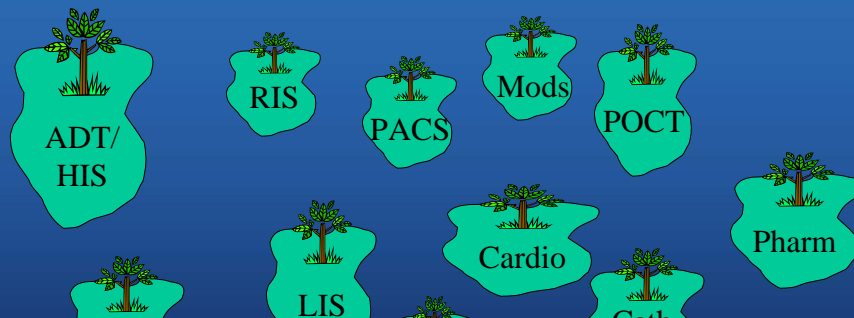


PACS/RIS/HIS Integration using HL7, DICOM and IHE

최승욱
(주)인피니트테크놀로지

What's the Problem?



*Islands of data across the healthcare
enterprise*

What's the Problem?

- Many Semi-autonomous Imaging and Information Systems
 - Incompatible data types and workflows
 - Expensive and difficult to integrate
- No Big-Bang Solution
 - Large investment in current systems
 - Complexity and special functions of individual systems
 - No one vendor does it all
- No Master Plan
 - No documented industry consensus for implementing standards to interface systems

What are the Consequences?

- Unpalatable Alternatives:
 - Many expensive and slow integration processes
 - --Or--
 - Systems connected only by human links
 - Slow transfer of information
 - Introduction of errors in information
- Ultimate Consequences:
 - Delays in treatment
 - Increased cost
 - Incomplete information for decision-making
 - Inefficient use of staff and equipment
 - Diminished quality of care

→ Information System Interoperability and Integration are essential and mandatory.

PACS/RIS/HIS Integration

- Information that should be integrated among PACS/RIS/HIS are:
 - Patient Information
 - Admit/Discharge/Transfer Patient
 - Change Patient Information
 - Merge Patients
 - Order Information
 - New Order, Cancel Order, Change Order
 - Report Information
 - Report ...
 - Others
 - Patient's History
 - Lab Results, ECG Results, Pathology Results
 - ...

How can we integrate them?

- Using Non-standard method
 - File Sharing
 - Database Gateway
- Using Standard method
 - HL7
 - DICOM
 - Other Standards

Standards are Essential . . .

- Provide the building blocks for interoperability
- Establish a common vocabulary for addressing integration issues
- Promote a culture of communication and cooperation in industry
- Achieve and document consensus on key points of connectivity between systems
- Raise expectations of users regarding interoperability of systems

. . . but not Sufficient

- Multiple standards and domains
- Overlap and redundancy = Conflict
 - Domain boundaries unclear
 - Different information models
- Standards are broad and abstract
 - Ambiguities and options
 - Room for interpretation in implementation

. . . not Sufficient

- Gaps between standards writing and implementation in systems
 - No coordinated implementation process
 - Limited tools for testing
 - Limited language for describing implementation/compliance
 - Limited guarantee of interoperability between compliant systems at the point of implementation

Standard Integration Methods

- Patient Information Integration
 - HL7 ADT Messages
 - DICOM Patient Management
- Order/Study Information Integration
 - HL7 ORM Messages
 - DICOM Study Management
 - DICOM Worklist Management
- Report Information Integration
 - HL7 ORU Messages
 - DICOM SR

Which standard should we use?

- Is there any guideline to integrate PACS and information systems?

→ IHE (Integrating the Healthcare Enterprise) provides a guideline to implement standard.

What is the IHE Solution?

- Coordinated implementation of standards for communication between systems to
 - Optimize data and workflow for clinical processes
 - Enable all useful sharing of patient information
- Tools and testing process for implementers to use in adopting standards-based solutions
- Communication tools for users and vendors to discuss and specify integration capabilities

How is IHE related to Standards?

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- Profiles are packaging
- IHE attacks real world integration problems
- HL7 and DICOM provide dictionaries
- IHE defines a “phrasebook” that solves real world problems by assembling pieces provided by DICOM/HL7

What is IHE?

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- A joint initiative to improve systems integration:
 - Process for coordinated adoption of standards
 - Clinicians define **needs for solutions**
 - Vendors develop solutions → **Technical Framework**
 - HIMSS/RSNA supervise documentation, testing and demonstration/promotion

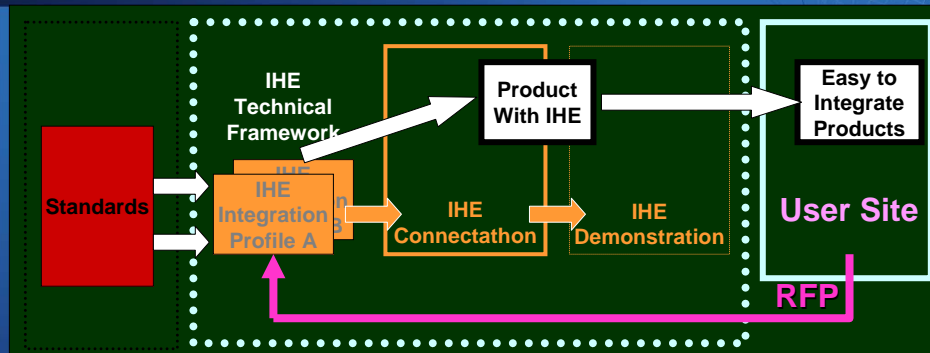
What are the Goals of IHE?

- Speed up the rate and quality of integration in healthcare environments
- Foster communication among vendors
- Prove that integration is attainable based on standards
- Improve the efficiency and effectiveness of clinical practice

What IHE is NOT!

- NOT a standards development organization
 - Uses established standards (HL7, DICOM, others) to address specific clinical needs
 - Activity complementary to SDOs
- NOT simply a demonstration project
 - Demos have been one means to the end—adoption
 - Key elements are documentation, tools, testing, and publication of information

A Proven Standards Adoption Process



- IHE Integration Profiles:
 - Detailed selection of standards and options each solving a specific integration problem
 - A growing set of effective provider/vendor agreed solutions
 - Vendors can implement with ROI
 - Providers can deploy with stability

IHE Key Concepts

- Generalized Systems → Actors
- Interactions between Actors → Transactions
- Problem/Solution Scenarios → Integration Profiles
- For each Integration Profile:
 - the context is described (which real-world problem)
 - the actors are defined (what systems are involved)
 - the transactions are defined (what must they do)

IHE Technical Approach

- Identify a coherent set of transactions required to integrate a specific information flow between several information systems/devices
- For each transaction, select a single standard (e.g. HL7 messages, RFC) for use in implementing the transaction
- Specify in detail the use of the standard in implementing the transaction

IHE Integration Profiles

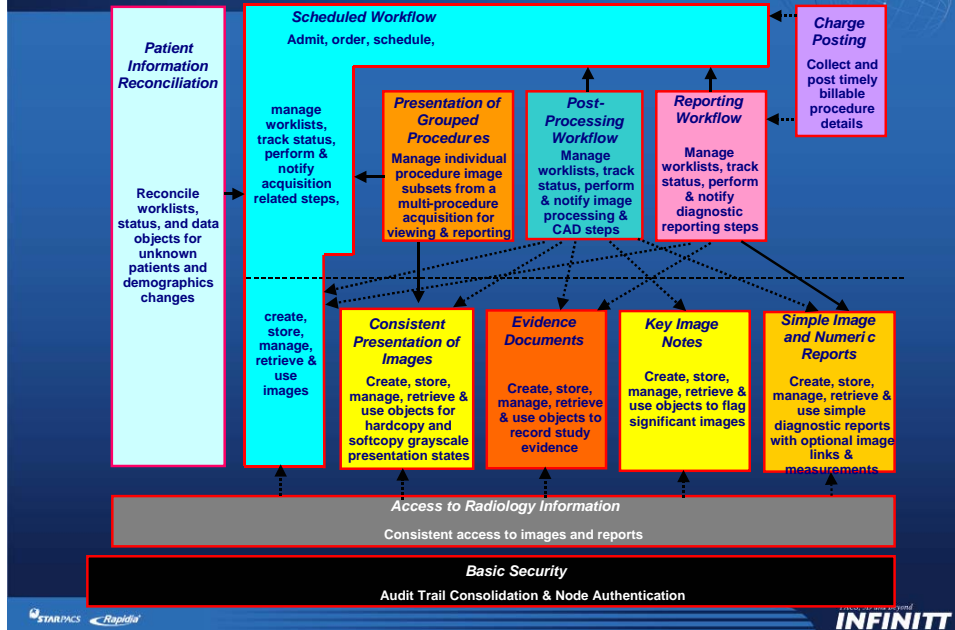
- Effective way to deal with info communication
 - Easy-to-understand, coherent set of transactions between systems to address a specific workflow problem.
 - Vendors can claim conformance to IHE Integration Profiles in their products
 - Users can include reference to IHE Integration Profiles in their product RFPs

→ IHE brings standards to the market

IHE Radiology Integration Profiles



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Which Integration Profile should we use?

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- To integrate PACS, RIS and HIS
 - SWF (Scheduled Workflow)
 - PIR (Patient Information Reconciliation)
 - SINR (Simple Image and Numeric Report)
 - CHG (Charge Posting)

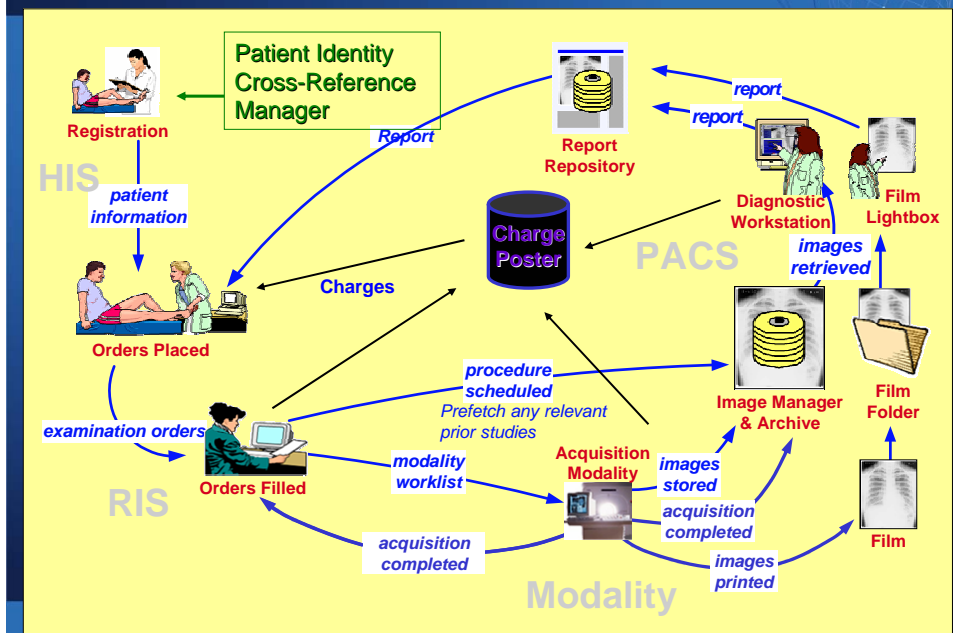


Real-world Problem 1

- Before the Technologist performs the acquisition, how do I make sure the correct info is used ?
 - Paper based workflow with data re-entry
 - Risk of error AND Inefficient
 - Stale information
 - Changes between time of print and time of data entry
 - Cancel orders, Generic Order / Order Changes
- After the Technologist completes acquisition, how do I let all systems know ?
 - When are things ready to be read (PACS)
 - When can things be deleted (Modality)
 - How do I know what to bill (RIS)
 - When do I wake up the referring physician

→ The Solution is ...

Scheduled Workflow



Scheduled Workflow

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- HL7 Transactions
 - Patient Registration [1]
 - HL7 ADT^A01 , ADT^A04, ADT^A05, ADT^A11, ADT^A38
 - Placer Order Management [2]
 - HL7 ORM^O01
 - Filler Order Management [3]
 - HL7 ORM^O01
 - Procedure Scheduled [4]
 - HL7 ORM^O01
 - ...

Scheduled Workflow

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- DICOM Transactions
 - Modality Worklist Provided [5]
 - DICOM Modality Worklist Management
 - Modality Procedure Step In Progress/Completed [6/7]
 - DICOM Modality Performed Procedure Step Management
 - Modality Images Stored [8]
 - DICOM Storage Service
 - Storage Commitment [10]
 - DICOM Storage Commitment Service
 - Images Availability Query [11]
 - DICOM Query Service
 - Retrieve Images [16]
 - DICOM Retrieve Service
 - ...

Example HL7 Messages

27

- ADT^A04

```
MSH|^~\&|MESA_ADT|XYZ_ADMITTING|MESA_IS|XYZ_HOSPITAL|||ADT^A04|101102|
P|2.3.1|||||
EVN||200004211000|||200004210950
PID||583020^^^ADT1||WHITE^CHARLES||19980704|M||AI|7616 STANFORD
AVE^^ST. LOUIS^MO^63130|||||20981701|||||
PV1||E|||||5101^NELL^FREDERICK^P^^DR|||||V1002^^^ADT1|||||
|||||200004210950|||||$VISIT_INDICATOR$|
```

- ORM^O01

```
MSH|^~\&|MESA_OF|XYZ_RADIOLOGY|MESA_IM|XYZ_IMAGE_MANAGER|||ORM^O01|101184|P|2.3.1|||||
PID||583020^^^ADT1||WHITE^CHARLES||19980704|M||AI|7616 STANFORD AVE^^ST.
LOUIS^MO^63130|||||20981701|||||
PV1||E|||||5101^NELL^FREDERICK^P^^DR|||||V1102^^^ADT1|||||20000421
0950|||||
ORC|NW|A101X^MESA_ORDPLC|B101X^MESA_ORDFIL|SC||1^once^^^S||200004210950|^ROSEWOOD^RANDOLPH|
|7101^ESTRADA^JAIME^P^^DR||3145551212|200004210950||922229-10^IHE-RAD^IHE-CODE-231||
OBR|1|A101X^MESA_ORDPLC|B101X^MESA_ORDFIL|P21^Procedure 21^ERL_MESA^X21_A1^SP Action Item
X21_A1^DSS_MESA|||||xxx||Radiology^^^R|7101^ESTRADA^JAIME^P^^DR||MOF5034|RP1037|SPS2042|
||MR||1^once^^^S||WALK|||||A|
ZDS|1.113654.100.101.3^100^Application^DICOM
```

STAR PACS Rapidia

PACS 3D and Beyond
INFINITT

Real-world Problem 2

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- John Doe Trauma Clean-Up
- Recovering After Systems Are Down
- Error in manual entry at modality
- VIP Privacy

→ The Solution is ...

STAR PACS Rapidia

PACS 3D and Beyond
INFINITT

Example HL7 Messages

31

- ADT^A08

```
MSH|^~\&|MESA_OF|XYZ_RADIOLOGY|MESA_IM|XYZ_IMAGE_MANAGER|||ADT^A08|103
132|P|2.3.1|||
EVN||200007011800|||200007011800
PID||583295^^^ADT1||SILVERHEELS^JAY||19000102|M||WH|7324 CLAYTON
RD^^ST. LOUIS^MO^63130|||20983295|||
PV1||E|ED|||1234^WEAVER^TIMOTHY^P^^DR|5101^NELL^FREDERICK^P^^DR|||
|||V1295^^^ADT1|||200007010800|||
```

- ADT^A40

```
MSH|^~\&|MESA_OF|XYZ_RADIOLOGY|MESA_IM|XYZ_IMAGE_MANAGER|||ADT^A40|104
184|P|2.3.1|||
EVN||200008101900|||200008101900
PID||583040^^^ADT1||BLUE^ERICA||18980502|F||BL|15 PRINCETON^^ST.
LOUIS^MO^63130|||20983040|||
MRG|583045^^^ADT1||583045^^^ADT1||DOE^J3
```

Real-world Problem 3

32

- Can you make a report like this?

Institution Identification
Patient Identification

Study Identification
Technique Identification

Discussion

Comparison is made to the prior study of 4/11/99. The left paratracheal lymph node (image 8, image 11) now measures 2.5x2.7x3.1 cm increasing from 2.0x2.1x2.6 previously. No other mediastinal, upper abdominal or axillary adenopathy is identified. No focal pulmonary lesions are seen. The..... are normal

Impression

Worsening L Paratracheal adenopathy

Signature

Simple Image and Numeric Report

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- Based on DICOM SR
- Report content is more than words
- Allows to include without transcription
 - Measurements
 - Image links
 - structured content
- Integrated with the imaging workflow
- Friendly to XML implementations
- Easy to export to the EHR (HL7)

Current Procedure Description: thickness: IV, spacing: 2.500000, kv: 1.250000, ma: 120

Vessel Section Diameters and Area Measurements

Measurement Name:	Section above Renal Arteries
Measurement Abbreviation:	D1
Mean Diameter:	28.829111 Millimeter
Short Axis:	27.314439 Millimeter
Long Axis:	29.661556 Millimeter
Area:	652.791565 Square Millimeter
Best Illustration of finding:	1.2.840.113619.2.80.2161049224.760.1002565988
Best Illustration of finding:	1.2.840.113619.2.80.2161049224.760.1002565988.8
Measurement Name:	Most Inferior Renal Artery
Measurement Abbreviation:	D2a

Simple Image and Numeric Report

34

- HL7 Transactions
 - Structured Report Export [28]
 - HL7 ORU^R01
- DICOM Transactions
 - Report Submission [24]
 - DICOM Storage Service
 - Report Issuing [25]
 - DICOM Storage Service
 - Query Report [26]
 - DICOM Query Service
 - Retrieve Report [27]
 - DICOM Retrieve Service

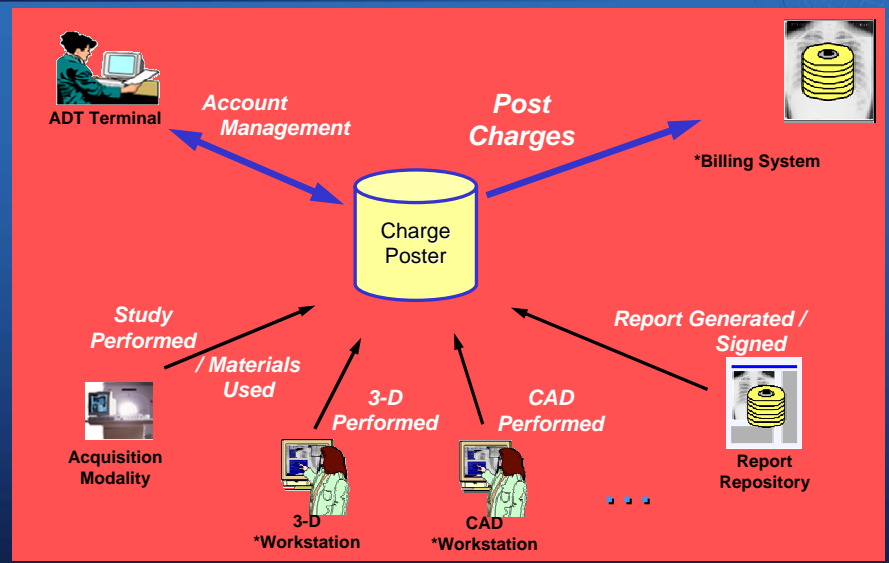
Example HL7 Messages

- ORU^R01

```

MSH|^~\&|MESA_RPT_MGR|EAST_RADIOLOGY|REPOSITORY|XYZ|||ORU^R01|MESA3F
5cb069|P|2.3.1|||||
PID|||CR3^^^ADT1|||CRTHREE^PAUL|||||PatientAcct|||||
OBR|1|A601Z^MESA_ORDPLC|B601Z^MESA_ORDFIL|||20010501141500.0000|||
|||||F|||||
OBX|1|HD|^SR Instance UID||1.113654.1.2001.30.2.1|||||F|||||
OBX|2|TX|^SR Text||History Cough|||||F|||||
OBX|3|TX|^SR Text||Findings PA evaluation of the chest demonstrates
the lungs to be expanded and clear.|||||F|||||
OBX|4|TX|^SR Text||Conclusions Normal PA chest x-ray.|||||F|||||
    
```

Charge Posting



Charge Posting

37

- HL7 Transactions
 - Charge Posted [35]
 - HL7 DFT^P03
 - Account Management [36]
 - HL7 BAR^P01, BAR^P05, BAR^P06

Example HL7 Messages

38

• DFT^P03

```
MSH|^~\&|MESA_OF|XYZ_XYZ_RADIOLOGY|MESA_CHARGE_SYSTEM|XYZ_HOSPITAL|||DFT^P03|130
1126|P|2.3.1|||
EVN||200208121330|||200208121330
PID||C1301^^^ADT1||ALABAMA^MONTGOMERY||19701125|F|WH|1200 GREENWAY^^ST.
LOUIS^MO^63130|||20951301|||
FT1|||20020812|20020812|CG|MR1001^MRI
HEAD^IHEDEMO|||1504^ZIEGLER^WILLIAM^P|7101^ESTRADA^JAIME^P^DR||B1301Z
^MESA_ORDFIL||P1^Procedure 1^ERL_MESA|
PR1|1|P1^Procedure 1^ERL_MESA|200208121210|D|||TC
```

• BAR^P01

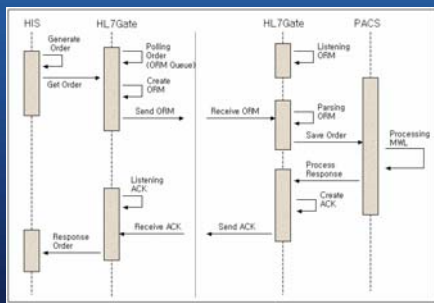
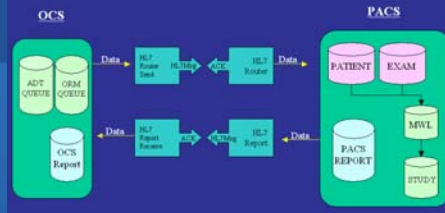
```
MSH|^~\&|MESA_ADT|XYZ_ADMITTING|MESA_IS|XYZ_HOSPITAL|||BAR^P01|1301102|P|2.3.1|
|||
EVN||200208120800|||200208120800
PID||C1301^^^ADT1||ALABAMA^MONTGOMERY||19701125|F|WH|1200 GREENWAY^^ST.
LOUIS^MO^63130|||20951301|||
DG1|1||Unable to complete tasks|A|||
GT1|1|ALABAMA^XAVIER|||
IN1|1|2401^AAA Plan 2401^IHE_DEMO|2400|AAA of Oak
Brook|
```

Integration Examples

- Domestic Sites
 - 경북대병원
 - 인천길병원
 - 원광대병원
 - 아주대병원
- Overseas Sites
 - USA
 - Warren Hospital
 - Waldo County General Hospital
 - Saint Memorial Medical Center
 - Jennie Stuart Medical Center
 - Taiwan
 - Sinlau Hospital

경북대병원

- 규모: 930병상
- 특징
 - OCS->PACS: ADT & ORM
 - PACS->OCS: ORU
 - HL7 LLP 이용
 - OCS 와 PACS 양쪽 모두 HL7Gate 이용



SENDREPLY : 검사상세정보

ESAMPL_KEY	NUMBER	검사번호	
TRIGGER_EVENT	WVCHWC(14)	발령일시	1
REFL_ID_EVENT	WVCHWC(14)	발령일시	2
EXAM_ID	WVCHWC(2)	검사번호	3
검사번호	WVCHWC(2)	검사번호	4
ESAMPL_KEY	WVCHWC(14)	검사번호	5
ESAMPL_KEY	WVCHWC(14)	검사번호	6
PATIENT_ID	WVCHWC(2)	환자번호	7
PATIENT_LOCATION	WVCHWC(2)	환자번호	8
PATIENT_ID_EVENT	WVCHWC(14)	검사번호	9
REQUEST_DATE	WVCHWC(2)	발령일시	10
REQUEST_DATE	WVCHWC(2)	발령일시	11
REQUEST_EVENT	WVCHWC(14)	발령일시	12
REQUEST_EVENT	WVCHWC(14)	발령일시	13
REQUEST_EVENT	WVCHWC(14)	발령일시	14
REQUEST_EVENT	WVCHWC(14)	발령일시	15
REQUEST_EVENT	WVCHWC(14)	발령일시	16
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PERFORM_STATION	WVCHWC(14)	검사번호	18
PERFORM_DEPARTMENT	WVCHWC(2)	검사번호	19
PERFORM_DEPARTMENT	WVCHWC(2)	검사번호	20
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ESAMPL_KEY	WVCHWC(14)	검사번호	24
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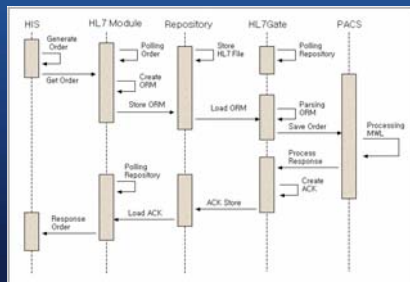
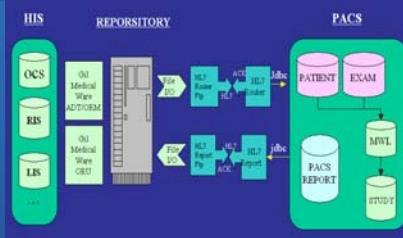
UPPERPRESS : OCS 검사 상세정보

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13. OPERATIONAL	NUMBER(10)	검사번호	6
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93. OPERATIONAL	NUMBER(10)	검사번호	86
94. OPERATIONAL	NUMBER(10)	검사번호	87
95. OPERATIONAL	NUMBER(10)	검사번호	88
96. OPERATIONAL	NUMBER(10)	검사번호	89
97. OPERATIONAL	NUMBER(10)	검사번호	90
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100. OPERATIONAL	NUMBER(10)	검사번호	93
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106. OPERATIONAL	NUMBER(10)	검사번호	99
107. OPERATIONAL	NUMBER(10)	검사번호	100

인천길병원

41

- 규모: 1670병상
- 특징
 - OCS->PACS: HL7 ADT, ORM
 - PACS->OCS: HL7 ORU
 - OCS쪽은 자체 HL7 모듈을 사용
 - HL7 Message File Transfer
 - 기존 MARKCARE PACS를 교체
 - 기존 ADT, ORM, ORU에 대한 Migration (2년치)



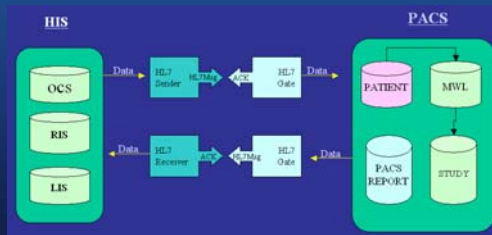
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원광대병원

42

- 규모 : 850병상
- 특징
 - HL7 LLP and Message File Transfer
 - UNIX 서버와의 연동 (비표준 Socket Handshaking)
 - OCS쪽은 자체 HL7Module을 개발하여 사용
 - Study Instance UID / Accession Number등을 PACS에서 생성
 - ORU의 쌍방통신 및 장애처리를 위한 Socket/File base의 병행처리
 - 환자 수술, 상병명 정보 Inbound (ORM/ZDS)
 - Merge 판독 Outbound (ORU/ZWK)

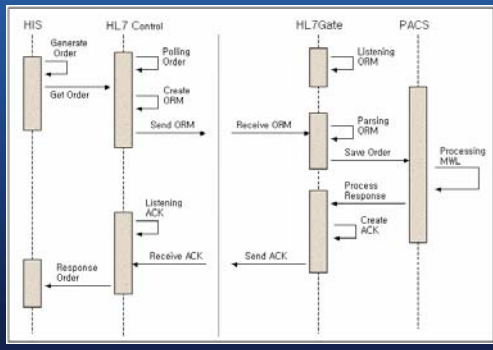


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아주대병원

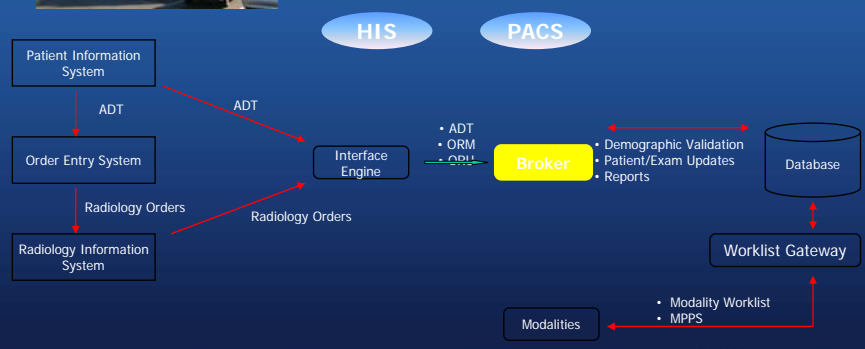
- 규모: 1033병상
- 특징
 - HL7 LLP and Message File Transfer
 - Cache DB에 따른 VB HL7Control 제작
 - Socket/File base의 병행처리
 - Pathology 정보 Inbound (ORM/ZDS 이용)



Warren Hospital



- Size: 200 beds
- Location: New Jersey, USA
- RIS Vendor: Siemens
- Messages: ADT^A08, ORM^O01, ORU^R01

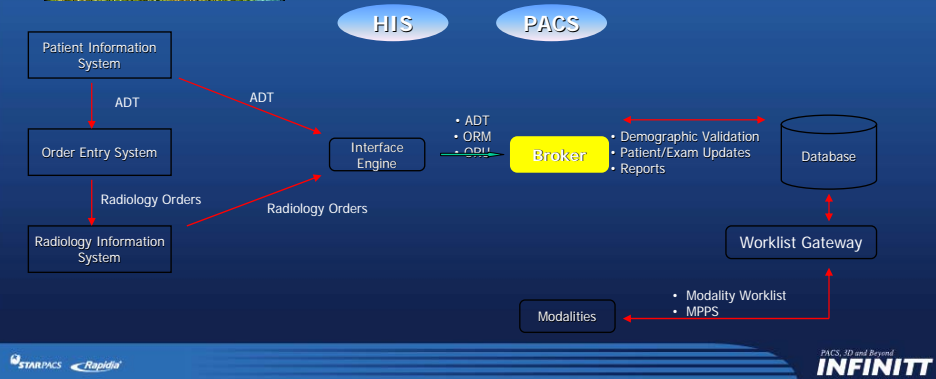


Waldo County General Hospital

45



- Size: 200 beds
- Location: Belfast, 미시간소재
- RIS Vendor: Swearingen
- Messages: ADT^A08, ORM^O01, ORU^R01

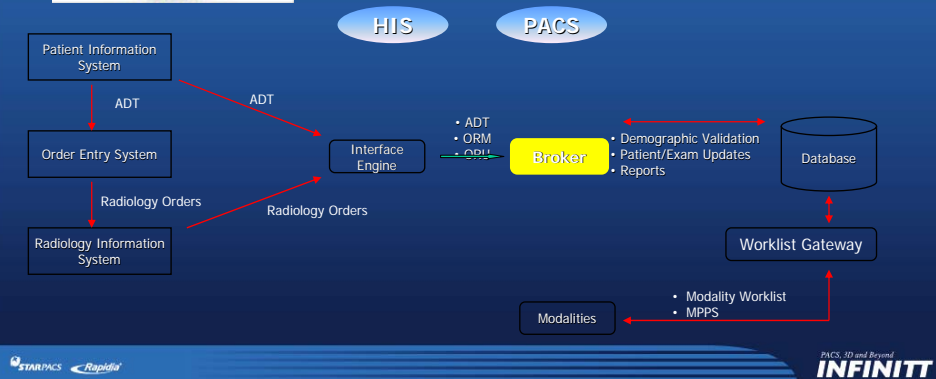


Saint Memorial Medical Center

46



- Size: 400 beds
- Location: Massachusetts, USA
- RIS Vendor: Meditech
- Message: ADT^A08, ORM^O01, ORU^R01

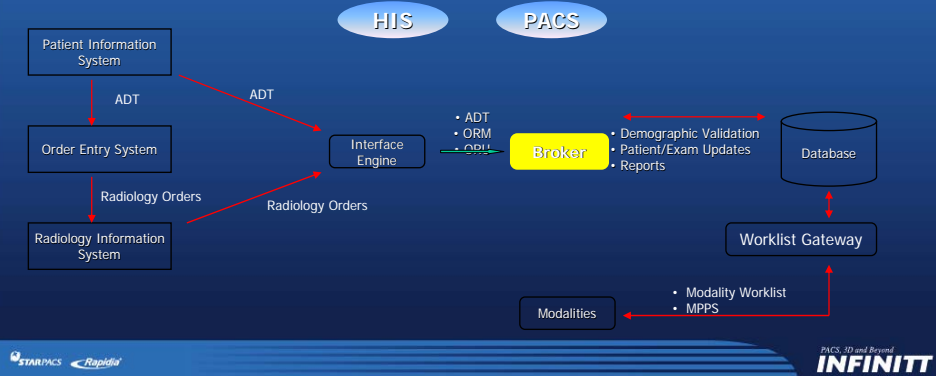


Jennie Stuart Medical Center

47



- Size: 400 beds
- Location: Massachusetts, USA
- RIS Vendor: GE
- Messages: ADT^A08, ORM^O01, ORU^R01

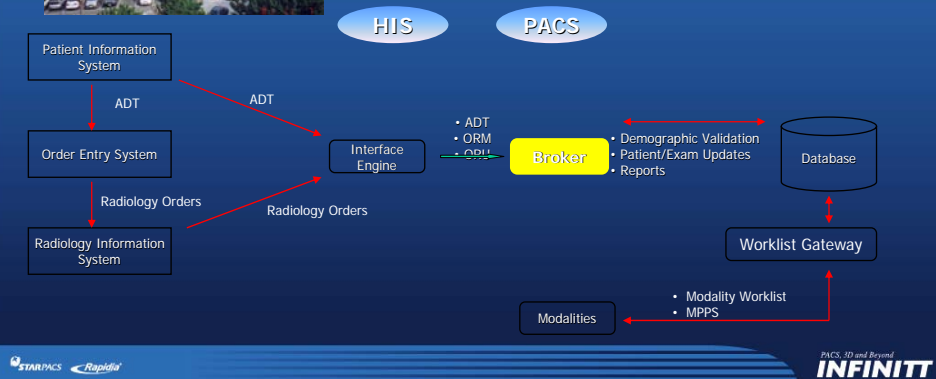


Sinlau Hospital

48



- Size: 800 beds
- Location: Tainan, Taiwan
- RIS Vendor: eXentric
- Messages: ADT^A08, ORM^O01, ORU^R01



Is HL7 a panacea for integration?

- We had a lot of difficulties:
 - Domestic Sites
 - No OCS were based on HL7
 - Not ready to integrate with HL7
 - Few people are interested in HL7
 - Overseas Sites
 - HL7 is already available and ready to integrate, but...
 - Differences in interpretation and implementation
 - Differences in versions and message encoding
 - HL7 Compliant, but **NOT** IHE Compliant
- Compliance to IHE Integration Profile will make it easy to integrate systems.

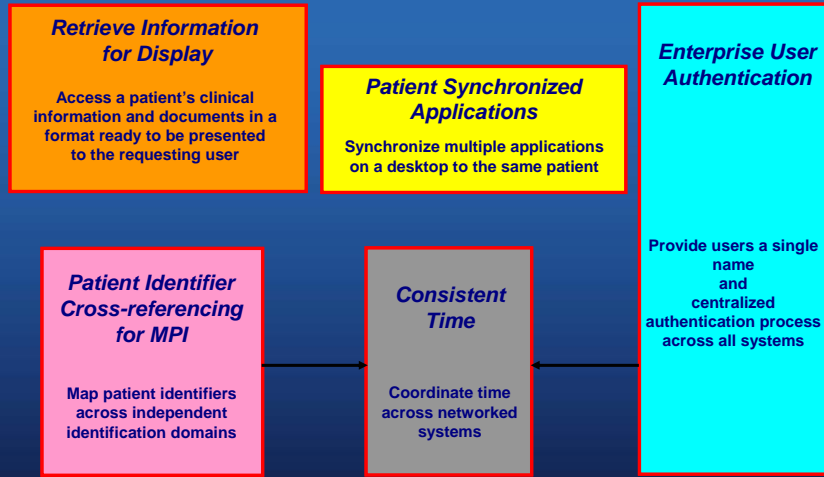
What's next?

- Using IHE Radiology Integration Profiles, we can integrate PACS, RIS and HIS using HL7 and DICOM.
- But it was limited to Patient, Order and Report information.
- What should we do to integrate **OTHER** information?

→ The next step is ...

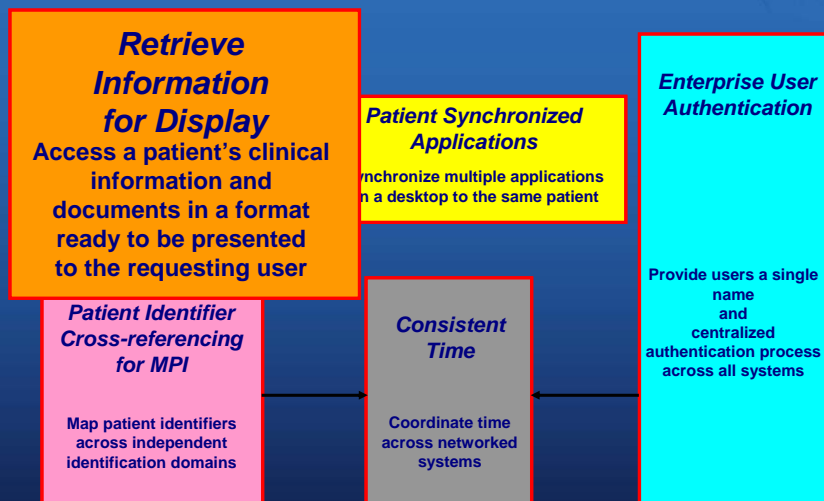
IHE IT-Infrastructure Integration Profiles

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Retrieve Information for Display

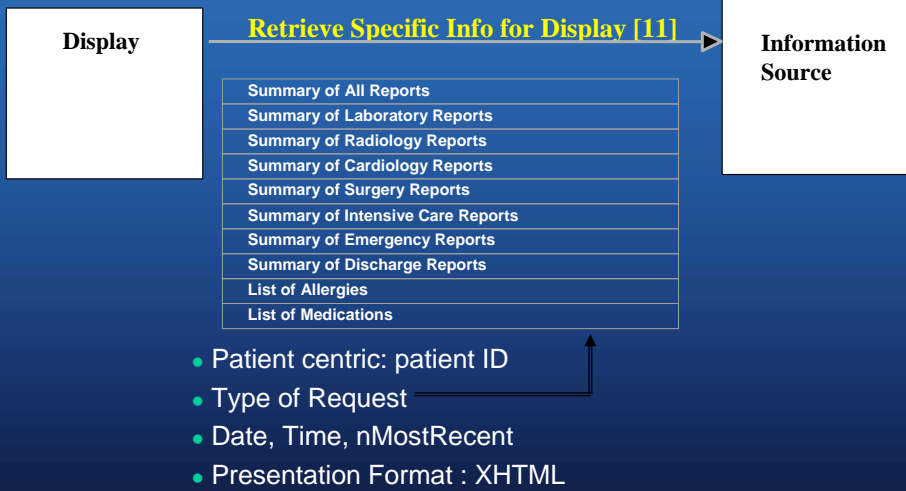
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Retrieve Information for Display

53

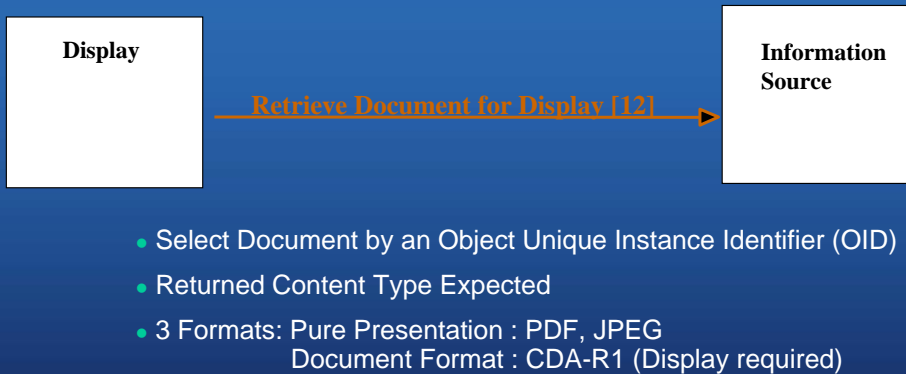
• Transaction Diagram



Retrieve Information for Display

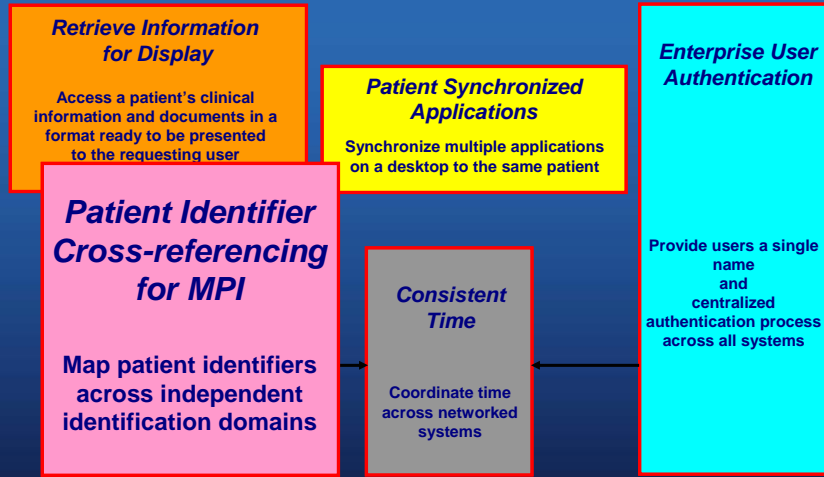
54

• Transaction Diagram



Patient Identifier Cross-referencing

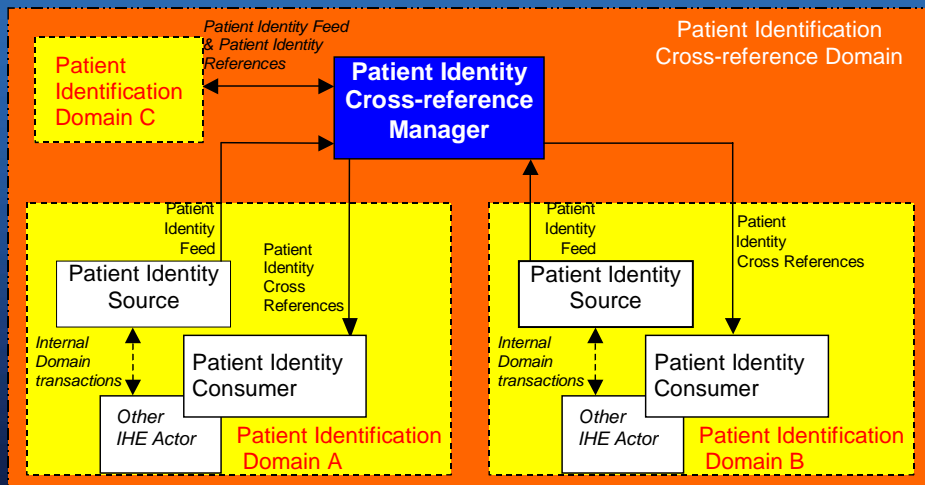
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Patient Identifier Cross-referencing

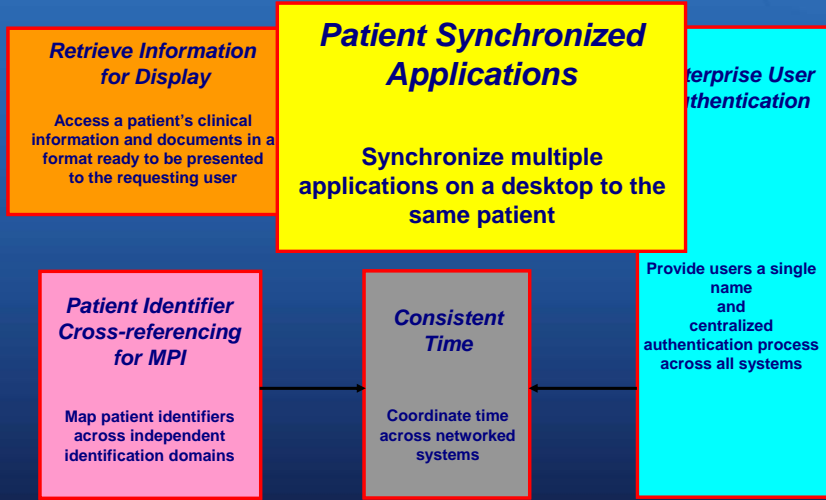
56

- ID Domains and Transactions



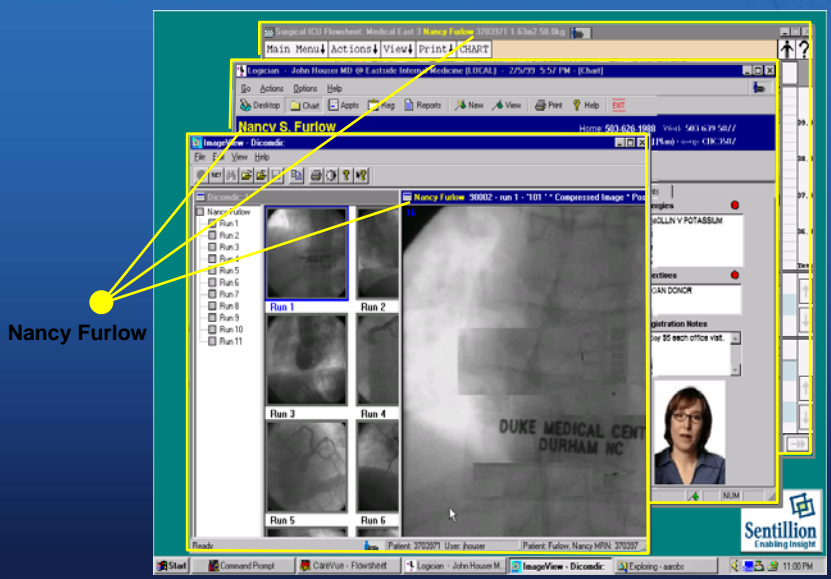
Patient Synchronized Application

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Patient Synchronized Application

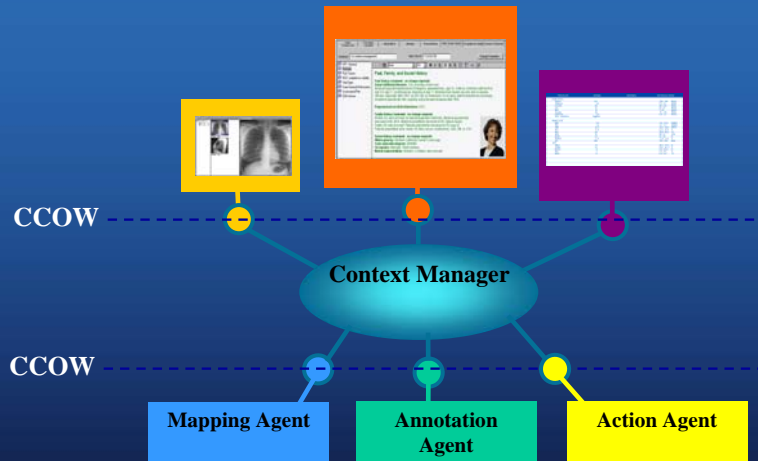
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Patient Synchronized Application

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Disparate Applications / CCOW Interfaces



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References

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- IHE Radiology Technical Framework
 - <http://www.rsna.org/IHE>
- IHE IT-Infrastructure Technical Framework
 - <http://www.himss.org/IHE>
- HL7/IHE Joint Demonstration Web Site
 - <http://hl7ihejointdemo.org>

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Questions

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- Questions?
- E-mail
 - switch@infinit.com