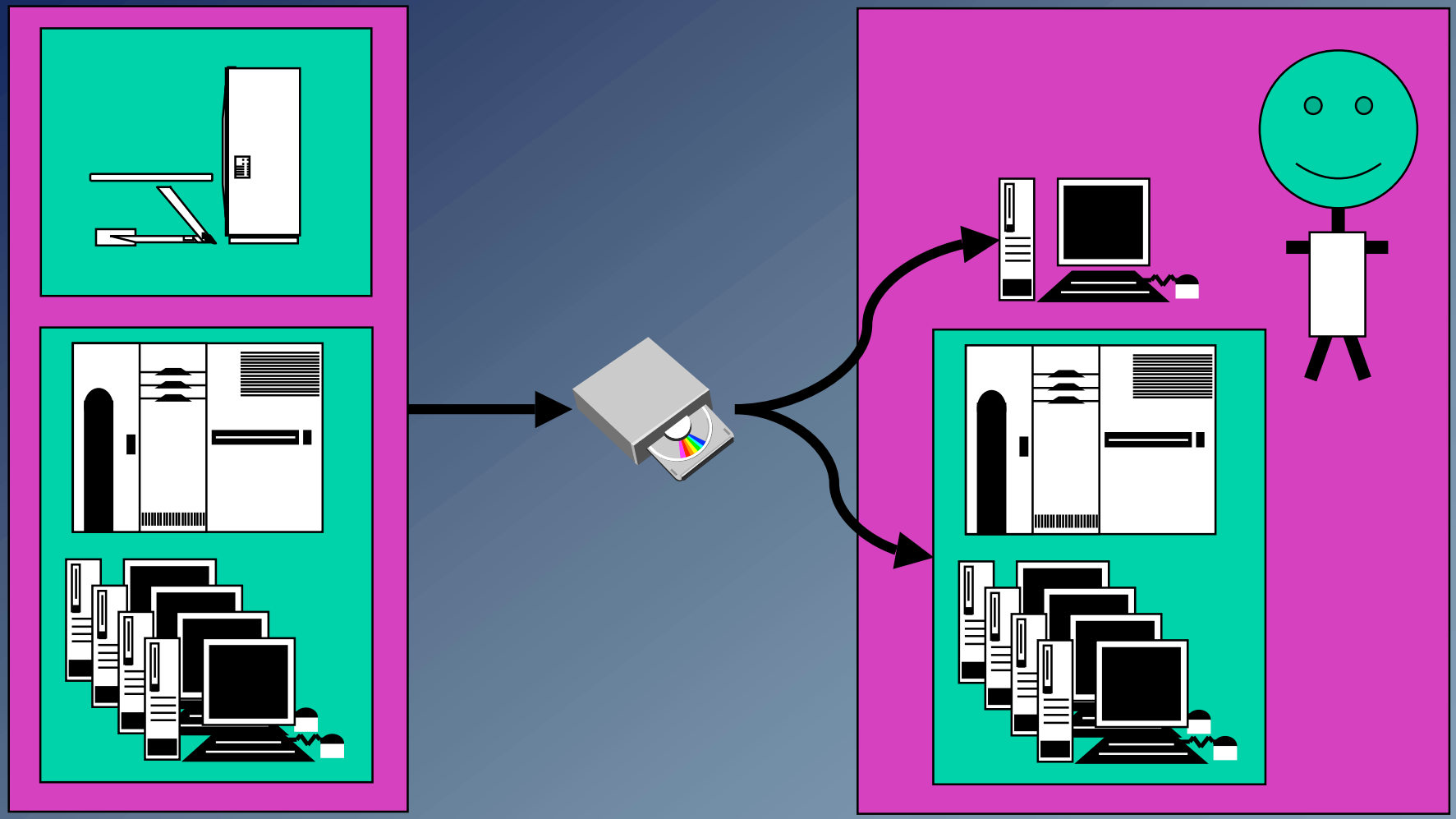
State of the Art: No PACS,all referrals using film



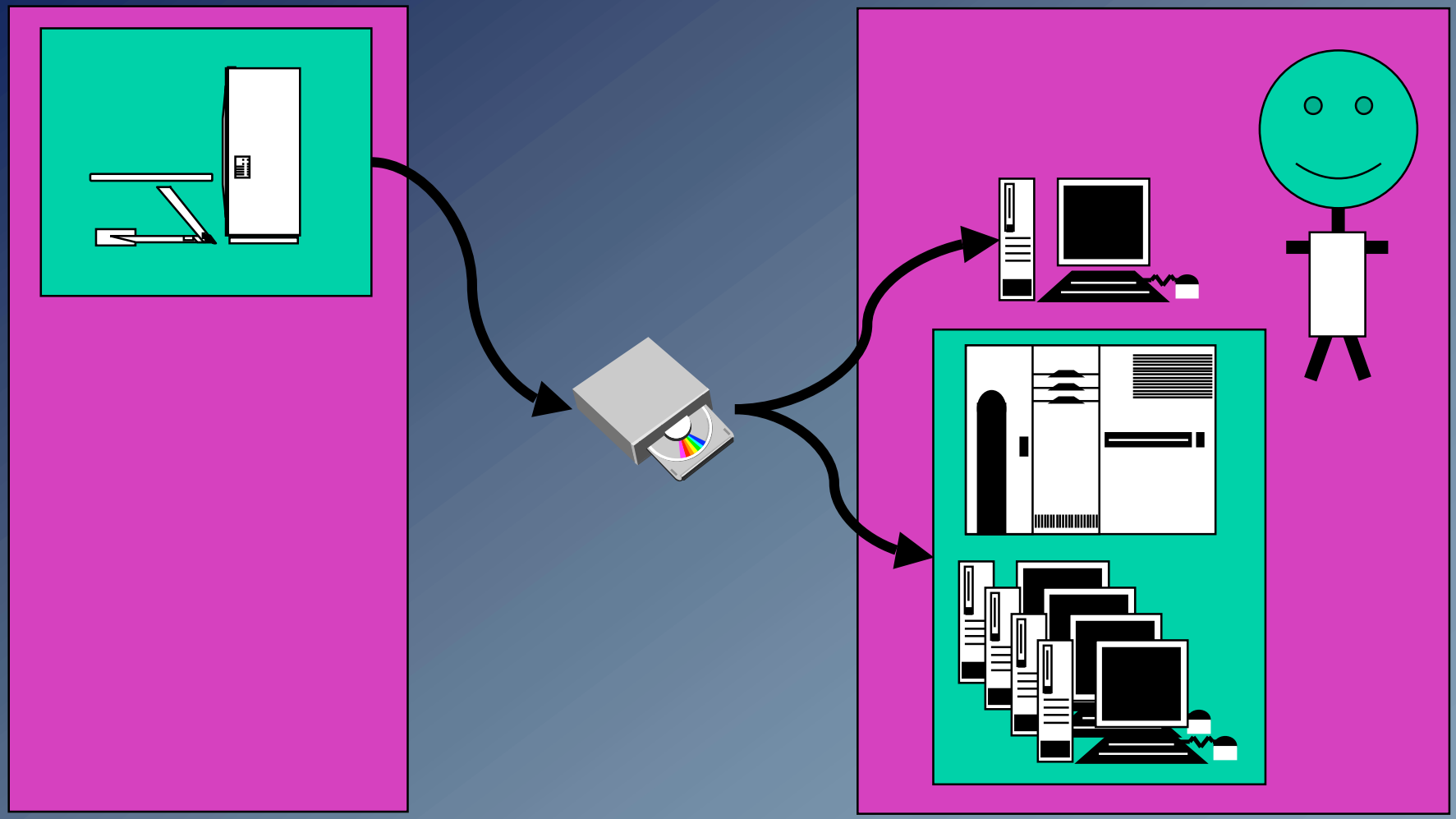
Ideal World: All PACS Connected, shared patient identifiers



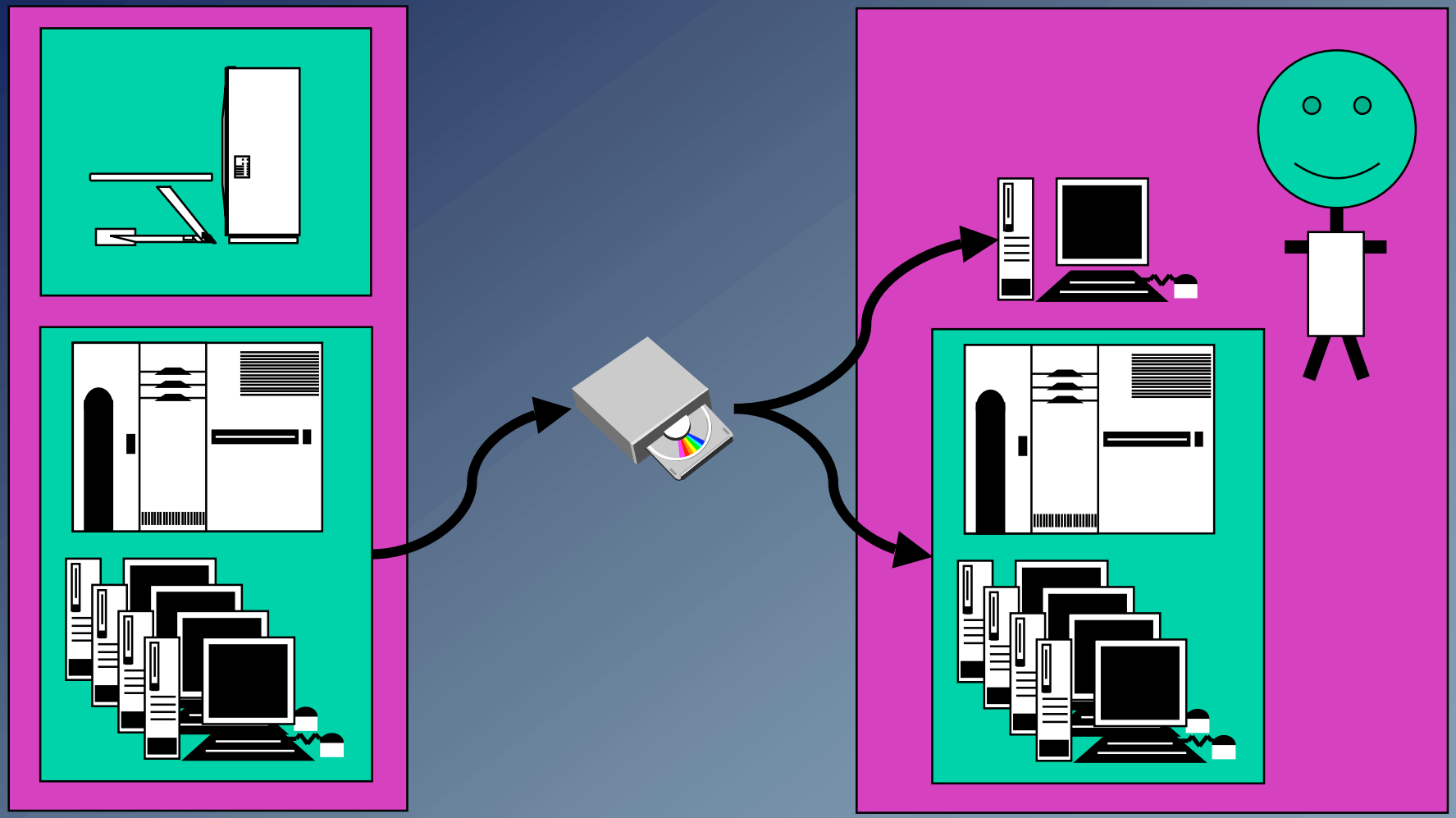
An ugly compromise for PACS destination sites: digitize film



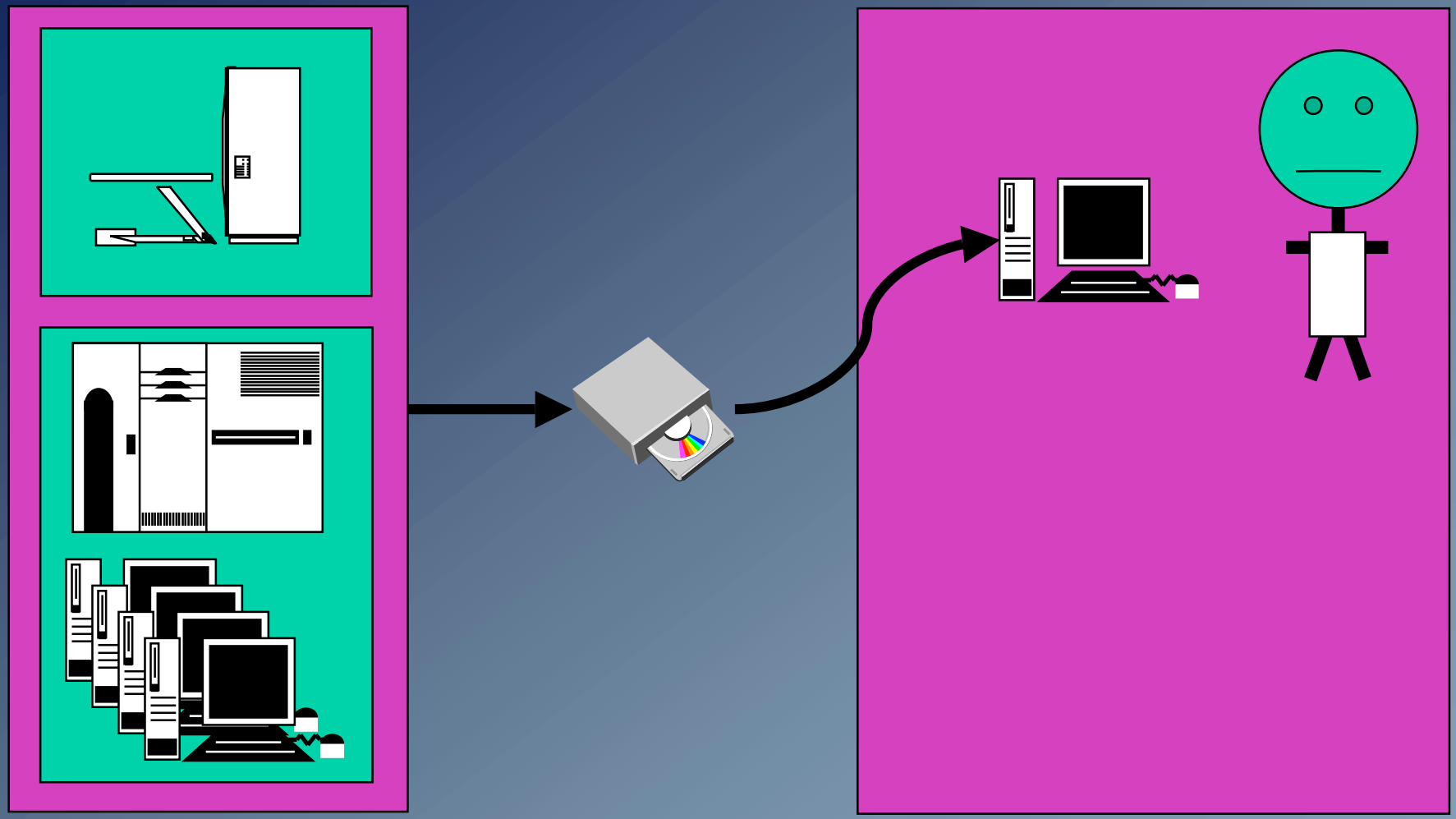
A realistic compromise: Standard Interchange Media



Modality -> Media -> PC Viewer or PACS Import



PACS -> Media -> PC Viewer or PACS Import



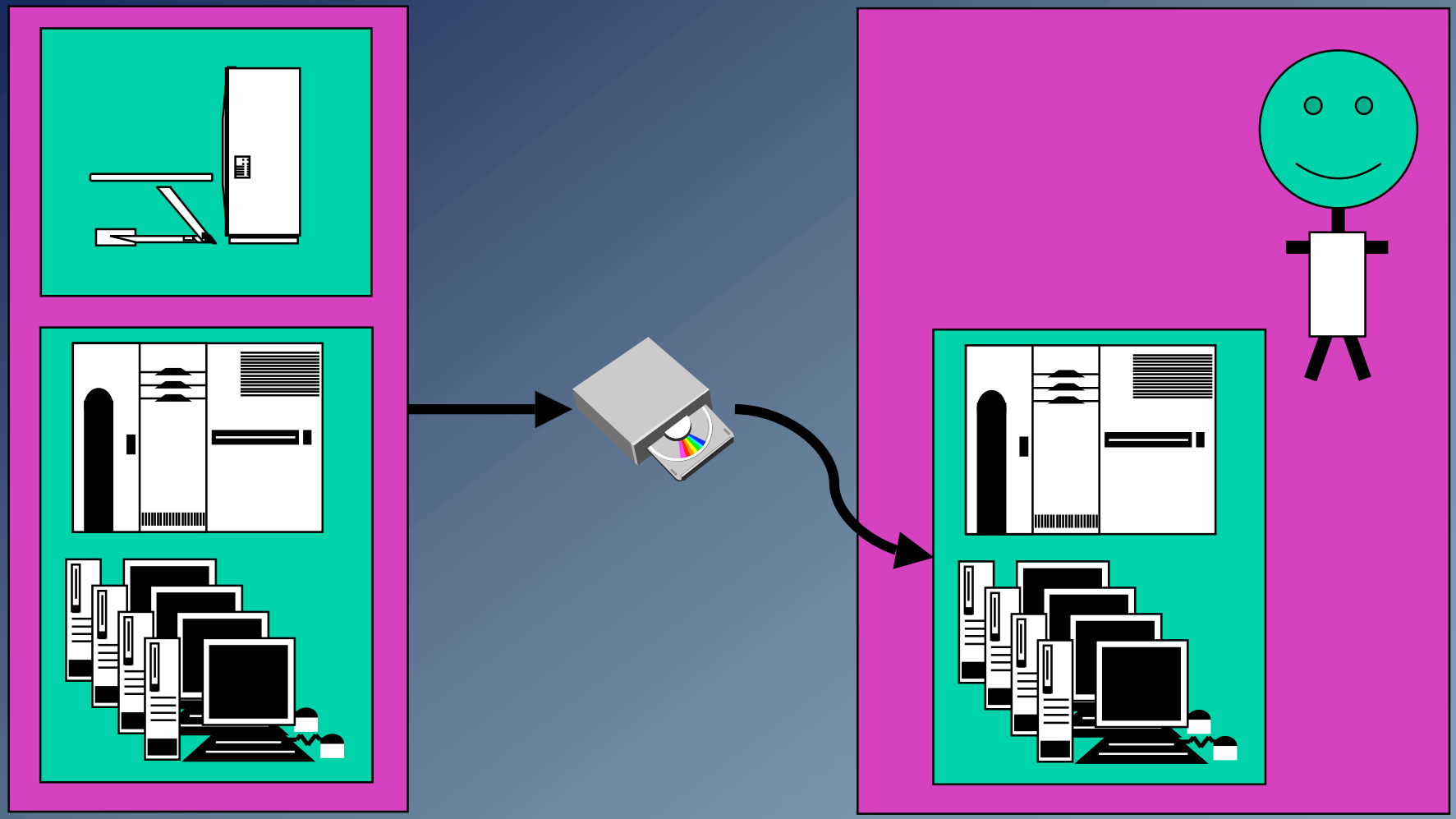
Is the Standalone PC Viewer a solution ?

Standalone PC Viewer Issues

- CDs burned with Windows auto-run viewer
- Does everyone have a PC ?
  - In the referring doctor's examining room ?
  - In the out-patient clinics ?
- Hospital IT security policy ?
  - Should IT allow any CD to be loaded on a PC ?
  - Risk of viruses - how many clinic PCs virus-safe ?
- Interference with running applications
  - Auto-run may need to be disabled

Standalone PC Viewer Issues

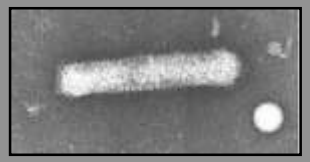
- Quality, training and ease of use for viewers
  - How many viewers does one need to learn ?
- Long-term access requirements
  - Need images to become part of legal record
  - Follow-up visits
  - Use during treatment (RT, surgery, etc.)
  - Need for distributed access
    - Internal referrals
    - Clinical conferences
    - Tumor boards

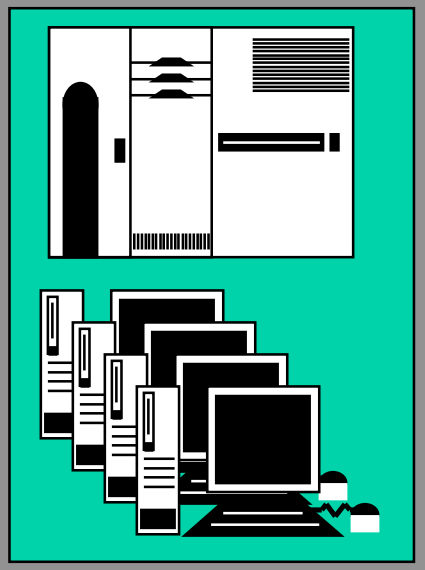


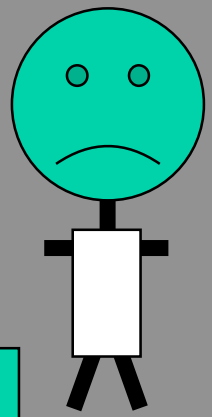
The best solution: Import standard media into the PACS

DICOM

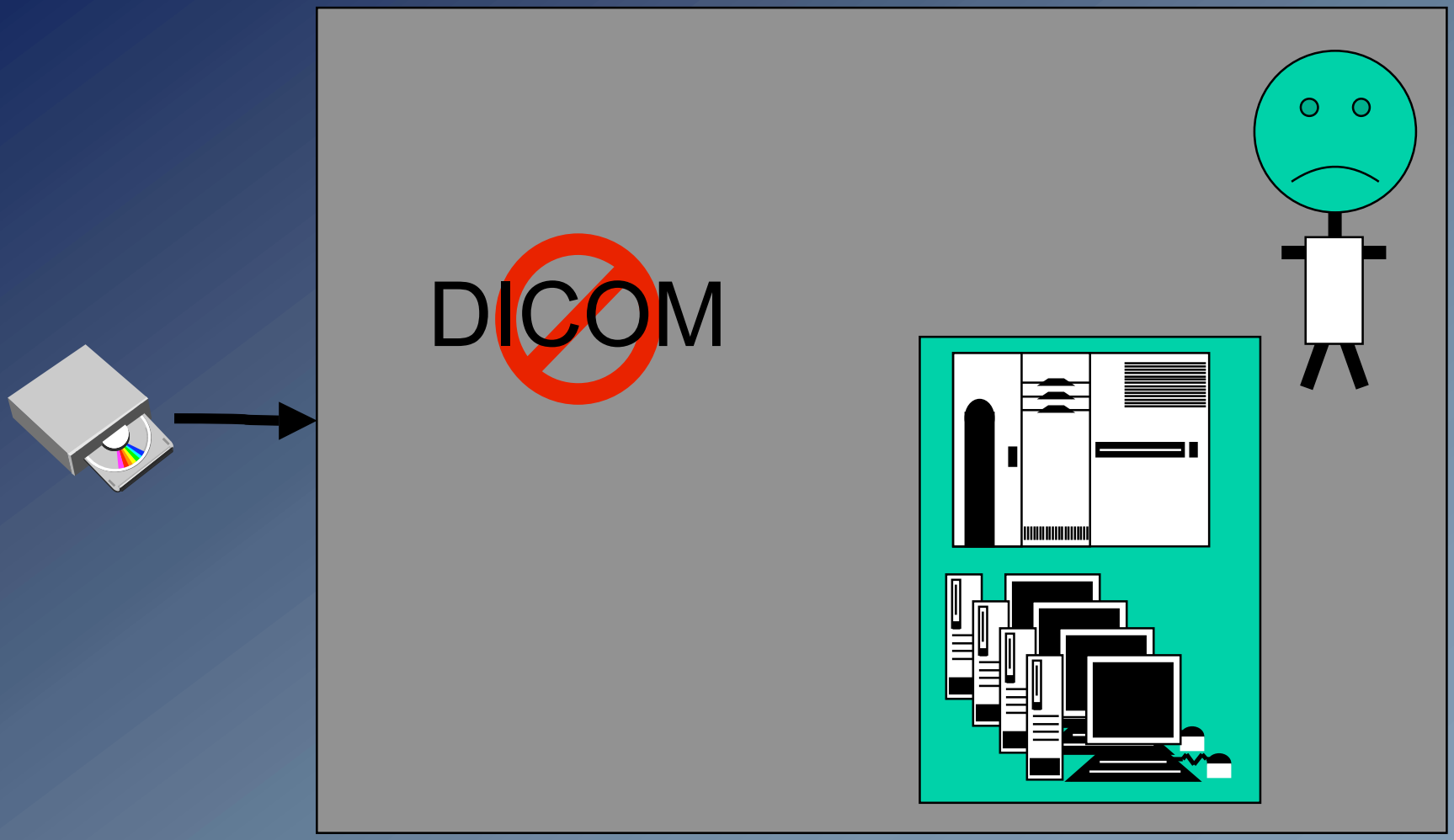
1234 Smith^Mary
--->
9876 Mary Smith







Barriers to PACS import: format, ID reconciliation, viruses



Barriers to PACS import: DICOM compliance issues

Issues with Import: Format

- General Purpose CD-R media profile
- Filesystem generally not a problem
  - Standard: ISO 9660 Level 1, but readers tolerant
- Image files are generally written properly
  - Rarely missing Part 10 meta information header
  - Rarely in wrong transfer syntax (e.g. not explicit)
- Filenames frequently illegal
  - Standard says 8 chars, capitals, no extension
  - Frequent errors - too long, with .dcm extension

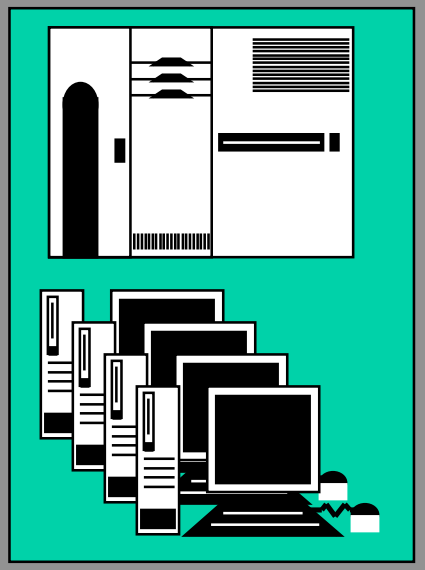
Issues with Import: Format

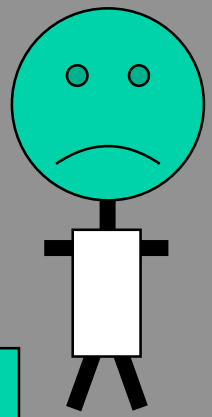
- DICOMDIR errors especially prevalent
  - Long filenames -> illegal DICOMDIR entries
  - CS VR of file name components
    - 16 characters
    - no periods
  - Missing required attributes
    - E.g. Referenced Transfer Syntax UID
  - Violation of identifier attribute types
    - DICOMDIR requires Type 1 Patient ID, Type 2 in image

Issues with Import: Format

- Media creators (writers):
  - Should do better & comply with standard
  - Absolutely no excuse for poor quality software
  - Absolutely no legitimate reason for deliberate violations (such as file naming)
- Media importers (readers):
  - Should be more tolerant
  - Huge installed base of non-compliant creators
  - Few errors have any impact on data integrity
  - Most problems just annoyances to workaround

1234 Smith^Mary
--->
9876 Mary Smith





Barriers to PACS import: ID reconciliation & import workflow

ID Reconciliation & Workflow

- There is no universal patient identifier
  - Even in the US, SSN not used or not reliable
- Outside scheme almost always different
  - Another hospital uses own local ID scheme
  - Community imaging centers: no scheme at all
- No consistent patient naming
  - Conventions differ: “Smith^Mary”,”Mary Smith”
  - Typographic errors: “Smith^Mry”
- Other identifiers, like DOB, may be absent

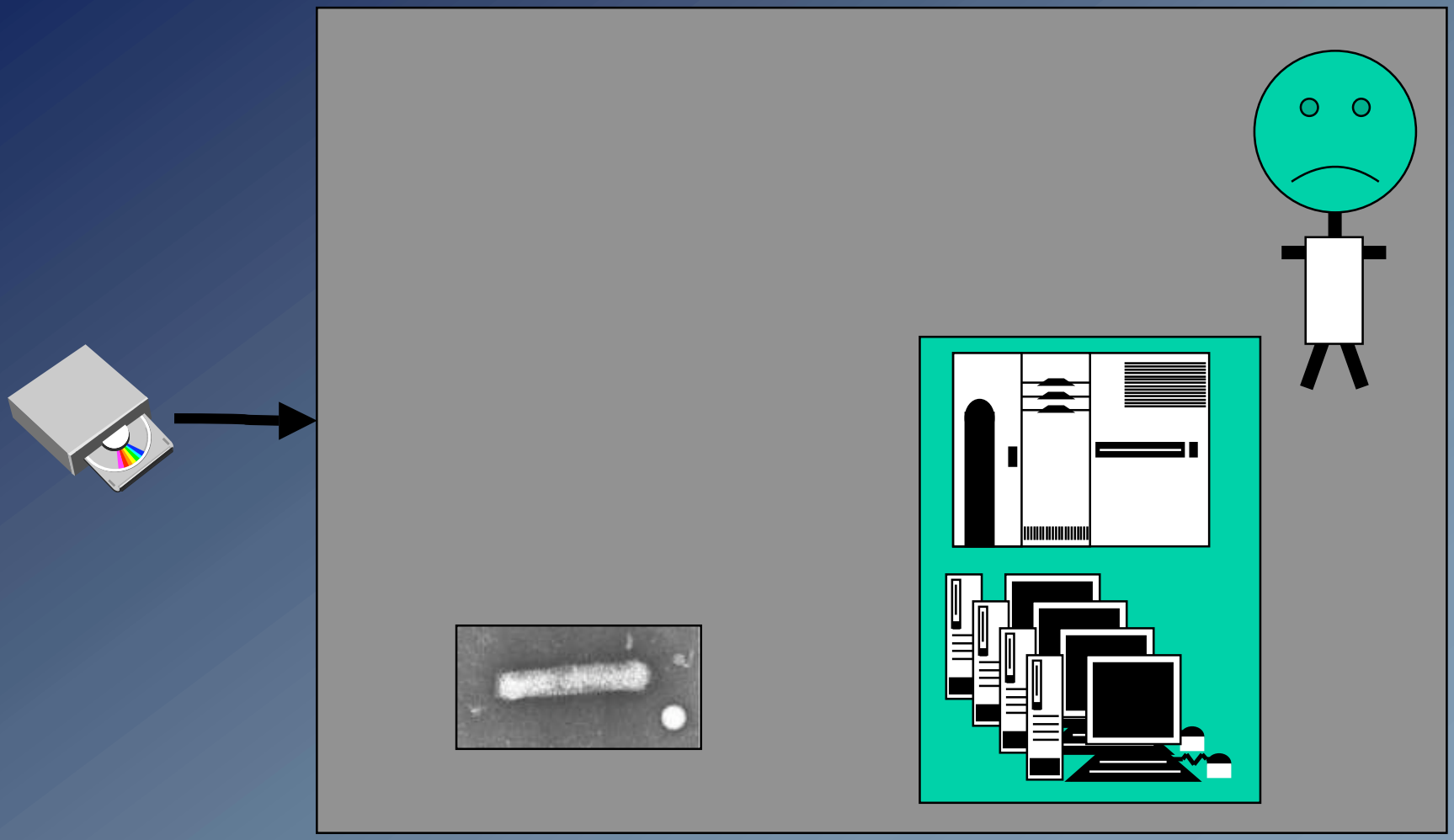
ID Reconciliation & Workflow

- Why are IDs so important ?

- Without proper ID, imported images “lost”
  - Can’t expect doctor to hunt through all possible
  - Failure of subsequent scheduling, routing, billing
- Can’t allow foreign IDs into system
  - Naïve import would use whatever present on CD
  - Potential for conflict with real local IDs

ID Reconciliation & Workflow

- Simple header editing
  - Manually edit DICOM ID attributes
  - Poor usability, risk of error, better than nothing
- Route into “lost” or “problem” pool
  - Poor workflow
  - Different staff responsible for reconciling
- Specific “Media Importation Workflow”
  - Manual, semi-automated or automated reconciliation
  - Scheduling of import (with an order and a work list)
  - Assignment to destination (clinic, physician, etc.)



Barriers to PACS import: Risk of exposure to viruses

Risk of Exposure to Viruses

- Windows PCs in PACS create risk
  - Most common target for viruses
  - Viruses can spread on media, though nowadays more common on network or via email
  - Auto-run executables would be greatest threat
- Impractical to depend on source sites
  - No control over where media comes from
  - Pre-qualifying sites impractical

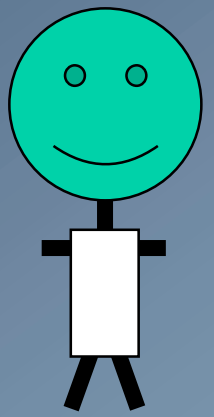
Risk of Exposure to Viruses

- Extreme solution: forbid media importation
- Use non-Windows platform for import station
- Isolate import station
  - Router should prevent anything except DICOM traffic
  - Prevent file sharing, tftp, smtp, web access, etc.
- Restrict permissions of import station user
  - No executable installation, etc.
- Disable auto-run capability (registry setting)
- Disable exploring media (application interface only)
- Automatic, frequent virus scanning with updates

Risk of Exposure to Viruses

- Same risk exists on physician's desktop
- Hence forbidding PACS import in favor of using PCs in the clinic makes little sense
- Admittedly, IT may have greater control over their "own" PCs, as opposed to those in a vendor's turn-key PACS

Media Import Summary



- Creators must do much better
  - They have no legitimate excuse
  - Simply poor quality
- PACS must support dedicated import feature
  - Must tolerate non-compliant media
  - Workflow that supports import
  - Perform identifier reconciliation and coercion
- Not something the DICOM standard can fix
- Perhaps an IHE profile is needed ?

So what is DICOM doing ?

Media Creation Management

- Use-case is “print to media” from workstation
- Images transferred normally
- New service handles
  - Request (what images, what profile, label, etc)
  - Status
- Media creating device (SCP)
  - Compresses images (if necessary)
  - Builds DICOMDIR
  - Burns media

Higher Capacity Media

- Not for archive but for interchange
- Large studies won’t fit on CD
- DVD additions (Supplement 80, June 2003)
  - Anything a DVD-ROM drive can (should) read
  - DVD-R,-RW,+R,+RW
  - Mandatory compression support for readers
  - JPEG or JPEG 2000, lossless and lossy

RAM Media

- Use-case is primarily for transfer to PDAs
- Includes
  - Compact FLASH and similar
  - USB memory
- Not likely to be useful for inter-institutional interchange
  - Individual pieces of media are too expensive